rexroth
A Bosch Company

# Frequency Converter

VFC x615 Series
VFC 3615 / VFC 5615

**Operating Instructions**
**R912009377**

Edition 01



## Record of Revision

| Edition | Release Date | Notes |
|---|---|---|
| DOK-RCON04-VFC-X615***-IT01-EN-P | 2024.04 | First release |

## Version Matching Table

| Firmware | Operating Instructions | Quick Start Guide |
|---|---|---|
| 03V44 | Edition 01 | Edition 02 |

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| D Deutsch | USA English | F Français |
|---|---|---|
| **⚠ WARNUNG Lebensgefahr bei Nichtbeachtung der nachstehenden Sicherheitshinweise!**<br>Nehmen Sie die Produkte erst dann in Betrieb, nachdem Sie die mit dem Produkt gelieferten Unterlagen und Sicherheitshinweise vollständig durchgelesen, verstanden und beachtet haben.<br>Sollten Ihnen keine Unterlagen in Ihrer Landessprache vorliegen, wenden Sie sich an Ihren zuständigen Rexroth-Vertriebspartner.<br>Nur qualifiziertes Personal darf an Antriebskomponenten arbeiten.<br>Nähere Erläuterungen zu den Sicherheitshinweisen entnehmen Sie Kapitel 1 dieser Dokumentation. | **⚠ WARNING Danger to life in case of non-compliance with the below-mentioned safety instructions!**<br>Do not attempt to install or put these products into operation until you have completely read, understood and observed the documents supplied with the product.<br>If no documents in your language were supplied, please consult your Rexroth sales partner.<br>Only qualified persons may work with drive components.<br>For detailed explanations on the safety instructions, see chapter 1 of this documentation. | **⚠ AVERTISSEMENT Danger de mort en cas de non-respect des consignes de sécurité figurant ci-après !**<br>Ne mettez les produits en service qu'après avoir lu complètement et après avoir compris et respecté les documents et les consignes de sécurité fournis avec le produit.<br>Si vous ne disposez pas de la documentation dans votre langue, merci de consulter votre partenaire Rexroth.<br>Seul un personnel qualifié est autorisé à travailler sur les composants d'entraînement.<br>Vous trouverez des explications plus détaillées relatives aux consignes de sécurité au chapitre 1 de la présente documentation. |
| **⚠ WARNUNG Hohe elektrische Spannung! Lebensgefahr durch elektrischen Schlag!**<br>Betreiben Sie Antriebskomponenten nur mit fest installiertem Schutzleiter.<br>Schalten Sie vor Zugriff auf Antriebskomponenten die Spannungsversorgung aus.<br>Beachten Sie die Entladezeiten von Kondensatoren. | **⚠ WARNING High electrical voltage! Danger to life by electric shock!**<br>Only operate drive components with a permanently installed equipment grounding conductor.<br>Disconnect the power supply before accessing drive components.<br>Observe the discharge times of the capacitors. | **⚠ AVERTISSEMENT Tensions électriques élevées ! Danger de mort par électrocution !**<br>N'exploitez les composants d'entraînement que si un conducteur de protection est installé de manière permanente.<br>Avant d'intervenir sur les composants d'entraînement, coupez toujours la tension d'alimentation.<br>Tenez compte des délais de décharge de condensateurs. |
| **⚠ WARNUNG Gefahrbringende Bewegungen! Lebensgefahr!**<br>Halten Sie sich nicht im Bewegungsbereich von Maschinen und Maschinenteilen auf.<br>Verhindern Sie den unbeabsichtigten Zutritt für Personen.<br>Bringen Sie vor dem Zugriff oder Zutritt in den Gefahrenbereich die Antriebe sicher zum Stillstand. | **⚠ WARNING Dangerous movements! Danger to life!**<br>Keep free and clear of the ranges of motion of machines and moving machine parts.<br>Prevent personnel from accidentally entering the range of motion of machines.<br>Make sure that the drives are brought to safe standstill before accessing or entering the danger zone. | **⚠ AVERTISSEMENT Mouvements entraînant une situation dangereuse ! Danger de mort !**<br>Ne séjournez pas dans la zone de mouvement de machines et de composants de machines.<br>Évitez tout accès accidentel de personnes.<br>Avant toute intervention ou tout accès dans la zone de danger, assurez-vous de l'arrêt préalable de tous les entraînements. |

| D Deutsch | USA English | F Français |
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| **⚠WARNUNG**<br>**Elektromagnetische / magnetische Felder! Gesundheitsgefahr für Personen mit Herzschrittmachern, metallischen Implantaten oder Hörgeräten!**<br>Zutritt zu Bereichen, in denen Antriebskomponenten montiert und betrieben werden, ist für oben genannten Personen untersagt bzw. nur nach Rücksprache mit einem Arzt erlaubt. | **⚠WARNING Electromagnetic / magnetic fields! Health hazard for persons with heart pacemakers, metal implants or hearing aids!**<br>The above-mentioned persons are not allowed to enter areas in which drive components are mounted and operated, or rather are only allowed to do this after they consulted a doctor. | **⚠AVERTISSEMENT Champs électromagnétiques / magnétiques ! Risque pour la santé des porteurs de stimulateurs cardiaques, d'implants métalliques et d'appareils auditifs !**<br>L'accès aux zones où sont montés et exploités les composants d'entraînement est interdit aux personnes susmentionnées ou bien ne leur est autorisé qu'après consultation d'un médecin. |
| **⚠VORSICHT Heiße Oberflächen (> 60 °C)! Verbrennungsgefahr!**<br>Vermeiden Sie das Berühren von metallischen Oberflächen (z. B. Kühlkörpern). Abkühlzeit der Antriebskomponenten einhalten (mind. 15 Minuten). | **⚠CAUTION Hot surfaces (> 60 °C [140 °F])! Risk of burns!**<br>Do not touch metallic surfaces (e.g. heat sinks). Comply with the time required for the drive components to cool down (at least 15 minutes). | **⚠ATTENTION Surfaces chaudes (> 60 °C)! Risque de brûlure !**<br>Évitez de toucher des surfaces métalliques (p. ex. dissipateurs thermiques). Respectez le délai de refroidissement des composants d'entraînement (au moins 15 minutes). |
| **⚠VORSICHT Unsachgemäße Handhabung bei Transport und Montage! Verletzungsgefahr!**<br>Verwenden Sie geeignete Montage- und Transporteinrichtungen.<br>Benutzen Sie geeignetes Werkzeug und persönliche Schutzausrüstung. | **⚠CAUTION Improper handling during transport and mounting! Risk of injury!**<br>Use suitable equipment for mounting and transport.<br>Use suitable tools and personal protective equipment. | **⚠ATTENTION Manipulation incorrecte lors du transport et du montage ! Risque de blessure !**<br>Utilisez des dispositifs de montage et de transport adéquats.<br>Utilisez des outils appropriés et votre équipement de protection personnel. |
| **⚠VORSICHT Unsachgemäße Handhabung von Batterien! Verletzungsgefahr!**<br>Versuchen Sie nicht, leere Batterien zu reaktivieren oder aufzuladen (Explosions- und Verätzungsgefahr).<br>Zerlegen oder beschädigen Sie keine Batterien. Werfen Sie Batterien nicht ins Feuer. | **⚠CAUTION Improper handling of batteries! Risk of injury!**<br>Do not attempt to reactivate or recharge low batteries (risk of explosion and chemical burns).<br>Do not dismantle or damage batteries. Do not throw batteries into open flames. | **⚠ATTENTION Manipulation incorrecte de piles! Risque de blessure!**<br>N'essayez pas de réactiver des piles vides ou de les charger (risque d'explosion et de brûlure par acide).<br>Ne désassemblez et n'endommagez pas les piles. Ne jetez pas des piles dans le feu. |

| E Español | P Português | I Italiano |
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| **⚠ ADVERTENCIA ¡Peligro de muerte en caso de no observar las siguientes indicaciones de seguridad!**<br>Los productos no se pueden poner en servicio hasta después de haber leído por completo, comprendido y tenido en cuenta la documentación y las advertencias de seguridad que se incluyen en la entrega.<br>Si no dispusiera de documentación en el idioma de su país, diríjase a su distribuidor competente de Rexroth.<br>Solo el personal debidamente cualificado puede trabajar en componentes de accionamiento.<br>Encontrará más detalles sobre las indicaciones de seguridad en el capítulo 1 de esta documentación. | **⚠ ATENÇÃO Perigo de vida em caso de inobservância das seguintes instruções de segurança!**<br>Utilize apenas os produtos depois de ter lido, compreendido e tomado em consideração a documentação e as instruções de segurança fornecidas juntamente com o produto.<br>Se não tiver disponível a documentação na sua língua, dirija-se ao seu parceiro de venda responsável da Rexroth.<br>Apenas pessoal qualificado pode trabalhar nos componentes de acionamento.<br>Explicações mais detalhadas relativamente às instruções de segurança constam no capítulo 1 desta documentação. | **⚠ AVVERTENZA Pericolo di morte in caso di inosservanza delle seguenti indicazioni di sicurezza!**<br>Mettere in funzione i prodotti solo dopo aver letto, compreso e osservato per intero la documentazione e le indicazioni di sicurezza fornite con il prodotto.<br>Se non dovesse essere presente la documentazione nella vostra lingua, siete pregati di rivolgervi al rivenditore Rexroth competente.<br>Solo personale qualificato può eseguire lavori sui componenti di comando.<br>Per ulteriori spiegazioni riguardanti le indicazioni di sicurezza consultare il capitolo 1 di questa documentazione. |
| **⚠ ADVERTENCIA ¡Alta tensión eléctrica! ¡Peligro de muerte por descarga eléctrica!**<br>Active sólo los componentes de accionamiento con el conductor protector firmemente instalado.<br>Desconecte la alimentación eléctrica antes de manipular los componentes de accionamiento.<br>Tenga en cuenta los tiempos de descarga de los condensadores. | **⚠ ATENÇÃO Alta tensão elétrica! Perigo de vida devido a choque elétrico!**<br>Opere componentes de acionamento apenas com condutores de proteção instalados.<br>Desligue a alimentação de tensão antes de aceder aos componentes de acionamento.<br>Respeite os períodos de descarga dos condensadores. | **⚠ AVVERTENZA Alta tensione elettrica! Pericolo di morte in seguito a scosse elettriche!**<br>Mettere in esercizio i componenti di comando solo con conduttore di messa a terra ben installato.<br>Staccare l'alimentazione prima di intervenire sui componenti di comando.<br>Osservare i tempi di scarica del condensatore. |
| **⚠ ADVERTENCIA ¡Movimientos peligrosos! ¡Peligro de muerte!**<br>No permanezca en la zona de movimiento de las máquinas ni de sus piezas.<br>Impida el acceso accidental de personas.<br>Antes de acceder o introducir las manos en la zona de peligro, los accionamientos se tienen que haber parado con seguridad. | **⚠ ATENÇÃO Movimentos perigosos! Perigo de vida!**<br>Não permaneça na área de movimentação das máquinas e das peças das máquinas.<br>Evite o acesso involuntário para pessoas.<br>Antes de entrar ou aceder à área perigosa, imobilize os acionamentos de forma segura. | **⚠ AVVERTENZA Movimenti pericolosi! Pericolo di morte!**<br>Non sostare nelle zone di manovra delle macchine e delle loro parti.<br>Impedire un accesso non autorizzato per le persone.<br>Prima di accedere alla zona di pericolo, arrestare e bloccare gli azionamenti. |

| E Español | P Português | I Italiano |
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| **⚠ ADVERTENCIA ¡Campos electromagnéticos/magnéticos! ¡Peligro para la salud de las personas con marcapasos, implantes metálicos o audífonos!**<br>El acceso de las personas arriba mencionadas a las zonas de montaje o funcionamiento de los componentes de accionamiento está prohibido, salvo que lo autorice previamente un médico. | **⚠ ATENÇÃO Campos eletromagnéticos / magnéticos! Perigo de saúde para pessoas com marcapassos, implantes metálicos ou aparelhos auditivos!**<br>Acesso às áreas, nas quais os componentes de acionamento são montados e operados, é proibido para as pessoas em cima mencionadas ou apenas após permissão de um médico. | **⚠ AVVERTENZA Campi elettromagnetici / magnetici! Pericolo per la salute delle persone portatrici di pacemaker, protesi metalliche o apparecchi acustici!**<br>L'accesso alle zone in cui sono installati o in funzione componenti di comando è vietato per le persone sopra citate o consentito solo dopo un colloquio con il medico. |
| **⚠ ATENCIÓN ¡Superficies calientes (> 60 °C)! ¡Peligro de quemaduras!**<br>Evite el contacto con las superficies calientes (p. ej., disipadores de calor). Observe el tiempo de enfriamiento de los componentes de accionamiento (mín. 15 minutos). | **⚠ CUIDADO Superfícies quentes (> 60 °C)! Perigo de queimaduras!**<br>Evite tocar superfícies metálicas (p. ex. radiadores). Respeite o tempo de arrefecimento dos componentes de acionamento (mín. 15 minutos). | **⚠ ATTENZIONE Superfici bollenti (> 60 °C)! Pericolo di ustioni!**<br>Evitare il contatto con superfici metalliche (ad es. dissipatori di calore). Rispettare i tempi di raffreddamento dei componenti di comando (almeno 15 minuti). |
| **⚠ ATENCIÓN ¡Manipulación inadecuada en el transporte y montaje! ¡Peligro de lesiones!**<br>Utilice dispositivos de montaje y de transporte adecuados.<br>Utilice herramientas adecuadas y equipo de protección personal. | **⚠ CUIDADO Manejo incorreto no transporte e montagem! Perigo de ferimentos!**<br>Utilize dispositivos de montagem e de transporte adequados.<br>Utilize ferramentas e equipamento de proteção individual adequados. | **⚠ ATTENZIONE Manipolazione inappropriata durante il trasporto e il montaggio! Pericolo di lesioni!**<br>Utilizzare dispositivi di montaggio e trasporto adatti.<br>Utilizzare attrezzi adatti ed equipaggiamento di protezione personale. |
| **⚠ ATENCIÓN ¡Manejo inadecuado de las pilas! ¡Peligro de lesiones!**<br>No trate de reactivar o cargar pilas descargadas (peligro de explosión y cauterización).<br>No desarme ni dañe las pilas. No tire las pilas al fuego. | **⚠ CUIDADO Manejo incorreto de baterias! Perigo de ferimentos!**<br>Não tente reativar nem carregar baterias vazias (perigo de explosão e de queimaduras com ácido).<br>Não desmonte nem danifique as baterias. Não deite as baterias no fogo. | **⚠ ATTENZIONE Utilizzo inappropriato delle batterie! Pericolo di lesioni!**<br>Non tentare di riattivare o ricaricare batterie scariche (pericolo di esplosione e corrosione).<br>Non scomporre o danneggiare le batterie. Non gettare le batterie nel fuoco. |

| S Svenska | DK Dansk | NL Nederlands |
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| **⚠VARNING Livsfara om följande säkerhetsanvisningar inte följs!**<br>Använd inte produkterna innan du har läst och förstått den dokumentation och de säkerhetsanvisningar som medföljer produkten, och följ alla anvisningar.<br>Kontakta din Rexroth-återförsäljare om dokumentationen inte medföljer på ditt språk.<br>Endast kvalificerad personal får arbeta med drivkomponenterna.<br>Se kapitel 1 i denna dokumentation för närmare beskrivningar av säkerhetsanvisningarna. | **⚠ ADVARSEL Livsfare ved manglende overholdelse af nedenstående sikkerhedsanvisninger!**<br>Tag ikke produktet i brug, før du har læst og forstået den dokumentation og de sikkerhedsanvisninger, som følger med produktet, og overhold de givne anvisninger.<br>Kontakt din Rexroth-forhandler, hvis dokumentationen ikke medfølger på dit sprog.<br>Det er kun kvalificeret personale, der må arbejde på drive components.<br>Nærmere forklaringer til sikkerhedsanvisningerne fremgår af kapitel 1 i denne dokumentation. | **⚠WAARSCHUWING Levensgevaar bij niet-naleving van onderstaande veiligheidsinstructies!**<br>Stel de producten pas in bedrijf nadat u de met het product geleverde documenten en de veiligheidsinformatie volledig gelezen, begrepen en in acht genomen heeft.<br>Mocht u niet beschikken over documenten in uw landstaal, kunt u contact opnemen met uw plaatselijke Rexroth distributiepartner.<br>Uitsluitend gekwalificeerd personeel mag aan de aandrijvingscomponenten werken.<br>Meer informatie over de veiligheidsinstructies vindt u in hoofdstuk 1 van deze documentatie. |
| **⚠VARNING Hög elektrisk spänning! Livsfara genom elchock!**<br>Använd endast drivkomponenterna med fastmonterad skyddsledare.<br>Koppla bort spänningsförsörjningen före arbete på drivkomponenter.<br>Var medveten om kondensatorernas urladdningstid. | **⚠ ADVARSEL Elektrisk højspænding! Livsfare på grund af elektrisk stød!**<br>Drive components må kun benyttes med et fast installeret jordstik.<br>Sørg for at koble spændingsforsyningen fra, inden du rører ved drive components.<br>Overhold kondensatorernes afladningstider. | **⚠WAARSCHUWING Hoge elektrische spanning! Levensgevaar door elektrische schok!**<br>Bedien de aandrijvingscomponenten uitsluitend met vast geïnstalleerde aardleiding.<br>Schakel voor toegang tot aandrijvingscomponenten de spanningsvoorziening uit.<br>Neem de ontlaadtijden van condensatoren in acht. |
| **⚠VARNING Farliga rörelser! Livsfara!**<br>Uppehåll dig inte inom maskiners och maskindelars rörelseområde.<br>Förhindra att obehöriga personer får tillträde.<br>Innan du börjar arbeta eller vistas inom drivsystemets riskområde måste maskinen vara stillastående. | **⚠ ADVARSEL Farlige bevægelser! Livsfare!**<br>Du må ikke opholde dig inden for maskiners og maskindeles bevægelsesradius.<br>Sørg for, at ingen personer kan få utilsigtet adgang.<br>Stands drevene helt, inden du rører ved drevene eller træder ind i deres fareområde. | **⚠WAARSCHUWING Risicovolle bewegingen! Levensgevaar!**<br>Houdt u niet op in het bewegingsbereik van machines en machineonderdelen.<br>Voorkom dat personen onbedoeld toegang verkrijgen.<br>Voor toegang tot de gevaarlijke zone moeten de aandrijvingen veilig tot stilstand gebracht zijn. |

| S Svenska | DK Dansk | NL Nederlands |
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| **⚠VARNING Elektromagnetiska/ magnetiska fält! Hälsofara för personer med pacemaker, implantat av metall eller hörapparat!**<br>Det är förbjudet för ovan nämnda personer (eller kräver överläggning med läkare) att beträda områden där drivkomponenter är monterade och i drift. | **⚠ ADVARSEL Elektromagnetiske/magnetiske felter! Sundhedsfare for personer med pacemakere, metalliske implantater eller høreapparater!**<br>For disse personer er der adgang forbudt eller kun adgang med tilladelse fra læge til de områder, hvor drive components monteres og drives. | **⚠WAARSCHUWING Elektromagnetische / magnetische velden! Gevaar voor de gezondheid van personen met pacemakers, metalen implantaten of hoorapparaten!**<br>Toegang tot gebieden, waarin aandrijvingscomponenten worden gemonteerd en bediend, is verboden voor voornoemde personen of uitsluitend toegestaan na overleg met een arts. |
| **⚠ OBSERVERA Varma ytor (> 60 °C)! Risk för brännskador!**<br>Undvik att vidröra metallytor (t.ex. kylelement). Var medveten om att det tar tid för drivkomponenterna att svalna (minst 15 minuter). | **⚠ FORSIGTIG Varme overflader (> 60 °C)! Risiko for forbrændinger!**<br>Undgå at berøre metaloverflader (f.eks. køleelementer). Overhold drive components nedkølingstid (min. 15 min.). | **⚠VOORZICHTIG Hete oppervlakken (> 60 °C)! Verbrandingsgevaar!**<br>Voorkom contact met metalen oppervlakken (bijv. Koellichamen). Afkoeltijd van de aandrijvingscomponenten in acht nemen (min. 15 minuten). |
| **⚠ OBSERVERA Felaktig hantering vid transport och montering! Skaderisk!**<br>Använd passande monterings- och transportanordningar.<br>Använd lämpliga verktyg och personlig skyddsutrustning. | **⚠ FORSIGTIG Fejlhåndtering ved transport og montering! Risiko for kvæstelser!**<br>Benyt egnede monterings- og transportanordninger.<br>Benyt egnet værktøj og personligt sikkerhedsudstyr. | **⚠VOORZICHTIG Onjuist gebruik bij transport en montage! Letselgevaar!**<br>Gebruik geschikte montage- en transportinrichtingen.<br>Gebruik geschikt gereedschap en een persoonlijke veiligheidsuitrusting. |
| **⚠ OBSERVERA Felaktig hantering av batterier! Skaderisk!**<br>Försök inte återaktivera eller ladda upp batterier (risk för explosioner och frätskador).<br>Batterierna får inte tas isär eller skadas. Släng inte batterierna i elden. | **⚠ FORSIGTIG Fejlhåndtering af batterier! Risiko for kvæstelser!**<br>Forsøg ikke at genaktivere eller oplade tomme batterier (eksplosions- og ætsningsfare).<br>Undlad at skille batterier ad eller at beskadige dem. Smid ikke batterier ind i åben ild. | **⚠VOORZICHTIG Onjuist gebruik van batterijen! Letselgevaar!**<br>Probeer nooit lege batterijen te reactiveren of op te laden (explosiegevaar en gevaar voor beschadiging van weefsel door cauterisatie).<br>Batterijen niet demonteren of beschadigen. Nooit batterijen in het vuur werpen. |

| FIN Suomi | PL Polski | CZ Český |
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| **⚠VAROITUS Näiden turvaohjeiden noudattamatta jättämisestä on seurauksena hengenvaara!**<br>Ota tuote käyttöön vasta sen jälkeen, kun olet lukenut läpi tuotteen mukana toimitetut asiakirjat ja turvallisuusohjeet, ymmärtänyt ne ja ottanut ne huomioon.<br>Jos asiakirjoja ei ole saatavana omalla äidinkielelläsi, ota yhteys asianomaiseen Rexrothin myyntiedustajaan.<br>Käyttölaitteiden komponenttien parissa saa työskennellä ainoastaan valtuutettu henkilöstö.<br>Lisätietoa turvaohjeista löydät tämän dokumentaation luvusta 1. | **⚠ OSTRZEŻENIE Zagrożenie życia w razie nieprzestrzegania poniższych wskazówek bezpieczeństwa!**<br>Nie uruchamiać produktów przed uprzednim przeczytaniem i pełnym zrozumieniem wszystkich dokumentów dostarczonych wraz z produktem oraz wskazówek bezpieczeństwa. Należy przestrzegać wszystkich zawartych tam zaleceń.<br>W przypadku braku dokumentów w Państwa języku, prosimy o skontaktowanie się z lokalnym partnerem handlowym Rexroth.<br>Przy zespołach napędowych może pracować wyłącznie wykwalifikowany personel.<br>Bliższe objaśnienia wskazówek bezpieczeństwa znajdują się w Rozdziale 1 niniejszej dokumentacji. | **⚠VAROVÁNÍ Nebezpečí života v případě nedodržení níže uvedených bezpečnostních pokynů!**<br>Před uvedením výrobků do provozu si přečtěte kompletní dokumentaci a bezpečnostní pokyny dodávané s výrobkem, pochopte je a dodržujte.<br>Nemáte-li k dispozici podklady ve svém jazyce, obraťte se na příslušného obchodního partnera Rexroth.<br>Na komponentách pohonu smí pracovat pouze kvalifikovaný personál.<br>Podrobnější vysvětlení k bezpečnostním pokynům naleznete v kapitole 1 této dokumentace. |
| **⚠VAROITUS Voimakas sähköjännite! Sähköiskun aiheuttama hengenvaara!**<br>Käytä käyttölaitteen komponentteja ainoastaan maadoitusjohtimen ollessa kiinteästi asennettuna.<br>Katkaise jännitteensyöttö ennen käyttölaitteen komponenteille suoritettavien töiden aloittamista.<br>Huomioi kondensaattoreiden purkausajat. | **⚠ OSTRZEŻENIE Wysokie napięcie elektryczne! Zagrożenie życia w wyniku porażenia prądem!**<br>Zespoły napędu mogą być eksploatowane wyłącznie z zainstalowanym na stałe przewodem ochronnym.<br>Przed uzyskaniem dostępu do podzespołów napędu należy odłączyć zasilanie elektryczne.<br>Zwracać uwagę na czas rozładowania kondensatorów. | **⚠VAROVÁNÍ Vysoké elektrické napětí! Nebezpečí života při zasažení elektrickým proudem!**<br>Komponenty pohonu smí být v provozu pouze s pevně nainstalovaným ochranným vodičem.<br>Než začnete zasahovat do komponent pohonu, odpojte je od elektrického napájení.<br>Dodržujte vybíjecí časy kondenzátorů. |
| **⚠VAROITUS Vaarallisia liikkeitä! Hengenvaara!**<br>Älä oleskele koneiden tai koneenosien liikealueella.<br>Pidä huolta siitä, ettei muita henkilöitä pääse alueelle vahingossa.<br>Pysäytä käyttölaitteet varmasti ennen vaara-alueelle koskemista tai menemistä. | **⚠ OSTRZEŻENIE Niebezpieczne ruchy! Zagrożenie życia!**<br>Nie wolno przebywać w obszarze pracy maszyny i jej elementów.<br>Nie dopuszczać osób niepowołanych do obszaru pracy maszyny.<br>Przed dotknięciem urządzenia/ maszyny lub zbliżeniem się do obszaru zagrożenia należy zgodnie z zasadami bezpieczeństwa wyłączyć napędy. | **⚠VAROVÁNÍ Nebezpečné pohyby! Nebezpečí života!**<br>Nezdržujte se v dosahu pohybu strojů a jejich součástí.<br>Zabraňte náhodnému přístupu osob.<br>Před zásahem nebo vstupem do nebezpečného prostoru bezpečně zastavte pohony. |

| FIN Suomi | PL Polski | CZ Český |
|---|---|---|
| **⚠VAROITUS**<br>**Sähkömagneettisia/magneettisia kenttiä! Terveydellisten haittojen vaara henkilöille, joilla on sydämentahdistin, metallinen implantti tai kuulolaite!**<br>Yllä mainituilta henkilöiltä on pääsy kielletty alueille, joilla asennetaan tai käytetään käyttölaitteen komponentteja, tai heidän on ensin saatava tähän suostumus lääkäriltään. | **⚠ OSTRZEŻENIE Pola elektromagnetyczne / magnetyczne! Zagrożenie zdrowia dla osób z rozrusznikiem serca, metalowymi implantami lub aparatami słuchowymi!**<br>Wstęp na teren, gdzie odbywa się montaż i eksploatacja napędów jest dla ww. osób zabroniony względnie dozwolony po konsultacji z lekarzem. | **⚠VAROVÁNÍ Elektromagnetická/ magnetická pole! Nebezpečí pro zdraví osob s kardiostimulátory, kovovými implantáty nebo naslouchadly!**<br>Výše uvedené osoby mají zakázán přístup do prostorů, kde jsou montovány a používány komponenty pohonu, resp. ho mají povolen pouze po poradě s lékařem. |
| **⚠HUOMIO Kuumia pintoja (> 60 °C)! Palovammojen vaara!**<br>Vältä metallipintojen koskettamista (esim. jäähdytyslevyt). Noudata käyttölaitteen komponenttien jäähtymisaikoja (väh. 15 minuuttia). | **⚠ PRZESTROGA Gorące powierzchnie (> 60 °C)! Niebezpieczeństwo poparzenia!**<br>Unikać kontaktu z powierzchniami metalowymi (np. radiatorami). Przestrzegać czasów schładzania podzespołów napędów (min. 15 minut). | **⚠UPOZORNĚNÍ Horké povrchy (> 60 °C)! Nebezpečí popálení!**<br>Nedotýkejte se kovových povrchů (např. chladicích těles). Dodržujte dobu ochlazení komponent pohonu (min. 15 minut). |
| **⚠HUOMIO Epäasianmukainen käsittely kuljetuksen ja asennuksen yhteydessä! Loukkaantumisvaara!**<br>Käytä soveltuvia asennus- ja kuljetuslaitteita.<br>Käytä omia työkaluja ja henkilökohtaisia suojavarusteita. | **⚠ PRZESTROGA Niewłaściwe obchodzenie się podczas transportu i montażu! Ryzyko urazu!**<br>Stosować odpowiednie urządzenia montażowe i transportowe.<br>Stosować odpowiednie narzędzia i środki ochrony osobistej. | **⚠UPOZORNĚNÍ Nesprávné zacházení při přepravě a montáži! Nebezpečí zranění!**<br>Používejte vhodná montážní a dopravní zařízení.<br>Používejte vhodné nářadí a osobní ochranné vybavení. |
| **⚠HUOMIO Paristojen epäasianmukainen käsittely! Loukkaantumisvaara!**<br>Älä yritä saada tyhjiä paristoja toimimaan tai ladata niitä uudelleen (räjähdys- ja syöpymisvaara).<br>Älä hajota paristoja osiin tai vaurioita niitä. Älä heitä paristoja tuleen. | **⚠ PRZESTROGA Niewłaściwe obchodzenie się z bateriami! Ryzyko urazu!**<br>Nie próbować reaktywować i nie ładować zużytych baterii (niebezpieczeństwo wybuchu oraz poparzenia żrącą substancją).<br>Nie demontować i nie niszczyć baterii. Nie wrzucać baterii do ognia. | **⚠UPOZORNĚNÍ Nesprávné zacházení s bateriemi! Nebezpečí zranění!**<br>Nepokoušejte se znovu aktivovat nebo dobíjet prázdné baterie (nebezpečí výbuchu a poleptání).<br>Nerozebírejte ani nepoškozujte baterie. Neházejte baterie do ohně. |

| SLO Slovensko | SK Slovenčina | RO Română |
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| **⚠ OPOZORILO Življenjska nevarnost pri neupoštevanju naslednjih napotkov za varnost!**<br>Izdelke začnite uporabljati šele, ko v celoti preberete, razumete in upoštevate izdelkom priloženo dokumentacijo in varnostne napotke.<br>Če priložena dokumentacija ni na voljo v vašem maternem jeziku, se obrnite na pristojnega distributerja Rexroth.<br>Samo kvalificirano osebje sme delati na pogonskih komponentah.<br>Podrobnejša pojasnila o varnostnih navodilih najdete v poglavju 1 v tej dokumentaciji. | **⚠ VAROVANIE Nebezpečenstvo ohrozenia života pri nedodržiavaní nasledujúcich bezpečnostných pokynov!**<br>Výrobky uvádzajte do prevádzky až potom, čo ste úplne prečítali, pochopili a zobrali do úvahy podklady a bezpečnostné pokyny dodané s výrobkom.<br>Ak by ste nemali k dispozícii žiadne podklady v jazyku svojej krajiny, obráťte sa prosím na svojho príslušného predajcu Rexroth.<br>Na komponentoch pohonu smie pracovať iba kvalifikovaný personál.<br>Bližšie vysvetlenia k bezpečnostným pokynom zistite z kapitoly 1 tejto dokumentácie. | **⚠ AVERTIZARE Pericol de moarte în cazul nerespectării următoarelor instrucţiuni de siguranţă!**<br>Punerea în funcţiune a produselor trebuie efectuată după citirea, înţelegerea şi respectarea documentelor şi instrucţiunilor de siguranţă, care sunt livrate împreună cu produsele.<br>În cazul în care documentele nu sunt în limba dumneavoastră maternă, vă rugăm să contactaţi partenerul de vânzări Rexroth.<br>Numai un personal calificat poate lucra cu componentele de acţionare.<br>Explicaţii detaliate privind instrucţiunile de siguranţă găsiţi în capitolul 1 al acestei documentaţii. |
| **⚠ OPOZORILO Visoka električna napetost! Življenjska nevarnost zaradi električnega udara!**<br>Pogonske komponente uporabljajte samo s fiksno nameščenim zaščitnim vodnikom.<br>Pred dostopom do pogonske komponente odklopite napajanje.<br>Upoštevajte čase praznjenja kondenzatorjev. | **⚠ VAROVANIE Vysoké elektrické napätie! Nebezpečenstvo ohrozenia života v dôsledku zásahu elektrickým prúdom!**<br>Komponenty pohonu prevádzkujte iba s pevne nainštalovaným ochranným vodičom.<br>Pred prístupom na komponenty pohonu odpojte zdroj napätia.<br>Rešpektujte časy vybitia kondenzátorov. | **⚠ AVERTIZARE Tensiune electrică înaltă! Pericol de moarte prin electrocutare!**<br>Exploataţi componentele de acţionare numai cu împământarea instalată permanent.<br>Înainte de intervenţia asupra componentelor de acţionare, deconectaţi alimentarea cu tensiune electrică.<br>Ţineţi cont de timpii de descărcare ai condensatorilor. |
| **⚠ OPOZORILO Nevarni premiki! Življenjska nevarnost!**<br>Ne zadržujte se v območju delovanja strojev.<br>Preprečite nenadzorovan dostop oseb.<br>Pred prijemom ali dostopom v nevarno območje varno zaustavite vse gnane dele. | **⚠ VAROVANIE Pohyby prinášajúce nebezpečenstvo! Nebezpečenstvo ohrozenia života!**<br>Nezdržiavajte sa v oblasti pohybu strojov a častí strojov.<br>Zabráňte nepovolanému prístupu osôb.<br>Pred zásahom alebo prístupom do nebezpečnej oblasti uveďte pohony bezpečne do zastavenia. | **⚠ AVERTIZARE Mişcări periculoase! Pericol de moarte!**<br>Nu staţionaţi în zona de mişcare a maşinilor şi a componentelor în mişcare a maşinilor.<br>Împiedicaţi accesul neintenţionat al persoanelor în zona de lucru a maşinilor.<br>Înainte de intervenţia sau accesul în zona periculoasă, opriţi în siguranţă componentele de acţionare. |

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| **⚠ OPOZORILO**<br>**Elektromagnetna / magnetna polja! Nevarnost za zdravje za osebe s spodbujevalniki srca, kovinskimi vsadki ali slušnimi aparati!**<br>Dostop do območij, v katerih so nameščene delujoče pogonske komponente, je za zgoraj navedene osebe prepovedan oz. dovoljen samo po posvetu z zdravnikom. | **⚠ VAROVANIE**<br>**Elektromagnetické/magnetické polia! Nebezpečenstvo pre zdravie osôb s kardiostimulátormi, kovovými implantátmi alebo načúvacími prístrojmi!**<br>Prístup k oblastiam, v ktorých sú namontované a prevádzkujú sa komponenty pohonu, je pre hore uvedené osoby zakázaný resp. je dovolený iba po konzultácii s lekárom. | **⚠ AVERTIZARE**<br>**Câmpuri electromagnetice / magnetice! Pericol pentru sănătatea persoanelor cu stimulatoare cardiace, implanturi metalice sau aparate auditive!**<br>Intrarea în zone, în care se montează sau se exploatează componente de acționare, este interzisă pentru persoanele sus numite respectiv este permisă numai cu acordul medicului. |
| **⚠ POZOR**<br>**Vroče površine (> 60 °C)! Nevarnost opeklin!**<br>Izogibajte se stiku s kovinskimi površinami (npr. hladilnimi telesi). Upoštevajte čas hlajenja pogonskih komponent (najm. 15 minut). | **⚠ UPOZORNENIE**<br>**Horúce povrchy (> 60 °C)! Nebezpečenstvo popálenia!**<br>Zabráňte kontaktu s kovovými povrchmi (napr. chladiacimi telesami). Dodržiavajte čas vychladenia komponentov pohonu (min. 15 minút). | **⚠ ATENȚIE**<br>**Suprafețe fierbinți (> 60 °C)! Pericol de arsuri!**<br>Nu atingeți suprafețele metalice (de ex. radiatoare de răcire). Respectați timpii de răcire ai componentelor de acționare (min. 15 minute). |
| **⚠ POZOR**<br>**Nestrokovno ravnanje med transportom in namestitvijo! Nevarnost poškodb!**<br>Uporabljajte ustrezne pripomočke za nameščanje in transport.<br>Uporabite ustrezno orodje in osebno zaščitno opremo. | **⚠ UPOZORNENIE**<br>**Neodborná manipulácia pri transporte a montáži! Nebezpečenstvo poranenia!**<br>Používajte vhodné montážne a transportné zariadenia.<br>Používajte vhodné náradie a osobné ochranné prostriedky. | **⚠ ATENȚIE**<br>**Manipulare necorespunzătoare la transport și montaj! Pericol de vătămare!**<br>Utilizați dispozitive adecvate de montaj și transport.<br>Folosiți instrumente corespunzătoare și echipament personal de protecție. |
| **⚠ POZOR**<br>**Nepravilno ravnanje z baterijami! Nevarnost poškodb!**<br>Ne poskušajte ponovno aktivirati ali napolniti praznih baterij (Nevarnost zaradi eksplozij ali jedkanja).<br>Ne razstavljajte ali poškodujte nobenih baterij. Baterij ne mečite v ogenj. | **⚠ UPOZORNENIE**<br>**Neodborná manipulácia s batériami! Nebezpečenstvo poranenia!**<br>Nepokúšajte sa reaktivovať alebo nabíjať prázdne batérie (nebezpečenstvo výbuchu a poleptania).<br>Batérie nerozoberajte ani nepoškodzujte. Nehádžte batérie do ohňa. | **⚠ ATENȚIE**<br>**Manipulare necorespunzătoare a bateriilor! Pericol de vătămare!**<br>Nu încercați să reactivați sau să încărcați bateriile goale (pericol de explozie și pericol de arsuri).<br>Nu dezasamblați și nu deteriorați bateriile. Nu aruncați bateriile în foc. |

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| **⚠ FIGYELMEZTETÉS! Az alábbi biztonsági útmutatások figyelmen kívül hagyása életveszélyes helyzethez vezethet!**<br>Üzembe helyezés előtt olvassa el, értelmezze, és vegye figyelembe a csomagban található dokumentumban foglaltakat és a biztonsági útmutatásokat.<br>Amennyiben a csomagban nem talál az Ön nyelvén írt dokumentumokat, vegye fel a kapcsolatot az illetékes Rexroth-képviselővel.<br>A hajtás alkatrészein kizárólag képzett személy dolgozhat.<br>A biztonsági útmutatókkal kapcsolatban további magyarázatot ennek a dokumentumnak az első fejezetében találhat. | **⚠ ПРЕДУПРЕЖДЕНИЕ Опасност за живота при неспазване на посочените по-долу инструкции за безопасност!**<br>Използвайте продуктите след като сте се запознали подробно с приложената към продукта документация и указания за безопасност, разбрали сте ги и сте се съобразили с тях.<br>Ако текстът не е написан на Вашия език, моля обърнете се към Вашия компетентен търговски представител на Rexroth.<br>Със задвижващите компоненти трябва да работи само квалифициран персонал.<br>Подробни пояснения към инструкциите за безопасност можете да видите в Глава 1 на тази документация. | **⚠ BRĪDINĀJUMS Turpinājumā doto drošības norādījumu neievērošana var apdraudēt dzīvību!**<br>Sāciet lietot izstrādājumu tikai pēc tam, kad esat pilnībā izlasījuši, sapratuši un ņēmuši vērā kopā ar izstrādājumu piegādātos dokumentus.<br>Ja dokumenti nav pieejami Jūsu valsts valodā, vērsieties pie pilnvarotā Rexroth izplatītāja.<br>Darbus pie piedziņas komponentiem drīkst veikt tikai kvalificēts personāls.<br>Detalizētus paskaidrojumus attiecībā uz drošības norādījumiem skatiet šī dokumenta 1. nodaļā. |
| **⚠ FIGYELMEZTETÉS! Magas elektromos feszültség! Életveszély áramütés miatt!**<br>A hajtás alkatrészeit csak véglegesen telepített védővezetővel üzemeltesse!<br>Mielőtt hozzányúl a hajtás alkatrészeihez, kapcsolja ki az áramellátást.<br>Ügyeljen a kondenzátorok kisülési idejére! | **⚠ ПРЕДУПРЕЖДЕНИЕ Високо електрическо напрежение! Опасност за живота от удар от електрически ток!**<br>Работете със задвижващите компоненти само при здраво закрепен заземяващ проводник.<br>Преди работа по задвижващите компоненти, изключете захранващото напрежение.<br>Обърнете внимание на времето за разреждане на кондензаторите. | **⚠ BRĪDINĀJUMS Augsts elektriskais spriegums! Dzīvības apdraudējums elektriskā trieciena dēļ!**<br>Piedziņas komponentus darbiniet tikai ar fiksēti uzstādītu zemējumvadu.<br>Pirms darba pie piedziņas komponentiem atslēdziet elektroapgādi.<br>Ņemiet vērā kondensatoru izlādes laikus. |
| **⚠ FIGYELMEZTETÉS! Veszélyes mozgás! Életveszély!**<br>Ne tartózkodjon a gépek és a gépalkatrészek mozgási területén belül!<br>Illetéktelen személyeket ne engedjen a gép közelébe!<br>Mielőtt beavatkozik, vagy a veszélyes zónába belép a hajtásokat biztonságosan állítsa le. | **⚠ ПРЕДУПРЕЖДЕНИЕ Опасни движения! Опасност за живота!**<br>Не стойте в обсега на движение на машините и частите на машините.<br>Не допускайте непреднамерен достъп на хора.<br>Преди работа или влизане в опасната зона, спрете надеждно приводния механизъм. | **⚠ BRĪDINĀJUMS Bīstamas kustības! Dzīvības apdraudējums!**<br>Neuzturieties mašīnu un mašīnas detaļu kustību zonā.<br>Novērsiet nepiederošu personu piekļūšanu.<br>Pirms darba bīstamajās zonās pilnībā apstādiniet piedziņu. |

| H Magyar | BG Български | LV Latviski |
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| **⚠ FIGYELMEZTETÉS!**<br>**Elektromágneses / mágneses mező! Káros hatással lehet a szívritmus-szabályozó készülékkel, fémbeültetéssel vagy hallókészülékkel rendelkezők egészségére!**<br>Azokra a területekre, ahol hajtások alkatrészeit szerelik és üzemeltetik, a fent említett személyeknek tilos a belépés, illetve csak orvosi konzultációt követően szabad az adott területekre lépniük. | **⚠ ПРЕДУПРЕЖДЕНИЕ**<br>**Електромагнитни / магнитни полета! Опасност за здравето на хора със сърдечни стимулатори, метални импланти или слухови апарати!**<br>Достъпът за гореспоменатите лица до зони, в които ще се монтират и ще работят задвижващи компоненти се забранява, или разрешава само след консултация с лекар. | **⚠ BRĪDINĀJUMS**<br>**Elektromagnētiskais / magnētiskais lauks! Veselības apdraudējums personām ar sirds stimulatoriem, metāliskiem implantiem vai dzirdes aparātiem!**<br>Tuvošanās zonām, kurās tiek montēti un darbināti piedziņas komponenti, iepriekš minētajām personām ir aizliegta, respektīvi, atļauta tikai pēc konsultēšanās ar ārstu. |
| **⚠ VIGYÁZAT! Forró felületek (> 60 °C)! Égésveszély!**<br>Ne érjen hozzá fémfelületekhez (pl. hűtőtestekhez)! Vegye figyelembe a hajtás alkatrészeinek kihűlési idejét (min. 15 perc)! | **⚠ ВНИМАНИЕ Горещи повърхности (> 60 °C)! Опасност от изгаряне!**<br>Не докосвайте метални повърхности (например радиатори). Съблюдавайте времето на охлаждане на задвижващите компоненти (мин. 15 минути). | **⚠ UZMANĪBU Karstas virsmas (> 60 °C)! Apdedzināšanās risks!**<br>Neskarieties pie metāliskām virsmām (piemēram, dzesētāja). Ļaujiet piedziņas komponentiem atdzist (min. 15 minūtes). |
| **⚠ VIGYÁZAT! Szakszerűtlen kezelés szállításkor és szereléskor! Sérülésveszély!**<br>A megfelelő beszerelési és szállítási eljárásokat alkalmazza!<br>Használjon megfelelő szerszámokat és személyes védőfelszerelést! | **⚠ ВНИМАНИЕ Неправилно боравене по време на транспорт и монтаж!Опасност от нараняване!**<br>Използвайте подходящо монтажно и транспортно оборудване.<br>Използвайте подходящи инструменти и лични предпазни средства. | **⚠ UZMANĪBU Nepareizi veikta transportēšana un montāža! Traumu gūšanas risks!**<br>Izmantojiet piemērotas montāžas un transportēšanas ierīces.<br>Izmantojiet piemērotus instrumentus un individuālos aizsardzības līdzekļus. |
| **⚠ VIGYÁZAT! Akkumulátorok szakszerűtlen kezelése! Sérülésveszély!**<br>Üres akkumulátorokat ne aktiváljon újra, illetve ne töltsön fel (robbanás- és marásveszély)!<br>Az akkumulátorokat ne szedje szét, és ne rongálja meg! Az akkumulátort ne dobja tűzbe! | **⚠ ВНИМАНИЕ Неправилно боравене с батерии! Опасност от нараняване!**<br>Не се опитвайте да активирате отново или да зареждате разредени батерии (Опасност от експлозия и напръскване с агресивен агент).<br>Не разглобявайте и не повреждайте батерии. Не хвърляйте батерии в огън. | **⚠ UZMANĪBU Nepareiza bateriju lietošana! Traumu gūšanas risks!**<br>Nemēģiniet no jauna aktivizēt vai uzlādēt tukšas baterijas (eksploziju un ķīmisko apdegumu draudi).<br>Neizjauciet un nesabojājiet baterijas. Nemetiet baterijas ugunī. |

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| **⚠ ĮSPĖJIMAS Pavojus gyvybei nesilaikant toliau pateikiamų saugumo nurodymų!**<br>Naudokite gaminį tik kruopščiai perskaitę prie jo pridėtus aprašus, saugumo nurodymus. Susipažinkite su jais ir vadovaukitės naudodami gaminį.<br>Jei Jūs negavote aprašo gimtąja kalba, kreipkitės į įgaliotus Rexroth atstovus.<br>Prie pavaros komponentų leidžiama dirbti tik kvalifikuotam personalui.<br>Išsamesnius saugumo nurodymų paaiškinimus rasite šios dokumentacijos 1 skyriuje. | **⚠ HOIATUS Alljärgnevate ohutusjuhiste eiramine on eluohtlik!**<br>Võtke tooted käiku alles siis, kui olete toodetega kaasasolevad materjalid ning ohutusjuhised täielikult läbi lugenud, neist aru saanud ja neid järginud.<br>Kui Teil puuduvad emakeelsed materjalid, siis pöörduge Rexrothi kohaliku müügiesinduse poole.<br>Ajamikomponentidega tohib töötada üksnes kvalifitseeritud personal.<br>Täpsemaid selgitusi ohutusjuhiste kohta leiate käesoleva dokumentatsiooni peatükist 1. | **⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Κίνδυνος θανάτου σε περίπτωση μη συμμόρφωσης με τις παρακάτω οδηγίες ασφαλείας!**<br>Θέστε το προϊόν σε λειτουργία αφού διαβάσετε, κατανοήσετε και λάβετε υπόψη το σύνολο των οδηγιών ασφαλείας που το συνοδεύουν.<br>Εάν δεν υπάρχει τεκμηρίωση στη γλώσσα σας, απευθυνθείτε σε εξουσιοδοτημένο αντιπρόσωπο της Rexroth.<br>Μόνο εξειδικευμένο προσωπικό επιτρέπεται να χειρίζεται στοιχεία μετάδοσης κίνησης.<br>Περαιτέρω επεξηγήσεις των οδηγιών ασφαλείας διατίθενται στο κεφάλαιο 1 της παρούσας τεκμηρίωσης. |
| **⚠ ĮSPĖJIMAS Aukšta elektros įtampa! Pavojus gyvybei dėl elektros smūgio!**<br>Pavaros komponentus eksploatuokite tik su fiksuotai instaliuotu apsauginiu laidu.<br>Prieš prieidami prie pavaros komponentų išjunkite maitinimo įtampą.<br>Atsižvelkite į kondensatorių išsikrovimo trukmę. | **⚠ HOIATUS Kõrge elektripinge! Eluohtlik elektrilöögi tõttu!**<br>Käitage ajamikomponente üksnes püsivalt installeeritud maandusega.<br>Lülitage enne ajamikomponentidega tööde alustamist toitepinge välja.<br>Järgige kondensaatorite mahalaadumisaegu. | **⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Υψηλή ηλεκτρική τάση! Κίνδυνος θανάτου από ηλεκτροπληξία!**<br>Θέτετε σε λειτουργία τα στοιχεία μετάδοσης κίνησης μόνο εφόσον έχει τοποθετηθεί καλά προστατευτικός αγωγός γείωσης.<br>Πριν από οποιαδήποτε παρέμβαση, αποσυνδέστε την τροφοδοσία των στοιχείων μετάδοσης κίνησης.<br>Λάβετε υπόψη τους χρόνους αποφόρτισης των πυκνωτών. |
| **⚠ ĮSPĖJIMAS Pavojingi judesiai! Pavojus gyvybei!**<br>Nebūkite mašinų ar jų dalių judėjimo zonoje.<br>Neleiskite netyčia patekti asmenims.<br>Prieš patekdami į pavojaus zoną saugiai išjunkite pavaras. | **⚠ HOIATUS Ohtlikud liikumised! Eluohtlik!**<br>Ärge viibige masina ja masinaosade liikumispiirkonnas.<br>Tõkestage inimeste ettekavatsematu sisenemine masina ja masinaosade liikumispiirkonda.<br>Tagage ajamite turvaline seiskamine enne ohupiirkonda juurdepääsu või sisenemist. | **⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ Επικίνδυνες τάσεις! Κίνδυνος θανάτου!**<br>Μην στέκεστε στην περιοχή κίνησης μηχανημάτων και εξαρτημάτων.<br>Αποτρέπετε την τυχαία είσοδο ατόμων.<br>Πριν από την παρέμβαση ή πρόσβαση στην περιοχή κινδύνου, μεριμνήστε για την ασφαλή ακινητοποίηση των συστημάτων μετάδοσης κίνησης. |

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| **⚠ ĮSPĖJIMAS**<br>**Elektromagnetiniai / magnetiniai laukai! Pavojus asmenų su širdies stimuliatoriais, metaliniais implantais arba klausos aparatais sveikatai!**<br>Prieiga prie zonų, kuriose montuojami ir eksploatuojami pavaros komponentai, aukščiau nurodytiems asmenims yra draudžiama arba leistina tik pasitarus su gydytoju. | **⚠ HOIATUS**<br>**Elektromagnetilised / magnetilised väljad! Terviseohtlik südamestimulaatorite, metallimplantaatide ja kuulmisseadmetega inimestele!**<br>Sisenemine piirkondadesse, kus toimub ajamikomponentide monteerimine ja käitamine, on ülalnimetatud isikutele keelatud või lubatud üksnes pärast arstiga konsulteerimist. | **⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ**<br>**Ηλεκτρομαγνητικά/μαγνητικά πεδία! Κίνδυνος για την υγεία ατόμων με καρδιακούς βηματοδότες, μεταλλικά εμφυτεύματα ή συσκευές ακοής!**<br>Η είσοδος σε περιοχές όπου πραγματοποιείται συναρμολόγηση και λειτουργία στοιχείων μετάδοσης κίνησης απαγορεύεται στα προαναφερθέντα άτομα, εκτός αν τους έχει δοθεί σχετική άδεια κατόπιν συνεννόησης με γιατρό. |
| **⚠ PERSPĖJIMAS**<br>**Karšti paviršiai (> 60 °C)! Nudegimo pavojus!**<br>Venkite liesti metalinius paviršius (pvz., radiatorių). Išlaikykite pavaros komponentų atvėsimo trukmę (bent 15 minučių). | **⚠ ETTEVAATUST**<br>**Kuumad välispinnad (> 60 °C)! Põletusoht!**<br>Vältige metalsete välispindade (nt radiaatorid) puudutamist. Pidage kinni ajamikomponentide mahajahtumisajast (vähemalt 15 minutit). | **⚠ ΠΡΟΣΟΧΗ**<br>**Καυτές επιφάνειες (> 60 °C)! Κίνδυνος εγκαύματος!**<br>Αποφεύγετε την επαφή με μεταλλικές επιφάνειες (π.χ. μονάδες ψύξης). Λάβετε υπόψη το χρόνο ψύξης των στοιχείων μετάδοσης κίνησης (τουλάχιστον 15 λεπτά). |
| **⚠ PERSPĖJIMAS**<br>**Netinkamas darbas transportuojant ir montuojant! Susižalojimo pavojus!**<br>Naudokite tinkamus montavimo ir transportavimo įrenginius.<br>Naudokite tinkamus įrankius ir asmens saugos priemones. | **⚠ ETTEVAATUST**<br>**Asjatundmatu käsitsemine transportimisel ja montaažil! Vigastusoht!**<br>Kasutage sobivaid montaaži- ja transpordiseadiseid.<br>Kasutage sobivaid tööriistu ja isiklikku kaitsevarustust. | **⚠ ΠΡΟΣΟΧΗ**<br>**Ακατάλληλος χειρισμός κατά τη μεταφορά και συναρμολόγηση! Κίνδυνος τραυματισμού!**<br>Χρησιμοποιείτε κατάλληλους μηχανισμούς συναρμολόγησης και μεταφοράς.<br>Χρησιμοποιείτε κατάλληλα εργαλεία και ατομικό εξοπλισμό προστασίας. |
| **⚠ PERSPĖJIMAS**<br>**Netinkamas darbas su baterijomis! Susižalojimo pavojus!**<br>Nebandykite tuščių baterijų reaktyvuoti arba įkrauti (sprogimo ir išėsdinimo pavojus).<br>Neardykite ir nepažeiskite baterijų. Nemeskite baterijų į ugnį. | **⚠ ETTEVAATUST**<br>**Patareide asjatundmatu käsitsemine! Vigastusoht!**<br>Ärge üritage kunagi tühje patareisid reaktiveerida või täis laadida (plahvatus- ja söövitusoht).<br>Ärge demonteerige ega kahjustage patareisid. Ärge visake patareisid tulle. | **⚠ ΠΡΟΣΟΧΗ**<br>**Ακατάλληλος χειρισμός μπαταριών! Κίνδυνος τραυματισμού!**<br>Μην επιδιώκετε να ενεργοποιήσετε ξανά ή να φορτίσετε κενές μπαταρίες (κίνδυνος έκρηξης και διάβρωσης).<br>Μην διαλύετε ή καταστρέφετε τις μπαταρίες. Μην απορρίπτετε τις μπαταρίες στη φωτιά. |

| CN 中文 |
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| ⚠警告 **如果不按照下述指定的安全说明使用，将会导致人身伤害！**<br>在没有阅读，理解随本产品附带的文件并熟知正当使用前，不要安装或使用本产品。<br>如果没有您所在国家官方语言文件说明，请与 Rexroth 销售伙伴联系。<br>只允许有资格人员对驱动器部件进行操作。<br>安全说明的详细解释在本文档的第一章。 |
| ⚠警告 **高电压！电击导致生命危险！**<br>只有在安装了永久良好的设备接地导线后才可以对驱动器的部件进行操作。<br>在接触驱动器部件前先将驱动器部件断电。<br>确保电容放电时间。 |
| ⚠警告 **危险运动！生命危险！**<br>保证设备的运动区域内和移动部件周围无障碍物。<br>防止人员意外进入设备运动区域内。<br>在接近或进入危险区域之前，确保传动设备安全停止。 |
| ⚠警告 **电磁场/磁场！对佩戴心脏起搏器、金属植入物和助听器的人员会造成严重的人身伤害！**<br>上述人员禁止进入安装及运行的驱动器区域，或者必须事先咨询医生。 |
| ⚠小心 **热表面（大于 60 度）！灼伤风险！**<br>不要触摸金属表面（例如散热器）。驱动器部件断电后需要时间进行冷却（至少 15 分钟）。 |
| ⚠小心 **安装和运输不当导致受伤危险！当心受伤！**<br>使用适当的运输和安装设备。<br>使用适合的工具及用适当的防护设备。 |
| ⚠小心 **电池操作不当！受伤风险！**<br>请勿对低电量电池重新激活或重新充电（爆炸和腐蚀的危险）。<br>请勿拆解或损坏电池。请勿将电池投入明火中。 |

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# 1 Safety Instructions for Electric Drives and Controls

## 1.1 Definitions of Terms

### Documentation

A documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, mounting, installing, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Instruction Manual, Commissioning Manual, Application Description, Assembly Instructions, Project Planning Manual, Safety Notes, Product Insert, etc.

### Component

A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

### Control System

A control system comprises several interconnected control components placed on the market as a single functional unit.

### Device

A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

### Electrical Equipment

Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

### Electric Drive System

An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

### Installation

An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

### Machine

A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements,

as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

### Manufacturer

The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

### Product

Examples of a product: Device, component, part, system, software, firmware, among other things.

### Qualified Persons

In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them

2) to be trained or instructed to maintain and use adequate safety equipment

3) to attend a course of instruction in first aid

### User

A user is a person installing, commissioning or using a product which has been placed on the market.

## 1.2 Explanation of Signal Words and the Safety Alert Symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

**⚠ DANGER**

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

**⚠ WARNING**

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

**⚠ CAUTION**

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

***NOTICE***

In case of non-compliance with this safety instruction, property damage could occur.

## 1.3 General Information

### 1.3.1 Using the Safety Instructions and Passing Them on to Others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Bosch Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

**Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.**

### 1.3.2 Requirements for Safe Use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Bosch Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in

which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Disconnect the internal EMC filter when installing the drive on an IT system (an ungrounded power system or a high-resistance-grounded [over 30 ohms] power system), otherwise the system will be connected to ground potential through the EMC filter capacitors. This may cause danger or damage the drive. Disconnect the internal EMC filter when installing the drive on a corner-grounded TN system, otherwise the drive will be damaged. When the internal EMC filter is disconnected, the drive is not EMC compatible.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

*National regulations which the user must take into account*

- European countries: In accordance with European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

### 1.3.3 Hazards by Improper Use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

## 1.4 Instructions with Regard to Specific Dangers

### 1.4.1 Protection Against Contact With Electrical Parts and Housings



This section concerns components of the electric drive and control system with voltages **higher than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

**High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!**

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **10 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

**High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!**

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.

## 1.4.2 Protective Extra-Low Voltage as Protection Against Electric Shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Bosch Rexroth, all connections and terminals with voltages between 5 and 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

**Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!**

If extra-low voltage circuits of devices containing voltages and circuits higher than 50 volts (e.g., the mains connection) are connected to Bosch Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

## 1.4.3 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case

that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

**Dangerous movements! Danger to life, risk of injury, serious injury or property damage!**

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

**To avoid accidents, injury and/or property damage:**

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control

and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

### 1.4.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors or permanent magnets of electric motors represent a serious danger to persons with heart pacemakers, metal implants and hearing aids.

**Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric components!**

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the electric drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs so greatly that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above.

### 1.4.5 Protection Against Contact with Hot Parts

**Hot surfaces of components of the electric drive and control system. Risk of burns!**

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

### 1.4.6 Protection During Handling and Mounting

**Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!**

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

# 2 Important Directions for Use

## 2.1 Appropriate Use

Bosch Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products can only be used in the appropriate way. Otherwise, situations resulting in property damage and personal injury may occur.



Bosch Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the rights to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Bosch Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied.

- Personnel that in any way or form use our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the products take the form of hardware, they must remain in their original state, in other words, no structural changes are permitted.
- It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

## 2.2 Inappropriate Use

Using the frequency converters outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "**inappropriate use**".

Frequency converters shall not be used under following conditions:

- They are subject to operating conditions that do not meet the specified ambient conditions. These include, for example, operation under water, extreme temperature fluctuations or extremely high temperatures.
- Furthermore, the frequency converters shall not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

# 3 Documentation Information

## 3.1 About this Documentation

This **Operating Instructions** contains necessary data and information related to the product, which is the basis for any of other types of documentation.

**⚠ WARNING**

**Personal injury or property damage caused by incorrect operations of applications, machines and installations!**

Do not attempt to install or put the product into operation until you have completely read and understood the descriptions in this documentation!

## 3.2 Relevant Software

- IndraWorks

  Click www.boschrexroth.com, choose "Products > Electric Drives and Controls > Engineering > Software tools > IndraWorks Engineering > Downloads", then download the software package.

## 3.3 Reference

For documentation available in other type or language, please consult your local **Bosch Rexroth** sales partner or check:

www.boschrexroth.com/vfcx615

| Documentation type | Short text / Type code | Material number |
|---|---|---|
| Operating Instructions | DOK-RCON04-VFC-x615***-ITRS-EN-P | R912009377 |
| Quick Start Guide | DOK-RCON04-VFC-x615***-QURS-EN-P | R912009379 |
| Safety Instructions | DOK-RCON**-SAFETY*****-SARS-BP-P | R911339218 |
| | DOK-RCON**-SAFETY*****-SARS-DE-P | R911339363 |
| | DOK-RCON**-SAFETY*****-SARS-EN-P | R911339362 |
| | DOK-RCON**-SAFETY*****-SARS-ES-P | R911339216 |
| | DOK-RCON**-SAFETY*****-SARS-FR-P | R911339213 |
| | DOK-RCON**-SAFETY*****-SARS-IT-P | R911339215 |
| | DOK-RCON**-SAFETY*****-SARS-RU-P | R911339217 |
| | DOK-RCON**-SAFETY*****-SARS-ZH-P | R912004727 |
| Instruction Manual (UL) | DOK-RCON01-REX*F*UL***-INRS-EN-P | R912004711 |
| Mounting Instructions (Extension card module) | DOK-RCON0*-XFC-X610***-ASRS-EN-P | R912006261 |
| Product Insert (I/O module) | DOK-RCON0*-XFC-X610***-ISRS-EN-P | R912006326 |
| Product Insert (PROFIBUS Card) | DOK-RCON0*-XFC-X610COM-ISRS-EN-P | R912006458 |
| Product Insert (CANopen Card) | DOK-RCON0*-XFCX610*CAN-ISRS-EN-P | R912006723 |
| Product Insert (Multi-Ethernet Card) | DOK-RCON0*-XFCX610*MUL-ISRS-EN-P | R912006847 |
| Product Insert (Assembled Extension Module) | DOK-RCON0*-INT*EXT*MOD-ISRS-EN-P | R912006859 |
| Instruction Manual (CANopen Card) | DOK-RCON0*-XFCX610*CAN-ITRS-EN-P | R912006713 |
| Instruction Manual (Multi-Ethernet Card) | DOK-RCON0*-XFCX610*MUL-ITRS-EN-P | R912006860 |
| Operating Instructions (Brake Chopper) | DOK-RCON04-VFC*BRAKE**-ITRS-EN-P | R912007234 |

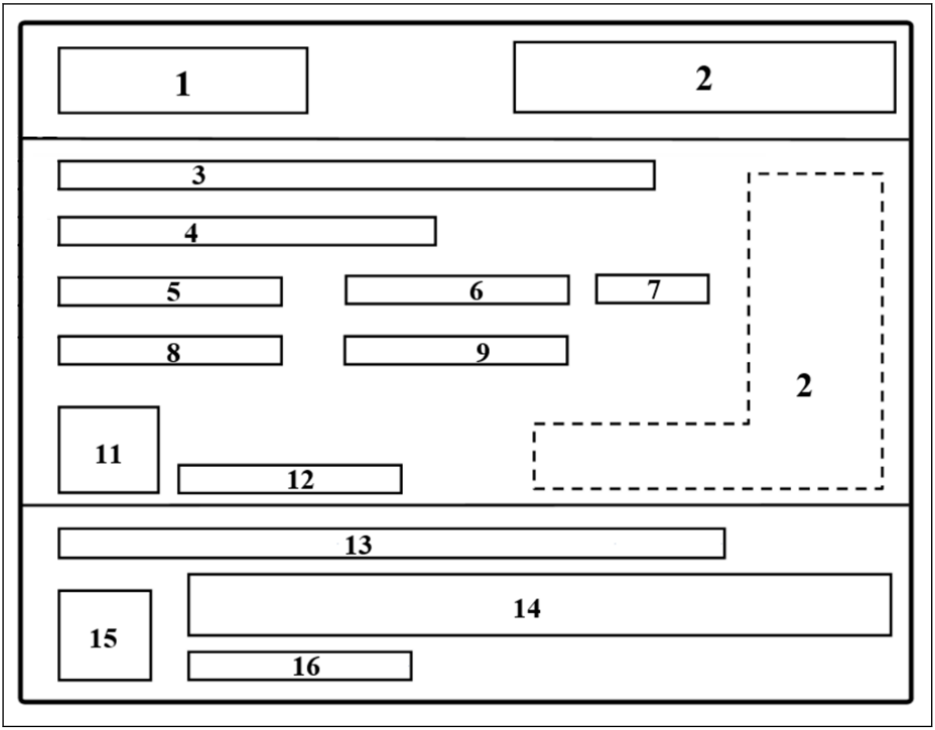
**Tab. 3-1:** Documentation overview

# 4 Delivery and Storage

## 4.1 Product Identification

### 4.1.1 Packing Nameplate

Check if the model information on the packing nameplate is the same as you ordered **immediately** after receipt. If the model is wrong, please contact Bosch Rexroth distributor.

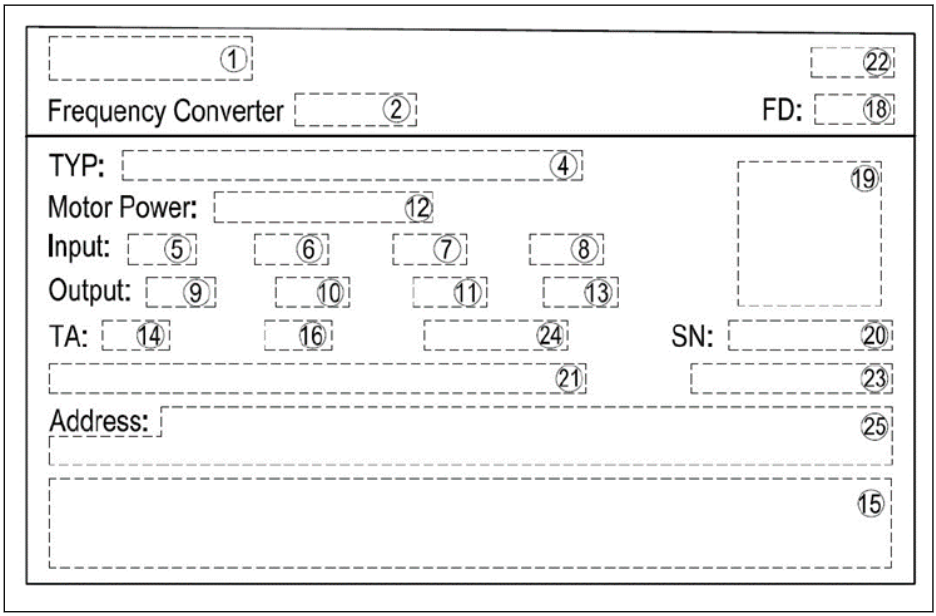



**1** Rexroth LOGO
**2** Identification
**3** TYP
**4** Volume
**5** Net Weight
**6** MNR
**7** Version
**8** Total Weight
**9** FD
**11** SN CODE
**12** SN
**13** Company
**14** Address
**15** QR CODE
**16** TEL

**Fig. 4-1:** Packing nameplate

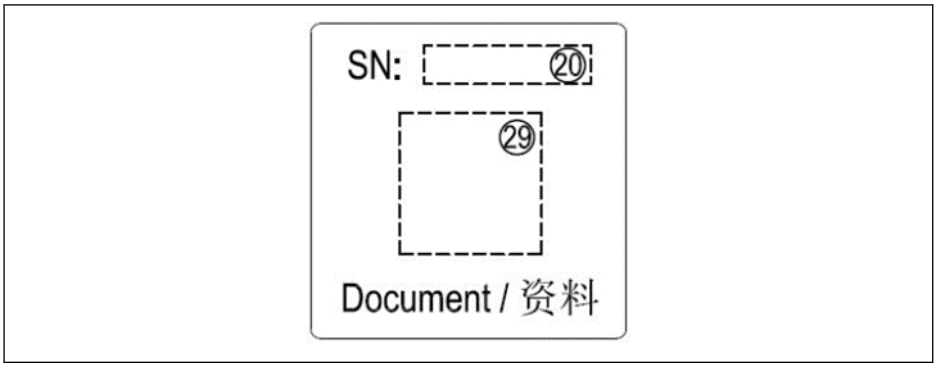
### 4.1.2 Product Nameplate

Check if the model information on product nameplate is the same as you ordered **immediately** after unpacking. If the model is wrong, please contact Bosch Rexroth distributor.




**1** Company Logo
**2** Product series
**4** Type designation
**5** Input voltage type
**6** Input voltage range
**7** Input current
**8** Input frequency
**9** Output voltage type
**10** Output voltage range
**11** Output current
**12** Motor power
**13** Output frequency range
**14** Ambient temperature
**15** Certification logo
**16** Protection category
**18** Manufacturing date
**19** QR code
**20** Serial number
**21** manufacturer
**22** Plant (SAP)
**23** Designation of origin
**24** Efficiency classification
**25** Company address

**Fig. 4-2:** Product nameplate




**20** Serial number
**29** Document QR code

**Fig. 4-3:** Product document QR code

## 4.2 Visual Inspection

Check the product for transport damages, e.g. deformation or loose parts, immediately after unpacking. In case of damage, contact the forwarder at once and arrange for a thorough review of the situation.



This is also applicable if the packaging is undamaged.

## 4.3 Scope of Supply

If any of the following standard supply items is missing, please contact Bosch Rexroth distributor.

- Frequency Converter VFC x615 (According to type code)

## 4.4 Transport of the Components

| Description | Symbol | Unit | Value |
|---|---|---|---|
| Temperature range | $T_{a_tran}$ | °C | -25...70 |
| Relative humidity | – | % | 5...95 |
| Absolute humidity | – | $g/m^3$ | 1...60 |
| Climate category (IEC 721) | – | – | 2K3 |
| Moisture condensation | – | – | not allowed |
| Icing | – | – | not allowed |

**Tab. 4-1:** Transport conditions

## 4.5 Storage of the Components

**⚠ CAUTION**

**Damage to the components caused by long storage periods!**

**A frequency converter contains electrolytic capacitors which may deteriorate during storage.**

When storing these components for a long period of time, remember to operate them once a year:

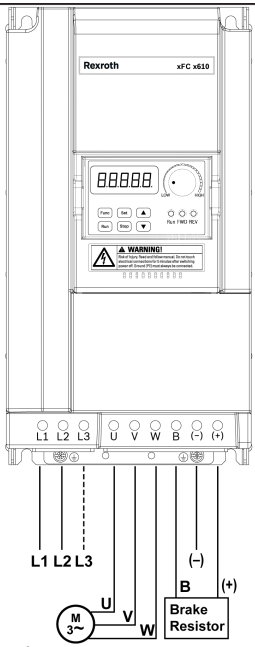
- Run Frequency Converter VFC x615 under power $U_{LN}$ for at least 1 hour.
- For more information of electrolytic capacitors, please contact service.

| Description | Symbol | Unit | Value |
|---|---|---|---|
| Temperature range | $T_{a_store}$ | °C | -20...60 |
| Relative humidity | – | % | 5...95 |
| Absolute humidity | – | $g/m^3$ | 1...29 |
| Climate category (IEC 721) | – | – | 1K3 |
| Moisture condensation | – | – | not allowed |
| Icing | – | – | not allowed |

**Tab. 4-2:** Storage conditions

# 5 Drive System Overview

| Name | 1P 200 VAC | 3P 400 VAC | Description |
|---|---|---|---|
| Power supply | L1 L2 | L1 L2 L3 | **Power supply**<br>Ensure that the power supply meets the rated values specified in this documentation. |
| Fuse | | | **Fuse**<br>A frequency converter may take a high input current when being switched on. Please select an appropriate fuse.① |
| Electromagnetic contactor | | | **Electromagnetic contactor (MC)**<br>Do not use an MC as Run/Stop switch frequently. Ensure not exceed the frequency of once/15 minutes.② |
| AC input choke | | | **AC input choke**<br>An AC input choke is recommended to improve power factors.<br>The wiring length must be less than 10 m. |
| EMC filter | | | **EMC filter** |
| Frequency converter | N N | | **Frequency converter**<br>See the figure on the right side for connections of other accessories. |
| AC output choke | | | **AC output choke**<br>It is recommended to use an AC output choke and multi-conductor twisted cables in order to avoid motor insulation destruction. ③ |
| Motor | M 3~ | | **Motor** |




**Caution:**
For a 1P 200 VAC frequency converter, removing the cover of terminal L3 is not allowed. ④

**Fig. 5-1:** Drive system overview

①: To select an appropriate fuse, see chapter 8.2.1 "Power Cables" on page 54.

②: Excessively frequent starting and stopping will shorten the life time of relay contacts and DC-bus capacitors, and may destroy the resistor for capacitor charging and current limitation.

③: Whether using an AC output choke or not depends on the factors of: the length, shielding and distribution capacitance of the motor cables, as well as the insulation of the motor.

④: The covers of terminal (+), (-) and B can be removed as needed.

# 6 Frequency Converter Overview

## 6.1 Product Features

### 6.1.1 Input

| | |
|---|---|
| Power supply voltage | 1P 200...240 VAC (-10 % / +10 %) (IT-Net, TN-Net) |
| | 3P 380...480 VAC (-15 % / +10 %) (IT-Net, TN-Net) |
| Power supply frequency | 50 / 60 Hz (±5 %) |

### 6.1.2 Output

| | |
|---|---|
| Rated voltage | Corresponding to input voltage |
| Rated power | 0.4...2.2 kW (1P 200 VAC) |
| | 0.4...400 kW (3P 380 VAC) |
| Rated frequency | 0.00...400.00 Hz |
| Default carrier frequency | 0K40...110K0: 4k |
| | 132K...400K: 2k |
| Carrier frequency range | 0.4...30 kW: 1...15 kHz |
| | 37...110 kW: 1...12 kHz |
| | 132...400 kW: 1...6 kHz |
| Efficiency | > 95 % |
| Overload capability | Heavy Duty*: 150 % of rated current for 60 s[1)] |
| | Normal Duty*: 120 % of rated current for 60 s[2)] |
| dv / dt (Without filter) | < 5kV / us |

*: Heavy Duty / Normal Duty modes are applicable for models 5K50 and above.

1): 150 % of HD rated current for 60 s, and then 540 s with rated current for recovery from the overload influence, after this comes next overload period.

2): 120 % of ND rated current for 60 s, and then 540 s with rated current for recovery from the overload influence, after this comes next overload period.

### 6.1.3 V/f Control Performance

| | |
|---|---|
| V/f curve | Linear mode, square curve mode, user-defined multi-point curve mode |
| Speed regulation range | 1:50 |
| Start-up torque | 150 % of rated torque at 3.00 Hz<br>100 % of rated torque at 1.50 Hz |

### 6.1.4 SVC Control Performance

| | |
|---|---|
| Speed regulation range | 1:200 |
| Start-up torque | 200 % of rated torque at 0.50 Hz |

## 6.1.5 Main Functions

| | |
|---|---|
| Frequency setting resolution | Analog setting: 1/1,000 of maximum frequency<br>Digital setting: 0.01 Hz |
| Frequency setting accuracy | Analog setting: ±0.1 % of maximum frequency (25 ℃ ± 10 ℃)<br>Digital setting: ±0.01 % of maximum frequency (-10…50 ℃) |
| Acceleration / deceleration curve mode | Linear, S-curve<br>8 sets of acceleration / deceleration time: 0.1…6,000.0 s |
| Stop DC-braking | DC-braking initial frequency: 0.00…50.00 Hz<br>DC-braking time: 0.0…20.0 s<br>Stop DC-braking current: 0.0…150.0 % |
| Jog function | Jog frequency range: 0.00 Hz…maximum output frequency<br>Jog acceleration / deceleration time: 0.1…6,000.0 s |
| Multi-speed control | 16 stages by digital input control |
| Simple PLC control | 16 stages with pause / stop control |
| PID control | PID control with sleep / wake function |
| Digital input | 5 digital inputs support PNP and NPN wiring, X5 supports 50.0 kHz pulse input |
| Analog input | 2 Analog inputs: 0 / 2…10 V or 0 / 4…20 mA |
| Digital output | 1 Open collector output, supports 32.0 kHz pulse output and pull-up and pull-down wiring<br>1 Relay output |
| Analog output | Analog output 0…10 V or 0…20 mA, to output setting frequency, output frequency, output current, output power, output voltage, analog input voltage and analog input current |
| Other functions | Carrier frequency automatic adjustment, first and second frequency setting source, slip compensation, torque boost, automatic voltage stabilization, power loss restart mode, 2-wire / 3-wire control, quick start parameters, parameter copy, output current limitation, power fault ride-through, etc. |

## 6.1.6 Communication

| | |
|---|---|
| Standard communication protocol | Modbus |
| Standard communication interface | RS485 |
| Optional communication protocol and interface | Depending on communication module<br>(Needs to be ordered additionally) |

## 6.1.7 Operating Panel

| | |
|---|---|
| LED panel | **Display**: Display parameters, settings, status codes, warning codes and error codes<br>**Buttons**: Set parameters, switch display, reset warnings, execute run and stop command, increase or decrease parameter group / code / value<br>**Potentiometer**: Set frequency<br>**Indicator**: Run, FWD, REV |
| Dust cover | Indicating Run, FWD, REV and Power* |

*: Indicator is displayed only if the option module is not used.

## 6.1.8 Protection

Over current protection, over- / under- voltage protection, surge current / short circuit protection, input / output phase loss protection, converter over- / under- temperature protection, motor overload protection, motor over temperature protection, direction lock protection, analog input broken wire detection, etc.

### 6.1.9 Conditions

| | |
|---|---|
| Rated ambient temperature | -10...40 °C |
| Derating / ambient temperature | 1.5 % / 1 °C (40...50 °C) |
| Rated storage temperature | -20...60 °C |
| Rated altitude | ≤ 1,000 m |
| Derating / altitude | 1 % / 100 m (1,000...4,000 m) |
| Relative humidity | ≤ 90 % RH (No condensation) |
| Degrees of protection | IP 20 (Control cabinet mounting) |
| Degrees of pollution | 2 (EN 50178) |
| Vibration | 10 Hz ≤ f ≤ 57 Hz amplitude: 0.075 mm<br>57 Hz < f ≤ 150 Hz acceleration: 1 g |
| Mounting mode | Wall mounting |
| Cooling type | Natural cooling (≤ 0K75)<br>Enforced air cooling (≥ 1K50) |
| Certification | CE (applicable to 0K40...400K)<br>EAC (applicable to 0K40...400K) |

## 6.2 Technical Data

### 6.2.1 Electric Data

| Model | Motor power [kW] | 200 V / 240 V Input current [A] | 200 V / 240 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 0K40 | 0.4 | 6.2 / 5.1 | 2.4 /2.0 | 0.8 |
| 0K75 | 0.75 | 10.1 / 8.4 | 4.1 / 3.4 | 1.4 |
| 1K50 | 1.5 | 16.2 / 13.5 | 7.3 / 6.1 | 2.5 |
| 2K20 | 2.2 | 22.3 / 18.6 | 10.1 / 8.4 | 3.5 |

**Tab. 6-1:** 1P 200 VAC 0K40...2K20 electric data

| Model | Motor power [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 0K40 | 0.4 | 1.5 / 1.2 | 1.3 / 1.1 | 0.9 |
| 0K75 | 0.75 | 2.6 / 2.0 | 2.3 / 1.8 | 1.5 |
| 1K50 | 1.5 | 4.8 / 3.8 | 4.0 / 3.2 | 2.7 |
| 2K20 | 2.2 | 6.8 / 5.4 | 5.6 / 4.4 | 3.7 |
| 3K00 | 3.0 | 9.1 / 7.2 | 7.4 / 5.9 | 4.9 |
| 4K00 | 4.0 | 11.9 / 9.4 | 9.7 / 7.7 | 6.4 |

**Tab. 6-2:** 3P 380 VAC 0K40...4K00 electric data

| Model | Motor power Heavy Duty [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 5K50 | 5.5 | 15.7 / 12.4 | 12.7 /10.0 | 8.3 |
| 7K50 | 5.5 | 15.7 / 12.4 | 12.7 /10.0 | 8.3 |
| 11K0 | 7.5 | 21.0 / 16.7 | 16.8 / 13.3 | 11.1 |
| 15K0 | 11.0 | 28.0 / 22.2 | 24.3 / 19.2 | 16.0 |
| 18K5 | 15.0 | 37.8 / 29.9 | 32.4 / 25.6 | 21.3 |
| 22K0 | 18.5 | 45.8 / 36.3 | 39.2 / 31.0 | 25.8 |
| 30K0 | 22.0 | 52.7 / 41.7 | 45.0 / 36.0 | 29.7 |
| 37K0 | 30.0 | 71.2 / 56.3 | 60.8 / 48.1 | 40.0 |
| 45K0 | 37.0 | 87.2 / 69.0 | 73.7 / 58.3 | 48.5 |
| 55K0 | 45.0 | 105.0 / 84.0 | 89.0/71.0 | 58.7 |
| 75K0 | 55.0 | 128.0 / 102.0 | 108.0 / 86.0 | 71.3 |
| 90K0 | 75.0 | 174.0 / 138.0 | 147.0 / 116.0 | 96.9 |
| 110K | 90.0 | 208.0 / 165.0 | 176.0 / 139.0 | 115.6 |
| 132K | 110.0 | 205.0 / 162.0 | 212.0 / 168.0 | 139.6 |

| Model | Motor power Heavy Duty [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 160K | 132.0 | 252.0 / 200.0 | 253.0 / 200.0 | 166.0 |
| 185K | 160.0 | 305.0 / 242.0 | 303.0 / 240.0 | 199.0 |
| 200K | 185.0 | 354.0 / 280.0 | 351.0 / 278.0 | 231.0 |
| 220K | 200.0 | 383.0 / 303.0 | 380.0 / 301.0 | 249.4 |
| 250K | 220.0 | 419.0 / 332.0 | 411.0 / 325.0 | 270.2 |
| 280K | 250.0 | 461.0 / 365.0 | 467.0 / 370.0 | 307.4 |
| 315K | 280.0 | 516.0 / 409.0 | 522.0 / 413.0 | 343.6 |
| 355K | 315.0 | 580.0 / 459.0 | 588.0 / 465.0 | 387.0 |
| 400K | 400.0 | 730.0 / 578.0 | 738.0 /584.0 | 486.0 |

**Tab. 6-3:** 3P 380 VAC 5K50...400K, electric data, Heavy Duty



37K0...400K: available with ONLY VFC 5615.

Please select the current rating of frequency converter according to the motor rated current on the nameplate.

| Model | Motor power Normal Duty [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 5K50 | 7.5 | 21.0 / 16.7 | 16.8 / 13.3 | 11.1 |
| 7K50 | 7.5 | 21.0 / 16.7 | 16.8 / 13.3 | 11.1 |
| 11K0 | 11.0 | 28.0 / 22.2 | 24.3 / 19.2 | 16.0 |
| 15K0 | 15.0 | 37.8 / 29.9 | 32.4 / 25.6 | 21.3 |
| 18K5 | 18.5 | 45.8 / 36.3 | 39.2 / 31.0 | 25.8 |
| 22K0 | 22.0 | 52.7 / 41.7 | 45.0 / 36.0 | 29.7 |
| 30K0 | 30.0 | 71.2 / 56.3 | 60.8 / 48.0 | 40.0 |
| 37K0 | 37.0 | 87.2 / 69.0 | 73.7 / 58.3 | 48.5 |
| 45K0 | 45.0 | 105.5 / 83.5 | 89.1 / 70.5 | 58.7 |
| 55K0 | 55.0 | 128.0 / 102.0 | 108.0 / 86.0 | 71.3 |
| 75K0 | 75.0 | 174.0 / 138.0 | 147.0 / 116.0 | 96.9 |
| 90K0 | 90.0 | 208.0 / 165.0 | 176.0 / 139.0 | 115.6 |
| 110K | 110.0 | 254.0 / 201.0 | 212.0 / 168.0 | 139.6 |
| 132K | 132.0 | 252.0 / 200.0 | 253.0 / 200.0 | 166.0 |
| 160K | 160.0 | 305.0 / 242.0 | 303.0 / 240.0 | 199.0 |
| 185K | 185.0 | 354.0 / 280.0 | 351.0 / 278.0 | 231.0 |
| 200K | 200.0 | 383.0 / 303.0 | 380.0 / 300.0 | 250.0 |
| 220K | 220.0 | 419.0 / 332.0 | 411.0 / 325.0 | 270.2 |
| 250K | 250.0 | 476.0 / 377.0 | 467.0 / 370.0 | 307.0 |

| Model | Motor power Normal Duty [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 280K | 280.0 | 516.0 / 409.0 | 522.0 / 413.0 | 343.6 |
| 315K | 315.0 | 580.0 / 459.0 | 588.0 / 465.0 | 387.0 |
| 355K | 355.0 | 651.0 / 515.0 | 659.0 / 474.0 | 433.7 |

**Tab. 6-4:** 3P 380 VAC 5K50...355K, electric data, Normal Duty



37K0...355K: available with ONLY VFC 5615.

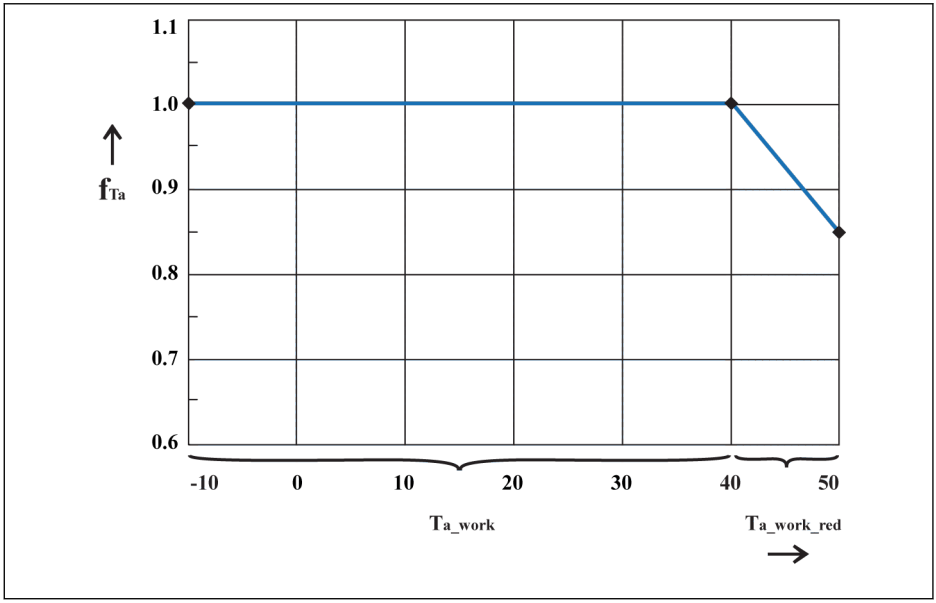
Please select the current rating of frequency converter according to the motor rated current on the nameplate.

## 6.2.2 Derating of Electric Data

### Derating and ambient temperature

The ambient temperature for Frequency Converter VFC x615 is -10...50 ℃. Out of this range, there will be no possibility to install and run the frequency converter, even the performance data have been additionally reduced.

- If the ambient temperature is -10...40 ℃, there will be no need for derating.
- If the ambient temperature is 40...50 ℃, derating must be performed as indicated in the figure below.




$f_{Ta}$ Load factor
Ta_work Ambient temperature range for operation with rated data
Ta_work_red Ambient temperature range for operation with reduced rated data

**Fig. 6-1:** Derating and ambient temperature (℃)

### Derating and mains voltage

Reduce overcurrent based on mains voltage.

Frequency Converter VFC x615 is thermally dimensioned for the rated current. This rated current is available with the specified rated voltage. With deviating voltages in the permissible range, please pay attention to the following:

- $U_{mains} < U_{rated}$:

  With mains voltage below the rated voltage, no higher current may be withdrawn to ensure that the dissipated power remains.

- $U_{mains} > U_{rated}$:

  With mains voltage above the rated voltage, a reduction of the permissible output permanent current takes place to compensate for the increased switching losses.

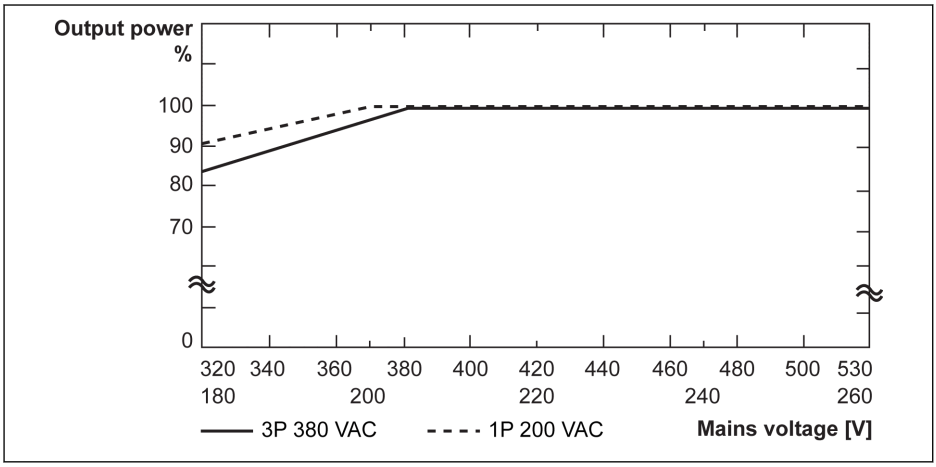
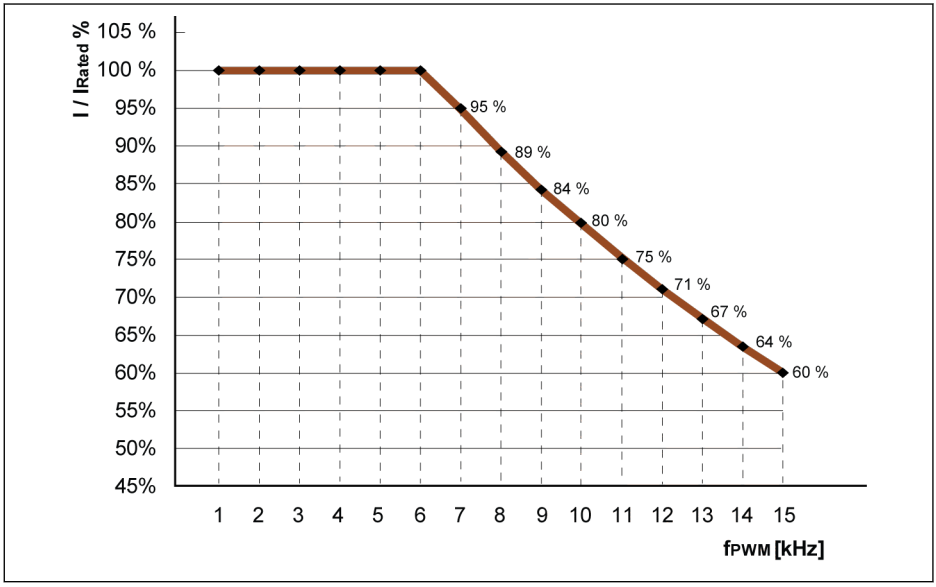



**Fig. 6-2:** Derating and mains voltage

- 3P 380 VAC: 1 % power derating every 4 V lower than 380 V.
- 1P 200 VAC: 1 % power derating every 2 V lower than 200 V.

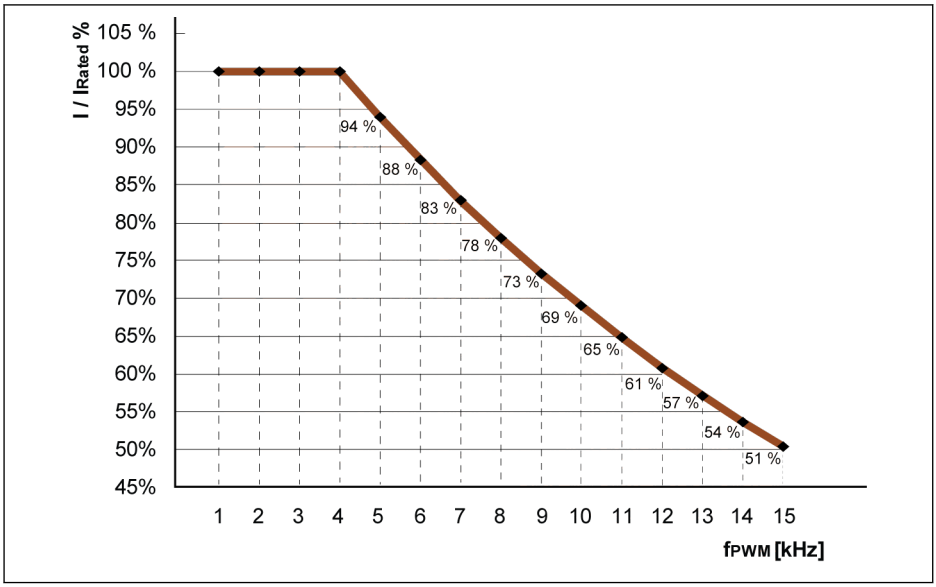
## Derating and carrier frequency

In case of higher carrier frequency, the output current is reduced so that the power dissipation in power section remains more or less constant. The figure below shows the current reduction based on the carrier frequency for the frequency converters:



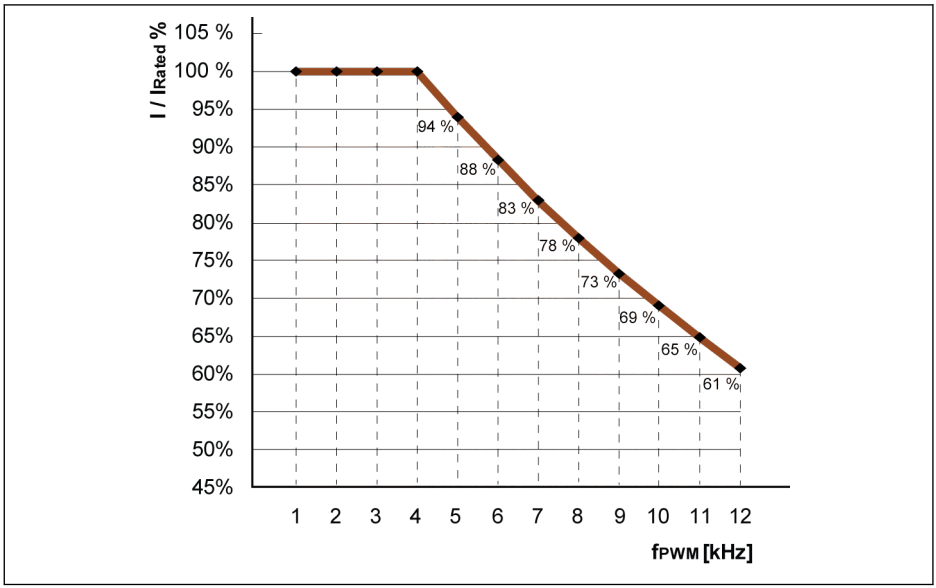

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 6-3:** Derating and carrier frequency for 0K40...4K00 models (Normal Duty)



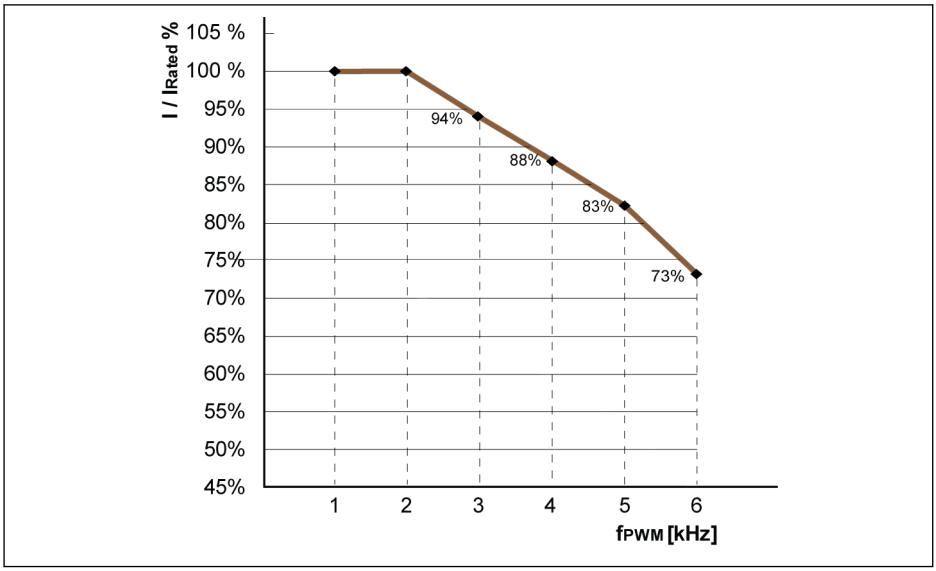

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 6-4:** Derating and carrier frequency for 5K50...30K0 models (Normal Duty and Heavy Duty)



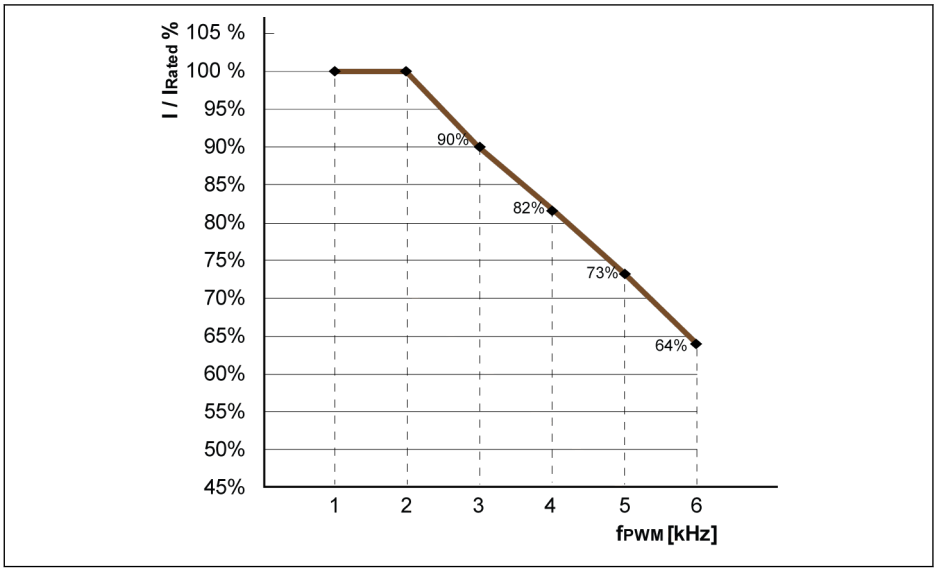

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 6-5:** Derating and carrier frequency for 37K0...110K models (Normal Duty and Heavy Duty)




**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 6-6:** Derating and carrier frequency for 132K..200K models (Normal Duty and Heavy Duty)




**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 6-7:** Derating and carrier frequency for 220K...400K models (Normal Duty and Heavy Duty)

### 6.2.3 Maximum Length of Motor Cables

| Model | Configuration | Maximum length of motor cables for C3 [m] |
|---|---|---|
| 0K40...30K0 | VFC x615 | - |
| | VFC x615 + External mains EMC filter | 50 |
| 37K0...200K | VFC x615 | - |
| | VFC x615 + External mains EMC filter | 100 |
| 220K...400K | VFC x615 | - |
| | VFC x615 + External mains EMC filter | 150 |

**Tab. 6-5:** Maximum length of motor cables



**SHIELDED MOTOR CABLES** are used in test.

### 6.2.4 Minimum Inductance Between Two Motor Terminals

The following formula is used to calculate the minimum inductance between two motor terminals:

$L_{min} = U_{DC} / (8 \times f_{PWM} \times \sqrt{2} \times I_{nom} \times 0.2)$ (in mH)

$U_{DC}$: DC-link voltage

$f_{PWM}$: Desired switching frequency in kHz

$I_{nom}$: Output current according to the type code (rms value)

# 7 Frequency Converter Mounting

## 7.1 Installation Conditions

The frequency converter must be vertically installed.

If one frequency converter is arranged above another, make sure the upper limit of air temperature into the inlet is not exceeded (see [External link could not be resolved.]). An air guide is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter if the upper limit of air temperature is exceeded.

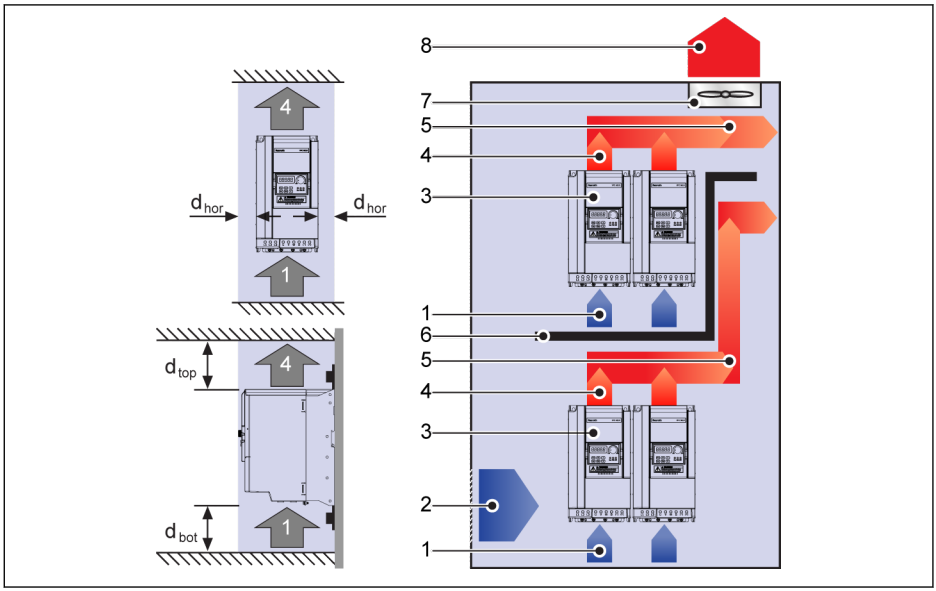



**Fig. 7-1:** Mounting distance and arrangement

$d_{hor}$ (Distance horizontal):

$d_{hor}$ = 0 mm (0K40...30K0); $d_{hor}$ = 100 mm (37K0...280K); $d_{hor}$ = 200 mm (315K...400K)

Do not place any equipment and components near the fan outlet on the side of the converter.

$d_{top}$ (Minimum top distance):

$d_{top}$ = 125 mm (0K40...110K); $d_{top}$ = 350 mm (132K...400K)

$d_{bot}$ (Minimum bottom distance):

$d_{bot}$ = 125 mm (0K40...110K); $d_{bot}$ = 350 mm (132K...400K)

1: Air inlet at frequency converter; 2: Air inlet at control cabinet

3: Frequency converter; 4: Air outlet at frequency converter

5: Heated air conveying direction; 6: Air guide in control cabinet

7: Fan in control cabinet; 8: Discharge of heated air

## 7.2 Heat Dissipation

### 1P 200 VAC

| Frame | Model | Heat dissipation | |
|---|---|---|---|
| | | [W] | [BTU/h] |
| B | 0K40 | 40 | 136 |
| B | 0K75 | 70 | 256 |
| C | 1K50 | 120 | 409 |
| D | 2K20 | 165 | 563 |

**Tab. 7-1:** 1P 200 VAC heat dissipation

### 3P 380 VAC

| Frame | Model | Heat dissipation | |
|---|---|---|---|
| | | [W] | [BTU/h] |
| B | 0K40 | 20 | 68 |
| B | 0K75 | 37 | 126 |
| C | 1K50 | 75 | 256 |
| C | 2K20 | 99 | 338 |
| D | 3K00 | 135 | 461 |
| D | 4K00 | 180 | 614 |
| E | 5K50 | 210 | 714 |
| E | 7K50 | 210 | 714 |
| E | 11K0 | 255 | 867 |
| F | 15K0 | 320 | 1,088 |
| F | 18K5 | 435 | 1,479 |
| G | 22K0 | 530 | 1,802 |
| G | 30K0 | 640 | 2,176 |
| H | 37K0 | 745 | 2,533 |
| H | 45K0 | 874 | 2,972 |
| I | 55K0 | 1,388 | 4,737 |
| I | 75K0 | 1,927 | 6,574 |
| J | 90K0 | 2,082 | 7,103 |
| J | 110K | 2,613 | 8,916 |
| K | 132K | 2,530 | 8,602 |
| K | 160K | 2,772 | 9,425 |
| L | 185K | 3,650 | 12,446 |

| Frame | Model | Heat dissipation | |
|---|---|---|---|
| | | [W] | [BTU/h] |
| L | 200K | 3,813 | 13,002 |
| M | 220K | 4,366 | 14,888 |
| M | 250K | 5,121 | 17,462 |
| M | 280K | 6,500 | 22,165 |
| N | 315K | 5,600 | 19,096 |
| N | 355K | 6,350 | 21,653 |
| N | 400K | 7,100 | 24,226 |

**Tab. 7-2:** 3P 380 VAC heat dissipation

## 7.3 Air Flow of Fans

### 1P 200 VAC

| Frame | Model | Fan for heat sink | | | Fan for internal components | | | Total air flow | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | [CFM] | [m³/min] | Quantity | [CFM] | [m³/min] | [CFM] | [m³/min] |
| B | 0K40 | – | – | – | – | – | – | – | – |
| B | 0K75 | – | – | – | – | – | – | – | – |
| C | 1K50 | 1 | 19.20 | 0.54 | – | – | – | 19.20 | 0.54 |
| D | 2K20 | 1 | 19.20 | 0.54 | – | – | – | 19.20 | 0.54 |

**Tab. 7-3:** 1P 200 VAC air flow of fans

### 3P 380 VAC

| Frame | Model | Fan for heat sink | | | Fan for internal components | | | Total air flow | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | [CFM] | [m³/min] | Quantity | [CFM] | [m³/min] | [CFM] | [m³/min] |
| B | 0K40 | – | – | – | – | – | – | – | – |
| B | 0K75 | – | – | – | – | – | – | – | – |
| C | 1K50 | – | – | – | – | – | – | – | – |
| C | 2K20 | 1 | 19.20 | 0.54 | – | – | – | 19.2 | 0.54 |
| D | 3K00 | 1 | 19.20 | 0.54 | – | – | – | 19.2 | 0.54 |
| D | 4K00 | 1 | 19.20 | 0.54 | – | – | – | 19.2 | .054 |
| E | 5K50 | 1 | 40.00 | 1.13 | – | – | – | 40 | 1.13 |
| E | 7K50 | 1 | 40.00 | 1.13 | – | – | – | 40 | 1.13 |
| E | 11K0 | 1 | 40.00 | 1.13 | – | – | – | 40 | 1.13 |
| F | 15K0 | 2 | 40.00 | 1.13 | – | – | – | 80 | 2.26 |
| F | 18K5 | 2 | 40.00 | 1.13 | – | – | – | 80 | 2.26 |
| G | 22K0 | 2 | 40.00 | 1.13 | – | – | – | 80 | 2.26 |
| G | 30K0 | 2 | 49.20 | 1.39 | – | – | – | 98.4 | 2.78 |
| H | 37K0 | 2 | 120.20 | 3.40 | – | – | – | 240.4 | 6.8 |
| H | 45K0 | 2 | 120.20 | 3.40 | – | – | – | 240.4 | 6.8 |
| I | 55K0 | 2 | 215.74 | 6.11 | – | – | – | 431.48 | 12.22 |
| I | 75K0 | 2 | 215.74 | 6.11 | – | – | – | 431.48 | 12.22 |
| J | 90K0 | 2 | 215.74 | 6.11 | – | – | – | 431.48 | 12.22 |
| J | 110K | 2 | 215.74 | 6.11 | – | – | – | 431.48 | 12.22 |
| K | 132K | 3 | 243.64 | 6.90 | – | – | – | 730.92 | 20.7 |
| K | 160K | 3 | 243.64 | 6.90 | – | – | – | 730.92 | 20.7 |
| L | 185K | 3 | 243.64 | 6.90 | – | – | – | 730.92 | 20.7 |

| Frame | Model | Fan for heat sink | | | Fan for internal components | | | Total air flow | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | [CFM] | [$m^3$/min] | Quantity | [CFM] | [$m^3$/min] | [CFM] | [$m^3$/min] |
| L | 200K | 3 | 243.64 | 6.90 | – | – | – | 730.92 | 20.7 |
| M | 220K | 4 | 243.64 | 6.90 | – | – | – | 974.56 | 27.6 |
| M | 250K | 4 | 243.64 | 6.90 | – | – | – | 974.56 | 27.6 |
| M | 285K | 4 | 243.64 | 6.90 | – | – | – | 974.56 | 27.6 |
| N | 315K | 5 | 243.64 | 6.90 | 1 | 243.64 | 6.9 | 1461.84 | 41.4 |
| N | 355K | 5 | 243.64 | 6.90 | 1 | 243.64 | 6.9 | 1461.84 | 41.4 |
| N | 400K | 5 | 243.64 | 6.90 | 1 | 243.64 | 6.9 | 1461.84 | 41.4 |

**Tab. 7-4:** 3P 380 VAC air flow of fans

## 7.4 Figures and Dimensions

### 7.4.1 Standard Models

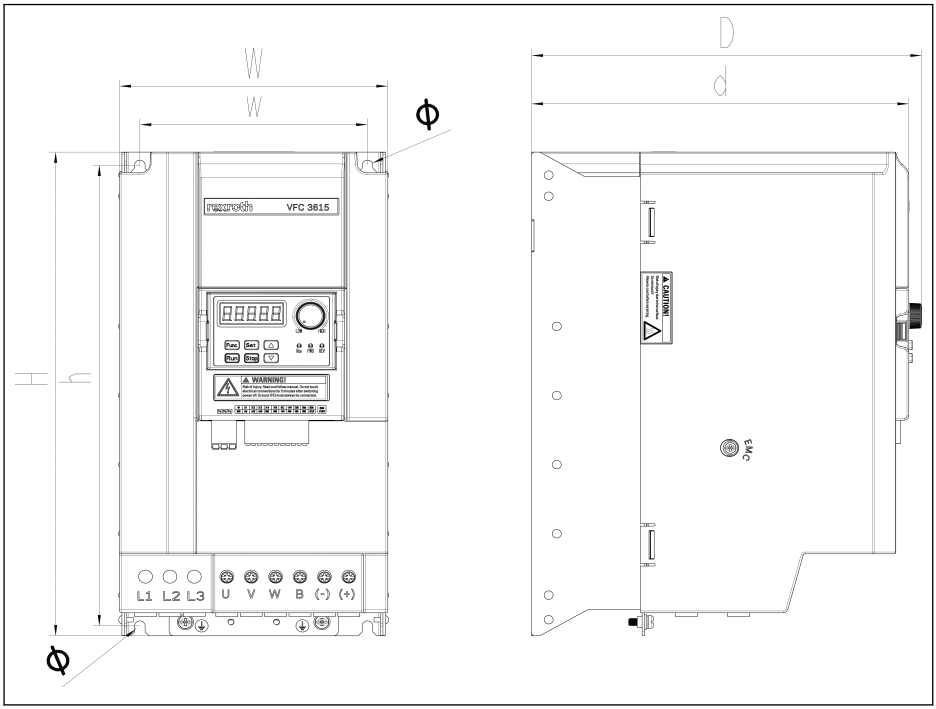



**Fig. 7-2:** VFC x615 0K40...22K0 dimensions figure

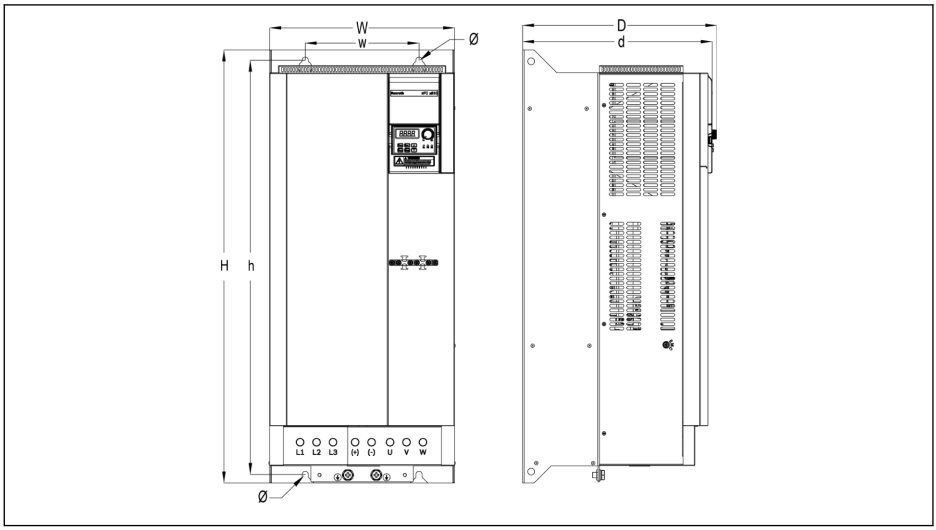



**Fig. 7-3:** VFC 5615 30K0...90K0 dimensions figure

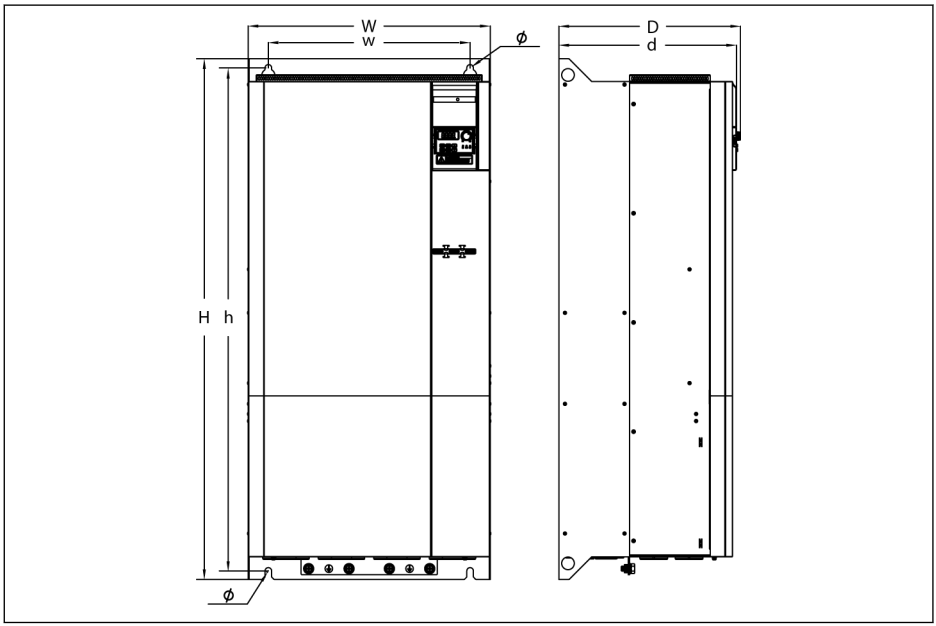



**Fig. 7-4:** VFC 5615 110K...250K dimensions figure

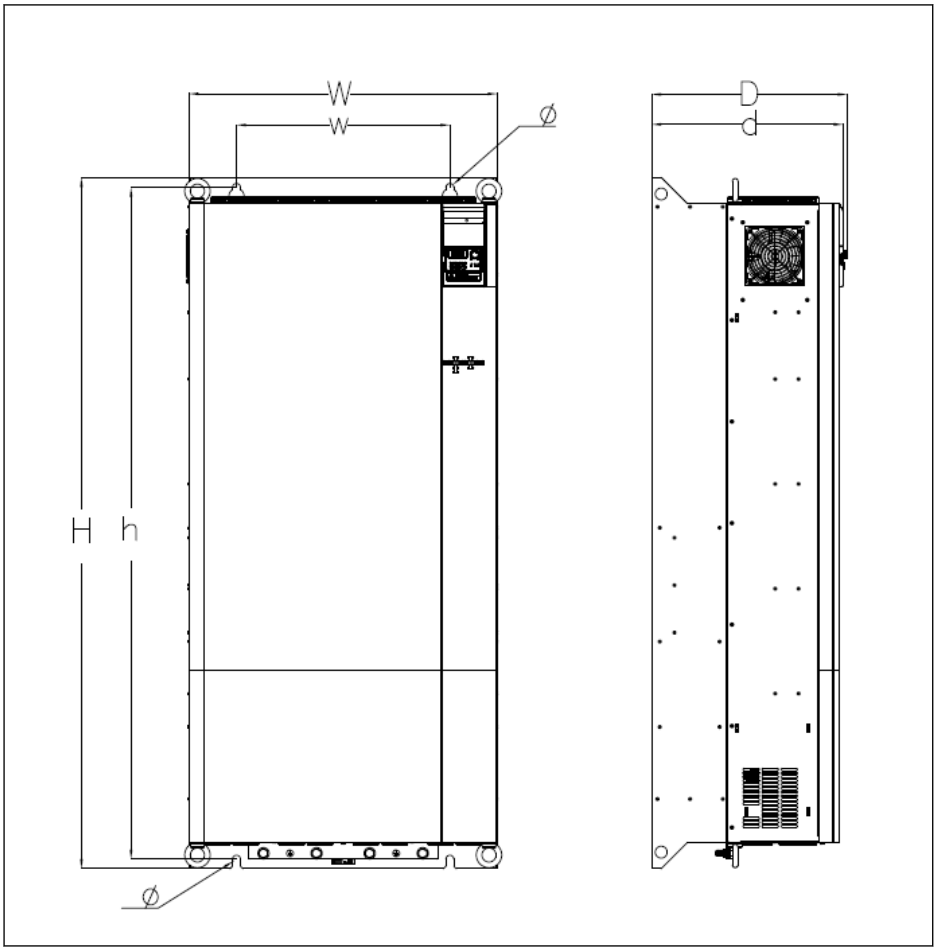



**Fig. 7-5:** VFC 5615 280K...400K dimensions figure

| Frame | Model① | Dimensions [mm] | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D④ | w | h | d④ | Ø | | |
| B | 0K40 | 95 | 166 | 167 | 66 | 156 | 159 | 4.5 | M4 | 1.5 |
| B | 0K75 | 95 | 166 | 167 | 66 | 156 | 159 | 4.5 | M4 | 1.5 |
| C | 1K50 | 95 | 206 | 170 | 66 | 196 | 162 | 4.5 | M4 | 1.8 |
| D | 2K20 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |

**Tab. 7-5:** VFC x610 1P 200 VAC dimensions

| Frame | Model① | Dimensions [mm] | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D④ | w | h | d④ | Ø | | |
| B | 0K40 | 95 | 166 | 167 | 66 | 156 | 159 | 4.5 | M4 | 1.5 |
| B | 0K75 | 95 | 166 | 167 | 66 | 156 | 159 | 4.5 | M4 | 1.5 |
| C | 1K50 | 95 | 206 | 170 | 66 | 196 | 162 | 4.5 | M4 | 1.8 |
| C | 2K20 | 95 | 206 | 170 | 66 | 196 | 162 | 4.5 | M4 | 1.8 |
| D | 3K00 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |
| D | 4K00 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |
| E | 5K50 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 3.6 |
| E | 7K50 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 3.6 |
| E | 11K0 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 3.9 |
| F | 15K0 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 5.0 |
| F | 18K0 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 5.7 |
| G | 22K5 | 165 | 315 | 241 | 140 | 300 | 233 | 6.5 | M6 | 7.3 |
| G | 30K0 | 165 | 315 | 241 | 140 | 300 | 233 | 6.5 | M6 | 8.0 |
| H③ | 37K0 | 250 | 510 | 272 | 200 | 492 | 264 | 7.0 | M6 | 20.2 |
| H③ | 45K0 | 250 | 510 | 272 | 200 | 492 | 264 | 7.0 | M6 | 20.2 |
| I③ | 55K0 | 265 | 585 | 325 | 200 | 555 | 317 | 11.0 | M10 | 33.0 |
| I③ | 75K0 | 265 | 585 | 325 | 200 | 555 | 317 | 11.0 | M10 | 35.0 |
| J③ | 90K0 | 325 | 760 | 342 | 200 | 727 | 334 | 11.0 | M10 | 45.0 |
| J③ | 110K0 | 325 | 760 | 342 | 200 | 727 | 334 | 11.0 | M10 | 52.5 |
| K③ | 132K | 385 | 923 | 350 | 250 | 893 | 342 | 11.0 | M10 | 71.7 |
| K③ | 160K | 385 | 923 | 350 | 250 | 893 | 342 | 11.0 | M10 | 76.6 |
| L③ | 185K | 480 | 1030 | 360 | 400 | 995 | 352 | 13.0 | M12 | 108.0 |
| L③ | 200K | 480 | 1030 | 360 | 400 | 995 | 352 | 13.0 | M12 | 108.0 |
| M③ | 220K | 595 | 1337 | 386 | 425 | 1300 | 378 | 13.0 | M12 | 170.0 |
| M③ | 250K | 595 | 1337 | 386 | 425 | 1300 | 378 | 13.0 | M12 | 170.0 |
| M③ | 280K | 595 | 1337 | 386 | 425 | 1300 | 378 | 13.0 | M12 | 170.0 |
| N③ | 315K | 650 | 1458 | 412 | 450 | 1417 | 404 | 17.0 | M16 | 208.0 |
| N③ | 355K | 650 | 1458 | 412 | 450 | 1417 | 404 | 17.0 | M16 | 210.0 |
| N③ | 400K | 650 | 1458 | 412 | 450 | 1417 | 404 | 17.0 | M16 | 210.0 |

**Tab. 7-6:** VFC x610 3P 380 VAC dimensions

- ①: The complete type code for frequency converter is:
  VFCX615-xKxx-xPx-MNA-xx-NNNNN-NNNN, see chapter 19.2 "Appendix II: Type Coding" on page 518.
  E.g., type code for VFC 5615 5K50 (3P 380 VAC model) is:
  VFC5615-5K50-3P4-MNA-7P-NNNNN-NNNN.
- ②: 4 screws are needed for wall mounting of VFC x615.
- ③: **ONLY** available with VFC 5615.
- ④: Add **35 mm** to dimension **D** and **d** when option module is used and installed.

## 7.4.2 Wall-Through Models

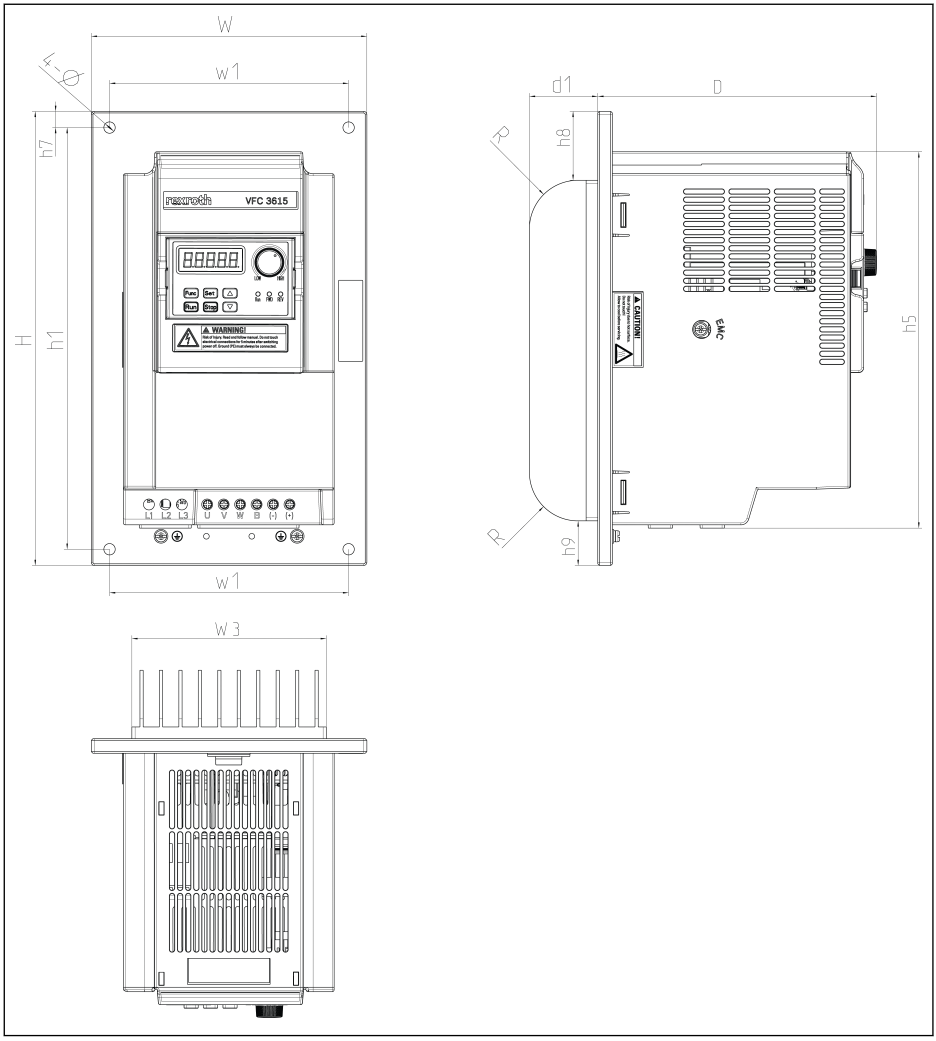



**Fig. 7-6:** VFC 5615 5K5...7K5 dimensions figure (wall-through models)

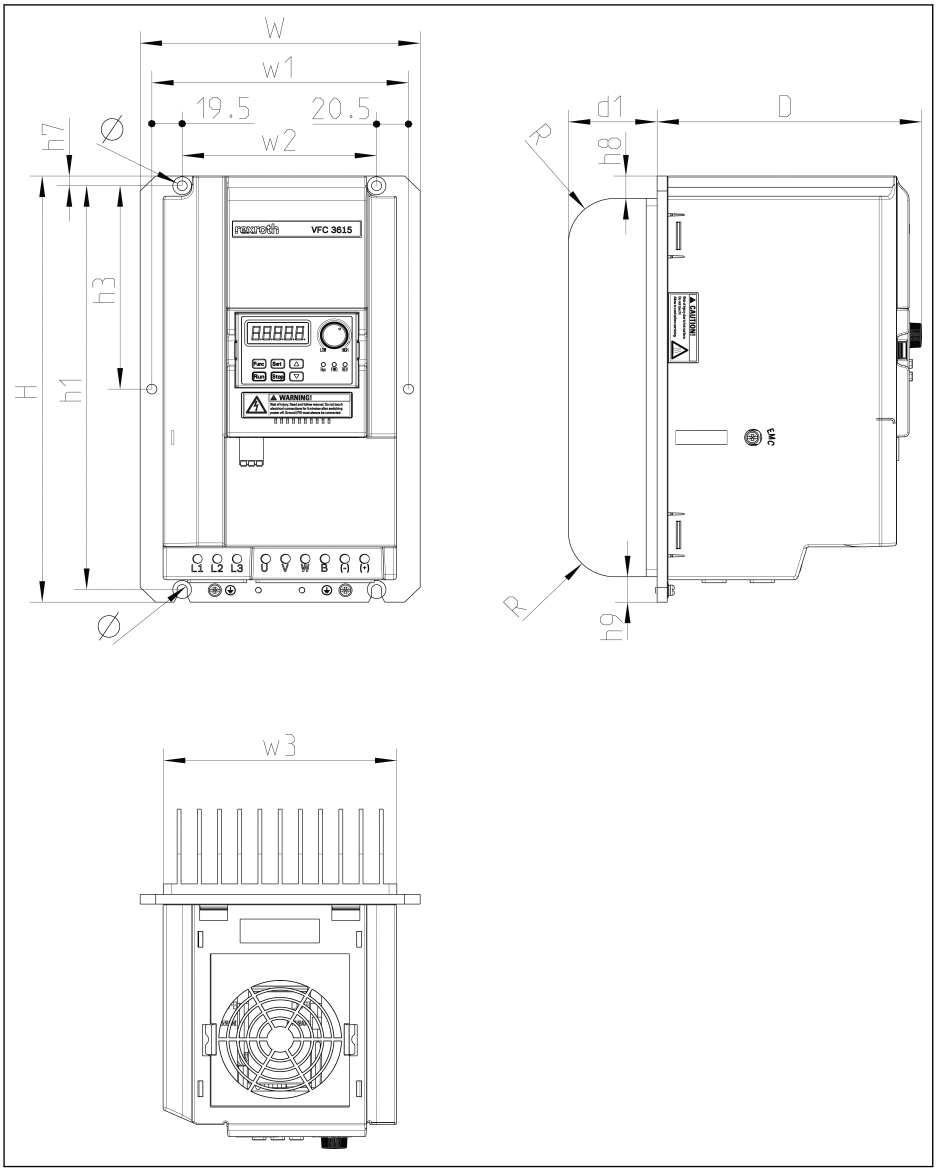



**Fig. 7-7:** VFC 5615 15K0 dimensions figure (wall-through models)

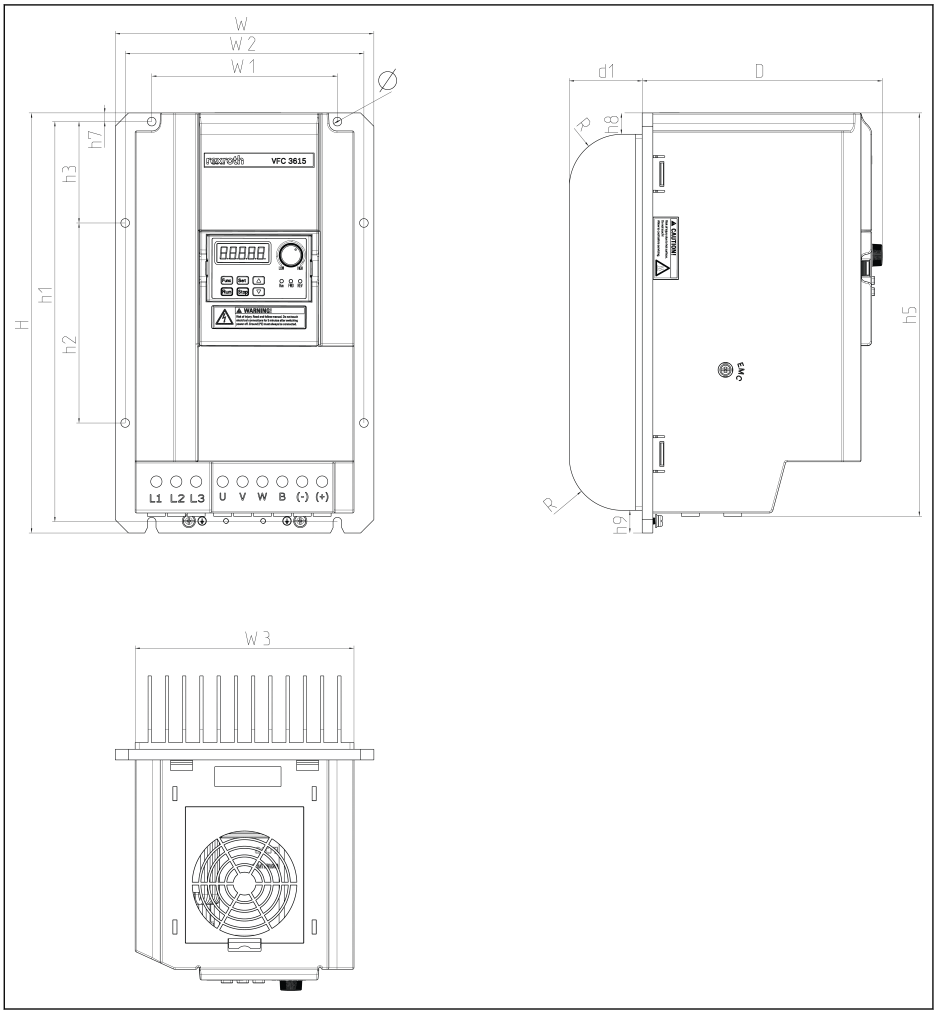



**Fig. 7-8:** VFC 5615 22K0 dimensions figure (wall-through models)

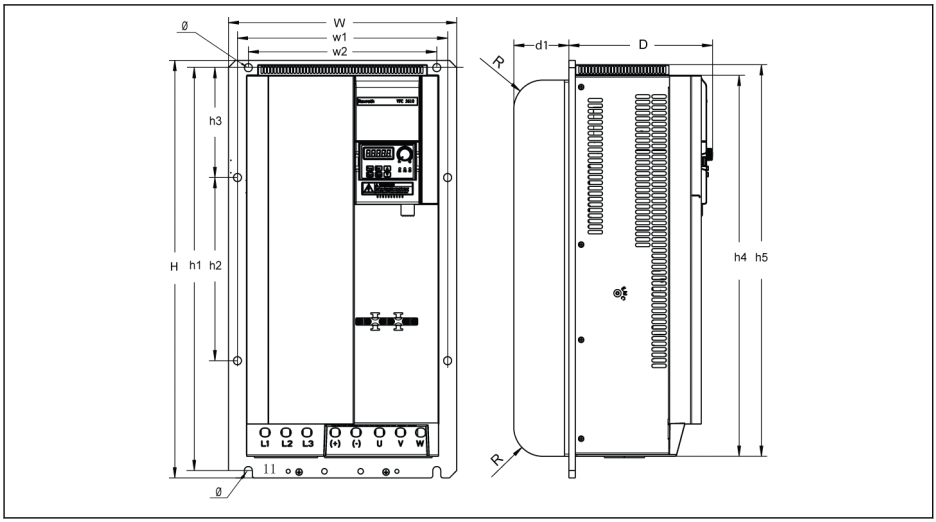



**Fig. 7-9:** VFC 5615 45K0...55K0 dimensions figure (wall-through models)

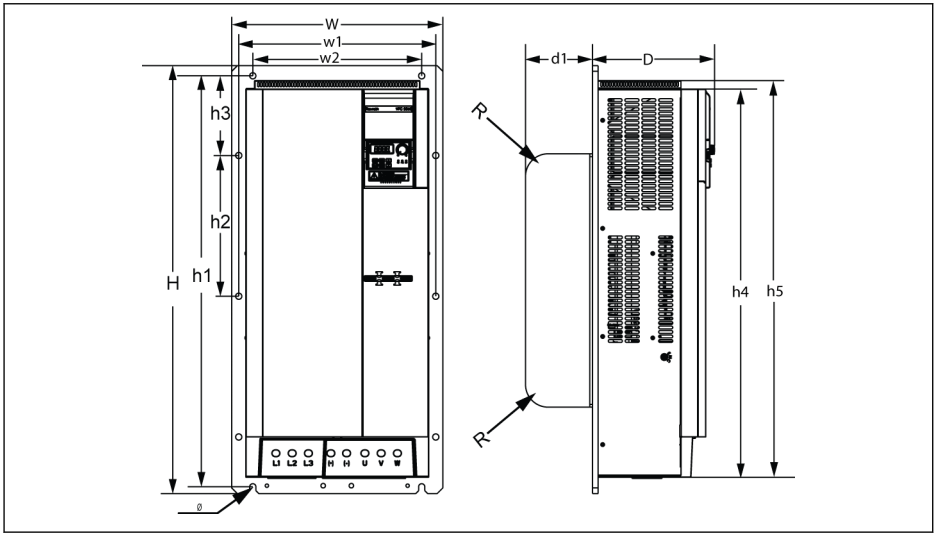



**Fig. 7-10:** VFC 5615 30K0...90K0 dimensions figure (wall-through models)

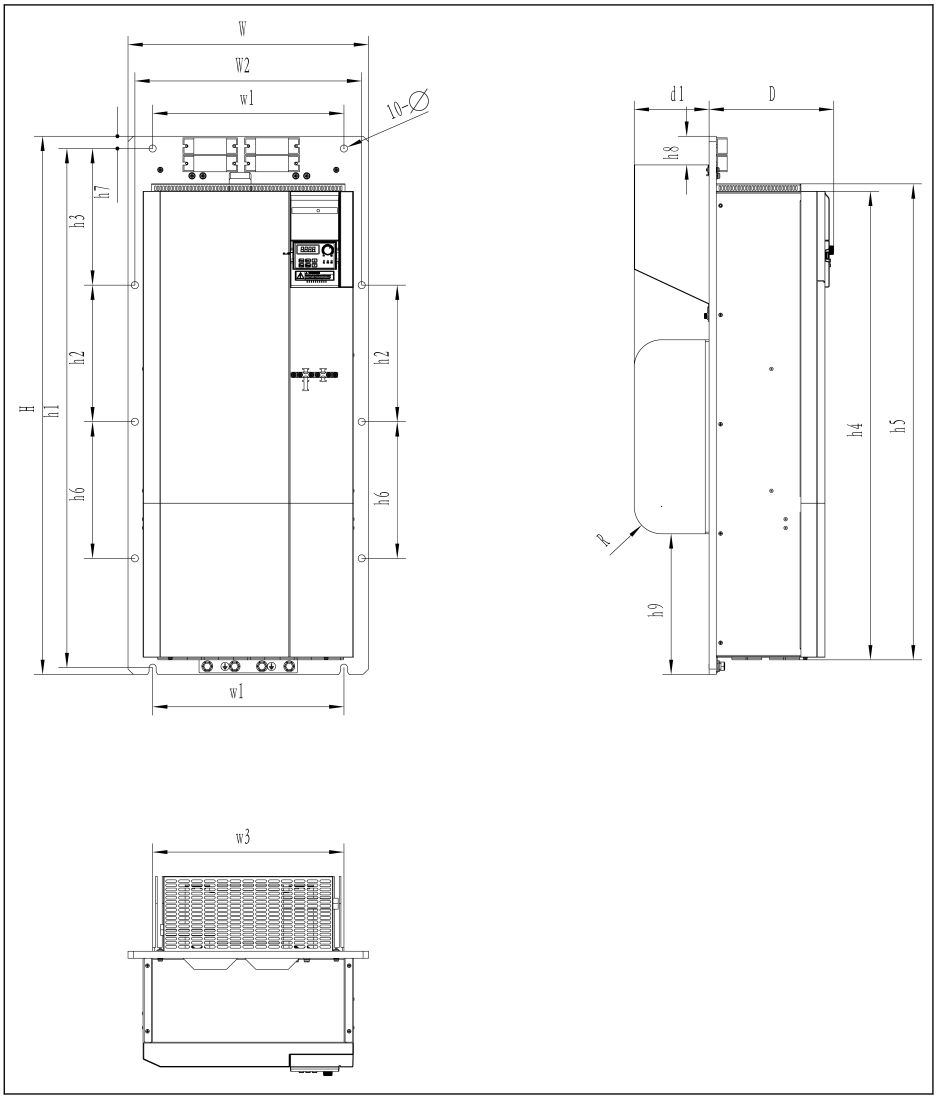



**Fig. 7-11:** VFC 5615 110K0...185K0 dimensions figure (wall-through models)

| Model | 5K5 & 7K5 | 11K0 & 15 K0 | 18K5 & 22 K0 | 30K0 & 37 K0 | 45K0 | 45K0 & 55K0 | 75K0 & 90K0 | 110K0 & 132K0 | 160K0 & 1 85K0 |
|---|---|---|---|---|---|---|---|---|---|
| W | 170 | 180 | 195 | 290 | 315 | 315 | 375 | 440 | 530 |
| w1 | 130 | 150 | 180 | 270 | 290 | 290 | 350 | 385 | 505 |
| w2 | 147.5 | 125 | 140 | 250 | 260 | 260 | 300 | 350 | 350 |
| w3 | - | - | - | - | - | - | - | 350 | 350 |
| H | 280 | 285 | 315 | 490 | 570 | 570 | 760 | 985 | 1080 |
| h1 | 260 | 270 | 300 | 470 | 550 | 550 | 730 | 950 | 1055 |
| h2 | - | - | 150 | 150 | 250 | 250 | 250 | 250 | 300 |
| h3 | - | 136 | 76 | 200 | 150 | 150 | 141.5 | 250 | 250 |
| h4 | - | 253 | 282 | 453 | 520 | 520 | 690 | 858 | 945 |
| h5 | - | - | - | 466.5 | 534.5 | 534.5 | 705 | 871 | 959 |
| h6 | - | - | - | - | - | - | - | 250 | 300 |
| h7 | - | - | - | - | - | - | - | 22.5 | 15 |
| h8 | - | - | - | - | - | - | - | 52.5 | 57 |
| D | 172 | 170 | 180 | 160 | 200 | 200 | 217 | 228 | 232 |
| d1 | 42.5 | 57 | 67 | 77 | 76 | 106 | 119 | 137 | 138 |
| Ø | 7 | 6.5 | 6.5 | 6.5 | 11 | 11 | 11 | 13 | 13 |
| R | 30 | 30 | 40 | 40 | 40 | 40 | 40 | 50 | 50 |
| Screw size | M6 | M6 | M6 | M6 | M10 | M10 | M10 | M12 | M12 |
| weight(Kg) | 4.2 | 6.5 | 8 | TBD | 27 | 32 | 44 | TBD | TBD |



Wall-Through models are only support HD (Heavy Duty) mode.

# 8 Frequency Converter Wiring

## 8.1 Wiring Diagram

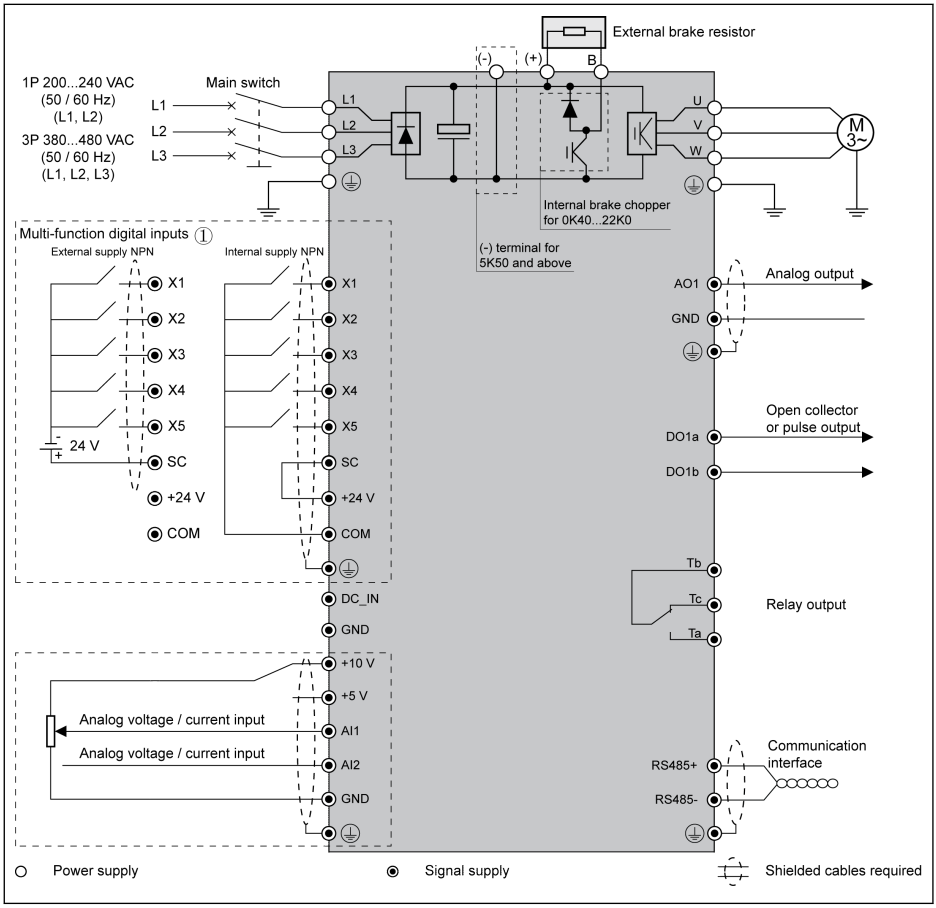



**Fig. 8-1:** Wiring diagram

- For cable size, fuse, screw torque, see chapter 8.2 "Cable Specifications" on page 54.
- For terminals, see chapter 8.3 "Terminals" on page 62.
- ①: PNP modes, see chapter "Digital input NPN / PNP wiring" on page 73.
- Pulse input can be **ONLY** set via 'Multi-function digital input X5'.
- When analog current input function is applied, the supply voltage of analog input terminal can not exceed +5 V.

## 8.2 Cable Specifications

### 8.2.1 Power Cables

**Cable specification for international without USA / Canada**

- Use copper wires specified for 90 ℃ or above.
- Insulation based on IEC60364-5-52.
- Cable with concentric shielding must be used.
- According to IEC61800-5-1, PE cable must be at least 10 $mm^2$ or a double PE cable must be used.
- *: If additional labels available with the terminals of 0K40...11K0, please refer to the torque data on labels.

| VFC x615 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | | B1 | B2 | E | | |
| | [A] | [$mm^2$] | | | [$mm^2$] | [N·m / lbf·in] (Mx) |
| 0K40 | 10.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 0K75 | 16.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 1K50 | 25.0 | 4.0 | 4.0 | 2.5 | 10.0<br>4.0*2 | 1.00* / 9.0 (M3) |
| 2K20 | 32.0 | 6.0① | 6.0① | 4.0 | 10.0<br>6.0*2 | 1.00* / 9.0 (M3) |

**Tab. 8-1:** 1P 200 VAC fuse and cable dimensions for international without USA / Canada

①: Stranded with ferrule without plastic sleeve.

| VFC x615 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | [A] | B1 | B2 | E | | |
| | | [$mm^2$] | | | [$mm^2$] | [N·m / lbf·in] (Mx) |
| 0K40 | 6.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 0K75 | 10.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 1K50 | 10.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |

| VFC x615 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | [A] | B1 | B2 | E | | |
| | | [mm²] | | | [mm²] | [N·m / lbf·in] (Mx) |
| 2K20 | 16.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 3K00 | 20.0 | 4.0 | 4.0 | 2.5 | 10.0<br>4.0*2 | 1.00* / 9.0 (M3) |
| 4K00 | 20.0 | 4.0 | 4.0 | 2.5 | 10.0<br>4.0*2 | 1.00* / 9.0 (M3) |
| 5K50 | 32.0 | 6.0 | 6.0 | 4.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 7K50 | 32.0 | 6.0 | 6.0 | 4.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 11K0 | 40.0 | 6.0 | 10.0 | 6.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 15K0 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 18K5 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 22K0 | 80.0 | 25.0 | 25.0 | 16.0 | 16.0 | 3.73 / 33.0 (M5) |
| 30K0 | 100.0 | 25.0 | 35.0 | 25.0 | 25.0 | 3.73 / 33.0 (M5) |
| 37K0 | 125.0 | 35.0 | 50.0 | 35.0 | 25.0 | 3.80 / 33.6 (M6) |
| 45K0 | 125.0 | 35.0 | 50.0 | 35.0 | 35.0 | 3.80 / 33.6 (M6) |
| 55K0 | 160.0 | 50.0 | 70.0 | 50.0 | 35.0 | 28.0 / 248.0 (5/16 in) |
| 75K0 | 200.0 | 70.0 | 95.0 | 70.0 | 50.0 | 28.0 / 248.0 (5/16 in) |
| 90K0 | 250.0 | 120.0 | 150.0 | 95.0 | 95.0 | 28.0 / 248.0 (5/16 in) |
| 110K | 250.0 | 120.0 | 150.0 | 95.0 | 95.0 | 28.0 / 248.0 (5/16 in) |
| 132K | 315.0 | 120.0<br>95.0*2 | 150.0<br>95.0*2 | 120.0<br>95.0*2 | 95.0 | 15.0 / 132.7 (M10)①<br>8.0 / 70.8 (M8)② |
| 160K | 315.0 | 185.0<br>95.0*2 | 240.0<br>95.0*2 | 185.0<br>95.0*2 | 120.0 | 15.0 / 132.7 (M10)①<br>8.0 / 70.8 (M8)② |
| 185K | 400.0 | 120.0*2 | 120.0*2 | 120.0*2 | 150.0 | 15.0 / 132.7 (M10)② |

**Tab. 8-2:** 3P 380 VAC fuse and cable dimensions for international without USA / Canada—0K40...185K

| VFC x615 Model | Fuse (gG) | Power cables installation mode | | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|---|
| | | B1 | B2 | E | F | | |
| | [A] | [mm²] | | | | [mm²] | [N·m / lbf·in] (Mx) |
| 200K | 400.0 | - | 150*2 | - | - | 150.0 | 15.0 / 132.7 (M10)② |
| 220K | 500.0 | - | 185*2 | - | 95*2 | 185.0 | 15.0 / 132.7 (M10)② |
| 250K | 500.0 | - | 240*2 | - | 95*2 | 240.0 | 15.0 / 132.7 (M10)② |
| 280K | 630.0 | - | 120*2 | - | 120*2 | 120*2 | 15.0/132.7(M10)① |
| 315K | 630.0 | - | - | - | 95.0*4 | 150*2 | 20.0/177.0 (M12)① |
| 355K | 800.0 | - | - | - | 95.0*4 | 150*2 | 20.0/177.0(M12)① |
| 400K | 1000.0 | - | - | - | 120.0*4 | 240*2 | 20.0/177.0(M12)① |

**Tab. 8-3:** 3P 380 VAC fuse and cable dimensions for international without USA / Canada– 200K...400K

☞ ① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 132K and above. ① is the torque and screw of single cable and ② is the torque and screw of double cable.

## Cable specification for USA / Canada

- The data listed in the table below are only used to select fuse and cable dimensions for USA / Canada.
- Must use copper wires of 75 ℃ or above according to UL 61800-5-1.
- It is recommended to use shielded cables to connect the motor.
- *: If additional labels available with the terminals of 0K40...11K0, please refer to the torque data on labels.

| VFC x615 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lb·in] (Mx) |
|---|---|---|---|---|
| 0K40 | 10.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 0K75 | 15.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 1K50 | 25.0 | 10 | 8 | 1.00* / 9.0 (M3) |
| 2K20 | 30.0 | 10 | 8 | 1.00* / 9.0 (M3) |

**Tab. 8-4:** 1P 200 VAC fuse and cable dimensions for USA / Canada

| VFC x615 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lbf·in] (Mx) |
|---|---|---|---|---|
| 0K40 | 6.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 0K75 | 10.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 1K50 | 10.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 2K20 | 15.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 3K00 | 20.0 | 12 | 8 | 1.00* / 9.0 (M3) |
| 4K00 | 20.0 | 12 | 8 | 1.00* / 9.0 (M3) |
| 5K50 | 30.0 | 10 | 8 | 1.20* / 10.5 (M4) |
| 7K50 | 30.0 | 10 | 8 | 1.20* / 10.5 (M4) |
| 11K0 | 40.0 | 8 | 8 | 1.20* / 10.5 (M4) |
| 15K0 | 50.0 | 8 | 8 | 1.76 / 15.6 (M4) |
| 18K5 | 60.0 | 6 | 6 | 1.76 / 15.6 (M4) |
| 22K0 | 80.0 | 4 | 6 | 3.73 / 33.0 (M5) |
| 30K0 | 100.0 | 2 | 4 | 3.73 / 33.0 (M5) |
| 37K0 | 100.0 | 2 | 3 | 3.80 / 33.6 (M6) |
| 45K0 | 125.0 | 1 | 3 | 3.80 / 33.6 (M6) |
| 55K0 | 175.0 | 2 / 0 | 1 / 0 | 28.0 / 248.0 (5/16 in) |
| 75K0 | 200.0 | 4 / 0 | 3 / 0 | 28.0 / 248.0 (5/16 in) |

| VFC x615 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lbf·in] (Mx) |
|---|---|---|---|---|
| 90K0 | 250.0 | 250 kcmil | 4 / 0 | 28.0 / 248.0 (5/16 in) |
| 110K | 300.0 | 350 kcmil | 4 / 0 | 28.0 / 248.0 (5/16 in) |
| 132K | 300.0 | 400 kcmil | 3 / 0 | 15.0 / 132.7 (M10)① |
| | | 3 / 0 * 2 | | 8.0 / 70.8 (M8)② |
| 160K | 350.0 | 500 kcmil | 250 kcmil | 15.0 / 132.7 (M10)① |
| | | 250 kcmil * 2 | | 8.0 / 70.8 (M8)② |
| 185K | 450.0 | 350 kcmil * 2 | 350 kcmil | 15.0 / 132.7 (M10)② |
| 200K | 450.0 | 350 kcmil * 2 | 350 kcmil | 15.0 / 132.7 (M10)② |
| 220K | 500.0 | 300 kcmil * 2 | 300 kcmil | 15.0 / 132.7 (M10)② |
| 250K | - | - | - | - |
| 280K | - | - | - | - |
| 315K | - | - | - | - |
| 355K | - | - | - | - |

**Tab. 8-5:** 3P 380 VAC fuse and cable dimensions for USA / Canada

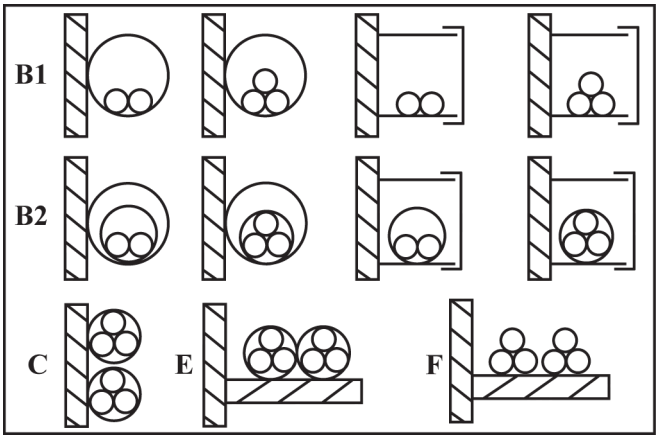
① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 132K and above. ① is the torque and screw of single cable and ② is the torque and screw of double cable.

### Dimensioning variables of the table values

1. **Installation types:**
   - B1 according to IEC 60364-5-52, e.g. stranded wires routed in cable duct
   - B2 according to IEC 60364-5-52, e.g. multi-core line routed in cable duct
   - E according to IEC 60364-5-52, e.g. multi-core line routed on open cable tray
   - F according to IEC 60364-5-52, e.g. single-core line routed on open cable tray
   - According to NFPA 79 (external wiring), UL 508A (internal wiring), NEC, NFPA 70:
     - 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor
     - Routed in pipe on the wall

     Internal wiring: Routing inside of control cabinet or of devices.

Field wiring: Routing of cross sections of terminal connectors wired by the user (in the field).




**B1** Conductors in installation pipes and in installation channels that can be opened
**B2** Cables or lines in installation pipes and in installation channels that can be opened
**C** Cables or lines on walls
**E / F** Cables or lines on open cable trays

**Fig. 8-2:** Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

2. **Recommendation for design of the fuses:**
   - **International except for USA / Canada:** Class gL-gG; 500 V, 690 V; design NH, D (DIAZED) or D0 (NEOZED).

---

**Characteristics**

In the case of error (e.g. ground error at connections L+, L-), fuses of characteristic **gL** (general-purpose fuse link for cables and lines) and **gG** (general-purpose fuse link for general installations) protect the **lines** in the frequency converter system.

To **protect the semiconductors** in the frequency converters, you can use fuses of characteristic **gR**.

---

   - USA / Canada: Class J; 600 V

3. **Terminal protection of power cables**

   Install and hot shrink the bushing on the copper-made lug and cable core line, and ensure that the bushing completely covers the cable conductor.

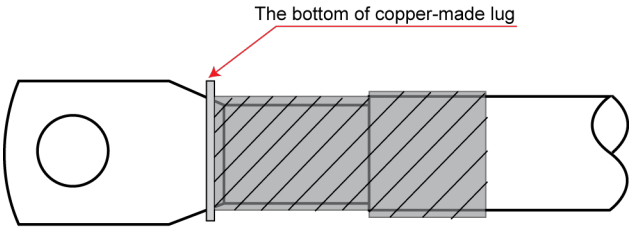



**Fig. 8-3:** Terminal protection of power cables

### 8.2.2 Control Cables

The following requirements are applicable to the signal connection wiring:

- Flexible cables with wire end sleeves
- Cable cross-section: 0.2...1.0 $mm^2$
- Cable cross-section for connectors with insulation sleeves: 0.25...1.0 $mm^2$
- Analog inputs AI1, AI2, EAI, +10 V, +5 V and GND: use shielded cables
- Digital inputs X1...X5, EX1...EX4, SC, +24 V and COM: use shielded cables
- Analog outputs AO1, EAO and GND: use shielded cables
- RS485 communication: use shielded twisted pair cables

☞ EAI, EX1...EX4 and EAO belong to I/O card.

Recommendations on cable insulation stripping:

Please strip the insulation of control cables according to the dimensions given below. Too long stripping may cause short circuit of adjacent cables; too short stripping may lead to cables becoming loose.

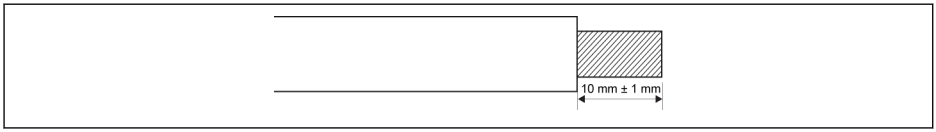


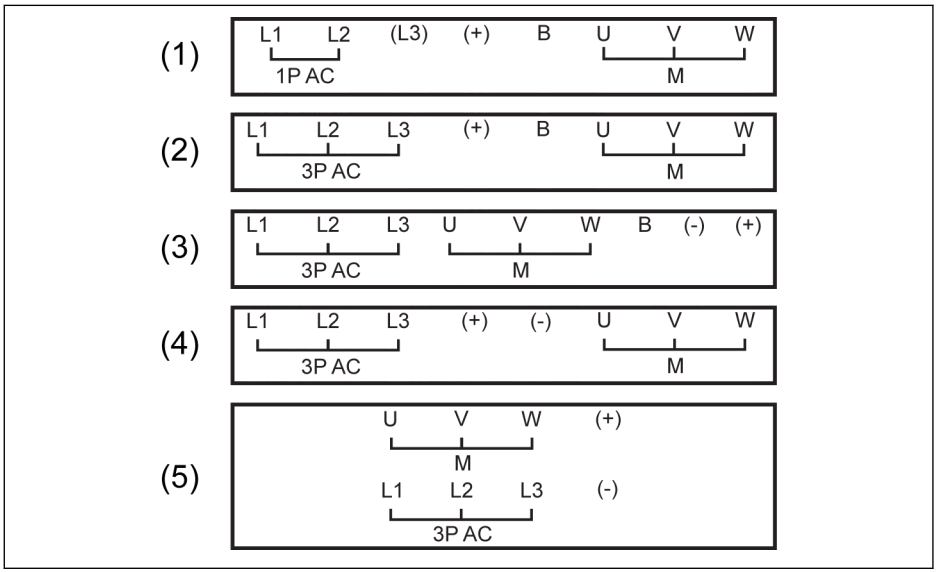

**Fig. 8-4:** Cable insulation stripping length

☞ Please follow the steps below for wiring of control terminals.
Step 1: Switch off the frequency converter before performing wiring.
Step 2: Deactivate the control signals in the wiring process.
Step 3: Switch on the frequency converter.
Step 4: Set respective parameters.
Step 5: Activate respective control signals.

# 8.3 Terminals

## 8.3.1 Power Terminals

### Power Terminals Figure




**(1)** 1P 200 VAC 0K40...2K20
**(2)** 3P 380 VAC 0K40...4K00
**(3)** 3P 380 VAC 5K50...30K0
**(4)** 3P 380 VAC 37K0...110K
**(5)** 3P 380 VAC 132K...400K
**1P AC:** Single phase AC power supply
**3P AC:** Three phases AC power supply
**M:** For three phases motor connection

**Fig. 8-5:** Power terminals

## Power Terminals Description

| Terminal | Description |
|---|---|
| L1, L2 | Mains supply input terminals |
| U, V, W | Converter output terminals |
| B | External brake resistor terminal |
| (+) | DC positive bus terminal |

**Tab. 8-6:** 1P 200 VAC power terminals description

| Terminal | Description |
|---|---|
| L1, L2, L3 | Mains supply input terminals |
| U, V, W | Converter output terminals |
| B | External brake resistor terminal |
| (-) | DC negative bus terminal (only available with models of 5K50 and above) |
| (+) | DC positive bus terminal |

**Tab. 8-7:** 3P 380 VAC power terminals description

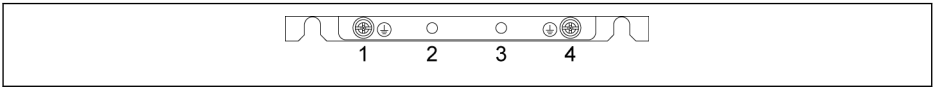



**Fig. 8-6:** Grounding and PE terminals

1: Grounding terminal for mains cables

2: Reserved for PE / shielding adapter (Order additionally)

3: Reserved for PE / shielding adapter (Order additionally)

4: Grounding terminal for motor cables

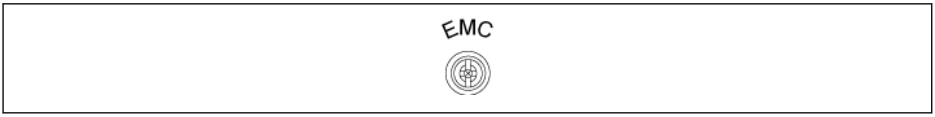


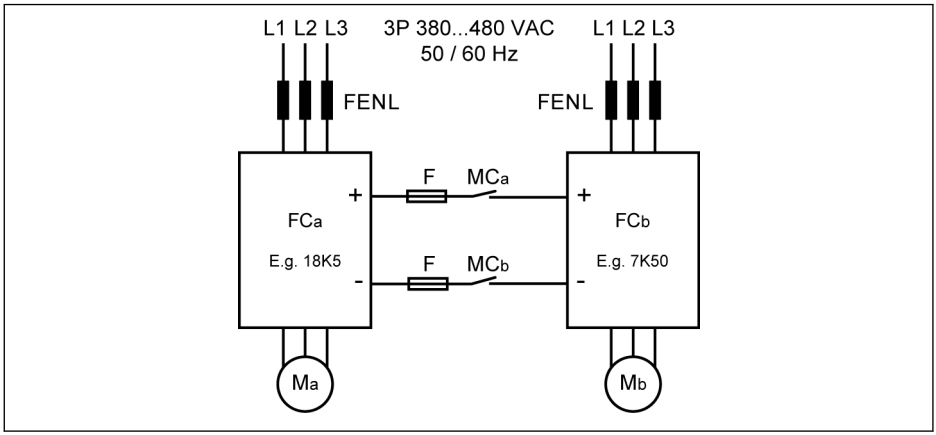

**Fig. 8-7:** Connection screw for internal EMC filter

Internal EMC filter must be disconnected in isolated neutral power system (e.g., IT-Net). Otherwise, the system will be grounded via the capacitor of the EMC filter, which may lead to danger or damage to the frequency converter. The connection screw for the internal EMC filter as shown in the figure above is located at the side of the frequency converter.

With the internal EMC filter disconnected, the specified EMC performance of the frequency converter cannot be reached.

## Notes on DC-bus terminals

### Wiring of DC-bus in parallel




**FENL** Mains choke
**$FC_a$** Frequency converter a
**$FC_b$** Frequency converter b
**F** Fuse
**$MC_a$** Magnetic contactor a
**$MC_b$** Magnetic contactor b
**$M_a$** Motor a
**$M_b$** Motor b

**Fig. 8-8:** Wiring of DC-bus in parallel

### Conditions for DC-bus in parallel

- In the above typical application, $FC_b$ runs in generation mode and $FC_a$ runs in motor mode. The power rating of $FC_a$ needs to be 3 levels higher than that of $FC_b$.

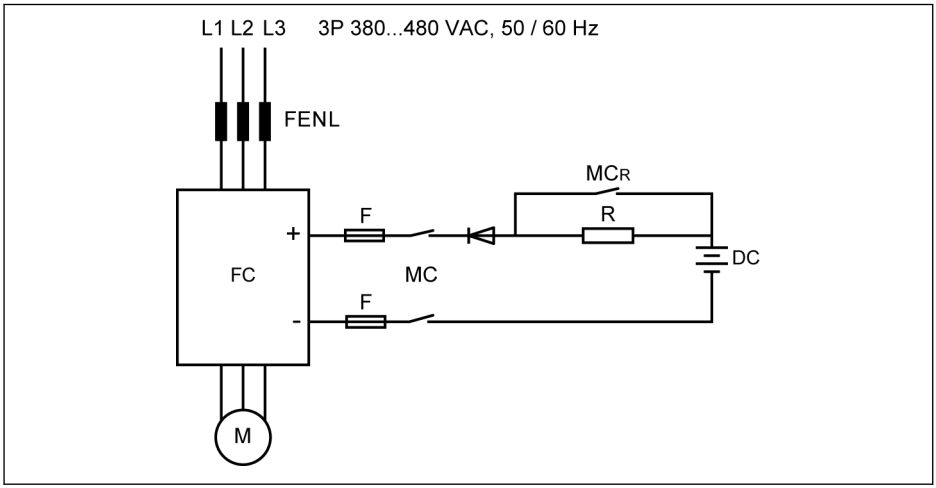
  E.g., $FC_b$ is 7K50, $FC_a$ needs to be 18K5 (11K0 and 15K0 in between)
- DC-bus voltage is within the specified range: 457...745 V.
- Use mains choke.
- Select fuses according to $FC_b$ which runs in generator mode, see chapter "DC-bus fuse specification" on page 69.
- Use external brake resistor to keep the DC-bus voltage within the normal range, especially when converter a is running with light load instead of full load.
- Switch on mains supply to the frequency converters first, and then close $MC_a$ and $MC_b$ after the LED display is active with both frequency converters. The contactor $MC_a$ and $MC_b$ will be switched off by the respective relay output of the frequency converter when an error happens to any of the two frequency converters.

- Select contactors according to the current ratings in chapter "DC-bus fuse specification" on page 69.
- Connect the relay output of $FC_a$ to $MC_a$, $FC_b$ to $MC_b$.
- Set [E2.15] = '14: Converter error' to control $MC_a$ by relay output of $FC_a$.
- Set [E2.15] = '14: Converter error' to control $MC_b$ by relay output of $FC_b$.



By default, the relay output in inactive when the frequency converter is not running.

### Wiring of DC-bus with external DC power supply




**FENL** Mains choke
**FC** Frequency converter
**F** Fuse
**MC** Magnetic contactor
**$MC_R$** Magnetic contactor of softstart resistor
**DC** External DC power supply
**M** Motor
**R** Softstart resistor

**Fig. 8-9:** Wiring of DC-bus with external DC power supply

### Conditions for DC-bus with external DC power supply

- DC-bus voltage is within the specified range: 457...745 V.
- Use mains choke.
- Select fuses according to chapter "DC-bus fuse specification" on page 69.
- Use the relay output of the frequency converter to control the contactor MC of the DC-bus. The contactor will be switched off by the relay output once the frequency converter encounters an error.
- For 5K50...18K5 models, select the external softstart resistor according to the allowed maximum charging current defined in the table below.

| Model | Maximum charging current [A] |
|---|---|
| 5K50 | 25 |
| 7K50 | 25 |
| 11K0 | 35 |
| 15K0 | 50 |
| 18K5 | 75 |
| 22K0 | 100 |

**Tab. 8-8:** Allowed maximum charging current

- Set [E2.15] = '14: Converter error' to control MC by relay output of FC. Connect relay output of FC to MC.



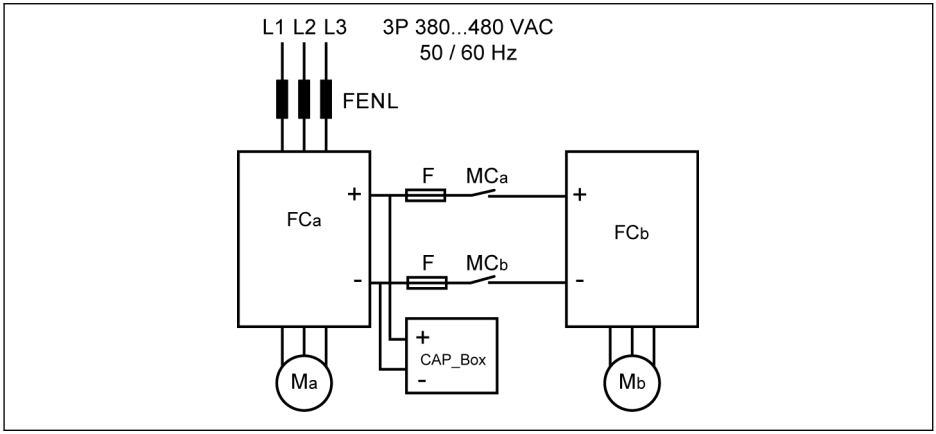
By default, the relay output is inactive when there is no error. Please use an additional device to keep the relay output status when the frequency converter is switched off without power input. Without such a device, the relay output will be restored to be inactive as the frequency converter will lose the control.

**⚠ WARNING**

The external softstart circuit must be properly controlled to avoid direct charging of the capacitor with external DC power supply, especially when DC power supply is the only power source for the frequency converter.

- Use a diode to ensure the current is always in the direction of flowing-in the frequency converter.

## Through-wall models provide DC-bus power wiring




| | | | |
|---|---|---|---|
| **FENL** | Mains choke | **$MC_b$** | Magnetic contactor b |
| **$FC_a$** | Frequency converter a | **$M_a$** | Motor a |
| **$FC_b$** | Frequency converter b | **$M_b$** | Motor b |
| **F** | Fuse | **CAP_Box** | External capacitor box accessories (optional) |
| **$MC_a$** | Magnetic contactor a | | |

**Fig. 8-10:** Through-wall models provide DC-bus power wiring

## Through-wall models provide DC-bus power supply conditions

- The above application is for 45kW-160kW through-wall models, where FCa provides DC bus power to FCb externally, and FCb should be smaller than the power of FCa to ensure that the sum of output current of FCa and FCb is less than the nominal input current of FCa, and FCa can provide reasonable bus power and output power to FCb and Ma respectively.
- Optional parallel capacitor box fitting for DC bus to extend the power down time of FCa and FCb after FCa power failure.
- The DC bus voltage should be within the specified range: 457...745V.
- Use mains choke
- Choose a fuse according tochapter "DC-bus fuse specification" on page 69 or choose a suitable lower current DC bus fuse according to the power of FCb.
- According tochapter "DC-Bus Capacitor Box Cable Specifications" on page 68 select external bus capacitor box cable.
- Use an external braking resistor to keep the DC bus voltage within the normal range.
- Close the contactors MCa and MCb first, and then turn on the FCa (Frequency converter a) power supply to reduce the impulse currentat the moment of FCb power supply.

- If any of the frequency converters fails, the corresponding frequency converter relay output will cut off the corresponding contactors MCa and MCb.

  -Connect the relay output of FCa to MCa and the relay output of FCb to MCb.

  -Set [E2.15] = '14: frequency converter fault', thus controlling the MCa via the FCa relay output.



When the frequency converter is not running, the relay output is invalid by default. When the frequency converter is powered off with no output, please use other devices to save the relay output status. Otherwise, when there is no frequency converter control, the relay output will be reset to invalid state.

## DC-Bus Capacitor Box Cable Specifications

| VFC Through-wall models | Capacitor box cable dimensions |
|---|---|
| 45K0 | 16 $mm^2$/AWG5 |
| 55K0 | 16 $mm^2$/AWG5 |
| 75K0 | 16 $mm^2$ x 2 / AWG5 x 2 |
| 90K0 | 16 $mm^2$x 2 / AWG5 x 2 |
| 110K | 25 $mm^2$ x 2 / AWG3 x 2 |
| 132K | 25 $mm^2$ x 2 / AWG3 x 2 |
| 160K | 25 $mm^2$ x 2 / AWG3 x 2 |

**Tab. 8-9:** DC Bus Capacitor Box Cable Specifications

### DC-bus fuse specification

The fuse rating depends on the fuse type (gG) and the temporary overload capability of the frequency converter.



If no overload happens in an application, the fuses can be selected directly according to the power rating of the frequency converter.

Recommended fuse ratings at DC-bus voltage of 513 V are shown in the table below.

| Model | Motor power [kW] | Motor efficiency | DC-current [A] | gG fuses [A] |
|---|---|---|---|---|
| 5K50 | 5.5 | 85.8 % | 12.5 | 16 |
| 7K50 | 5.5 | 85.8 % | 12.5 | 16 |
| 11K0 | 7.5 | 87.1 % | 16.8 | 25 |
| 15K0 | 11.0 | 88.5 % | 24.2 | 35 |
| 18K5 | 15.0 | 89.5 % | 32.7 | 50 |
| 22K0 | 18.5 | 90.1 % | 40.0 | 50 |
| 30K0 | 22.0 | 90.6 % | 52.7 | 63 |
| 37K0 | 30.0 | 91.5 % | 71.1 | 80 |
| 45K0 | 37.0 | 92.1 % | 87.1 | 100 |
| 55K0 | 45.0 | 92.6% | 94.7 | 125 |
| 75K0 | 55.0 | 93.1% | 115.2 | 125 |
| 90K0 | 75.0 | 93.7% | 156.0 | 200 |
| 110K | 90.0 | 94.0% | 186.6 | 200 |
| 132K | 110.0 | 94.6% | 226.7 | 250 |
| 160K | 132.0 | 94.8% | 271.4 | 300 |
| 185K | 160.0 | 94.8% | 353.0 | 400 |
| 200K | 185.0 | 94.8% | 380.4 | 400 |
| 220K | 200.0 | 94.6% | 412.0 | 500 |
| 250K | 220.0 | 94.6% | 453.0 | 500 |
| 285K | 250.0 | 95% | 512.98 | 630 |

**Tab. 8-10:** Recommended fuse ratings

$I_{DC} = P_{Motor} / (V_{DC} \times \eta_{Motor})$

$V_{DC} = 1.35 \times V_{in}$

$V_{in}$ is the RMS value of the AC input voltage.

For example, if $V_{DC}$ = 513 V, the equivalent $V_{in}$ = 380 V.

The recommended fuse rated current is calculated based on the selected motor. In actual application, please check the value according to the equation above and the actual motor efficiency.

## 8.3.2 Control Terminals

### Control terminals figure

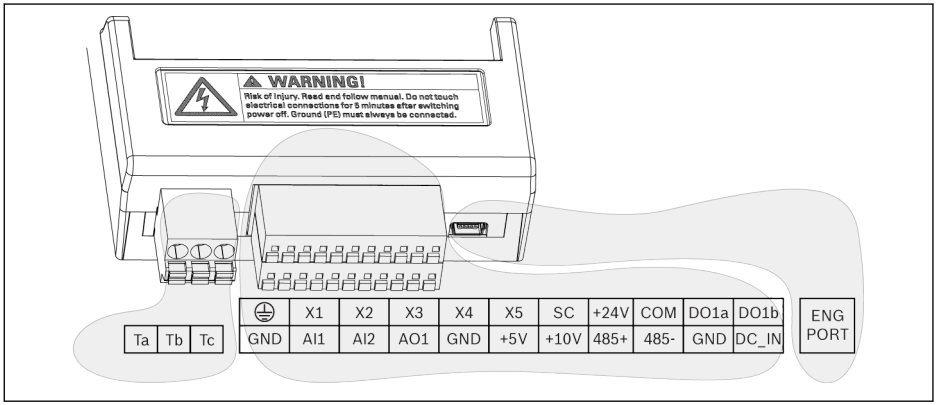



**Fig. 8-11:** Control circuit terminals

**⚠ CAUTION** **The frequency converter might be damaged!**

Please make sure that the power supply of the frequency converter has been switched off before plugging or unplugging the connector.

☞ The terminal blocks provide wiring connection points only. Additional measures by the user need to be taken to provide strain relief or other types of cable restraints.

## Control terminals description

### Digital inputs

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| X1...X5 | Multi-function digital inputs | See Group E1 | Inputs via opto-electric couplers:<br>24 VDC, 8 mA / 12 VDC, 4 mA<br>Pulse input: Max. 50.0 kHz |
| X5 (multiplex) | Pulse input | | |
| SC | Shared connection | Shared connection for isolation opto-electric couplers | – |
| +24 V | Power supply for digital inputs | COM is reference<br>Isolated from GND | Max. output current: 100 mA |
| COM | | | |

### Analog inputs

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| +10 V | Power supply for analog inputs | GND is reference | Max. output current: 30 mA |
| +5 V | | | Max. output current: 10 mA |
| AI1 | Analog voltage input 1/ Analog current input 1 | Analog voltage / current inputs are used as external frequency setting channels<br>To switch between voltage and current or to set the input related functions, see Group E1 | Voltage input range: 0/2...10 V<br>Input impedance: 27 kΩ<br>Resolution: 1/1,000<br>Current input range: 0/4...20 mA<br>Input impedance: 250 Ω<br>Resolution: 1/1,000 |
| AI2 | Analog voltage input 2/ Analog current input 2 | | |
| GND | Shared connection | Isolated from COM | – |
| ⏚ | Shielding connection | Connected with grounding terminals on heatsink internally | – |

### Digital outputs

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| DO1a | Open collector output or pulse output | See Group E2<br>COM is reference | Open collector output:<br>Max. 30 VDC, 50 mA<br>Pulse output Max. frequency: 32.0 kHz |
| DO1b | | | |
| Ta | Relay changeover contacts | See Group E2 | Rated capacity:<br>240 VAC, 3 A; 30 VDC, 3 A |
| Tc | | | |
| Tb | Relay shared contact | | |

### Analog outputs

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| AO1 | Analog output | See Group E2 | Voltage output: 0...10 V<br>Maximum load current for voltage output: 5 mA<br>Current output: 0...20 mA<br>Maximum load resistance for current output: 500 Ω |
| GND | Shared connection | Isolated from COM | – |

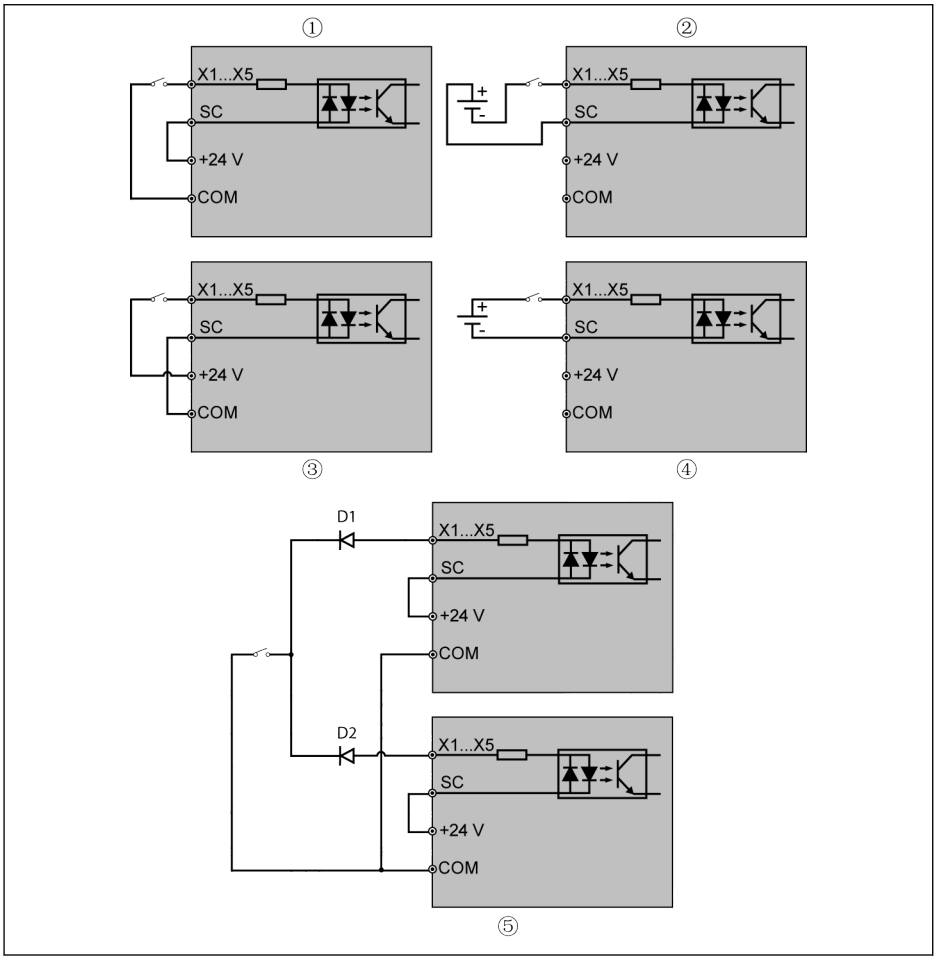
### Modbus communication

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| 485+ | Positive differential signal | GND is reference | – |
| 485- | Negative differential signal | | |

### External power supply

| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| DC_IN | Auxiliary power supply for control board | External +24 V supply input for control and panel boards<br>(**NOT** used for digital inputs) | Rated capacity:<br>24 V (-10...+15 %)<br>200 mA |
| GND | Shared connection | Isolated from COM | – |

## Digital input NPN / PNP wiring

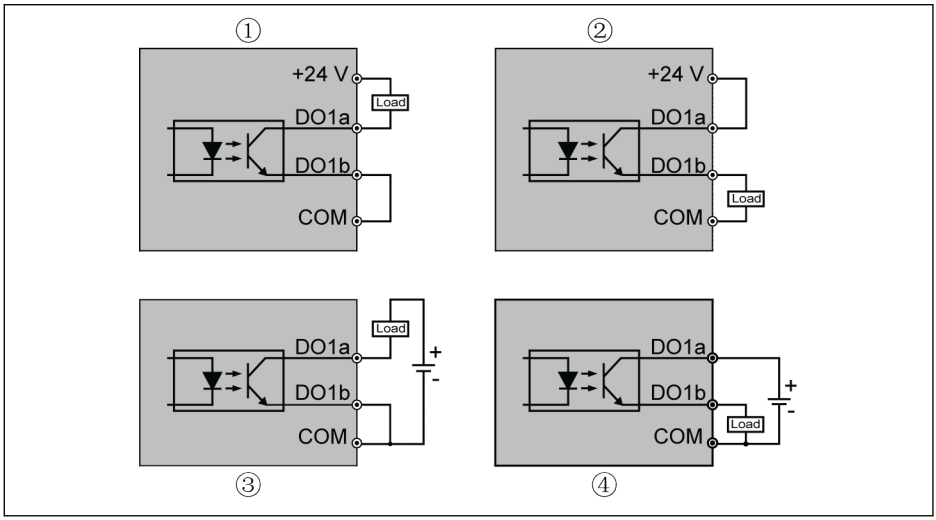



① NPN wiring with internal power supply
② NPN wiring with external power supply
③ PNP wiring with internal power supply
④ PNP wiring with external power supply
⑤ Parallel connection of DI terminals (NPN wiring with internal power supply)

**Fig. 8-12:** Digital input NPN / PNP wiring

⑤: When using this connection mode, it is necessary to connect the diode (diode anode connects the DI terminal) in series between the DI terminals of the two converters, and the diode must meet the conditions of "IF > 10 mA, μF < 1 V", otherwise the converter will misoperate.

## Digital output DO1a, DO1b load pull-up / pull-down wiring




① Load pull-up wiring with internal power supply
② Load pull-down wiring with internal power supply
③ Load pull-up wiring with external power supply
④ Load pull-down wiring with external power supply
**Load** Load

**Fig. 8-13:** Digital output DO1a, DO1b load pull-up / pull-down wiring

- For internal supply, **ONLY USE** terminal +24 V and **NEVER USE** terminal +10 V or +5 V!
- For external supply, its reference ground **MUST** be connected to terminal COM!
- When the digital output terminals are required to drive a relay, absorbent diodes should be installed on both sides of the relay coil. Be sure to install the polarity of the absorption diodes correctly, otherwise the DC 24V power supply will be burned out immediately when the digital output terminals have output.

### Analog input terminals (AI1, AI2, EAI, +10 V, +5 V, Earth and GND)

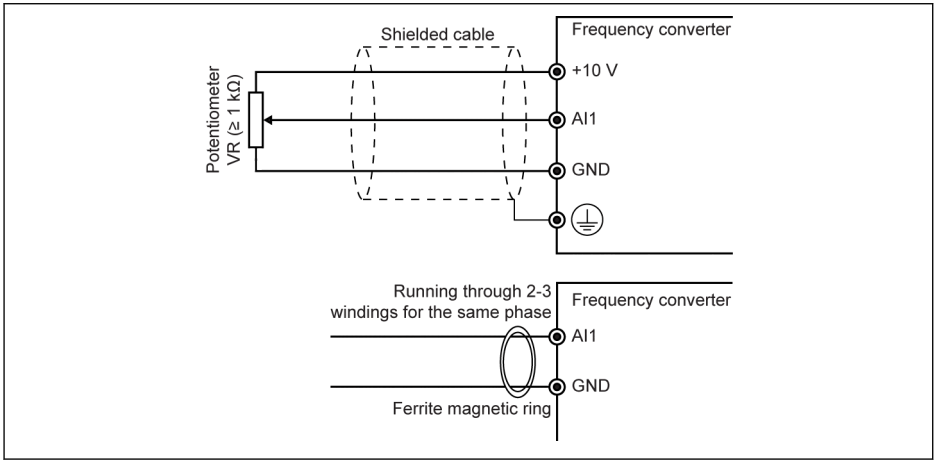
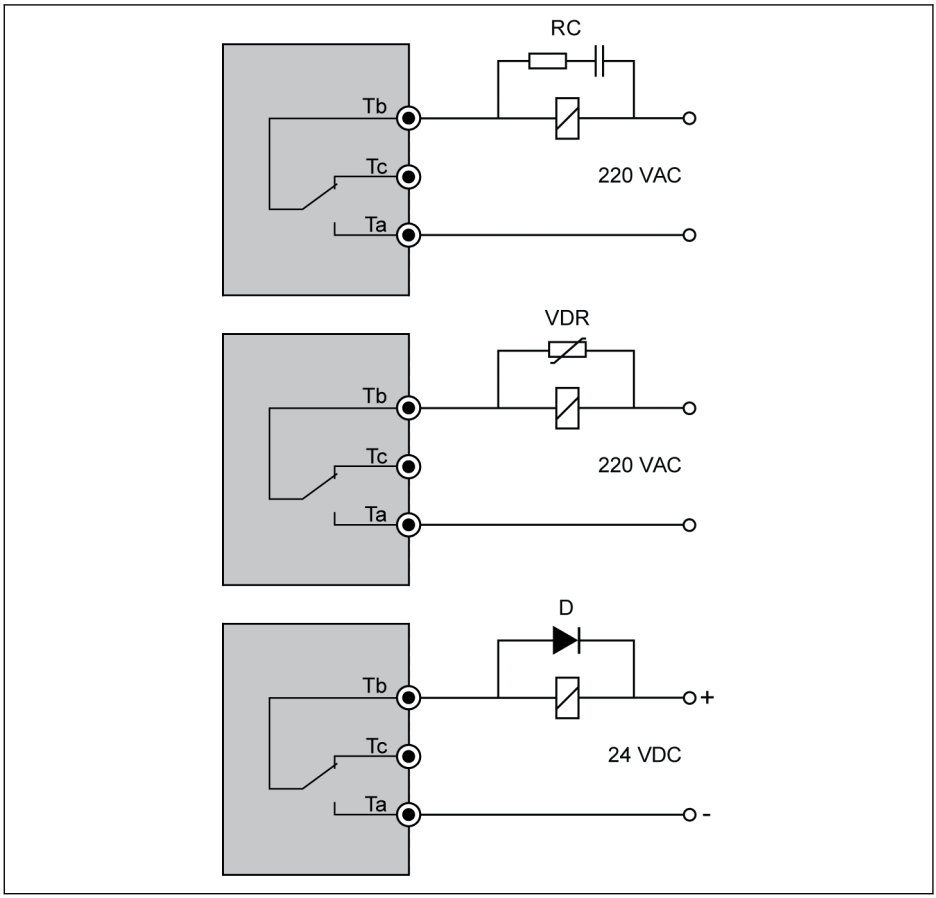



**Fig. 8-14:** Analog input terminals

- The figure for AI2 and +5 V is similar to the figure above.
- Incorrect operation may occur due to interference on the analog signal. In such cases, connect a ferrite magnetic ring at the input side of the analog signal, as shown above.
- The above figure is also valid for analog input EAI on I/O card.
- When analog current input function is applied, the supply voltage of analog input terminal can not exceed +5 V.

### Relay output terminals

When relay output terminals are connected with inductive loads (relays, contactors, solenoid valves, motors, etc.), following noise suppression circuits need to be applied at the coils of the inductive loads, as close as possible to the inductive loads, in order to reduce the electromagnetic interference generated from inductive load action.




**Tb** Shared terminal
**Tc** Normally closed contact
**Ta** Normally open contact
**RC** RC filtering
**VDR** Varistor
**D** Diode

**Fig. 8-15:** Noise suppression circuits for relay output terminals

### Notes on DC_IN terminal

#### Converter in running status: Converter stops with error 'UE-1' at AC power loss

| Conditions | Description |
|---|---|
| DC_IN power is available | 'UE-1' remains to be displayed on the panel<br>'Power loss restart mode' function does NOT work<br>Converter can NOT be started by any command source<br>**Limited* Parameters** can be viewed but can NOT be modified |
| DC_IN power is unavailable | Converter panel blackout after a short time |
| AC power resumes | Converter will remain in stop state, 'UE-1' can be reset<br>'Power loss restart mode' function works |

**Tab. 8-11:** Power loss in running status

#### Converter in stopped status: 'P.oFF' will be displayed at AC power loss

| Conditions | Description |
|---|---|
| DC_IN power is available | 'P.oFF' remains to be displayed on the panel<br>Converter can NOT be started by any command source<br>**Limited* Parameters** can be viewed but can NOT be modified |
| DC_IN power is unavailable | Converter panel blackout after a short time |
| AC power resumes | Converter will remain in stop state, 'P.oFF' disappears automatically |

**Tab. 8-12:** Power loss in stopped status

**Limited* Parameters**

| Code | Name | Code | Name |
|---|---|---|---|
| b0.00 | Access authority setting | E9.01 | Automatic error reset interval |
| E0.45 | Power loss restart mode | E9.05 | Last error type |
| E0.46 | Power loss restart delay | E9.06 | Second last error type |
| E8.00 | Communication protocol | E9.07 | Third last error type |
| E8.01 | Communication error detection time | E9.10 | Output frequency at last error |
| E8.02 | Communication error protection mode | E9.11 | Setting frequency at last error |
| E8.10 | Modbus baud rate | E9.12 | Output current at last error |
| E8.11 | Modbus data format | E9.13 | Output voltage at last error |
| E8.12 | Modbus local address | E9.14 | DC bus voltage at last error |
| E9.00 | Automatic error reset attempts | E9.15 | Power module temperature at last error |

**Tab. 8-13:** Limited parameters

Make sure that the voltage on DC_IN terminal is within 20...28 V, otherwise error code 'EPS-' will be displayed.

# 9 Electromagnetic Compatibility (EMC)

## 9.1 EMC Requirements

### 9.1.1 General Information

**The electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:**

- Sufficient noise immunity of an electric installation or an electric device against external electric, magnetic or electromagnetic interference via lines or through air.
- Sufficiently low noise emission of electric, magnetic or electromagnetic noise of an electric installation or an electric device to other surrounding devices via lines or through air.

### 9.1.2 Noise Immunity in the Drive System

**Basic structure for noise immunity**

The figure below illustrates the interference for definition of noise immunity requirements in the drive system.

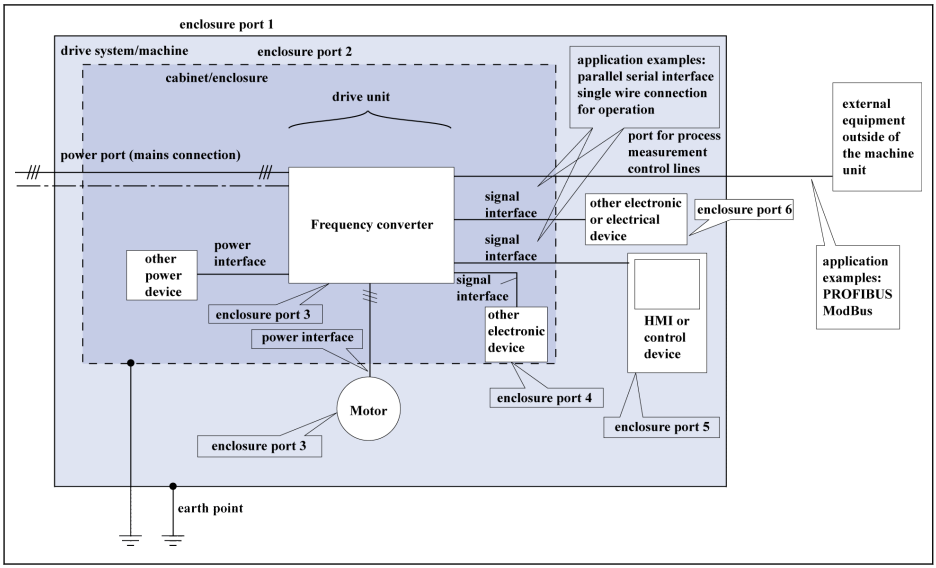



**Fig. 9-1:** Noise immunity in the drive system

### Minimum immunity requirements for PDSs intended for use in the second environment

| Port | Phenomenon | Basic standard for test method | Level | Performance (acceptance criterion) |
|---|---|---|---|---|
| Enclosure port | ESD | IEC 61000-4-2 | 4 kV CD or 8 kV AD<br>if CD impossible | B |
| | Radio-frequency electromagnetic field, amplitude modulated | IEC 61000-4-3 | 80...1000 MHz 10 V/m<br>1.4...2.0 GHz 3 V/m<br>2.0...2.7 GHz 1 V/m<br>80 % AM (1 kHz) | A |
| Power ports | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz | B |
| | Surge 1.2/50 µs, 8/20 µs | IEC 61000-4-5 | 1 kV [a], 2 kV [b] | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15...80 MHz 10 V<br>80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz<br>Capacitive clamp | B |
| Signal interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15...80 MHz 10 V<br>80 % AM (1 kHz) | A |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15...80 MHz 10 V<br>80 % AM (1 kHz) | A |

**Tab. 9-1:** Minimum immunity requirements for PDSs intended for use in the second environment

### Evaluation criterion

| Evaluation criterion | Explanation (abbreviated form from EN 61800-3) |
|---|---|
| A | Deviations within allowed range |
| B | Automatic recovery after interference |
| C | Switched off without automatic recovery. Device remains undamaged |

**Tab. 9-2:** Evaluation criterion

### 9.1.3 Noise Emission of the Drive System

#### Causes of noise emission

Controlled variable-speed drives contain converters containing snappy semiconductors. The advantage of modifying the speed with high precision is achieved by means of pulse width modulation of the converter voltage. This can generate sinusoidal current with variable amplitude and frequency in the motor.

The steeper voltage rises, the higher clock rate and the resulting harmonics cause unwanted but physically unavoidable emission of interference voltage and interference fields (wide band interference). The interference mainly is asymmetric interference against ground.

The propagation of this interference strongly depends on:

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- radiation conditions
- wiring and installation

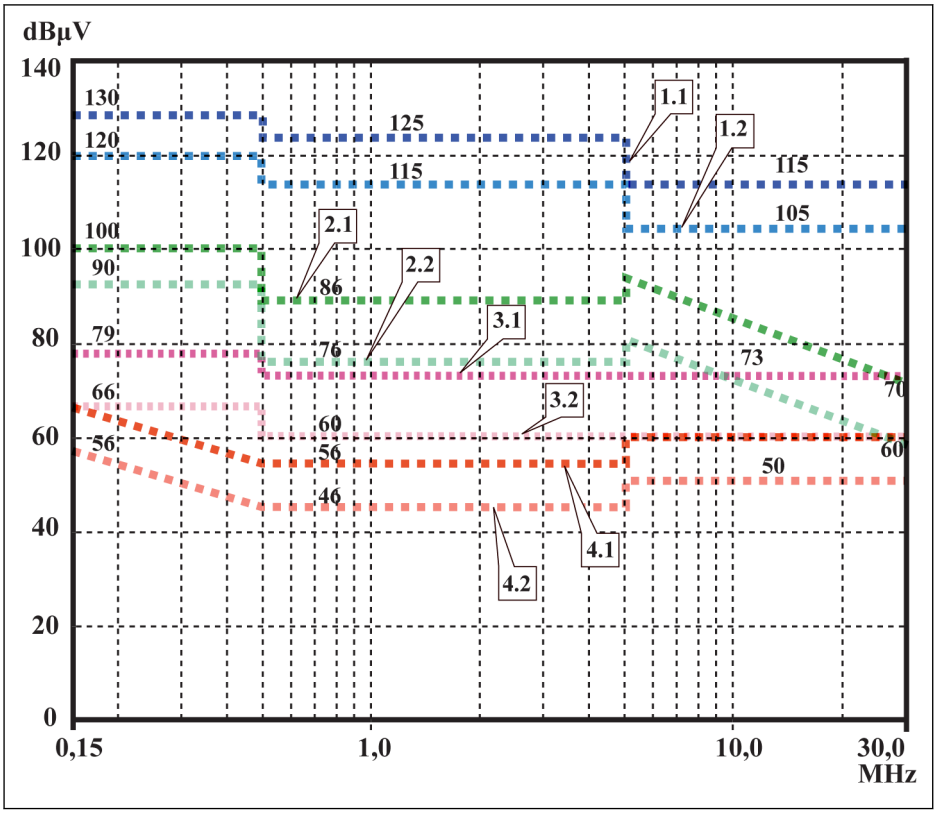
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

#### Limit values for line-based disturbances

According to IEC EN 61800-3 or CISPR 11 (corresponds to EN 55011), the limit values in the table below are distinguished. For this documentation both standards are combined in the limit value classes A2.1 to B1.

| IEC / EN 61800-3 | CISPR 11 | Explanation | In this document | Curves of limit value characteristic |
|---|---|---|---|---|
| Category C4<br>2nd environment | None | One of the following 3 requirements must have been fulfilled:<br>• Mains connection current > 400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter.<br>• Adjust limit values to use and operation on site.<br>• User has to carry out and provide evidence of EMC planning. | None | – |
| Category C3<br>2nd environment | Class A;<br>group 2,<br>I>100 A | Limit value in industrial areas to be complied with for applications operated at supply mains with nominal current > 100 A | A2.1 | 1.1<br>1.2 |
| Category C3<br>2nd environment | Class A;<br>group 2,<br>I≤100 A | Limit value in industrial areas to be complied with for applications operated at supply mains with nominal current ≤ 100 A | A2.2 | 2.1<br>2.2 |
| Category C2<br>1st environment | Class A;<br>group 1 | Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas to be complied with | A1 | 3.1<br>3.2 |
| Category C1<br>1st environment | Class B;<br>group 1 | Limit value in residential areas to be complied with | B1 | 4.1<br>4.2 |

**Tab. 9-3:** Limit values for line-based disturbances




**1.1 C3** 2nd environment, QP, I > 100 A (class A, group 2, I > 100 A)
**1.2 C3** 2nd environment, AV, I > 100 A (class A, group 2, I > 100 A)
**2.1 C3** 2nd environment, QP, I ≤ 100 A (class A, group 2, I ≤ 100 A)
**2.2 C3** 2nd environment, AV, I ≤ 100 A (class A, group 2, I ≤ 100 A)
**3.1 C2** 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class A, group 1)
**3.2 C2** 1st environment, AV (1st environment, even if source of interference in 2nd environment) (class A, group 1)
**4.1 C1** 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class B, group 1)
**4.2 C1** 1st environment, AV (1st environment, even if source of interference in 2nd environment) (class B, group 1)

**Fig. 9-2:** Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range

- Limit value for 1st environment is also relevant, if source of interference of 2nd environment affects 1st environment
- Designations “class” and “group” according to CISPR 11
- QP: measuring method quasi peak measurement
- AV: measuring method arithmetic averaging

### Second Environment, Industrial Area

Facilities not directly connected to a low-voltage mains to supply buildings in residential areas.

If the limit values in an industrial area separated from public supply by a transformer station only have to be complied with at the property boundary or in the neighboring low-voltage mains, the filter might not be necessary. In the vicinity such as measuring sensors, measuring lines or measuring devices, it is normally required to use the interference suppression filter.

Increasing the noise immunity of a sensitive device can often be the economically better solution compared to measures of interference suppression at the drive system of installation.

### First Environment

Environment containing residential areas and facilities directly connected, without interstage transformer, to a low-voltage mains supplying buildings in residential areas.

Medium-sized manufacturing plants and industrial establishments can be connected to the public low-voltage mains together with residential buildings. In this case there is a high risk for radio and television reception if there are not any measures for radio interference suppression taken. Therefore, the indicated measures are generally recommended.

### Nominal Current of Supply Mains

The nominal current of the supply mains ( > 100 A or ≤ 100 A) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply company.

Since it is impossible to obtain the lower limit values for residential areas with all applications by means of usual measures (like in the case of large and electrically not closed installations, longer motor cables or a large number of drives), the following note included in EN 61800-3 has to be observed.



According to EN 61800-3, components of VFC x615 drive system are products of category C3: with external EMC filter.

VFC x615 frequency converter with external EMC filter is applicable to industrial environment (category C3).

See the following chapters for the limit classes (as per categories C1, C2, C3, C4 according to EN 61800-3) which can be reached for Bosch Rexroth Frequency Converter VFC x615.

## 9.2 Ensuring the EMC Requirements

### Standards and Laws

On the European level there are the EU Directives. In the EU states these Directives are transformed into laws valid on a national level. The relevant directive for EMC is EU Directive 2004/108/EC which was transformed on the national level in Germany into the law EMVG (“Law concerning electromagnetic compatibility of devices”) of 2008-02-26.

### EMC Properties of Components

Drive and control components by Rexroth are designed and built, in accordance with the present state-of-the-art of standardization, according to legal regulations of the EU Directive EMC 2004/108/EC and the German law.

The compliance with EMC standards was tested by means of a typical arrangement with a test setup conforming to standard with the indicated external EMC filter.

- Category C3 requirements according to product standard EN 61800-3 have been complied with for VFC x615 with an external EMC filter.
- Minimum immunity requirements in the second environment according to product standard EN 61800-3 have been complied with for VFC x615 with an external EMC filter.

### Applicability for End Product

Measurements of the drive system with an arrangement typical for the system are not in all cases applicable to the status in a machine or installation. Noise immunity and noise emission strongly depend on:

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- radiation conditions
- wiring and installation

In addition, the required measures depend on the requirements of electric safety technology and economic efficiency in the application.

In order to prevent interference as far as possible, please read through and follow the detailed descriptions regarding on mounting and installation in this documentation.

### Cases to Distinguish for Declaration of EMC Conformity

For validity of the harmonized standards, we distinguish the following cases:

- Case 1: Delivery of the drive system.

  According to the regulations, VFC x615 drive system is complied with product standard EN 61800-3 C3 (with external EMC filters). The drive system is listed

in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.

- Case 2: Acceptance test of a machine or installation with the installed drive systems.

  The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In the last years, some new product standards were created at present.

These new product standards contain references to the product standard EN 61800-3 for drives or specify higher-level requirements demanding increased filter and installation efforts. When the machine manufacturer wants to put the machine/installation into circulation, the product standard relevant to his machine/ installation has to be complied with for his end product “machine/installation”. The authorities and test laboratories responsible for EMC normally refer to this product standard.

This documentation specifies the EMC properties which can be achieved, in a machine or installation, with a drive system consisting of the standard components.

It also specifies the conditions under which the indicated EMC properties can be achieved.

## 9.3 EMC Measures for Design and Installation

### 9.3.1 Rules for Design of Installations with Drive Controllers in Compliance with EMC

The following rules are the basics for designing and installing drives in compliance with EMC:

#### Mains Filter

Correctly use a mains filter recommended by Rexroth for radio interference suppression in the mains supply of the drive system.

For drive systems with 1P 200 VAC Frequency Converter VFC x615, it is recommended to install surge protection devices before the external filter.

#### Control Cabinet Grounding

Connect all metal parts of the cabinet with one another over the largest possible surface area to establish a good electric connection. This, too applies to the mounting of the external mains filter. If required, use serrated washers which cut through the paint surface. Connect the cabinet door to the control cabinet using the shortest possible grounding straps.

#### Line Routing

Avoid coupling routes between lines with high potential of noise and noise-free lines; therefore, signal, mains and motor lines and power cables have to be routed separately from another. Minimum distance: 10 cm. Provide separating sheets between power and signal lines. Ground separating sheets several times.

The lines with high potential of noise include:

- Lines at the mains connection (incl. synchronization connection)
- Lines at the motor connection
- Lines at the DC-bus connection

Generally, interference injections are reduced by routing cables close to grounded sheet steel plates. For this reason, cables and wires should not be routed freely in the cabinet, but close to the cabinet housing or mounting panels. Separate the incoming and outgoing cables of the radio interference suppression filter.

#### Interference Suppression Elements

Provide the following components in the control cabinet with interference suppression combinations:

- Contactors
- Relays
- Solenoid valves
- Electromechanical operating hours counters

Connect these combinations directly at each coil.

### Twisted Wires

Twist unshielded wires belonging to the same circuit (feeder and return cable) or keep the surface between feeder and return cable as small as possible. Wires that are not used have to be grounded at both ends.

### Lines of Measuring Systems

Lines of measuring systems must be shielded. Connect the shield to ground at both ends and over the largest possible surface area. The shield may not be interrupted, e.g. using intermediate terminals.

### Digital Signal Lines

Ground the shields of digital signal lines at both ends (transmitter **and** receiver) over the largest possible surface area and with low impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

### Analog Signal Lines

Ground the shields of analog signal lines at one end (transmitter **or** receiver) over the largest possible surface area and with lower impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

### Connection of Mains Choke

Keep connection lines of the mains choke at the drive controller as short as possible and twist them.

### Installation of Motor Power Cable

- Use shielded motor power cable or run motor power cables in a shielded duct
- Use the shortest possible motor power cable
- Ground shield of motor power cable at both ends over the largest possible surface area to establish a good electric connection
- It is recommended to run motor lines in shielded form inside the control cabinet
- Do not use any steel-shielded lines
- The shield of the motor power cable must not be interrupted by mounted components, such as output chokes, sine filter or motor filters

## 9.3.2 EMC-optimal Installation in Facility and Control Cabinet

### General Information

For EMC-optimal installation, a special separation of the interference-free area (mains connection) and the interference-susceptible area (drive components) is recommended, as shown in the figures below.



- For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.
- Frequency converters need to be mounted in metal cabinet and connected to power supply with grounding.
- For motor cables used in the EMC test of the frequency converters, see chapter 6.2 "Technical Data" on page 25.
- For the end application system with frequency converters, the conformity of EMC directions needs to be confirmed.

### Division into Areas (zones)

Exemplary arrangements in the control cabinet: See chapter 9.3.3 "Control Cabinet Mounting according to Interference Areas – Exemplary Arrangements" on page 90.

We distinguish three areas:

1. Interference-free area of control cabinet **(area A):**
   - Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines
   - All components that are not electrically connected with the drive system
2. Interference-susceptible area **(area B):**
   - Mains connections between drive system and mains filter for drives, mains contactor
   - Interface lines of drive controller
3. Strongly interference-susceptible area **(area C):**
   - Motor power cables including single cores

Never run lines of one of these areas in parallel with lines of another area so that there is not any unwanted interference injection from one area to the other and that the filter is jumped with regard to high frequency. Use the shortest possible connecting lines.

Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.

Badly grounded control cabinet doors act as antennas. Therefore, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 $mm^2$ or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

## 9.3.3 Control Cabinet Mounting according to Interference Areas – Exemplary Arrangements

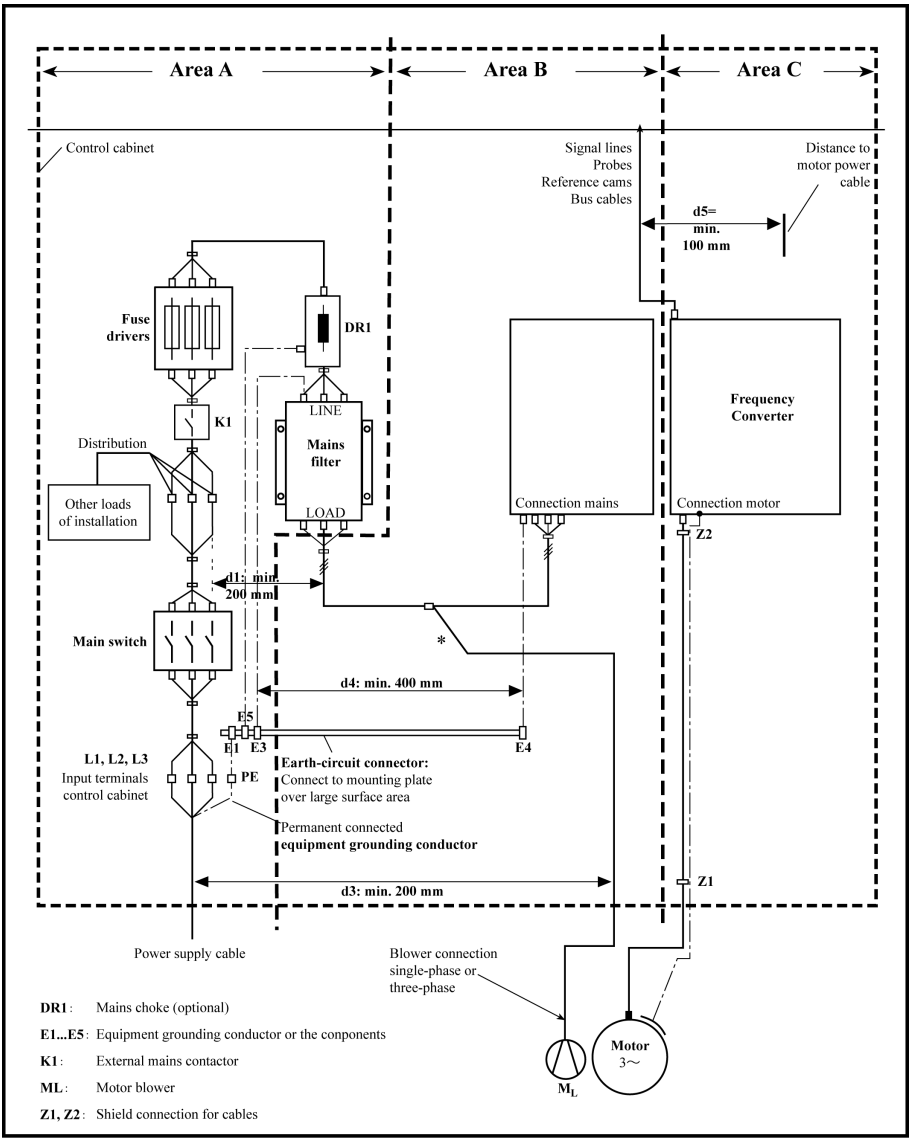



**Fig. 9-3:** Control cabinet mounting according to interference areas – exemplary arrangements

### 9.3.4 Design and Installation in Area A – Interference-free Area of Control Cabinet

#### Arrangement of the Components in the Control Cabinet

Comply with a distance of at least 200 mm (distance d1 in the figure):

- Between components and electric elements (switches, pushbuttons, fuses, terminal connectors) in the interference-free area A and the components in the two other areas B and C

Comply with a distance of at least 400 mm (distance d4 in the figure):

- Between magnetic components (such as transformers, mains chokes and DC-bus chokes that are directly connected to the power connections of the drive system) and the interference-free components and lines between mains and filter including the mains filter in area A

If these distances are not kept, the magnetic leakage fields are injected to the interference-free components and lines connected to the mains and the limit values at the mains connection are exceeded in spite of the installed filter.

#### Cable Routing of the Interference-free Lines to the Mains Connection

Comply with a distance of at least 200 mm (distance d1 and d3 in the figure):

- Between supply feeder or lines between filter and exit point from the control cabinet in area A and the lines in area B and C

If this is impossible, there are two alternatives:

1. Install lines in shielded form and connect the shield at several points (at least at the beginning and at the end of the line) to the mounting plate or the control cabinet housing over a large surface area.
2. Separate lines from the other interference-susceptible lines in areas B and C by means of a grounded distance plate vertically attached to the mounting plate.

Install the shortest possible lines within the control cabinet and install them directly on the grounded metal surface of the mounting plate or of the control cabinet housing.

Mains supply lines from areas B and C must not be connected to the mains without a filter.



In case you do not observe the information on cable routing given in this section, the effect of the mains filter is totally or partly neutralized. This will cause the noise level of the interference emission to be higher within the range of 150 kHz to 40 MHz and the limit values at the connection points of the machine or installation will thereby be exceeded.

### Routing and Connecting a Neutral Conductor (N)

If a neutral conductor is used together with a three-phase connection, it must not be installed unfiltered in areas B and C, in order to keep interference off the mains.

### Motor Blower at Mains Filter

Single-phase or three-phase supply lines of motor blowers, that are usually routed in parallel with motor power cables or interference-susceptible lines, must be filtered:

- In frequency converter with **only infeeding supply units**, via the available three phase filter of the frequency converter

When switching power off, make sure the blower is not switched off.

### Loads at Mains Filter of frequency converter

- Only operate allowed loads at the mains filter of the frequency converter!

### Shielding Mains Supply Lines in Control Cabinet

If there is a high degree of interference injection to the mains supply line within the control cabinet, although you have observed the above instructions (to be found out by EMC measurement according to standard), proceed as follows:

- Only use shielded lines in area A
- Connect shields to the mounting plate at the beginning and the end of the line by means of clips

The same procedure may be required for long cables of more than 2 m between the point of power supply connection of the control cabinet and the filter within the control cabinet.

### Mains Filters for AC Drives

Ideally, mount the external mains filter on the parting line between area A and B. Make sure the ground connection between filter housing and housing of the drive controllers has good electrically conductive properties.

If **single-phase** loads are connected on the load side of the external filter, their current may be a maximum of 10 % of the three-phase operating current. A highly imbalanced load of the external filter would deteriorate its interference suppression capacity.

If the mains voltage is higher than 480 V, connect the external filter to the output side of the transformer instead of the supply side of the transformer.

### Grounding

In the case of bad ground connections in the installation, the distance between the lines to the grounding points E1, E2 in area A and the other grounding points of the frequency converter should be at least d4 = 400 mm, in order to minimize interference injection from ground and ground cables to the power input lines.

See also "Division into Areas (zones)" on page 89.

#### Point of Connection for Environment Grounding Conductor at Machine, Installation, Control Cabinet

The equipment grounding conductor of the power cable of the machine, installation or control cabinet has to be permanently connected at point PE and have a cross section of at least 10 $mm^2$ or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN 61800-5-1: 2007, section 4.3.5.4). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must be accordingly bigger.

### 9.3.5 Design and Installation in Area B – Interference-susceptible Area of Control Cabinet

#### Arranging Components and Lines

Modules, components and lines in area B should be placed at a distance of at least d1 = 200 mm from modules and lines in area A.

Alternative: Shield modules, components and lines in area B by distance plates mounted vertically on the mounting plate from modules and lines in area A or use shield lines.

Only connect control voltage connections in the frequency converter to the mains via a mains filter. See "Division into Areas (zones)" on page 89.

Install the shortest possible lines between drive controller and filter.

#### Control Voltage or Auxiliary Voltage Connection

Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from area B and C of the frequency converter.

Run the connection between control voltage connection of the frequency converter and power supply unit used through area B over the shortest distance.

#### Line Routing

Run the lines along grounded metal surfaces, in order to minimize radiation of interference fields to area A (transmitting antenna effect).

### 9.3.6 Design and Installation in Area C – Strongly Interference-susceptible Area of Control Cabinet

Area C mainly concerns the motor power cables, especially at the connection point of the drive controller.

#### Influence of the Motor Power Cable

The longer the motor cable, the greater its leakage capacitors. To comply with a certain EMC limit value, the allowed leakage capacitance of he mains filter is limited.

- Run the shortest possible motor power cables.

#### Routing the Motor Power Cables and Motor Encoder Cables

Route the motor power cables and motor encoder cables along grounded metal surfaces, both inside the control cabinet and outside of it, in order to minimize radiation of interference fields. If possible, route the motor power cables and motor encoder cables in metal-grounded cable ducts.

Route the motor power cables and motor encoder cables

- with a distance of at least **d5 = 100 mm** to inference-free lines, as well as to signal cables and signal lines

  (alternatively separated by a grounded distance plate)
- in separate cable ducts, if possible

#### Routing the Motor Power Cables and Mains Connection Lines

For frequency converters (drive controllers with individual mains connection), route motor power cables and (unfiltered) mains connection lines **in parallel for a maximum distance of 300 mm**. After that distance, route motor power cables and power supply cables in opposite directions and preferably in separate **cable ducts.**

Ideally, the outlet of the motor power cables at the control cabinet should be provided in a distance of at least **d3 = 200 mm** from the (filtered) power supply cable.

## 9.3.7 Ground Connections

### Housing and Mounting Plate

By means of appropriate ground connections, it is possible to avoid the emission of interference, because interference is discharged to ground on the shortest possible way.

Ground connections of the metal housings of EMC-critical components (such as filters, devices of the frequency converter, connection points of the cable shields, devices with microprocessor and switching power supply units) have to be well contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate. The best solution is to use a zinc-coated mounting plate. Compared to a lacquered plate, the connections in this area have a good long-time stability.

### Connection Elements

For lacquered mounting plates, always use screw connections with tooth lock washers and zinc-coated, tinned screws as connection elements. At the connection points, remove the lacquer so that there is safe electric contact over a large surface area. You achieve contact over a large surface area by means of bare connection surfaces or several connection screws. For screw connections, you can establish the contact to lacquered surfaces by using tooth lock washers.

### Metal Surfaces

Always use connection elements (screws, nuts, plain washers) with good electroconductive surface.

Bare zinc-coated or tinned metal surfaces have **good electroconductive properties**.

Anodized, yellow chromatized, black gunmetal finish or lacquered metal surfaces have **bad electroconductive properties**.

### Ground Wires and Shield Connections

For connecting ground wires and shield connections, it is not the cross section but the size of contact surface that is important, as the high-frequency interference current mainly flow on the surface of the conductor.

### 9.3.8 Installing Signal Lines and Signal Cables

#### Line Routing

The following measures are recommend:

- Route signal and control lines separately from the power cables with a minimum distance of d5 = 100 mm (see "Division into Areas (zones)" on page 89) or with a grounded separating sheet. The optimum way is to route them in separate cable ducts. If possible, lead signal lines into the control cabinet at one point only.
- If signal lines are crossing power cables, route them in an angle of 90° in order to avoid interference injection.
- Ground spare cables, that are not used and have been connected, at least at both ends so that they do not have any antenna effect.
- Avoid unnecessary line lengths.
- Run cables as close as possible to grounded metal surfaces (reference potential). The ideal solution are closed, grounded cable ducts or metal pipes which, however, is only obligatory for high requirements (sensitive instrument leads).
- Avoid suspended lines or lines routed along synthetic carries, because they are functioning like reception antennas (noise immunity) and like transmitting antennas (emission of interference). Exceptional cases are flexible cable tracks over short distances of a maximum of 5 m.

#### Shielding

Connect the cable shield immediately at the devices in the shortest and most direct possible way and over the largest possible surface area.

Connect the shield of analog signal lines at one end over a large surface area, normally in the control cabinet at the analog device. Make sure the connection to ground/housing is short and over a large surface area.

Connect the shield of digital signal lines at both ends over a large surface area and in short form. In the case of potential differences between beginning and end of the line, run an additional bonding conductor in parallel. This prevents compensating current from flowing via the shield. The guide value for the cross section is 10 $mm^2$.

You absolutely have to equip separate connections with connectors with grounded metal housing.

In the case of non-shielded lines belongs to the same circuit, twist feeder and return cable.

### 9.3.9 General Measures of Radio Interference Suppression for Relays, Contactors, Switches, Chokes and Inductive Loads

If, in conjunction with electronic devices and components, inductive loads, such as chokes, contactors, relays are switched by contacts or semiconductors, appropriate interference suppression has to be provided for them:

- By arranging free-wheeling diodes in the case of d.c. operation
- In the case of a.c. operation, by arranging usual RC interference suppression elements depending on the contactor type, immediately at the inductance

Only the interference suppression element arranged immediately at the inductance does serve this purpose. Otherwise, the emitted noise level is too high which can affect the function of the electronic system and of the drive.

If possible, mechanical switches and contacts should only be realized as snap contacts. Contact pressure and contact material must be suited for the corresponding switching current.

Slow-action contacts should be replaced by snap switches or by solid-state switches, because slow-action contacts strongly bounce and are in an undefined switching status for a long time which emits electromagnetic waves in the case of inductive loads. These waves are an especially critical aspect in the case of manometric or temperature switches.

# 10 Operating Panel and Dust Cover

## 10.1 LED Panel

The LED panel is removable and composed of two areas: display and buttons. The display shows mode settings and operating state of the frequency converter. The buttons allow users to program the frequency converter.

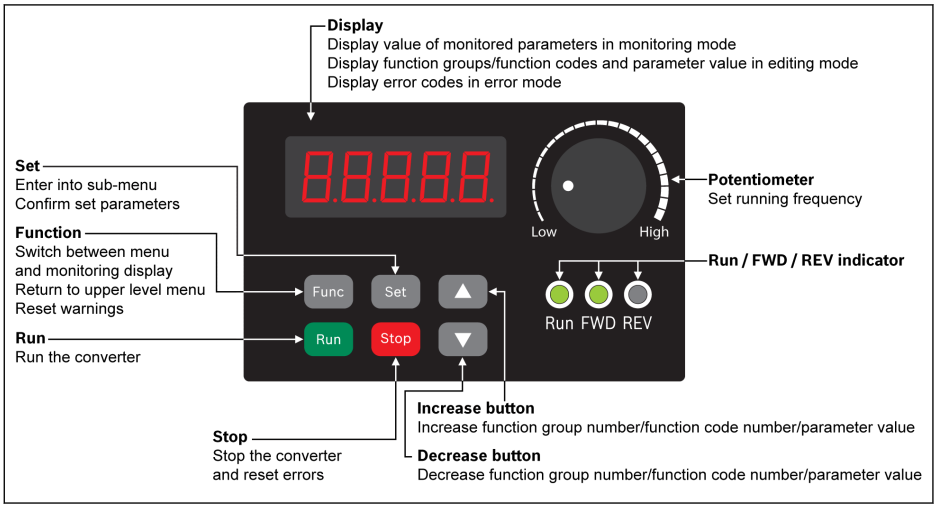



**Fig. 10-1:** LED panel

## 10.2 LED Display

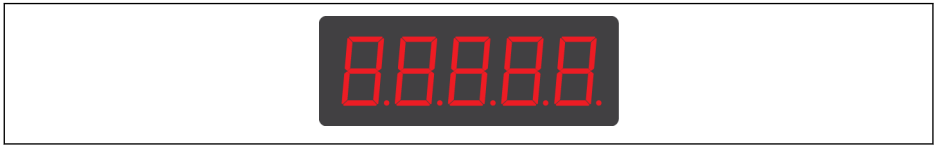


**Fig. 10-2:** LED display

## 10.3 Dust Cover

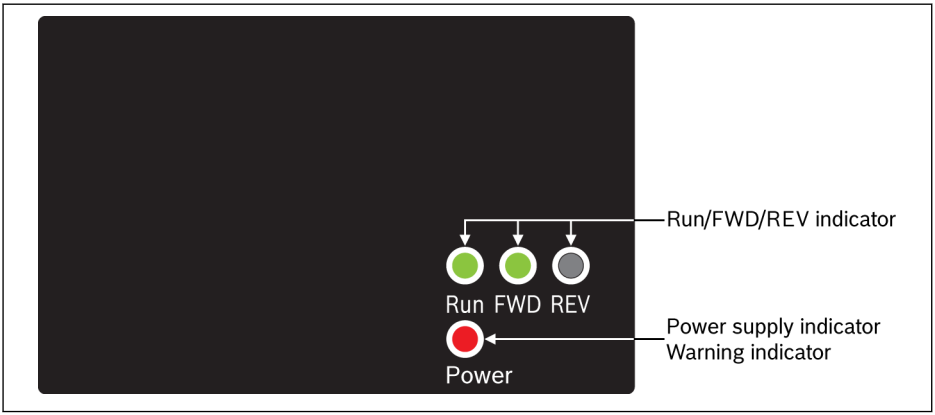



**Fig. 10-3:** Dust cover

Frequency Converter VFC x615 are available with **Dust Cover** instead of **LED Panel** on demand. To operate frequency converters with **Dust Cover**,

- Order an **LED Panel** additionally, and then set the frequency converter with chapter 12.1.3 "Parameter Copy" on page 114.

## 10.4 LED Indicator

| Mode | Run | FWD | REV | Power① |
|---|---|---|---|---|
| Power off | Off | Off | Off | Off |
| Ready | Off | Green / Off | Off / Green | Red |
| Run (FWD) | Green | Green | Off | Red |
| Run (REV) | Green | Off | Green | Red |
| Run pending<br>DC-braking at start<br>Direction change dead time | Blinks in green<br>(Short green<br>long dark) | Green / Off | Off / Green | Red |
| Deceleration stop phase<br>DC-braking at stop | Blinks in green<br>(Short dark<br>long green) | Green / Off | Off / Green | Red |
| Warning with FWD | Green | Green | Off | Blinks in red<br>(Short dark<br>long red) |
| Warning with REV | Green | Off | Green | Blinks in red<br>(Short dark<br>long red) |
| Warning at stop | Off | Green / Off | Off / Green | Blinks in red<br>(Short dark<br>long red) |
| Error | Off | Green / Off | Off / Green | Blinks in red<br>(Short red<br>long dark) |

**Tab. 10-1:** LED indicator status

- ①: Available on dust cover or when neither the LED panel nor the dust cover is installed.
- The frequency converter stops if FWD and REV commands are active at the same time.

## 10.5 Operating Descriptions

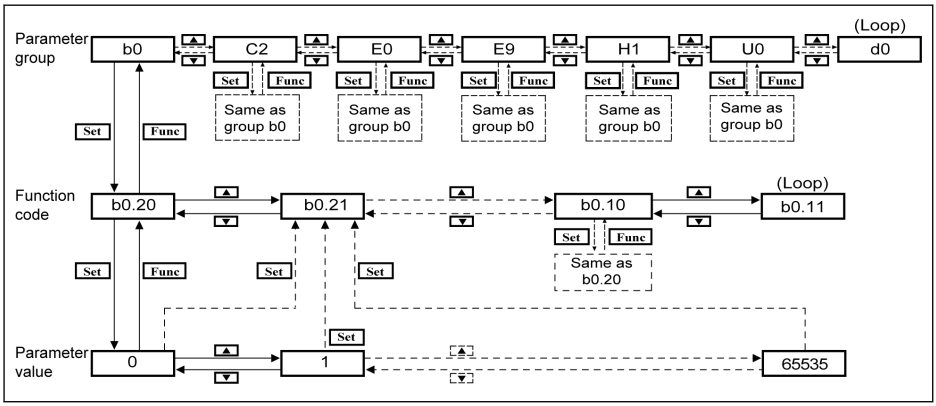



**Fig. 10-4:** Operating mode

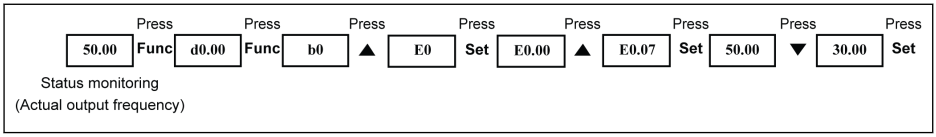



**Fig. 10-5:** Operating example

## 10.6 Fast Access to Parameters with Button Combinations

VFC x615 provides fast access to parameters within a parameter group with '**<Func> + <▲>**' or '**<Func> + <▼>**' combinations. This function is only valid for the tens digit of the function code index '□□.**x**□'.

- Pressing '**<Func> + <▲>**' once: '□□.**x**□' is changed to '□□.**x+1**□'
- Pressing '**<Func> + <▼>**' once: '□□.**x**□' is changed to '□□.**x-1**□'

Example: The frequency converter is now displaying 'E0.07' after setting with **<Func>**, **<Set>**, **<▲>** and **<▼>** buttons.

If 'E0.**1**7' needs to be displayed based on 'E0.**0**7', **<▲>** button has to be pressed for 10 times in the traditional way as described in the above figure. However, with button combination function, it is only necessary to press '**<Func> + <▲>**' buttons once.

---

- The parameter fast access function is only available when [b0.00] = 0, 1, or 2, unavailable with parameters in groups '-PF-' or '-EP-'
- Press **<Func>** button and do not release it until **<▲>** or **<▼>** button has been pressed.
- Press **<▲>** or **<▼>** button within 2 s if **<Func>** button is pressed.
- If the index of parameters is not continuous in a specific parameter group, the adjacent parameter will be accessed. For example, the display of 'E0.01' should be changed to 'E0.11' with '**<Func> + <▲>**' button function. However, parameter E0.11 is unavailable in group E. While the adjacent parameter is E0.15. In this case, 'E0.15' is accessed and displayed.

---

## 10.7 Digit Shifting Function for Modification of Parameter Values

VFC x615 also provides the digit shifting function for modification of parameter values. To activate this function, press '**<Func> + <▲>**' or '**<Func> + <▼>**' once when the frequency converter is displaying a certain parameter value. After this action, the unit digit of the value blinks.

To select the digit for modification, press the following button combinations.

- Pressing '**<Func> + <▲>**' once: the blinking digit is shifted one digit leftwards.
- Pressing '**<Func> + <▼>**' once: the blinking digit is shifted one digit rightwards.

Example: [E0.07] = 35.40. The frequency is now displaying '35.40'.

If the value '35.40' needs to be modified to be 15.40, execute the following steps.

- Step 1: Pressing '**<Func> + <▲>**' or '**<Func> + <▼>**' once to activate the digit function. '3**5**.40' is displayed with the unit digit '5' blinking.
- Step 2: Pressing '**<Func> + <▲>**' again to shift the blinking digit leftwards. '**3**5.40' is displayed with tens digit '3' blinking.
- Step 3: Pressing **<▼>** twice to change the tens digit '3' to be '1'. '**1**5.40' is displayed with tens digit '1' blinking.
- Step 4: Pressing **<Set>** to save the modified parameter value '15.40'. The display returns back to an upper menu level to show the next parameter with 'E0.08' displayed.



- The digit shifting function is only available for parameters with values and unavailable for parameter with options.
- Press **<Func>** button and do not release it until **<▲>** or **<▼>** button has been pressed.
- Press **<▲>** or **<▼>** button within 2 s if **<Func>** button is pressed.
- Press **<Func>** button over 2 s without pressing any other button to cancel the uncompleted setting with button combinations.

## 10.8 LCD Panel

### 10.8.1 LCD Panel Introduction

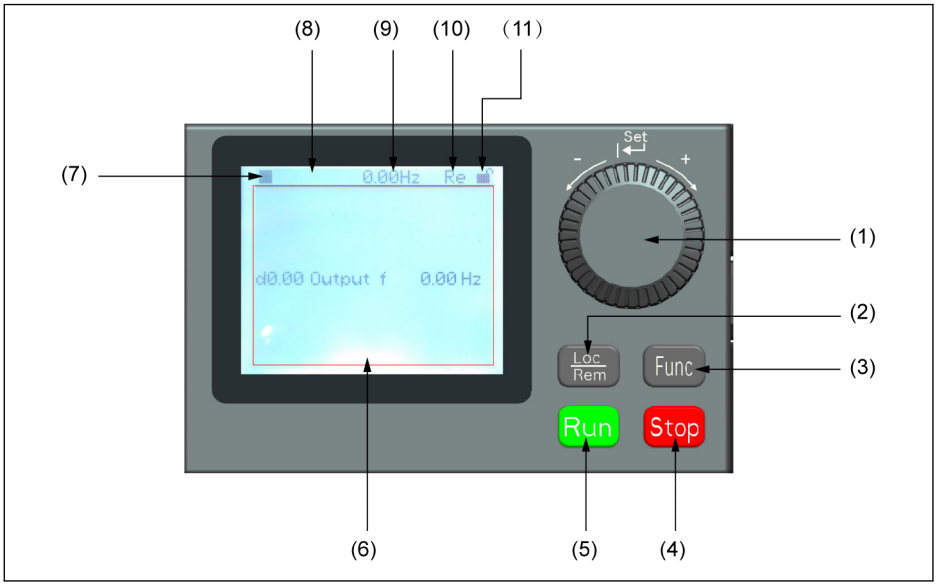



**Fig. 10-6:** LCD panel appearance

**(1) Navigation button**

1. Scroll between parameter and group code
2. Set the parameter value

**(2) Loc / Rem** button: Switch between "Remote" & "Local".

**(3) Func** button: Enter the parameter group screen and go back to previous screens.

**(4) Stop** button: Stop the frequency converter.

**(5) Run** button: Start the frequency converter.

**(6) Text area**: Used for displaying:

1. Parameter monitoring screen
2. Parameter group / Parameter code
3. Parameter name
4. Parameter value and unit
5. Other screens: Error / Warning display screen, welcome screen, customer information message screen

**(7) Run / Stop status**: It displays information regarding run / stop and forward / reverse state of the frequency converter. Details are shown in the table below.

| Frequency converter status | Details |
|---|---|
| • Running at 0 Hz (set RefDir: FWD) | ⏩: Blinking<br>⏪: Invisible<br>⏹: Invisible |
| • Running at 0 Hz (set RefDir: REV) | ⏩: Invisible<br>⏪: Blinking<br>⏹: Invisible |
| • Frequency converter in RUN state (set RefDir: REV) | ⏩: Invisible<br>⏪: Shown solid, not blinking<br>⏹: Invisible |
| • Frequency converter in RUN state (set RefDir: FWD) | ⏩: Shown solid, not blinking<br>⏪: Invisible<br>⏹: Invisible |

**Tab. 10-2:** Frequency converter status

**(8) Error / Warning information**: Error / Warning code will be displayed in this sector. Please refer to chapter 13 "Diagnosis" on page 405 for details.

**(9) Permanent monitoring**: By default, its display as "Actual output frequency" is set by parameter U2.09. Value and unit of parameter will be displayed.

**(10) Re / Lo**: **Re** stands for 'Remote' and **Lo** for 'Local'. Its display is set via **Loc / Rem** button or parameter U2.03.

**(11) Panel Locked / Unlocked**: Panel can be locked by the following ways:

- Setting [U2.02] to '1', or
- Pressing **Func** button with **Loc** button for longer than 3 s.

Panel can be unlocked by the following ways:

- Setting [U2.02] to '0' (only in communication mode), or
- Pressing **Func** button with **Loc** button for longer than 3 s.

## 10.8.2 Operating Example

Please follow the steps below to set parameter [b0.10] to '1: Restore to default settings' through LCD panel.

1. Press **Func** button.
2. Rotate **Navigation button** to select parameter group b0.
3. Press **Navigation button** and rotate it to select parameter b0.10.
4. Press **Navigation button** and rotate it to select parameter value '1: Restore to default settings'.
5. Press **Navigation button** to finish setting.

# 11 Quick Start

## 11.1 Checklist before Quick Start

### 11.1.1 Step 1: Check application conditions

| | |
|---|---|
| Rated ambient temperature | -10...40 °C |
| Derating / ambient temperature | 1.5 % / 1 °C (40...50 °C) |
| Rated storage temperature | -20...60 °C |
| Rated altitude | ≤ 1,000 m |
| Derating / altitude | 1 % / 100 m (1,000...4,000 m) |
| Mounting mode (Wall mounting) | Wall mounting |

**Tab. 11-1:** Application conditions checklist

See also in chapter 6.1.9 "Conditions" on page 24.

### 11.1.2 Step 2: Check mounting conditions

| | |
|---|---|
| Converter mounting direction | Vertical |
| Minimum top space | $d_{top}$ = 125 mm |
| Minimum bottom space | $d_{bot}$ = 125 mm |
| One converter is arranged above another | Air guide available is required in between |
| Mounting screws | 4 x M6, no loose screws |

**Tab. 11-2:** Mounting conditions checklist

See also in chapter 7.1 "Installation Conditions" on page 35.

### 11.1.3 Step 3: Check the wiring

| | |
|---|---|
| Mains connection | Connect L1, L2, (L3) of converter to mains accordingly |
| Motor connection | Connect U, V, W of converter to motor accordingly |
| Grounding | Must be securely connected |
| Shielding | Must be securely connected |
| Power cables | Must observe chapter 8.1 "Wiring Diagram" on page 52 |
| Control terminals connection | Must be securely connected |
| Control cables | Must observe chapter 8.2.2 "Control Cables" on page 61 |
| EMC | Must observe chapter 9 "Electromagnetic Compatibility (EMC)" on page 78 |
| Switches | Must be switched off |
| Load | Must be disconnected |

**Tab. 11-3:** Wiring checklist

## 11.2 Quick Start Parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.05 | Carrier frequency | DOM | DOM | 1 | Run |
| C1.05 | Motor rated power | 0.1...1,000.0 kW | DOM | 0.1 | Stop |
| C1.06 | Motor rated voltage | 0...480 V | DOM | 1 | Stop |
| C1.07 | Motor rated current | 0.01...655.00 A | DOM | 0.01 | Stop |
| C1.08 | Motor rated frequency | 5.00...400.00 Hz | 50.00 | 0.01 | Stop |
| C1.09 | Motor rated speed | 1...60,000 rpm | DOM | 1 | Stop |
| C2.00 | V/f curve mode | 0: Linear<br>1: Square<br>2: User-defined | 0 | – | Stop |
| E0.00 | First frequency setting source | 0...21 | 0 | – | Stop |
| E0.01 | First run command source | 0...2 | 0 | – | Stop |
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | Run |
| E0.08 | Maximum output frequency | 50.00...400.00 Hz | 50.00 | 0.01 | Stop |
| E0.09 | Output frequency high limit | [E0.10]...[E0.08] Hz | 50.00 | 0.01 | Run |
| E0.10 | Output frequency low limit | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E0.17 | Direction control | 0: Forward / Reverse<br>1: Forward only<br>2: Reverse only<br>3: Swap default direction | 0 | – | Stop |
| E0.25 | Acceleration / deceleration curve mode | 0: Linear mode<br>1: S-curve | 0 | – | Stop |
| E0.26 | Acceleration time | 0.1...6,000.0 s | DOM | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6,000.0 s | DOM | 0.1 | Run |
| E0.35 | Start mode | 0: Start directly<br>1: DC-braking before start<br>2: Start with speed capture<br>3: Automatic start / stop according to setting frequency | 0 | – | Stop |
| E0.50 | Stop mode | 0: Decelerating stop<br>1: Freewheeling stop 1<br>2: Freewheeling stop 2 | 0 | – | Stop |

**Tab. 11-4:** Quick start parameters

## 11.3 Control the Motor

**⚠ WARNING**

Ensure the enclosure is in place before the device is powered on. Wait for at least **10 minutes** after powering off to allow the DC capacitor being discharged, and do not remove the cover during this period!

| Step | Operation | Description |
|---|---|---|
| 1 | Rotate the potentiometer counterclockwise (leftwards) to the greatest extent | Output frequency setting is 0.00 |
| 2 | Press **<Run>** button | Control command active, 0.00 is displayed |
| 3 | Rotate the potentiometer clockwise (rightwards) slowly till 5.00 is displayed | The motor starts to run |
| | **Observe the running status:** | **Recommended operation:** |
| | If the motor runs in the correct direction | Stop the motor immediately by switching off the power if any abnormality occurs |
| | If the motor runs steadily | |
| | If there is any abnormal noise or problem | Restart commissioning only after error causes have been removed |
| 4 | Rotate the potentiometer clockwise | The motor accelerates |
| 5 | Rotate the potentiometer counterclockwise | The motor decelerates |
| 6 | Press **<Stop>** button | Stop command activated, the motor stops |
| 7 | Check parameters without load | Settings according to actual applications |
| 8 | Check parameters with load | Settings according to actual applications |

**Tab. 11-5:** Motor controlling procedure

- After powering on, VFC x615 will generate output if pressing down the **<Run>** button (or 'Control by terminals' is activated).
- By default, VFC x615 is set as:
  - The frequency converter is started or stopped by the operating panel.
  - The output frequency is set by the potentiometer on the operating panel.
- After powering on, please confirm:
  - The setting frequency is displayed (no error display).
  - The monitoring parameter is consistent with the actual situations.
- By default, **Output frequency** in run status and **Setting frequency** in stop status are displayed as the monitoring parameters, which can be changed to other parameters with parameters U1.00 and U1.10. The default settings are based on standard applications with standard motors.

☞ For frequency converters with dust cover, it is recommended to install an LED panel to perform the above operations.

## 11.4 Motor Parameters Auto-Tuning

For SVC control and applications with higher requirement to control accuracy in V/f control, motor parameter auto-tuning is necessary. Two modes of auto-tuning are available, static auto-tuning and rotational auto-tuning. The former mode is mainly used for V/f control and the latter is mainly used for SVC control.

**Check and make sure the following points before auto-tuning:**

- The motor is in standstill and not at high temperature.
- The power rating of the frequency converter is close to that of the motor.
- Set C1.05...C1.10 based on motor nameplate data. If the power factor data is unavailable on the nameplate, keep the default setting of C1.10.
- Set E0.08 according to motor parameters and actual application conditions.



Disconnect the load from the motor shaft for rotational auto-tuning.

**Set auto-tuning mode and start motor parameter auto-tuning:**

Set the following parameter according to the control mode of the frequency converter and the application situation.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.01 | Motor parameter tuning | 0...2 | 0 | – | Stop |

- 0: Inactive. SVC control can still be used, but with lower performance.
- 1: Static auto-tuning. This mode is suggested to be used for V/f control. It can also be used for SVC control when the load cannot be disconnected.
- 2: Rotational auto-tuning (suggested to be used for SVC control)

Press the **<Run>** button on the operating panel to start auto-tuning. In the process of auto-tuning, a status code 'tUnE' will be displayed on the operating panel. When the auto-tuning process is complete, the status code disappears and the settings of the following parameters will be obtained automatically:

| Static auto-tuning | Rotational auto-tuning | Parameters obtained by auto-tuning |
|---|---|---|
| √ | √ | C1.12: Motor rated slip frequency |
| √ | √ | C1.20: Motor no-load current |
| √ | √ | C1.21: Stator resistance |
| √ | √ | C1.22: Rotor resistance |
| √ | √ | C1.23: Leakage inductance |
| √ | √ | C1.24: Mutual inductance |
| √ | √ | C3.05: Current loop proportional gain |
| √ | √ | C3.06: Current loop integral time |
| – | √ | C3.00: Speed loop proportional gain |
| – | √ | C3.01: Speed loop integral time |

**Tab. 11-6:** Parameters obtained by auto-tuning

## 11.5 Possible Errors during Quick Start and Respective Solutions

| Errors | Solutions |
|---|---|
| Over current (SC, OC-1 or OC-2) occurs during acceleration | Increase the acceleration time |
| Over voltage (OE-3) occurs during deceleration | Increase the deceleration time |
| Over current (SC, OC-1 or OC-2) occurs immediately after pressing the **<Run>** button | Incorrect wiring. Check if U, V, W outputs of the main circuit are shorted or grounded |
| The motor runs in the direction opposite to expected | Change the sequence of any two phases of U, V and W |
| The motor vibrates and runs in uncertain directions after each starting | One phase of U, V and W is disconnected (output phase loss) |

**Tab. 11-7:** Solutions for simple errors during commissioning

## 11.6 Restoring Parameters to Factory Defaults

If the frequency converter fails to run the motor due to incorrect parameter settings, a simple solution is to initialize the parameters to factory defaults. Setting [b0.10] = 1 will start initialization.

Please be sure that the parameter settings match with the motor and the field applications after factory defaults restore. Adjust the parameter settings after factory defaults restore if necessary.

| | |
|---|---|
| Output frequency | Set by the potentiometer (E0.00) |
| Acceleration / deceleration time | Linear, Acc. for 5 s / Dec. for 5 s (E0.26, E0.27) |
| Protection mode in case of motor overload or overheat | Motor rated current (C1.07), Motor thermal model protection time constant (C1.74), low speed derating frequency (C1.75), and zero speed load (C1.76) |
| Operating panel operation | **<Run>**, **<Stop>** buttons as command sources, potentiometer as frequency setting source |
| V/f curve mode | Linear |

**Tab. 11-8:** Parameter settings by factory defaults

# 12 Functions and Parameters

## 12.1 b0: Basic System

### 12.1.1 Access Authority Setting

This function is used to set parameters or read parameter settings in a fast way. Five access modes are available with parameter b0.00.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| b0.00 | Access authority setting | 0...4 | 0 | - | – | Run |

Setting range of b0.00:

- **0: Basic parameters**

  b0, d0, C0, E0, U0, U1, U2, -EP- are visible.

- **1: Standard parameters**
  - For VFC 5615, b0, d0, C0, C1, C2, C3, E0, E5, E8, U0, U1, U2, -EP- are visible.
  - For VFC 3615, b0, d0, C0, C1, C2, E0, E5, E8, U0, U1, U2, -EP- are visible.
- **2: Advanced parameters**
  - s
  - For VFC 5615, b0, d0, C0, C1, C2, C3, E0, E1, E2, E3, E4, E5, E8, E9, H0, H1, H2, H8, H9, U0, U1, U2, F0, -EP- are visible.
  - For VFC 3615, b0, d0, C0, C1, C2, E0, E1, E2, E3, E4, E5, E8, E9, H0, H1, H2, H8, H9, U0, U1, U2, F0, -EP- are visible.
- **3: Start-up parameters**

  b0, d0, -St-, -EP- are visible.

- **4: Modified parameters**
  - b0, d0, -PF-, -EP- are visible.
  - -PF- group consists of only modified parameters which are different from the default setting. Parameter settings can be modified directly in -PF- group.
  - If a parameter in -PF- group was changed back to its default setting is still visible in -PF- group. It is invisible once the group has been exited and re-accessed.
  - Parameters b0.10, b0.11, b0.20, b0.21, C0.53, C1.01, E9.05...E9.07, E9.10...E9.15, H8.87, H9.97 are excluded from this function.
  - If -PF- group is accessed if no parameter is different from default the warning message noCP will be displayed for 1.5s, then it will fall back to group selection screen.

| Code | Name | Code | Name |
|---|---|---|---|
| C0.05 | Carrier frequency | E0.08 | Maximum output frequency |
| C1.05 | Motor rated power | E0.09 | Output frequency high limit |
| C1.06 | Motor rated voltage | E0.10 | Output frequency low limit |
| C1.07 | Motor rated current | E0.17 | Direction control |
| C1.08 | Motor rated frequency | E0.25 | Acceleration / Deceleration curve mode |
| C1.09 | Motor rated speed | E0.26 | Acceleration time |
| C2.00 | V/f curve mode | E0.27 | Deceleration time |
| E0.00 | First frequency setting source | E0.35 | Start mode |
| E0.01 | First run command source | E0.50 | Stop mode |
| E0.07 | Digital setting frequency | | |

**Tab. 12-1:** -St- group contents

-EP- group is only visible if there are erroneous parameters during parameter restore (error E.Par).



- Parameters which are linked to an extension are only shown if the corresponding card is installed.

  Example: Groups H1...H9 will only be shown if the related extension card is installed.
- Group U2 will only be shown if a LCD panel is installed. At the same time, because LED panel is uninstalled, U1 will not be visible any longer.
- ASF related parameter groups F1...F3 will only be shown if an ASF is loaded and b0.00 = 2.

### 12.1.2 Parameter Initialization

This function is used to restore the parameters back to the factory defaults.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| b0.09 | Parameter initialization setting | 1: Base device and non fieldbus options<br>2: Fieldbus options<br>3: Base device, non fieldbus and fieldbus options | 1 | – | – | Stop |
| b0.10 | Parameter initialization | 0...2 | 0 | – | – | Stop |

Setting range of b0.10:

- **0: Inactive**

  This parameter will be reset to 0 automatically after parameter initialization is finished.

- **1: Restore to default settings**

  Parameters will be restored to factory default based on the setting of b0.09:

  – b0.09 = 1: b0, d0, C0, C1, C2, C3, E0, E1, E2, E3, E4, E5, E8, E9, H0, H8, H9, U0, U1, U2, F0, F1, F2, F3

  – b0.09 = 2: H1, H2, H3, H4

  – b0.09 = 3: All parameters are restored to factory default

  Following parameters will not be cleared, independent of the setting of b0.09:

  – C0.51 (Fan total running time)

  – E9.05...E9.07, E9.10...E9.15, E9.97...E9.99 (Error records)

  – d0.23 (Power stage running time)

- **2: Clear error and warning record**

  Parameters E9.05...E9.07 and E9.10...E9.15, E9.97...E9.99 will be cleared.

### 12.1.3 Parameter Copy

This function is used to copy parameter settings between multiple frequency converters via the operating panel. Parameters can be stored on the panel of the frequency converter, after the panel is plugged into a different converter the same settings can be copied to this converter.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| b0.11 | Parameter copy | 0...2 | 0 | – | – | Stop |

Setting range of b0.11:

- **0: Inactive**

  This parameter will be reset to 0 automatically after parameter copy is finished.

- **1: Backup parameters to panel**

  All customer parameter settings are copied to the panel.

- **2: Restore parameters from panel**

  All customer parameters settings are restored from the panel.

The following parameters are not included in parameter copy function:

- Read only parameters(d0 group, F0 group, C0.51, E9.05...E9.99, U0.99, H0.01, H0.02, H0.03, H0.18, H0.19, H0.20, H0.30, H0.23, H0.33, H1.01, H1.02)
- Panel parameters(U1 group, U2 group)
- Auto reset after execution parameters(b0.09, b0.10, b0.11, b0.20, b0.21, C0.53, C1.01)
- Real time data parameters(E2.20, E2.28, H0.00, H0.10, H0.12, H0.14, H0.15, H0.16, H0.50, H8.23, H8.28)
- MEP card parameters(H3 group, H4 group)
- Diagnosis parameters(H8.87, H9.97)

All other operations will be inactive during parameter replication. The panel can't be operated, data can't be accessed with engineering tools or fieldbus until the operation is finished.

When a parameter restore is started, all the parameters on the device will be set to the initial values first, this ensures a compatible behavior also over different firmware versions.

The state of progress during the operation is shown in the panel as below:

| Display in the panel | State of progress |
|---|---|
| "-" | 0...25% finished |
| "--" | 26...50% finished |
| "---" | 51...75% finished |
| "----" | 76...100% finished |

**Tab. 12-2:** State of progress

If parameter restore is triggered via communication it may lead to a communication breakdown if the parameters in the backup are not set according to the current settings.

If the panel is unplugged during the backup process the parameter image in the panel is not valid and can't be restored to another device. If the panel is unplugged during restore process the state of the converter is undefined. Process has to be repeated or default values have to be loaded.

When the parameter backup was taken with a different firmware version then the restore is done, some parameters might not be available, those will be set to initial values.

If a parameter from a backup has a different value range (e.g. from different device class) the error E.Par will be shown. Parameters which are set to invalid values will be shown in -EP- group.

If one or more parameters in the backup are not found in the device they will be skipped during parameter restore without notification.

## 12.1.4 Parameter Set Switch

This function allows to switch between two sets of parameters. It is used if the motors are switched at the output of the frequency converter and two motors should be driven by one device.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| b0.12 | Parameter set selection | 0: Parameter set 1 active<br>1: Parameter set 2 active | 0 | – | – | Stop |

Following parameters are inside the switchable parameter set:

| Code | Name | Code | Name |
|---|---|---|---|
| C0.00* | Control mode | C1.71 | Motor overload pre-warning delay |
| C1.00* | Motor type | C1.74 | Motor thermal model protection time constant |
| C1.05 | Motor rated power | C1.75 | Low speed derating frequency |
| C1.06 | Motor rated voltage | C1.76 | Zero speed load |
| C1.07 | Motor rated current | C2.00 | V/f curve mode |
| C1.08 | Motor rated frequency | C2.01 | V/f frequency 1 |
| C1.09 | Motor rated speed | C2.02 | V/f voltage 1 |
| C1.10 | Motor rated power factor | C2.03 | V/f frequency 2 |
| C1.11 | Motor poles | C2.04 | V/f voltage 2 |
| C1.12 | Motor rated slip frequency | C2.05 | V/f frequency 3 |
| C1.13 | Motor inertia mantissa | C2.06 | V/f voltage 3 |
| C1.14 | Motor inertia exponent | C2.07 | Slip compensation factor |
| C1.20 | Motor no-load current | C2.21 | Torque boost setting |
| C1.21 | Stator resistance | C2.22 | Automatic torque boost factor |
| C1.22 | Rotor resistance | E0.00 | First frequency setting source |
| C1.23 | Leakage inductance | E0.01 | First run command source |
| C1.24 | Mutual inductance | E0.07 | Digital setting frequency |
| C1.69 | Motor thermal model protection setting | E0.09 | Output frequency high limit |
| C1.70 | Motor overload pre-warning level | | |

**Tab. 12-3:** Parameter set contents



*: C0.00 and C1.00 are ONLY included in the switchable parameter set for VFC 5615.

Parameter set switch can be carried out in 2 different ways:

- By parameter b0.12:

  When the value is changed the parameter set according to the parameter will be loaded. A parameter set switch can only be carried out in STOP mode. Dur-

ing power up parameter set is loaded according to setting of b0.12, if none of the digital inputs is used to switch between the parameters sets.

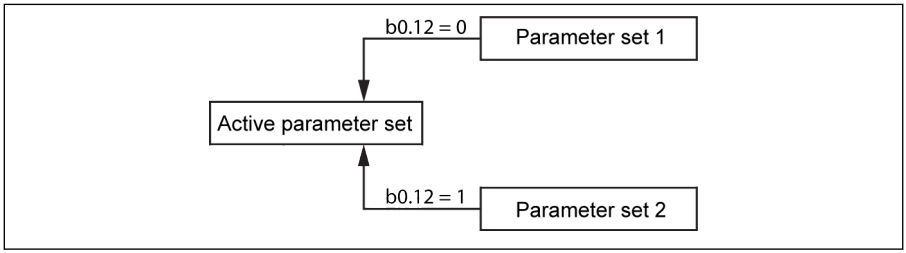



**Fig. 12-1:** Parameter set selection by b0.12

- By digital input:

  Parameter set switch will be carried out with an digital input if one of the parameters E1.00...E1.04 or H8.00...H8.04 is set to option “46: Parameter set selection”. If one of the digital inputs is configured to option 46 it will override the setting of b0.12 and load the parameter set according to the digital input during power up. If an attempt to change [b0.12] as long as a digital input is configured, 'S.Err' will be shown.

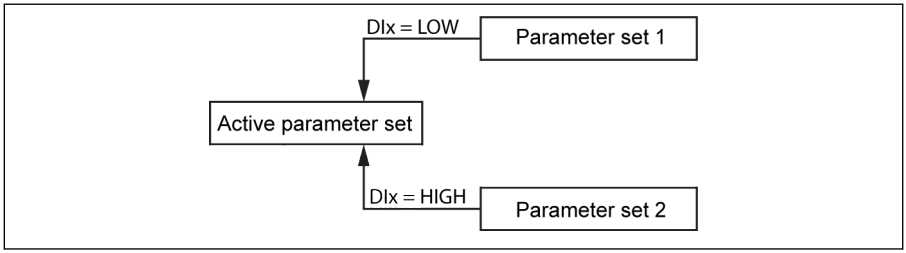



**Fig. 12-2:** Parameter set selection by digital input

Terminal value is considered for active parameter set selection only during STOP mode. If converter is in RUN, terminal value change will be ignored for parameter set selection. After STOP, parameter switching will be triggered once again, if the configured terminal value is not matching active parameter set.

Parameter set switch and other commands (e.g. RUN) can be given at the same time, but all other commands will be delayed until the parameter set switch is finished and triggered afterwards. If a parameter set switch is initiated during another parameter set switch in progress, the first switch will be finished and then the second switch will be carried out directly after the first one.

During parameter default loading both parameter sets will be restored to default values. During parameter set switch from set 1 to set 2, “PAr2” will be displayed on panel and during switching from set 2 to set 1, “PAr1” will be displayed with the following restrictions.



During parameter backup both sets will be copied and during restore both sets will be restored.

If any parameter data status is found invalid (e.g. from restore with different device), invalid data status parameter will be skipped and continue with update of other parameters.

### 12.1.5 Password Protection

Two kinds of passwords are available, user password and manufacturer password:

- User password: used to protect parameter settings from unauthorized or unintended changes.
- Manufacturer password: used for service purposes **ONLY**.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| b0.20 | User password | 0...65,535 | 0 | – | 1 | Run |
| b0.21 | Manufacturer password | 0...65,535 | 0 | – | 1 | Run |

Both passwords always read as 0.

Possible operations with passwords are as below:

- **Set user password**

  The default setting of user password is '0' (inactive). Enter any integer number between 1 and 65,535.

- **Change user password**

  Enter the existing user password and then modify to the value of any integer number between 1 and 65,535.

- **Clear user password**

  Enter the existing user password and modify to ‘0’ to deactivate the password protection. If the super user password is entered the user password will be cleared directly.

When a user password is set all parameters can only be changed if the correct password (user or manufacturer) was input by the user. Parameter b0.00 can always be changed as this just changes the view, but does not allow other parameters to be changed.

If the user password can’t be remembered anymore or was set by accident, our service department can help with a super user password.

User password protection does not affect frequency adjustment with Up and Down buttons in running status or frequency saving.

After a boot process the password protection will be active if the password protection is activated.

## 12.1.6 High Frequency Mode

This parameter allows to switch between two frequency modes: low frequency mode and high frequency mode.

| Code | Name | Setting range | Default | Unit | Step | Attri. | Device |
|---|---|---|---|---|---|---|---|
| b0.22 | Device frequency mode | 0: Low frequency mode<br>1: High frequency mode | 1 | - | 1 | Stop | VFC3615 3P 0.4...30kW |

- **Low frequency mode**

  In low frequency mode, device can reach up to 400 Hz. Resolution of frequency parameters is 2 decimals in this mode. Range of E0.08 parameter is 50.00 to 400.00 Hz.

- **High frequency mode**

  In high frequency mode, device can reach up to 1000 Hz. Resolution of frequency parameters is 1 decimal in this mode. Range of E0.08 parameter is 50.00 to 2000.0 Hz.



**VFC3610 3P 0.4...30kW**

- b0.22 will not be reset to defaults when factory resets is done (b0.10=1).
- High frequency mode only works in V/F control mode.

## 12.2 C0: Power Control

### 12.2.1 Control Mode Selection

This function is used to select control mode for VFC 5615.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.00 | Control mode | 0: V/f control<br>1: Sensorless vector control<br>2: Vector control with speed sensors | 0 | – | – | Stop |

Setting range of C0.00:

- **0: V/f control**

  Used for pump and fan applications and other application without high requirement for the load, it also can be used for the application when one converter drives more motors.

  With this control mode C2-group parameters are used for configuration.

- **1: Sensorless vector control***

  Used for application which require higher performance control, one converter can only drive one motor.

  With this control mode C3-group parameters are used for configuration.

- **2 : Vector control with speed sensors***

  It is used in applications with high accuracy of speed and torque control, where one inverter drives one motor. This function is activated when using an encoder card. To use this mode, you need to configure the C3 group parameters.



(1) Synchronous motor control is only active with sensorless vector control or vector control with encoder for VFC5615.

(2) *: The functions of sensorless vector control, vector control with encoder and synchronous motor control are not suitable for 1 kHz model.

## 12.2.2 Normal Duty / Heavy Duty Setting

This function is used to set duty rating according to the load type of application.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.01 | Normal / Heavy duty setting | 0: Normal duty (ND)<br>1: Heavy duty (HD) | 1 | – | – | Stop |

For some light load application, it is possible to use a lower power size frequency converter to drive a higher power size motor with normal duty setting.

- After parameter initialization the device and motor settings will be set to HD mode
- Switching from HD to ND will cause motor parameters reset to default value of normal duty, and vice versa.
- Switching from HD to ND will cause carrier frequency reset to default value of normal duty, and vice versa.

 This function is only available for 5.5kW and above devices.

Overload capability and output current in ND and HD modes are shown as below:

| Overload (%) | HD | ND |
|---|---|---|
| 110 | - | 200 |
| 120 | 400 | 60 |
| 130 | 149 | 22 |
| 140 | 88 | 13 |
| 150 | 60 | 10 |
| 160 | 42 | - |
| 170 | 13 | - |
| 180 | 3.2 | - |
| 190 | 1.5 | - |
| 200 | 1.0 | - |

### 12.2.3 Carrier Frequency Setting

This function is used to set proper carrier frequency for drive.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.05 | Carrier frequency | DOM | DOM | kHz | 1 | Run |
| C0.06 | Carrier frequency automatic adjustment | 0: Adjustment with temperature inactive<br>1: Adjustment with temperature active<br>2: Fixed carrier frequency | 1 | – | – | Stop |

C0.05 setting range and default:

| Product | Model | Setting range | Default | |
|---|---|---|---|---|
| | | | HD | ND |
| VFC x615 | 0K40...30K0 | 1...15 kHz | 4 kHz | 4 kHz |
| | 37K0...110K0 | 1...12 kHz | 4 kHz | 4 kHz |
| | 132K...400K | 1...6 kHz | 2 kHz | 2 kHz |

**Tab. 12-4:** C0.05 setting range and default



For SVC mode, the actual highest carrier frequency is 10kHz, even though the setting value is higher

The influence of carrier frequency on heat dissipation, noise level, and leakage current and interference is shown as below:

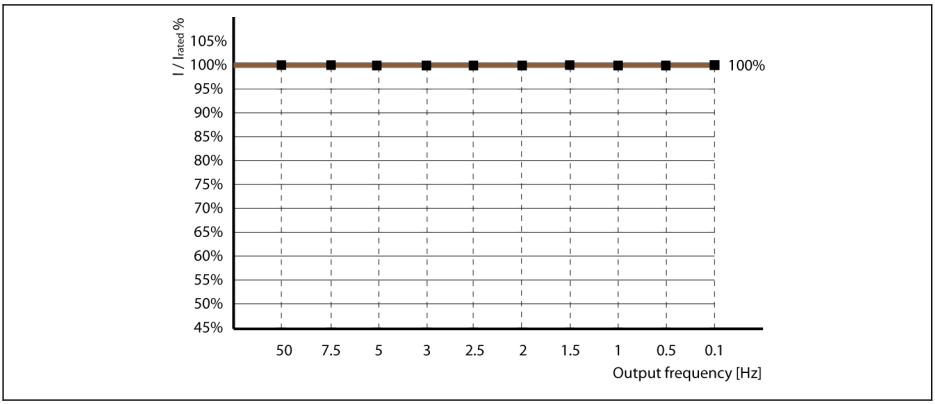
| | Heat dissipation | Noise | Leakage current and interference |
|---|---|---|---|
| **Higher carrier frequency** | Higher | Lower | Higher |
| **Lower carrier frequency** | Lower | Higher | Lower |

**Tab. 12-5:** Influence of carrier frequency

With C0.06 = 1, the carrier frequency will be changed automatically to keep the power module temperature within a normal range, but this could cause motor noise swing.

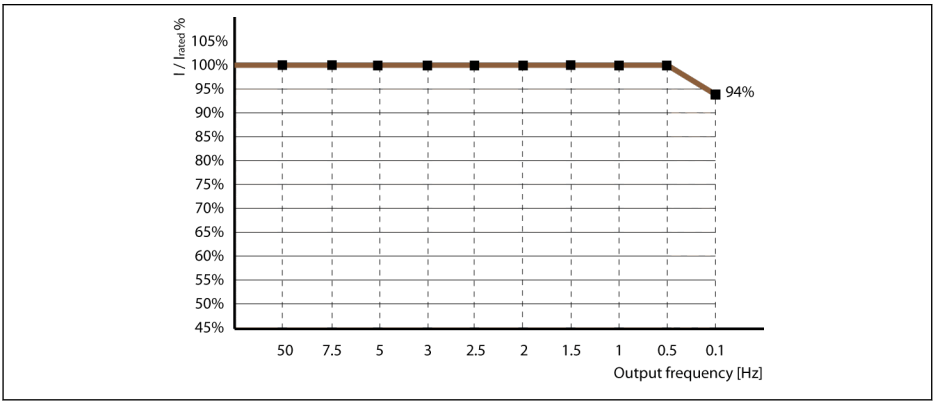
With C0.06 = 2, the carrier frequency is always fixed to C0.05.

**Derating figures for the output power are shown as the figures below:**



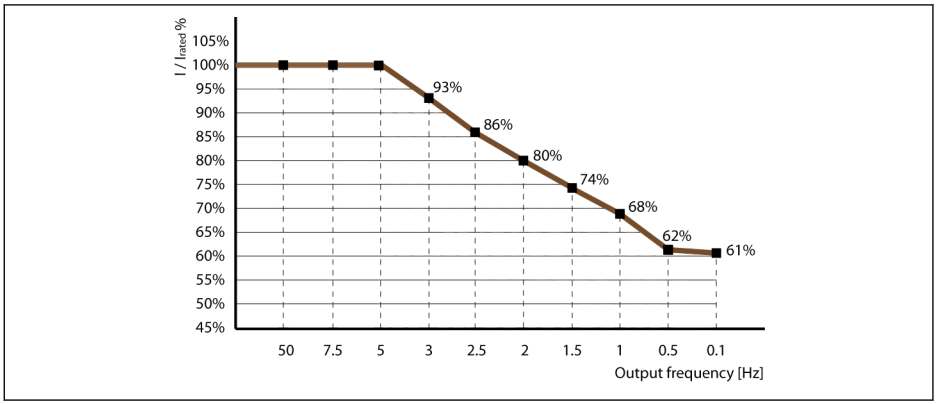

**I / $I_{rated}$ %** Percentage of rated output current

**Fig. 12-3:**




**I / $I_{rated}$ %** Percentage of rated output current

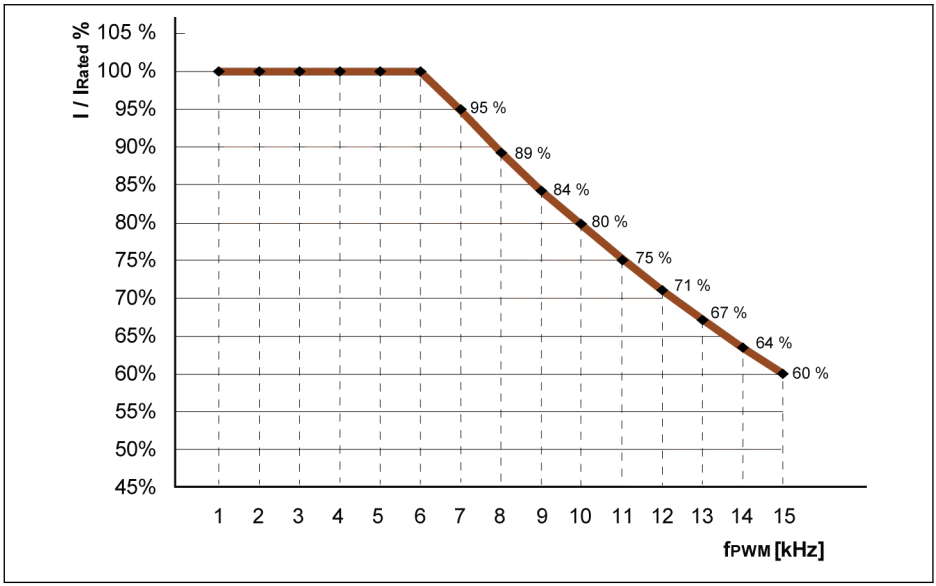
**Fig. 12-4:**




**I / $I_{rated}$ %** Percentage of rated output current

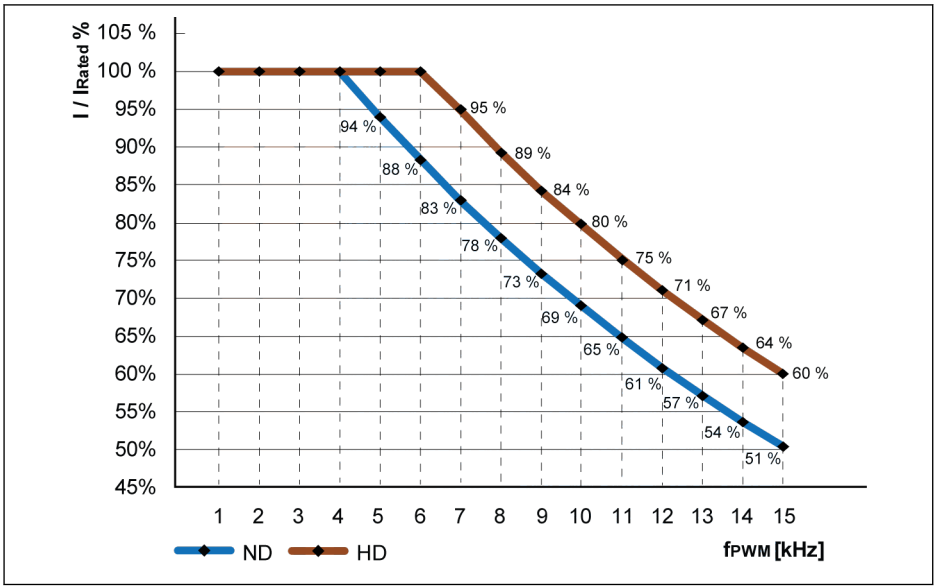
**Fig. 12-5:**

**Derating figures related to carrier frequency are shown as the figures below:**



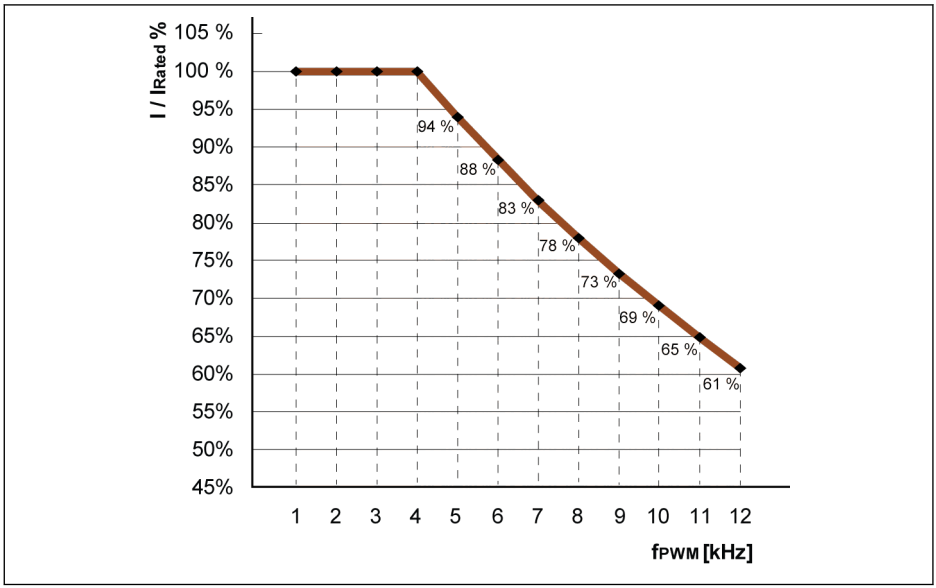

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 12-6:** Derating and carrier frequency for 0K40...4K00 models



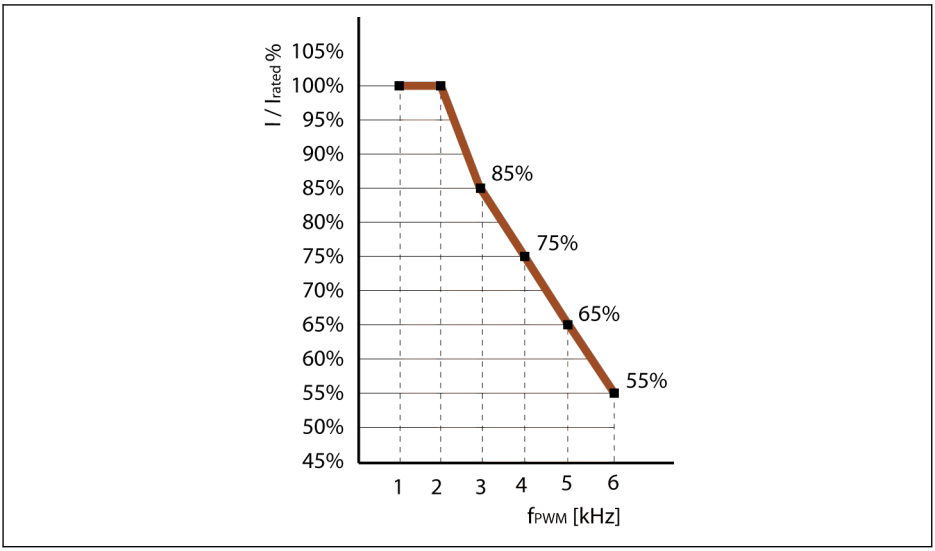

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency
**ND** Normal Duty
**HD** Heavy Duty

**Fig. 12-7:** Derating and carrier frequency for 5K50...30K0 models




**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 12-8:** Derating and carrier frequency for 37K0...110K models (Normal Duty and Heavy Duty)




**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

**Fig. 12-9:** Derating and carrier frequency for 132K...185K models (Normal Duty and Heavy Duty)

- C0.06 = 0 or 1: when output frequency is lower than 10Hz, the carrier frequency will be reduced automatically.
- C0.06 = 2: the carrier frequency is constant and will not change according to temperature and frequency.
- To achieve optimized performance, the carrier frequency setting should follow the equation: [C0.05] ≥ 10 x [E0.08].

## 12.2.4 PWM Mode

This function is used to set the PWM mode for drive.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.07 | PWM mode | 0: SVPWM<br>1: SVPWM with Overmodulation<br>2: DPWM<br>3: DPWM with Overmodulation | DOM | – | – | Run |
| C0.08 | DPWM switchover frequency upper limit | 8.00...400.00 | 12.00 | Hz | 0.01 | Run |

**C0.07 Setting range and default:**

| Model | Setting range | Default |
|---|---|---|
| 0K40...30K0 | 0...1 | 0 |
| 37K0...400K | 0...3 | 0 |

SVPWM mode is 7 segment continuous modulation, this mode has higher switching losses and lower current ripple.

DPWM mode is 5-segment discontinuous modulation, this mode has lower switching losses and higher current ripple, but may cause the motor not stable when higher output frequency.

In the overmodulation range, the converter can increase the output voltage by increasing the utilization rate of DC bus voltage.

Only in DPWM modes the parameter C0.08 is active. If the output frequency with slip compensation is above this limit then the DPWM mode is active.



Selecting overmodulation doesn't mean that the output voltage is directly increased in all cases. If overmodulation is selected then the final output voltage is only increased if it is needed from demanded output voltage. In that case the overmodulation can provide a further increase of output voltage. But the output voltage is no longer sinusoidal.

This may cause more current distortion or noise effects.

## 12.2.5 Automatic Voltage Stabilization

This function is used to keep the output voltage constant within the output capability, when the rated voltage deviation is inputted.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.10 | Automatic voltage stabilization | 0: Always active<br>1: Always inactive<br>2: Inactive only during deceleration | 0 | – | – | Stop |
| C0.11 | Automatic voltage stabilization reference voltage | 1P200 VAC: 180...264 V | 220 | V | 1 | Stop |
| | | 3P200 VAC: 180...264 V | | | | |
| | | 3P380 VAC: 323...528 V | 380 | | | |

Setting range of C0.10:

- **0: Always active**

  Constant voltage control is enabled, the converter will automatically control the output voltage within motor rated voltage, and the output voltage will not be higher than motor rated voltage.

- **1: Always inactive**

  Constant voltage control is disabled, then the output voltage will be in direct proportion to the input voltage.

- **2: Inactive only during deceleration**

  Constant voltage control is disabled during deceleration. This function can effectively reduce the 'OE' error for fast deceleration application.

In some application which require quick stop, automatic voltage stabilization function should be closed (C0.10 = 1 or 2). In this case the motor is in generation mode, braking torque produced by regeneration voltage will be helpful for the motor quick stop, so that over voltage error can be avoided, then in deceleration process, when DC-bus voltage is higher than the reference voltage set by C0.11, the output voltage will be higher, but it may cause motor overheat.



- When C0.10 = 1 or 2, output voltage might be higher than motor rated voltage.
- C0.11 is only active when C0.10 =1 or 2, it should be set according to mains voltage.

## 12.2.6 Brake Chopper Control

This function is used to get better braking performance via braking resistor.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.15 | Brake chopper start voltage | 1P 200 VAC: 300...390 V | 385 | V | 1 | Stop |
| | | 3P 380 VAC: 600...785 V | 770 | | | |
| C0.16 | Brake chopper duty cycle | 1...100% | 100 | – | 1 | Stop |

Brake chopper control:

- Enable resistor braking function by setting [C0.25] = 2 or 3.
- Set braking start voltage via [C0.15] according to power supply and load inertia. When DC-bus voltage is higher than [C0.15], the brake chopper switches on / off according to the duty [C0.16] with an internal hysteresis.
- Set braking duty cycle via [C0.16] according to actual application, excessive low setting of [C0.16] may bring overvoltage error during braking.

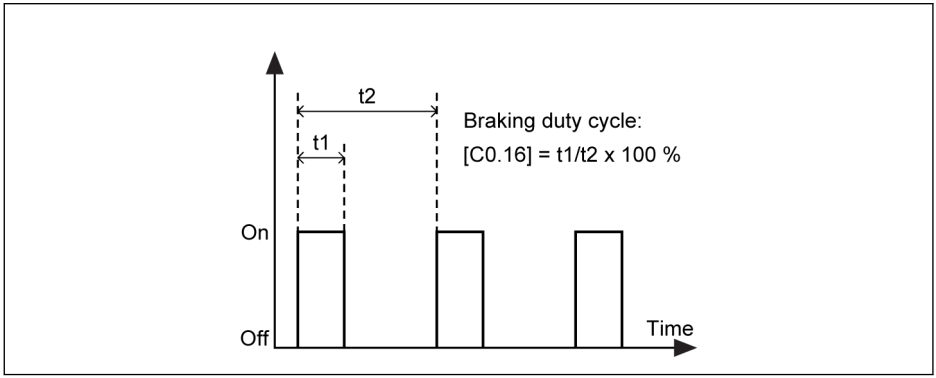



**Fig. 12-10:** Braking duty cycle

t1 = t2 x [C0.16] / 100 %; t2 = 1 / 100 Hz = 10 ms

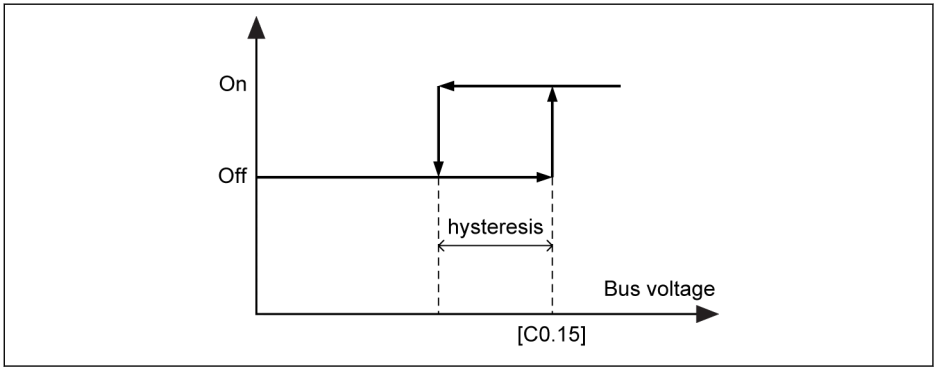



**Fig. 12-11:** Hysteresis

The hysteresis for different models is as listed below:

- 1P 200 VAC: 10 V
- 3P 380 VAC: 15 V



For power size >= 37 kW, there is no internal brake chopper, [C0.15] and [C0.16] are not visible.

### 12.2.7 Overvoltage suppression

This function is used to adjust the active slip compensation factor in order to match the higher mechanical speed due to reciprocating load characteristic.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.23 | Overvoltage suppression adjustment gain | 0.00...10.00 | 1.00 | – | 0.01 | Run |

Basic principle of reciprocating load application:

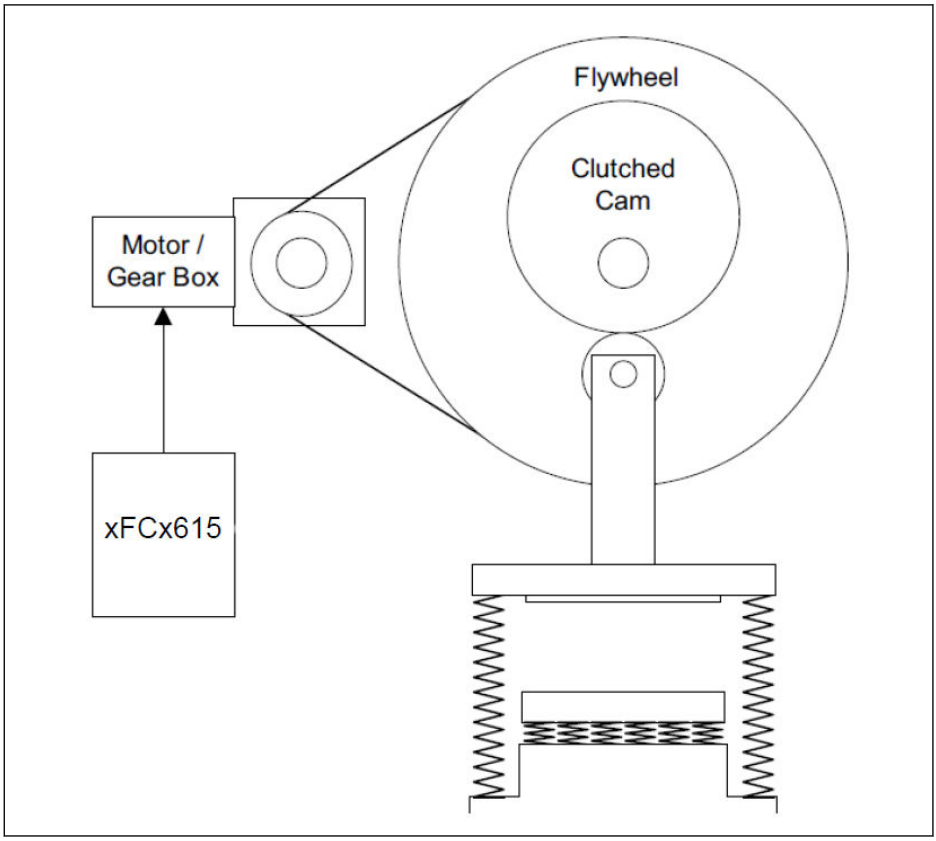



**Fig. 12-12:** Basic principle of reciprocating load

The character of load torque is kind of sine wave:

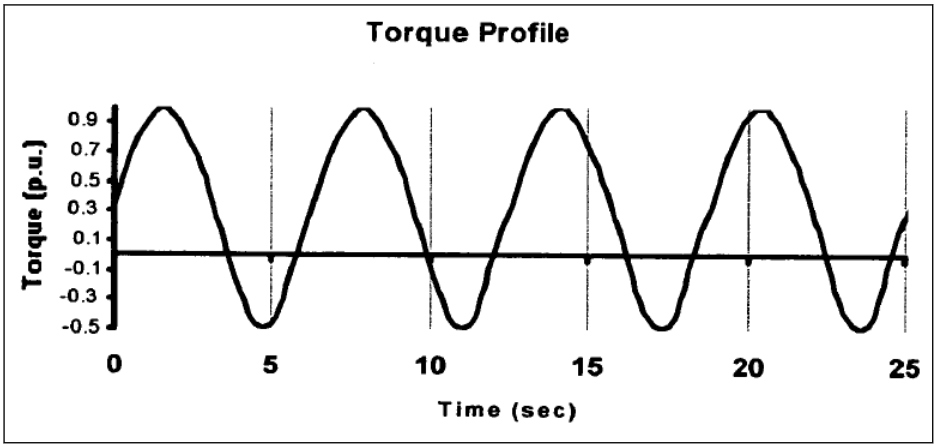



**Fig. 12-13:** Torque profile of reciprocating load

From the torque profile, the drive will work partly at motoring mode and partly at generating mode. In generating mode, the drive tends to be overvoltage of DC bus capacitor, in order to suppress the overvoltage, actual output frequency to the motor has to be adapted with the load torque.

In VFCx615, this is realized by adjusting the effective slip compensation factor when in generating mode via C0.23, so the resulting slip compensation factor will be:

$$Factor_{slip_comp} = \begin{cases} C2.07, & motoring\ mode \\ C0.23 * |C0.26 - Udc|, & generating\ mode \end{cases}$$

**Fig. 12-14:** Calculation formula

1. This overvoltage suppression mode only works in V/f control.
2. Proper parameters setting for C0.23 depends on the load. During commissioning, if the actual output frequency still can not catch up with real mechanical velocity which can trigger overvoltage error, E0.08 and E0.09 might be adjusted since these will limit the actual output frequency.
3. This overvoltage suppression function cannot be used to shorten the actual deceleration time on application with large loads, so it is strongly recommended to set stop mode (E0.50) to 1 (freewheeling to stop 1).
4. This overvoltage suppression mode is **NOT** active when the output frequency is at upper limit (E0.09). This is because this function needs frequency space room to adjust.

## 12.2.8 Overvoltage Prevention Mode

This function is used to select proper mode to prevent overvoltage during deceleration caused by heavy load or too short deceleration time.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.25 | Overvoltage prevention mode | 0...4 | 3 | – | 1 | Stop |

Setting range:

- 0: Stall overvoltage protection is disabled, resistor braking is disabled.
- 1: Stall overvoltage protection is enabled, adjust protection level via [C0.26], resistor braking is disabled.
- 2: Stall overvoltage protection is disabled, resistor braking is enabled, adjust braking start voltage and duty cycle via [C0.15] and [C0.16].
- 3: Both stall overvoltage protection and resistor braking are enabled.
- 4: Reciprocating load mode, used when the drive controls rotating machinery where part of the machine's cycle creates a cyclic regenerative (over-hauling) load, adjust overvoltage suppression adjustment gain via [C0.23].



- Please select freewheeling to stop when this function is activated.
- This function is only used for V/f control.

## 12.2.9 Stall Overvoltage Prevention

This function is used to automatically adjust the deceleration process to prevent over voltage error.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.24 | Stall overvoltage hysteresis voltage | 0...100 V | 1P 200 VAC: 30 | V | 1 | Stop |
| | | | 3P 380 VAC: 50 | | | |
| C0.26 | Stall overvoltage prevention level | 1P 200 VAC: 300...390 V | 385 | V | 1 | Stop |
| | | 3P 380 VAC: 600...785 V | 770 | | | |

Enable the function by setting [C0.25] =1 or 3.

With this function, the frequency converter detects the DC-bus voltage and compare it with [C0.26] during deceleration:

- [DC-bus voltage] > [C0.26]: Output frequency stops decreasing
- [DC-bus voltage] < [C0.26] - [C0.24]: Output frequency resumes decreasing

The typical behavior of stall overvoltage prevention is shown as the figure below:

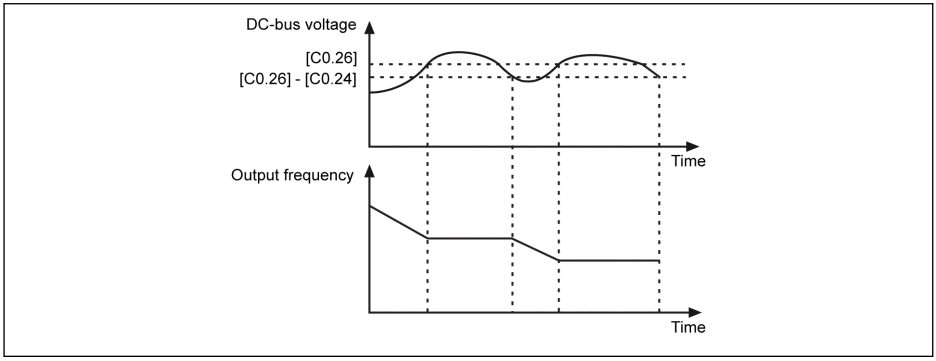



**Fig. 12-15:** Stall overvoltage prevention during deceleration

Enable stall overvoltage prevention function may cause the actual deceleration time is longer than expected. If the deceleration time needs to be accurate only resistor braking should be used.

## 12.2.10 Stall Overcurrent Prevention

This function is used to prevent the frequency converter from overcurrent when the load is excessively heavy or the acceleration time is excessively short. This function is always active during acceleration or at constant speed.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.27 | Stall overcurrent prevention level | 20.0...[C2.42] | 150.0 | - | 0.1 | Stop |

This function is always enabled and only controlled by the setting current level.

With this function, the frequency converter detects the output current and compares it with the level set in [C0.27] during acceleration and at constant speed:

- [Output current] > [C0.27]

  Output frequency stops increasing during acceleration or decreases with the set deceleration time at constant speed.

- [Output current] < [C0.27]

  Output frequency resumes increasing during acceleration or increases back to the setting frequency with the set acceleration time at constant speed.

Behavior of stall overcurrent prevention during acceleration is shown as the figure below:

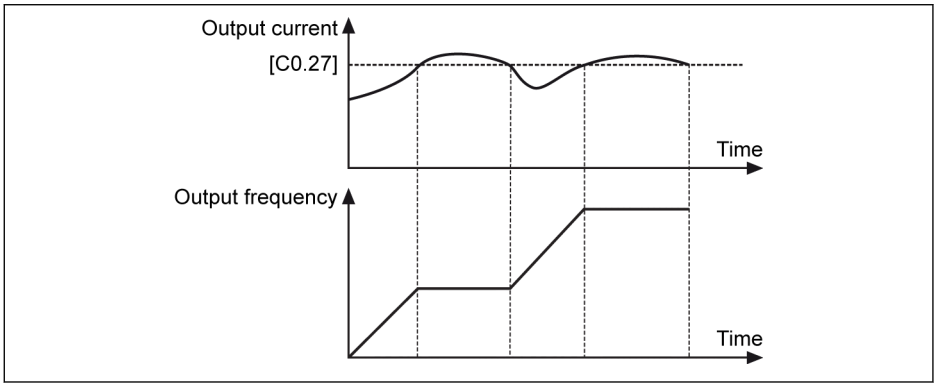



**Fig. 12-16:** Stall overcurrent during acceleration

- [Output current] > [C0.27]

  The output frequency stops increasing.

- [Output current] < [C0.27]

  The output frequency resumes increasing to the setting frequency with defined acceleration time.

Behavior of stall overcurrent at constant speed is shown as the figure below:

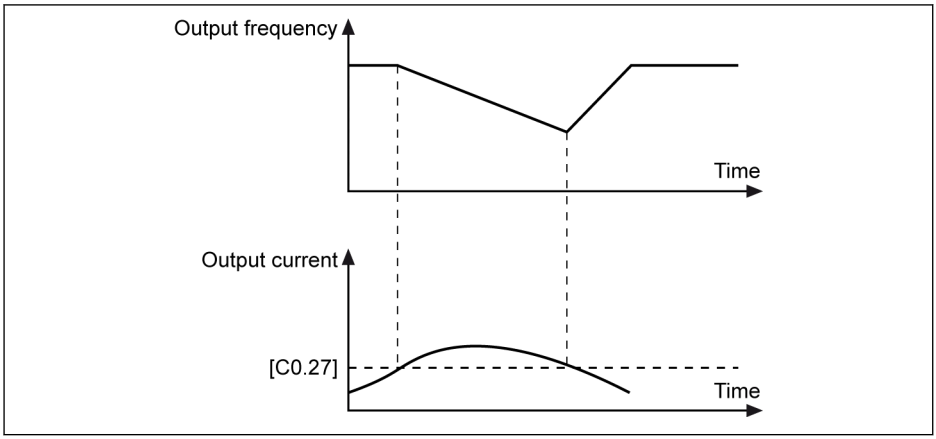



**Fig. 12-17:** Stall overcurrent at constant speed

- [Output current] > [C0.27]

  The output frequency decreases till the output current is lower than [C0.27] with defined deceleration time.

- [Output current] < [C0.27]

  The output frequency increases to the setting frequency with defined acceleration time.



This function can have influence on the speed accuracy during constant running and on the acceleration performance.

## 12.2.11 Phase Loss Protection

This function is used to detect input or output phase losses.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.28 | Phase loss protection mode | 0...3 | 3 | - | - | Run |

Setting range:

- **0: Both input and output phase loss protection active**
- **1: Only input phase loss protection active**
- **2: Only output phase loss protection active**
- **3: Both input and output phase loss protection inactive**

Phase loss protection will detect missing phases in the input or output line. Input phase loss detection will protect the converter power stage from overload, output phase loss detection will protect the motor phases from overload.

Both input and output phase loss protection will only work if the converter is in **RUN** state.

An input phase loss can also be triggered by line voltage imbalance or deterioration of DC-bus capacitors. The input phase loss cannot be detected in the following conditions:

- The output current is lower than 30 % of converter rated current
- During motor deceleration

The output phase loss has a dead zone in the following cases:

- The output frequency is lower than 1.00 Hz
- During DC-braking
- During restarting with speed capture
- During motor parameters auto-tuning
- Wrong settings of parameter C1.07 "Motor rated current"



Input phase loss protection only works on 3x400V devices.

## 12.2.12 Converter Overload Pre-Warning

Converter overload pre-warning will be notified if the load for the converter is too high for a defined time.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.29 | Converter overload pre-warning level | 20.0...200.0 | 110.0 | - | 0.1 | Stop |
| C0.30 | Converter overload pre-warning delay | 0.0...20.0 | 2.0 | s | 0.1 | Stop |

When the frequency converter output current is higher than [C0.29] "Converter overload pre-warning level" and lasts for longer than [C0.30] "Converter overload pre-warning delay", the "Converter overload pre-warning" signal will be active on the selected digital output terminal. The signal will be immediately inactive when the output current is lower than [C0.29].

Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.01, H9.02, H9.03 can be set to "11: Converter overload pre-warning" to configure the digital outputs to show this warning.

Behavior of converter overload pre-warning is shown as the figure below:

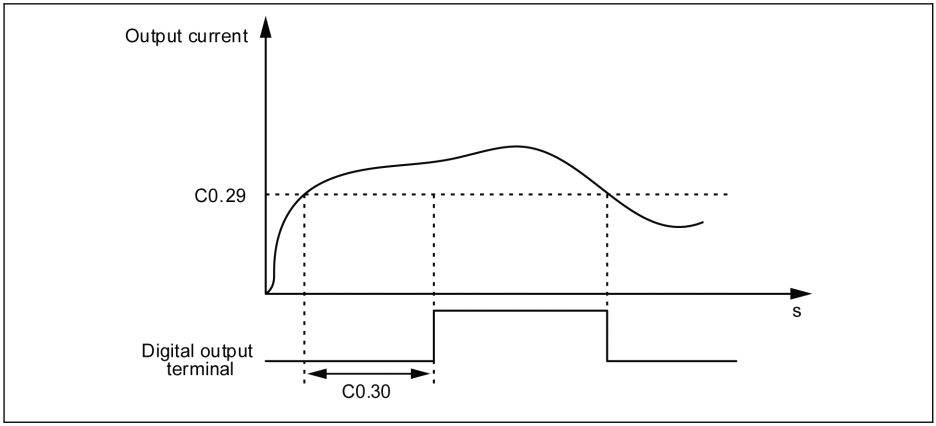



**Fig. 12-18:** Converter overload pre-warning

The actual overload pre-warning level will be reduced by the carrier frequency output current derating by the equation:

**[Actual overload pre-warning level] = [C0.29] x [Derating percentage]**

This derating percentage can be found in the hardware specification for each device.

## 12.2.13 Power Loss Ride-Through

This function is helpful for continuing running of frequency converter when temporary power loss occurs.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.40 | Power loss ride-through mode | 0: Inactive<br>1: Output disabled<br>2: Regain kinetic energy<br>3: Regain kinetic energy, decelerate to stop<br>4: Regain kinetic energy, decelerate no stop | 0 | - | - | Stop |
| C0.41 | Power loss ride-through recovery delay | 0.10...30.00 s | 0.50 | s | 0.01 | Stop |
| C0.42 | Power loss ride-through action voltage | 1P 200 VAC: 216...366 V | 240 | V | 1 | Stop |
| | | 3P 380 VAC: 406...739 V | 440 | | | |
| C0.43 | Power loss ride-through recover voltage | 1P 200 VAC: 223...373 V | 250 | V | 1 | Stop |
| | | 3P 380 VAC: 413...746 V | 450 | | | |
| C0.44 | Power loss ride-through deceleration time | 0.1...6000.0 s | 5.0 | s | 0.1 | Stop |
| C0.45 | Power loss ride-through control voltage | 1P 200VAC: 226...373V | 250 | V | 1 | Stop |
| | | 3P 400VAC: 416...746V | 450 | | | |
| C0.46 | Power loss ride-through limited voltage | 1P 200VAC: 233...373V | 280 | V | 1 | Stop |
| | | 3P 400VAC: 423...746V | 500 | | | |
| C0.47 | Power loss ride-through change frequency | 0.00...400.00 Hz | 5.00 | HZ | 0.01 | Stop |
| C0.48 | Power loss ride-through change frequency | 0...100 Hz/s | 10 | HZ/s | 1 | Stop |

When AC power is lost or not stable for a short time, the frequency converter will enter the power fault ride-through mode as long as the DC-bus voltage is still maintained stable:

- For 1P 200 VAC, DC-bus voltage is above 180 VDC
- For 3P 380 VAC, DC-bus voltage above 310 VDC

The power fault ride-through operation will be decided by the selected options as below:

1. The frequency converter output will be switched off

   When the power supply resumes, the frequency converter will execute speed capture and resume its previous operation, example for 3-Phase Device actual minimum action voltage and recover voltage:

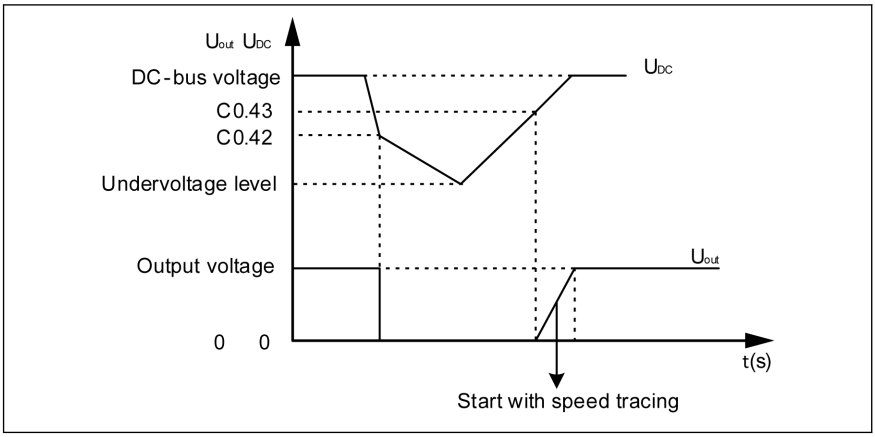



**Fig. 12-19:** Power loss ride-through mode 1

2. The frequency converter will decrease the output frequency to regain the kinetic energy from the rotating motor, to stabilize the DC bus voltage

   When DC bus voltage is recovered, then converter output frequency will rise again and converter will enter the normal running mode, example for 3-phase device actual minimum action voltage and recover voltage:

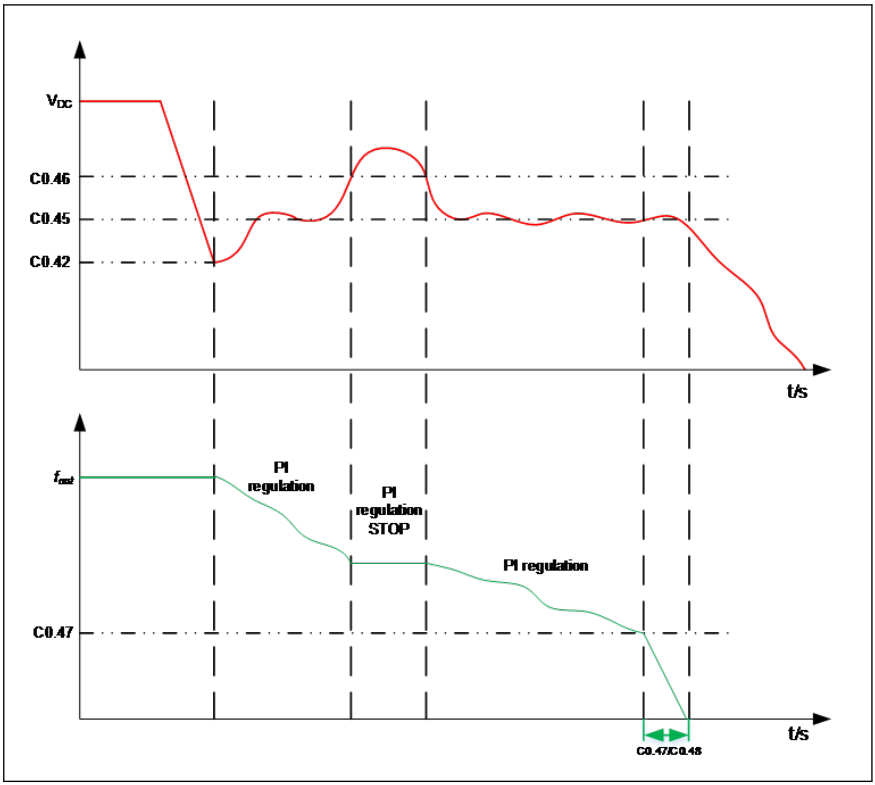



**Fig. 12-20:** Power loss ride-through mode 2

3. The frequency converter regains kinetic energy from the motor in generator mode with a defined ramp (defined by deceleration time [C0.44] which is the time from [E0.08] to 0Hz). Even when the power supply comes up again before the kinetic energy is consumed the drive will continue to decelerate down to stop. When the kinetic energy is consumed and the drive reaches the power fail voltage level the drive will be shut down, example for 3-phase device actual minimum action voltage and recover voltage:

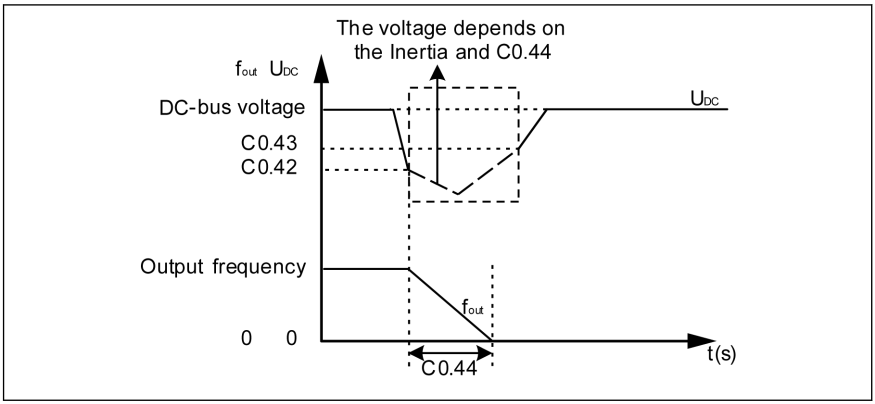



**Fig. 12-21:** Power loss ride-through mode 3

When option 3/4 is selected, special care must be taken by configuration of the deceleration time. If the time is too short overvoltage will occur. If the time is too long undervoltage will occur. For overvoltage a braking resistor may be used.

## 12.2.14 Fan Control and Maintenance

This function is used to set the running mode of both the fan for the heat sink and the capacitor fan, and to remind users maintaining the fan for the heat sink in time. The maintenance time can be set according to the actual application conditions.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C0.50 | Fan control | 0: Automatically controlled<br>1: Always on<br>2: On when converter run | 0 | - | - | Run |
| C0.51 | Fan total running time | 0...65,535 h | 0 | h | 1 | Read |
| C0.52 | Fan maintenance time | 0...65,535 h<br>(0: Inactive) | 0 | h | 1 | Stop |
| C0.53 | Fan total running time reset | 0: Inactive<br>1: Active<br>Reset to '0' after action is executed | 0 | - | - | Run |

Setting range:

- **C0.50 = 0: Automatically controlled**

  The fan for the heat sink is by default switched on / off automatically according to the temperature of the heat sink. In this mode, the noise level of the frequency converter can be reduced.

- **C0.50 = 1: Always on**

  The fan for the heat sink and the fan for electrolytic capacitor are switched on and running all the time once the frequency converter is powered on. In this mode, a better cooling performance of the frequency converter can be achieved.

- **C0.50 = 2: On when converter run**

  The fan for the heat sink and the fan for electrolytic capacitor on when converter runs, and off when converter stops.

To use the fan maintenance reminder function, take the following steps:

**Step 1: Set the maintenance time of the fan properly**

Set parameter C0.52 'Fan maintenance time' according to the actual application conditions.

**Step 2: Observe the fan lifetime status at warning**

When [C0.51] 'Fan total running time' is higher than [C0.52] 'Fan maintenance time', a warning code 'FLE' (Fan maintenance period expired) is displayed on the operating panel.

- Pause the display of the warning code 'FLE' by pressing the <Func> button.
- Perform fan maintenance or replacement.

**Step 3: Reset the fan lifetime counter after fan maintenance or replacement**

- Set parameter C0.53 'Fan total running time reset' to '1: Active'.

After the execution, [C0.53] and [C0.51] will be reset to '0' automatically. By now, the warning code 'FLE' is cleared completely.

- Adjust the value of C0.52 'Fan maintenance time' if necessary.



If C0.50 = "0: Automatically controlled", when the converter runs, the fan for electrolytic capacitor is switched on; When the converter stops, the fan for electrolytic capacitor is switched off.

## 12.3 C1: Motor and System

### 12.3.1 Motor Type Selection

This function is used to select which type of motor is connected.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.00 | Motor type | 0: Asynchronous motor<br>1: Synchronous motor | 0 | – | – | Stop |

- Synchronous motor is only for VFC 5615.
- After setting C1.00 to '1', the parameter C0.00 (the control mode) will be modified automatically to '1', and user can modify C0.00 to '2' manually.

### 12.3.2 Motor Parameter Tuning

The auto-tuning function will determine the motor parameters and adjust the control accordingly.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.01 | Motor parameter tuning | 0: Inactive<br>1: Static auto-tuning<br>2: Rotational auto-tuning | 0 | - | - | Stop |
| C1.02 | Expert mode | 0: Standard mode<br>1: Expert mode | 0 | - | - | Stop |

- C1.02 = 0: every change of a motor parameter leads to a recalculation based on the ascending rule.
- C1.02 = 1: Only for commissioning by manufacturer.

**The application level and setting order of motor parameters**

As shown in the table below, the motor control parameters are divided into 4 application levels that are interrelated on certain computational basis. In the process of parameter setting, the level attribute is a defining factor for the setting of the parameter value.

| Code | Name | Level |
|---|---|---|
| C0.00 | Control mode | Top level |
| C0.01 | Normal / Heavy duty setting | |
| C1.00 | Motor type | |
| C1.01 | Motor parameter tuning | |

| Code | Name | Level |
|---|---|---|
| C1.05 | Motor rated power | Nameplate level |
| C1.06 | Motor rated voltage | |
| C1.07 | Motor rated current | |
| C1.08 | Motor rated frequency | |
| C1.09 | Motor rated speed | |
| C1.10 | Motor rated power factor | |
| C1.11 | Motor poles | |
| C1.12 | Motor rated slip frequency | Physical parameter level |
| C1.13 | Motor inertia mantissa | |
| C1.14 | Motor inertia exponent | |
| C1.15 | Torque constant | |
| C1.20 | Motor no-load current | |
| C1.21 | Stator resistance | |
| C1.22 | Rotor resistance | |
| C1.23 | Leakage inductance | |
| C1.24 | Mutual inductance | |
| C1.25 | Rotor leakage inductance | |
| C2.43 | Current limitation proportional gain | Control parameter level |
| C2.44 | Current limitation integral time | |
| C3.00 | Speed loop proportional gain 1 | |
| C3.01 | Speed loop integral time 1 | |
| C3.02 | Speed loop proportional gain 2 | |
| C3.03 | Speed loop integral time 2 | |
| C3.05 | Current loop proportional gain | |
| C3.06 | Current loop integral time | |

**Tab. 12-6:** The application level of motor parameters

The user shall follow the order as specified below to set or modify the parameters if it is needed, Top level -> Nameplate level -> Physical parameter level -> Control parameter level.

Taking the example of SVC control for asynchronous motor, the user shall first set top level parameters, C0.00, C0.01 and C1.00, and next set the nameplate level parameters, C1.05...C1.10, and in the end execute parameter auto-tuning to acquire the parameters of physical parameter level and control parameter level.

If the user does not conform to the order as specified above, this would cause undesired change to the parameter setting.

For example, if by applying the parameter auto-tuning function, the user goes first to set the parameters of physical parameter level and control parameter lev-

el, and next execute the modify to the parameters of top level or nameplate level. After all, this would activate the internal computation function of motor parameters that end up with the change to the parameters of physical parameter level and control parameter level, namely the parameters defined after C1.12.

**Auto-tuning of Motor Parameters**

Check and make sure the following points before auto-tuning:

- The motor is in standstill and not at high temperature.
- The power rating of the frequency converter is close to that of the motor.
- For permanent magnetized synchronous motor, set C1.05, C1.07, C1.09, C1.11 based on motor nameplate data. C1.08 will be calculated by tuning, user can also set this parameter.

  If motor poles is unavailable on the nameplate, it can be calculated by **p = 60 f / n** (p: pole pairs; f: motor rated frequency; n: motor rated speed)
- For asynchronous motor, set C1.05...C1.09 based on motor nameplate data.
- If the power factor data is unavailable on the nameplate, keep the default setting of C1.10.
- Set E0.08, E0.09 according to motor parameters and actual application conditions.

**Set auto-tuning mode and start motor parameter auto-tuning:**

- **C1.01 = 0: Inactive**

  Auto-tuning is by default inactive. If the function was used it will reset to this value after function is finished.
- **C1.01 = 1: Static auto-tuning**

  Static auto-tuning is recommended to use as standard for all applications using V/f control. For vector control it can be used in case the load can't be disconnected.
- **C1.01 = 2: Rotational auto-tuning**

  Rotational auto-tuning is recommended to use as standard for all applications using vector control. The load must be disconnected during rotational auto-tuning.

Press the **<Run>** button on the operating panel when the setting is finished for auto-tuning. In the process of auto-tuning, a status code 'tUnE' will be displayed on the operating panel. When the auto-tuning process is completed, the status code disappears and the settings of the following parameters will be obtained automatically:

| Static auto-tuning | Rotational auto-tuning | Parameters obtained by auto-tuning |
|---|---|---|
| √ | √ | C1.12: Motor rated slip frequency **(Only for asynchronous motor)** |
| – | √ | C1.13: Motor inertia mantissa |

| Static auto-tuning | Rotational auto-tuning | Parameters obtained by auto-tuning |
|---|---|---|
| – | √ | C1.14: Motor inertia exponent |
| √ | √ | C1.20: Motor no-load current |
| √ | √ | C1.21: Stator resistance |
| √ | √ | C1.22: Rotor resistance **(Only for asynchronous motor)** |
| √ | √ | C1.23: Leakage inductance |
| √ | √ | C1.24: Mutual inductance **(Only for asynchronous motor)** |
| √ | √ | C1.25: Rotor leakage inductance |
| √ | √ | C3.00: Speed loop proportional gain 1 |
| √ | √ | C3.01: Speed loop integral time 1 |
| √ | √ | C3.05: Current loop proportional gain |
| √ | √ | C3.06: Current loop integral time |

**Tab. 12-7:** Parameters obtained by auto-tuning



- C1.01=2: Rotational auto-tuning is only for VFC 5615.
- Disconnect the load from the motor shaft for rotational auto-tuning.

### 12.3.3 Motor Name Plate Data

This function is about motor nameplate parameters configuration, most of motor data are available on the motor nameplate, based on which the following parameters of the frequency converter need to be set accordingly.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.05 | Motor rated power | 0.1...1,000.0 kW | DOM | kW | 0.1 | Stop |
| C1.06 | Motor rated voltage | 0...480 V | DOM | V | 1 | Stop |
| C1.07 | Motor rated current | 0.01...655.00 A (0.4...45 kW) | DOM | A | 0.01 | Stop |
| | | 0.1...6550.0 A (55 kW and above) | | | 0.1 | |
| C1.08 | Motor rated frequency | 5.00...400.00 Hz | 50.00 | Hz | 0.01 | Stop |
| C1.09 | Motor rated speed | 1...60,000 | DOM | - | 1 | Stop |
| C1.10 | Motor rated power factor | 0.00...0.99 | 0.00 | - | 0.01 | Stop |
| C1.11 | Motor poles | 2...256 | 4 | - | 1 | Stop |

The input of rating plate data must correspond with the wiring of the motor (star / delta). This means, if delta wiring is used for the motor, delta rating plate data has to be entered:

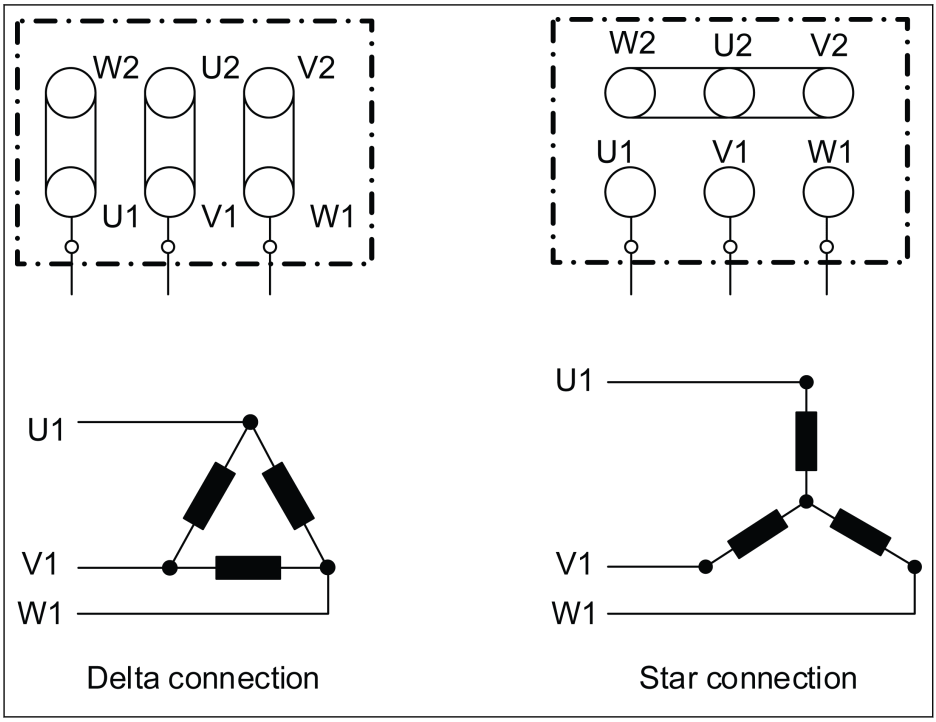



**Fig. 12-22:** Wiring of the motor

If the parameters above cannot be acquired from the motor nameplate. These parameters can be calculated according to the following steps or auto tuning. Only for synchrounus motors MSK. For the new MS2N motors the data can be find in the MS2N instruction manual.

1. Choose motor rated speed **Nn** as required.
2. Select "speed-torque" characteristic curve according to the actual working conditions, and derive torque **Mn** at the rated speed.
3. Rated power is calculated by **Pn = (Mn x Nn x 2π) / 60**.
4. Acquire torque constant **km-n** and number of pole pairs **o** from Rexroth motor instruction.
5. Rated current is calculated by **In = Mn / (Km-n)**.
6. Rated frequency is calculated by **fn = o x Nn / 60**.
7. The number of motor poles equals to **2 x o**.

Take the motor MSK071C-0450-NN as an example. The required motor rated speed is 1,500 rpm, motor works continuously and the housing temperature rise must not exceed 60 ℃. The parameters are calculated as follows.

According to the operation mode and temperature rise requirement, select **S1 (60K)** curve and derive **Mn** as 7.5 Nm, as shown in the following figure.

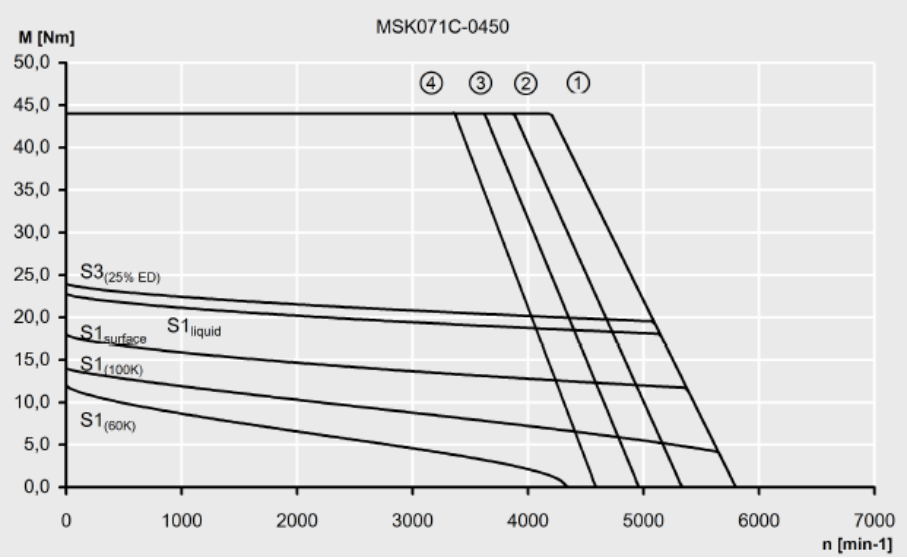



**Fig. 12-23:** Speed-torque characteristic curve

The torque constant **Km-n** of this motor is 1.49 Nm/A, the number of pole pairs **o** is 4.

Thus, the parameters can be calculated as:

Rated power is **Pn = (Mn x Nn x 2π) / 60 = 1.2 kW**

Rated current is **In = Mn / (Km-n) = 5 A**

Rated frequency is **fn = o x Nn / 60 = 100 Hz**

The number of pole pairs is **2 x o = 8**

- For the C1.09 'motor rated speed', do not put in the synchronous speed for an asynchronous motor.
- C1.10 = 0.00: Automatically identified; C1.10 = 0.01...0.99: Power factor setting.
- If the data for C1.10 'Motor rated power factor' is not available on the motor nameplate, keep its default setting '0.00: Automatically identified'. However, the rotational auto-tuning performance may be affected.

## 12.3.4 Motor Internal Data

This function is about motor internal data, which can be calculated internally or input by users.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.12 | Motor rated slip frequency | 0.00...60.00 Hz | DOM | Hz | 0.1 | Stop |
| C1.13 | Motor inertia mantissa | 1...5,000 | DOM | - | 1 | Stop |
| C1.14 | Motor inertia exponent | 0...7 | DOM | - | 1 | Stop |
| C1.15 | Torque constant | 0.01...200.00 Nm/A | DOM | Nm/A | 0.01 | Stop |
| C1.16 | Back emf voltage constant | 0.0 ... 6550.0 V/ 1000 $min^{-1}$ | 0.0 | V/1000 $min^{-1}$ | 0.1 | Read |
| C1.17 | Motor rated torque | 0.0...6553.5 N.m | DOM | N.m | 0.1 | Read |
| C1.20 | Motor no-load current | 0.00...[C1.07] A (0.4...45 kW) | DOM | A | 0.01 | Stop |
| | | 0.0...[C1.07] A (55 kW and above) | | | 0.1 | |
| C1.21 | Stator resistance | 0.00...50.00 Ω (0.4...45 kW) | DOM | Ω | 0.01 | Stop |
| | | 0.000...50.000 Ω (55 kW and above) | | | 0.001 | |
| C1.22 | Rotor resistance | 0.00...50.00 Ω (0.4...45 kW) | DOM | Ω | 0.01 | Stop |
| | | 0.000...50.000 Ω (55 kW and above) | | | 0.001 | |
| C1.23 | Leakage inductance | 0.00...600.00 mH | DOM | mH | 0.01 | Stop |
| C1.24 | Mutual inductance | 0.0...6,000.0 mH | DOM | mH | 0.1 | Stop |
| C1.25 | Rotor leakage inductance | 0.00...600.00 mH | DOM | mH | 0.01 | Stop |

### Motor rated slip frequency

By default, C1.12 (Motor rated slip frequency) will be set automatically according to the basic motor parameters. The value can be adjusted with the following equations:

- $n_s = f_n \times 60 / p$
- $s = (n_s - n_n) / n_s$
- $fs = s \times f_n$

$n_s$: synchronous speed; $f_n$: rated frequency

p: numbers of pole pairs; s: rated slip

$n_n$: rated speed; $f_s$: rated slip frequency

### Motor no-load current

The actual no-load current is limited to be less than 75 % of the motor rated current.

### Example

[C1.07] = 2.06, then set [C1.20] = 2.06, the actual setting value is 1.54.

### Motor inertia mantissa and Motor inertia exponent

The inertia parameter C1.13 and C1.14 is defined as:

$J = [C1.13] \times 10^{-[C1.14]}$

J - Inertia, Unit: $Kg.m^2$

Accurate system inertia is important for achieving the optimal control performance. If by using the default inertia value fail to achieve the required control performance, the following three methods can be used to obtain the inertia value:

1. Run rotational auto-tuning ( C1.01 = 2 ) and the motor inertia can be obtained automatically. This method is recommended if the motor is disconnectable from the load.
2. Look up for the inertia value on the nameplate of synchronous motor or in the datasheet of motor manufacturer.
3. If the inertia value is not available on the nameplate or in the datasheet, neither the motor load is removable that allows for the execution of the rotational auto-tuning, derive an estimated value according to the formula below and make fine tuning for better control effect.

   $J = ½ \times m \times r^2$

   m - Rotor weight of synchronous motor, unit: kg

   r - Rotor radius of synchronous motor, unit: m

   In case rotor weight and rotor radius are not available, the following formula can be used for rough estimation of inertia.

   $J = ½ \times k \times M \times R^2$

   M - Total weight of synchronous motor, unit: kg

   R - Stator radius of synchronous motor, unit: m

   k - Coefficient, generally ranging from 1/32 to 1/8. For compact motor, such as servo motor, a bigger value could be selected, while for general asynchronous motor, a smaller value may be more suitable.

Due to the fact that the actual inertia is not obtainable through static auto tuning, and additionally if the default inertia could not meet the control requirement, only method 2 and method 3 shall be used for identifying the inertia value.



C1.13 and C1.14 are only available for VFC 5615.

## 12.3.5 Motor Thermal Model

This function is designed to protect the motor from over-temperature according internal thermal model.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.69 | Motor thermal model protection setting | 0: idle<br>1:Reserve<br>2: Current monitoring on | 0 | - | - | Stop |
| C1.74 | Motor thermal model protection time constant | 0.0...400.0 min | DOM | min | 0.1 | Stop |

C1.69=2 When the output current exceeds the [C1.70] 'Motor overload warning level' setting and the duration exceeds [C1.71] 'Motor overload warning delay', the device stops immediately and indicates an OL-2 error.

[C1.74] is obtained by the equation below:

$$[C1.74] = \frac{Cv * M}{9 * [C1.21] * [C1.07]^2 * 60}$$

**Cv:** Specific heat capacity (J/kg)
**Cv of aluminum (Al):** 900 J/kg
**Cv of iron (Fe):** 450 J/kg
**M:** Motor weight (kg)

**Fig. 12-24:** Motor thermal protection time constant

Increase the value of C1.74 'Motor thermal model protection time constant' appropriately if motor overload protection error code 'OL-2' occurs frequently. This function can be disabled by setting [C1.69] = 0, if necessary.



Ensure that the converter output current does not exceed 110 % of the [C1.07] 'Motor rated current'.

### Motor derating frequency at low speed

This function is used to reduce the overload and thermal risks as motors have worse cooling performance at low speed compared with it at rated speed.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.75 | Low speed derating frequency | 0.10...300.00 | 25.00 | - | 0.01 | Run |
| C1.76 | Zero speed load | 25.0...100.0 % | 25.0 | - | 0.1 | Run |

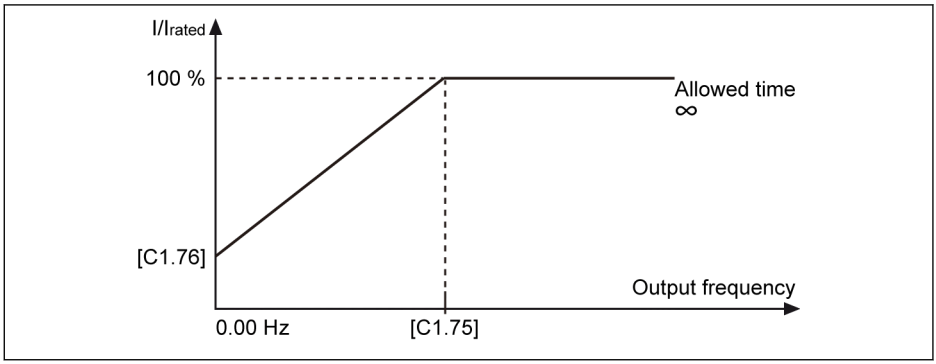



**Fig. 12-25:** Derating at low speed

- Low speed derating frequency

  When the output frequency is higher than [C1.75] 'Low speed derating frequency', the allowed continuous current is [C1.07] 'Motor rated current'.

  When the output frequency is lower than [C1.75], the allowed continuous current is reduced according to the above curve, with the lowest value to [C1.76] 'Zero speed load' at standstill.

- Zero speed load

  Zero speed load is the allowed continuous current (percentage of rated current) at standstill.

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☞ For a motor with external cooling, [C1.76] 'Zero speed load' is set to 100 %, and the low speed derating function is inactive.

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## 12.3.6 Motor Overload Pre-Warning

This function is used to monitor if the load for the motor is too high for a defined time, it will not lead to a device stop running but a digital output signal.

| Code | Name | Setting range | Default | Unit | Step | Attri. | Device |
|---|---|---|---|---|---|---|---|
| C1.69 | Motor thermal model protection setting | 0: Inactive<br>1: Reserve<br>2: Current monitoring active | 0 | - | - | Stop | All |
| C1.70 | Motor overload pre-warning level | 100.0...250.0 % | 100.0 | - | 0.1 | Run | All |
| C1.71 | Motor overload pre-warning delay | 0.0...20.0 | 2.0 | - | 0.1 | Run | All |

- **C1.69=0 or 1 ( Attention: valid only in motor overload pre-alarm )**

  When the output current exceeds the threshold defined by C1.70 'Motor overload pre-warning level' and lasts for C1.71 'Motor overload pre-warning delay', the "Motor overload pre-warning" signal will be active on the selected digital output terminal. The signal will be immediately inactive when the output current is lower than [C1.71].

  Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.10, H9.02, H9.03 can be set to "12: Motor overload pre-warning" to configure the digital outputs to show this warning.

  Behavior of motor overload pre-warning is shown as the figure below:

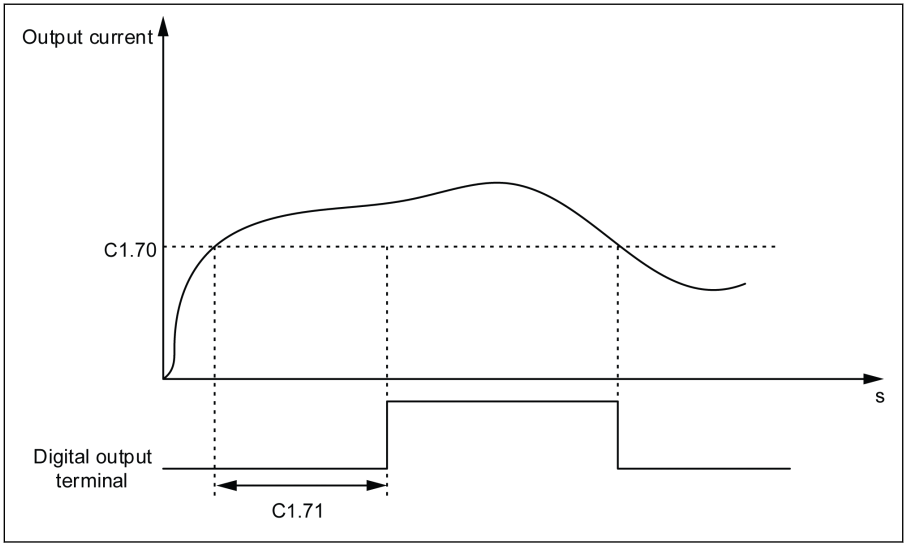



**Fig. 12-26:** Motor overload pre-warning

- Parameter E2.01, E2.15, H8.20, H8.21, H9.00, H9.10, H9.02, H9.03 can be set to "14: Converter error " to configure the digital outputs to show this error.

  Behavior of motor overload pre-warning is shown as the figure below:

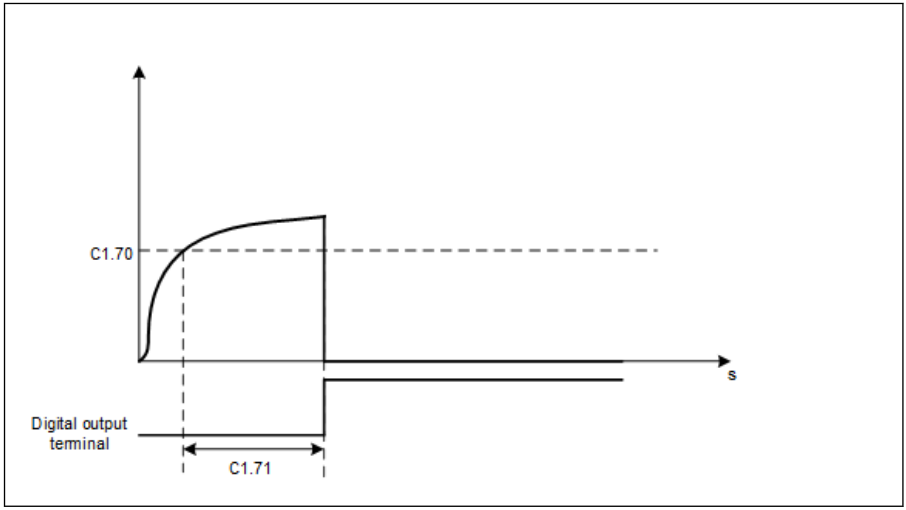



**Fig. 12-27:** Motor overload pre-warning

## 12.3.7 Motor Thermal Sensor Selection

This function is used to protect the motor against overheat. The analog voltage input can be used as temperature signal input.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C1.72 | Motor thermal sensor type | 0: KTY84/130 (PTC)<br>1 : PTC/SNM-150<br>2: PT100<br>3: PT1000<br>4: TDK G1551_8320 (NTC) | 0 | - | - | Stop |
| C1.73 | Motor thermal sensor protection level | 0.0...10.0 V | 2.0 | V | 0.1 | Stop |

To connect a temperature sensor to the converter, external wiring outside the converter is required.

For a temperature sensor with voltage supply, use terminals +10 V, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

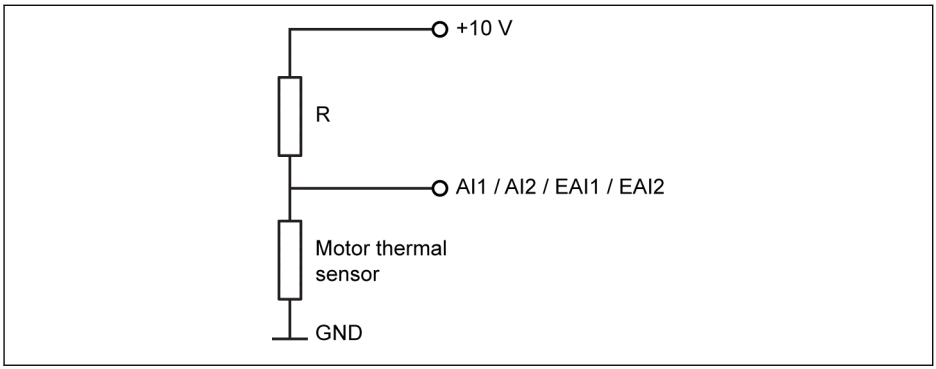



**Fig. 12-28:** Temperature sensor with voltage supply

For a temperature sensor with current supply, use terminals AO1 / EAO, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

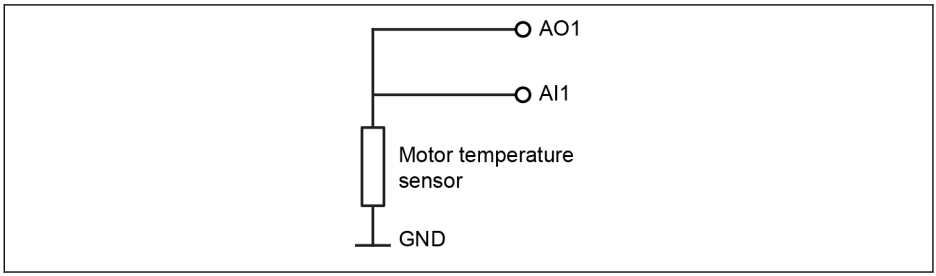



**Fig. 12-29:** Temperature sensor with current supply

**Activate the function of temperature monitoring with temperature sensor:**

Parameter [E1.60] 'Motor temperature sensor channel' is used enable to the protection with sensor.

**Select the sensor type:**

- [C1.72] = 0: KTY84/130

  For KTY84/130 sensors, the value of resistor R in the figure should be close to the sensor resistance when the motor is at high temperature.

  [C1.72] =1 : PTC/SNM-150

- [C1.72] = 2: PT100

  For a good resolution of temperature with PT100 sensors, the value of resistor R in the figure should be close to the sensor resistance at the motor temperature limit.

- [C1.72] = 3: PT1000

  For PT1000 sensors, the relationship between the resistor R and the motor temperature is:

  -30 ℃: 882 Ω

  0 ℃: 1,000 Ω

  200 ℃: 1,758 Ω

- [C1.72] = 4: TDK G1551_8320 (NTC)

**Supply source to the temperature sensor:**

- If [E2.26] = '11: Motor temperature sensor power supply' (or [H8.26] = 11), the analog output is shifted with current supply mode regardless of the setting of E2.25 (or H8.25). In this case, the output current on the selected analog output terminal is:
  - [C1.72] = 0, output current = 1.6 mA
  - [C1.72] = 2, output current = 9.1 mA
  - [C1.72] = 3, output current = 1 mA
  - [C1.72] = 4, output current = 4 mA
- If [E2.26] ≠ 11, the AO output mode is resumed to [E2.25] 'AO1 output mode' automatically.

- If [H8.26] ≠ 11, EAO output mode is resumed to [H8.25] 'EAO output mode' automatically.

### Set the motor protection level

Set C1.73 'Motor thermal sensor protection level' according to the characteristic of the temperature sensor. The setting value corresponds to the voltage value detected by of analog input.

**Example:** If [C1.72] = 0, 2, 3, [C1.73] = 2, it represents 2 V, and the frequency converter stops with error code 'Ot' displayed on the operating panel when the voltage level on analog input is higher than 2 V; if [C1.72] = 4, [C1.73] = 2, it represents 2 V, and the frequency converter stops with error code 'Ot' displayed on the operating panel when the voltage level on analog input is lower than 2 V.

## 12.4 C2: V/f Control

### 12.4.1 V/f Curve Setting

This function is used to adjust the output voltage in accordance with the V/f curve.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.00 | V/f curve mode | 0: Linear<br>1: Square<br>2: User-defined<br>3: V/f separation | 0 | - | - | Stop |
| C2.01 | V/f frequency 1 | 0.00...[C2.03] Hz | 0.00 | Hz | 0.01 | Stop |
| C2.02 | V/f voltage 1 | 0.0...120.0 % | 0.0 | - | 0.1 | Stop |
| C2.03 | V/f frequency 2 | [C2.01]...[C2.05] Hz | 0.00 | Hz | 0.01 | Stop |
| C2.04 | V/f voltage 2 | 0.0...120.0 % | 0.0 | - | 0.1 | Stop |
| C2.05 | V/f frequency 3 | [C2.03]...[E0.08] Hz | 50.00 | Hz | 0.01 | Stop |
| C2.06 | V/f voltage 3 | 0.0...120.0 % | 100.0 | - | 0.1 | Stop |
| C2.08 | V/f separation output voltage source selection | 0: Panel potentiometer<br>1: Panel button setting<br>2: AI1 analog input<br>10: X5 pulse input<br>20: Communication (Modbus 0x7F0B/Field-bus extension card H0.50)<br>22: Digital setting<br>23: Voltage PID control | 22 | - | - | Stop |
| C2.09 | V/f separation output voltage digital setting | 0.00...100.00 % | 0.00 | - | 0.01 | Run |
| C2.10 | V/f separation output voltage acceleration time | 0.0...6,000.0 s | 0.0 | - | 0.1 | Run |
| C2.11 | V/f separation output voltage deceleration time | 0.0...6,000.0 s | 0.0 | - | 0.1 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.12 | V/f separation stop mode selection | 0: Voltage and frequency decelerates independently<br>1: Voltage decelerates to zero, then frequency decelerates to zero | 0 | - | - | Run |
| C2.13 | V/f separation boost factor | 0.00...100.00 | 0.00 | - | 0.01 | Run |

The frequency converter provides four curve modes:

- **0: Linear**

  This mode refers to linear voltage / frequency control, which is used for normal constant torque loads.

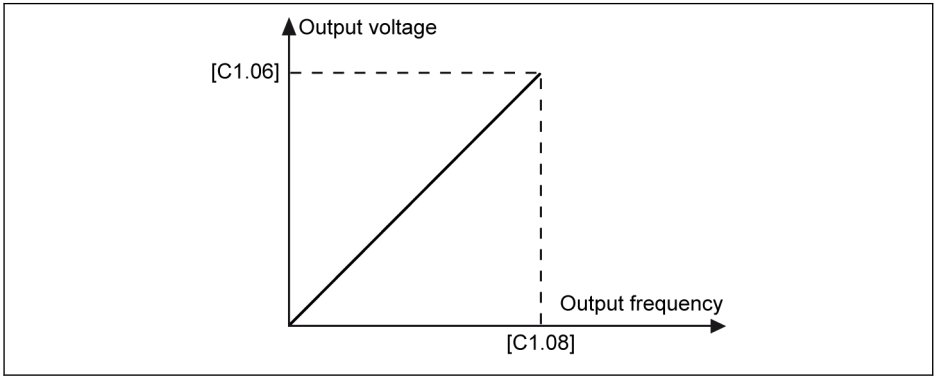



**Fig. 12-30:** Linear V/f curve

- **1: Square**

  This mode refers to square voltage / frequency control, which is used for variable torque loads of fans, pumps, etc.

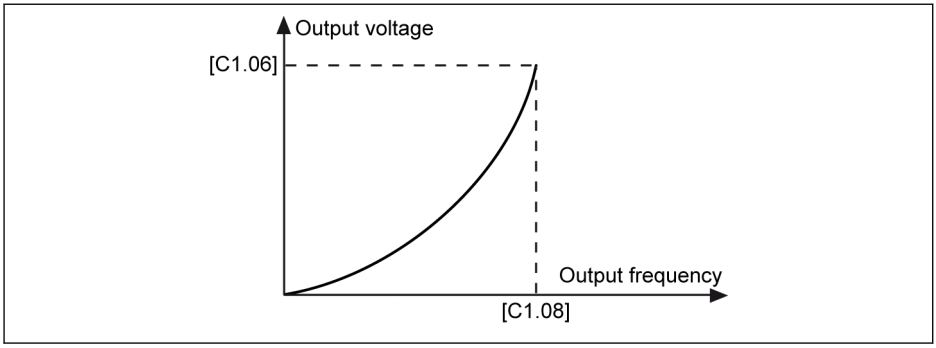



**Fig. 12-31:** Square V/f curve

- **2: User-defined**

  This mode refers to voltage / frequency control with curve defined according to actual application, which is used for special loads of dewatering machines, centrifuges, etc.

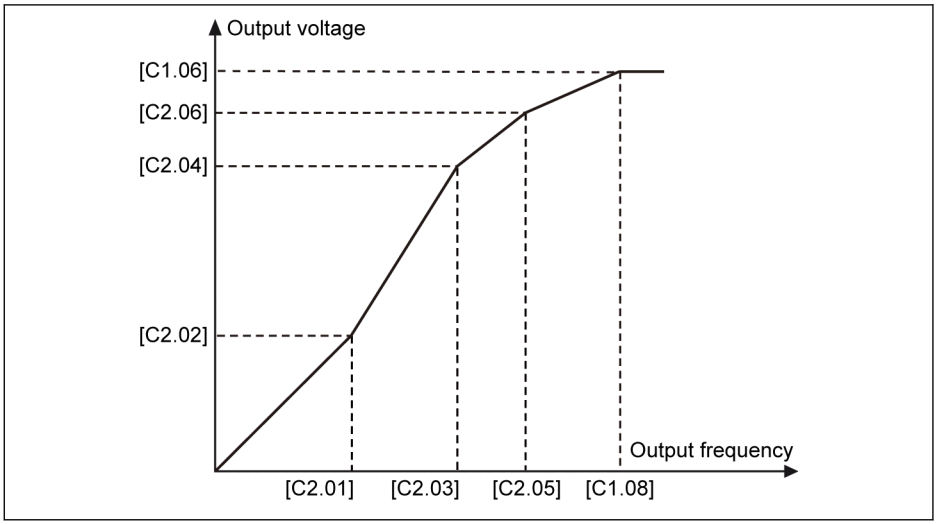



**Fig. 12-32:** User-defined V/f curve

Each of the three V/f frequency points is limited by the neighboring V/f frequency points. In general, each V/f frequency point shall be set according to following sequence: 0 ≤ [C2.01] ≤ [C2.03] ≤ [C2.05] ≤ [C1.08].

There are two modes of user-defined V/f curve:

1. User-defined V/f curve when [C2.05] ≤ [C1.08]

   In this mode, the output voltage is limited to 100 % even if [C2.06] 'V/f voltage 3' is higher than 100 %.

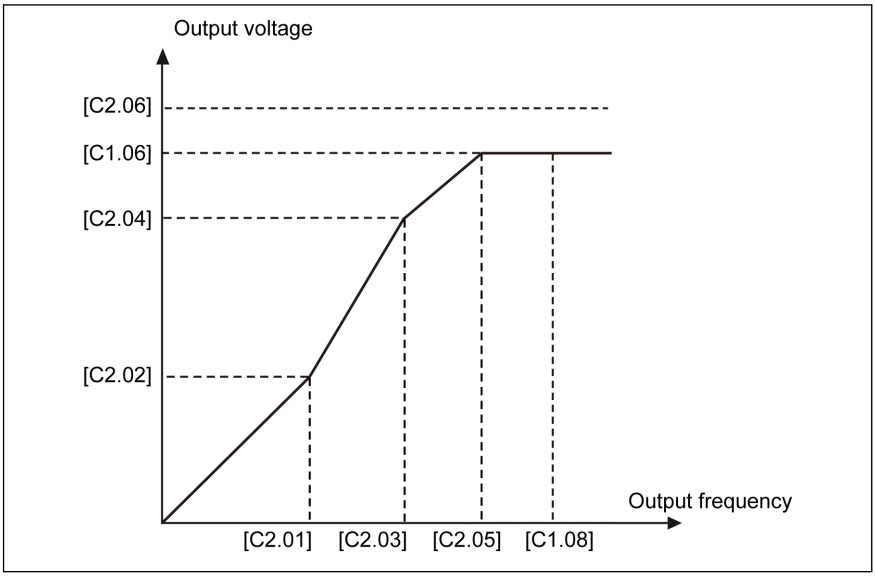



**Fig. 12-33:** User-defined V/f curve when [C2.05] ≤ [C1.08]

2. User-defined V/f curve when [C2.05] ≥ [C1.08]

   In field weakening range, output voltage needs to be higher than the rated voltage. In this case,

   - The maximum value of C2.05 'V/f frequency 3' can be higher than [C1.08] 'Motor rated frequency'.
   - The maximum value of C2.06 'V/f voltage 3' can be higher than 100 %.

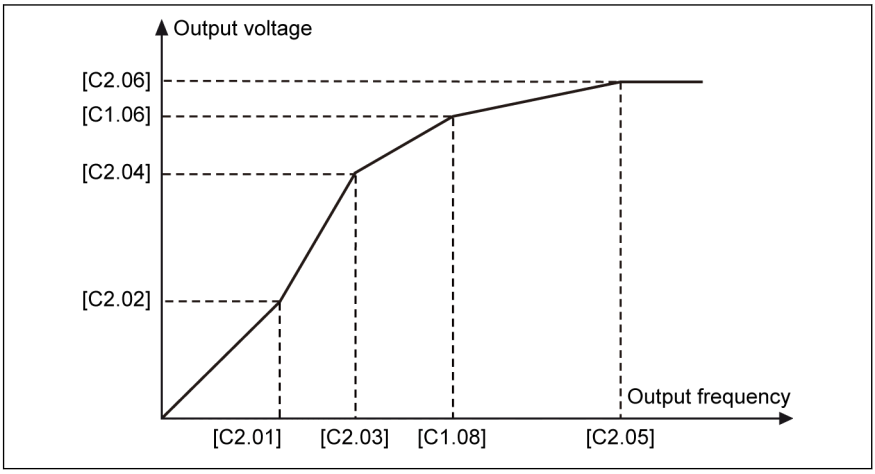



**Fig. 12-34:** User-defined V/f curve when [C2.05] ≥ [C1.08]

- **3: V/f separation**

  In case of V/f separation mode, voltage is not derived from the frequency instead user can control the voltage and frequency independently. In this mode, keeping the frequency constant, voltage can be varied and vice-versa. So that any curve can be followed based on the load requirements.

The voltage source selection can be made by setting the parameter C2.08 with the following options.

C2.08 setting range:

- **0: Panel potentiometer**

  The V/f separation output voltage is set by adjusting the potentiometer on the operating panel.

- **1: Panel button setting**

  Press **<▼>** and **<▲>** button on the operating panel will decrease and increase the V/f separation output voltage. The setting value will be saved to C2.09.

- **2: AI1 analog input**

  For AI1 analog input, curves are not considered. Maximum value of analog input will be directly converting to motor rated voltage.

- **10: X5 pulse input**

  For X5 pulse input, curves are not considered. Maximum value of pulse input will be directly converting to motor rated voltage.

- **20: Communication**

  The voltage command values are given in percentage through Modbus or any other Fieldbus communication. If Modbus is selected as communication channel for voltage command value, data is written through the register address 0x7F0B. If other Fieldbus communication is selected as channel for voltage command value, data can be written through the parameter H0.50.

- **22: Digital setting**

  C2.09 is used for setting the voltage in percentage value through panel or ConverterWorks.

- **23: Voltage PID control**

  The voltage reference value will be set by the PID output. In this mode the reference/feedback source of PID is limited:

  – E4.00 Valid voltage sources: Panel potentiometer, panel button digital setting, AI1, pulse train and communication

  – E4.01 Valid voltage sources: AI1 and pulse train output

    When the PID reference source is selected as panel button digital setting, the reference value will be saved to C2.09.

C2.10 'V/f separation output voltage acceleration time' is the time for V/f separation output voltage increase from 0 V to motor rated voltage.

C2.11 'V/f separation output voltage deceleration time' is the time for V/f separation output voltage decrease from motor rated voltage to 0 V.

**The voltage boost is calculated as the following way:**

Voltage boost (%) = (Factor [C2.13] * Total current * 100) / (Motor rated voltage)

Output voltage (%) = Set voltage (%) + Voltage boost (%)

Device has to start directly when 'RUN' command is issued irrespective of 'START' mode E0.35. Device has to stop directly when 'STOP' command is issued irrespective of 'STOP' mode E0.50. But it has to stop based on the new V/f separation 'STOP' mode C2.12.

Whenever V/f separation mode is enabled, setting voltage can be displayed through display parameter d0.09.

## 12.4.2 Slip Compensation

This function is used to compensate the speed difference caused by the load in the case of V/f control, to ensure that the rotator's speed is close to the synchronous speed and improve the mechanical behavior of the motor.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.07 | Slip compensation factor | 0...200 % | 0 | – | 1 | Run |

The actual slip compensation is calculated from [C1.12] 'motor rated slip frequency' and load, and is automatically compensated, with [C2.07] being the maximum compensation value:

- 0 %: No slip compensation

  The slip compensation function is deactivated.
- 1...100 %: Full slip compensation

  **Example:** [C1.12] = 2.50 Hz, [C2.07] = 100 %

  The maximum slip compensation is 2.50 Hz x 100 % = 2.50 Hz.
- 101...200 %: Over slip compensation

  **Example:** [C1.12] = 2.50 Hz, [C2.07] = 200 %

  The maximum slip compensation is 2.50 Hz x 200 % = 5.00 Hz.

## 12.4.3 0 Hz Output Mode

This function is used in some application when no torque output is required in 0 Hz.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.20 | 0 Hz output mode | 0: No output<br>1: Standard | 1 | – | 1 | Stop |

Setting range:

- 0: No output

  No any torque output in this mode.
- 1: Standard

  There is certain torque output in this mode.

## 12.4.4 Torque Boost Setting

The torque boost function is used to obtain higher output torque and better stabilization by boosting the output voltage, especially at low speed.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.21 | Torque boost setting | 0.0 %: Automatic boost<br>0.1... 20.0 %: Manual boost | DOM | – | 0.1 | Run |
| C2.22 | Automatic torque boost factor | 0...320 % | 50 | – | 1 | Run |

- **Manual torque boost with linear or user-defined V/f curve**

  In this V/f curve, the output voltage starts to be boosted when the output frequency is lower than half of [C1.08].

  **Example:** If [C1.08] = 50.00 Hz, then torque boost function is active when output frequency is lower than 25.00 Hz.

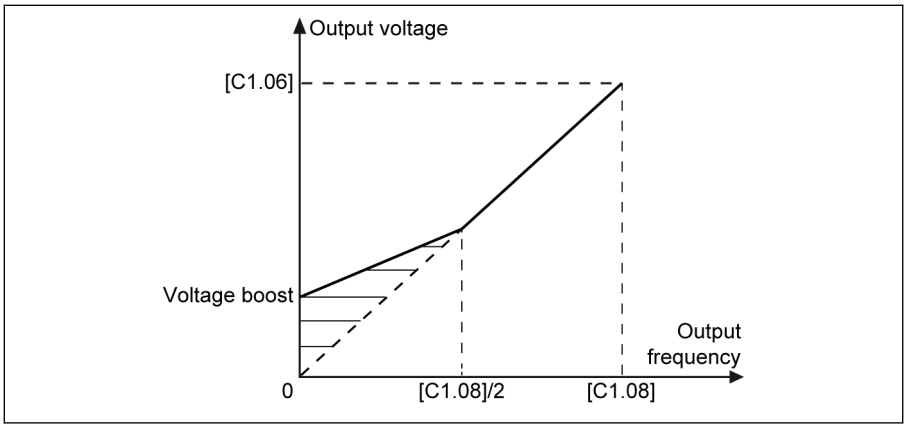



**Fig. 12-35:** Manual torque boost with linear or user-defined V/f curve

[C2.21] is the voltage boost value at 0.00 Hz. The actual voltage boost values for other frequency points decreases in linear along with output frequency increase.

- **Manual torque boost with square curve**

  In this square V/f curve, the output voltage starts to be boosted when the output frequency is lower than [C1.08].

  **Example:** If [C1.08] = 50.00 Hz, then torque boost function is active when the output frequency is lower than 50.00 Hz.

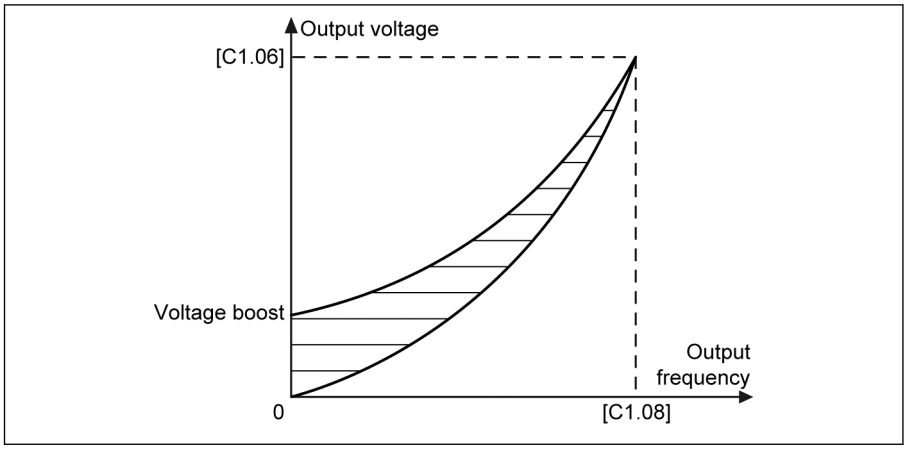



**Fig. 12-36:** Manual torque boost with square curve

In automatic boost mode, the output voltage boost percentage is determined automatically by the output frequency and the load current. The linear and square V/f curves for automatic torque boost are shown as figures below:

- **Automatic torque boost with linear V/f curve**

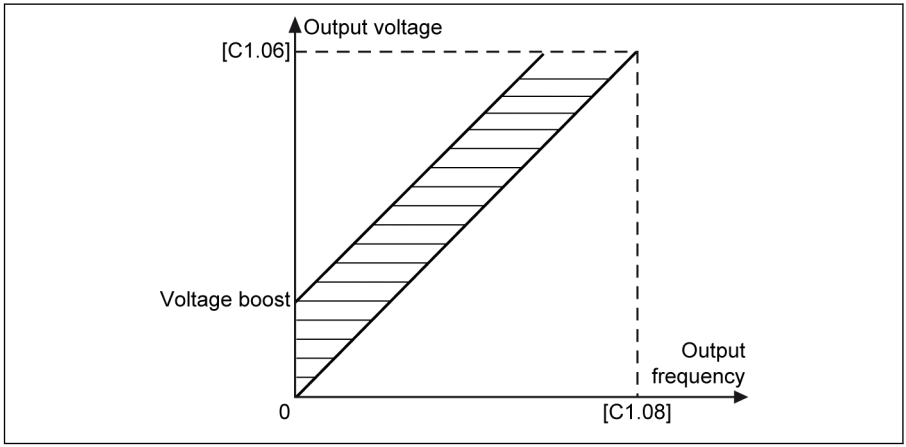



**Fig. 12-37:** Automatic torque boost with linear V/f curve

- **Automatic torque boot with square V/f curve**

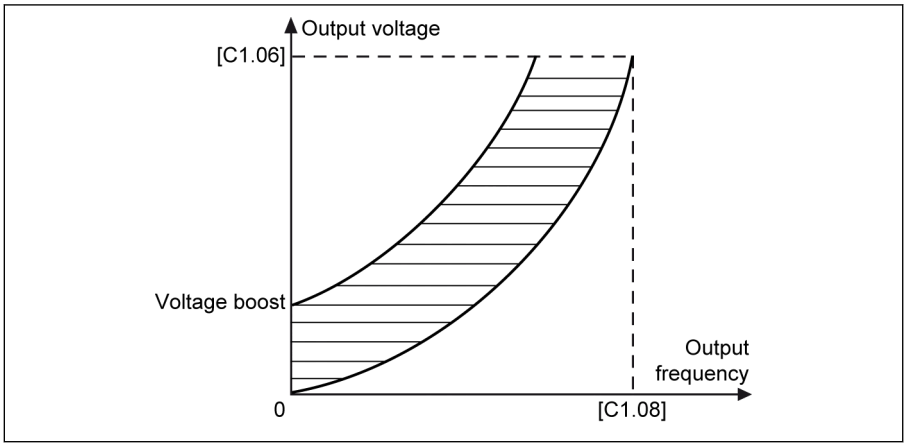



**Fig. 12-38:** Automatic torque boot with square V/f curve

For further adjustment of the voltage boost, set parameter C2.22 'Automatic torque boost factor'. Its default value 50 % means no adjustment. The calculation equation is shown as below:

**[Voltage boost] = √3 x 0.5 x $I_1$ x $R_1$ x [C2.22]**

$R_1$: stator resistance

$I_1$: stator current

## 12.4.5 Heavy Load Stabilization

This function is used to suppress the output voltage oscillation caused by large impact to DC-bus voltage in case of heavy load.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.23 | Heavy load stabilization | 0: Inactive<br>1: Active | 1 | – | – | Run |

Setting range:

- **0: Inactive**

  Heavy load stabilization function inactive.

- **1: Active**

  Heavy load stabilization function active.



This function can lead to slightly lower output voltage to the motor.

## 12.4.6 Light Load Oscillation Damping

This function is used to suppress the motor oscillation in the case of light load or no load.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.24 | Light load oscillation damping factor | 0...5,000 % | 0.4~110k W: 300<br>132kW and above: 100 | – | 1 | Run |
| C2.25 | Light load oscillation damping filter factor | 10...2,000 % | 0.4~110k W: 30<br>132kW and above: 50 | – | 1 | Run |

1. [C2.24] = 0 %: Oscillation suppression is inactive.
2. Increasing [C2.24] brings a better effect of oscillation suppression, but excessive increase leads to unstable running of the motor.
3. [C2.25] = 30 %: This setting can suppress oscillation in most situations.
4. Adjustment of [C2.25] is helpful in the following conditions:
   - Increase [C2.25] if the oscillation damping performance is not obvious, but excessive increase leads to slow suppression.
   - Decrease [C2.25] if the oscillation occurs at low speed.

## 12.4.7 Current Limitation

This function is used to avoid the tripping caused by over current when the load has large inertia or sudden changes.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C2.40 | Current limitation mode | 0...2 | 2 | – | – | Stop |
| C2.42 | Current limitation level | 20...250 % | 150 | – | 1 | Stop |
| C2.43 | Current limitation proportional gain | 0.000...10.000 | DOM | – | 0.001 | Stop |
| C2.44 | Current limitation integral time | 0.001...10.000 | DOM | – | 0.001 | Stop |

- **C2.40 = 0: Always inactive**

  Current limitation control function is inactive.

- **C2.40 = 1: Inactive at constant speed**

  Current limitation control is active during acceleration and deceleration, but inactive at constant speed.

- **C2.40 = 2: Active at constant speed**

  Current limitation control is active during acceleration, deceleration and at constant speed.

The current regulator is a PI regulator with configurable P factor and I factor.

- The higher value of C2.43 'Current limitation proportional gain', the faster the current suppression, but too high value of C2.43 will cause oscillation.
- The shorter value of C2.44 'Integral time', the more quick response of current suppression, but too short value of C2.44 will cause oscillation.

The default settings of C2.43 and C2.44 can meet requirements in most applications. If slight adjustment is necessary, increase [C2.43] first with no oscillation, and then decrease [C2.44] to achieve fast response without overshooting.

[C0.27] 'Stall overcurrent prevention level' should be smaller than [C2.42] 'Automatic current limitation level', otherwise a warning code 'PrSE' will be displayed on the operating panel and parameter setting can not be saved.

## 12.5 C3: Vector Control

### 12.5.1 Speed Loop Setting

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.00 | Speed loop proportional gain 1 | 0.00...655.35 | DOM | - | 0.01 | Run |
| C3.01 | Speed loop integral time 1 | 0.01...655.35 ms | DOM | ms | 0.01 | Run |
| C3.02 | Speed loop proportional gain 2 | 0.00...655.35 | DOM | - | 0.01 | Run |
| C3.03 | Speed loop integral time 2 | 0.00...655.35 ms | DOM | ms | 0.01 | Run |
| C3.10 | Speed loop switching frequency 1 | 0.00...[C3.11] | 4.00 | Hz | 0.01 | Stop |
| C3.11 | Speed loop switching frequency 2 | [C3.10]...[C1.08] | 6.00 | Hz | 0.01 | Stop |

Frequency converter can select different PI parameter while they are running in different frequency. When the running frequency is lower than switch frequency 1 (C3.10), speed loop PI tuned parameters are C3.00 and C3.01. When the running frequency is higher than switch frequency 2 (C3.11), speed loop PI tuned parameters are C3.02 and C3.03. The speed loop PI parameters that between switch frequency 1 and switch frequency 2 are the linear switch of two group parameters. It is shown as figure below:

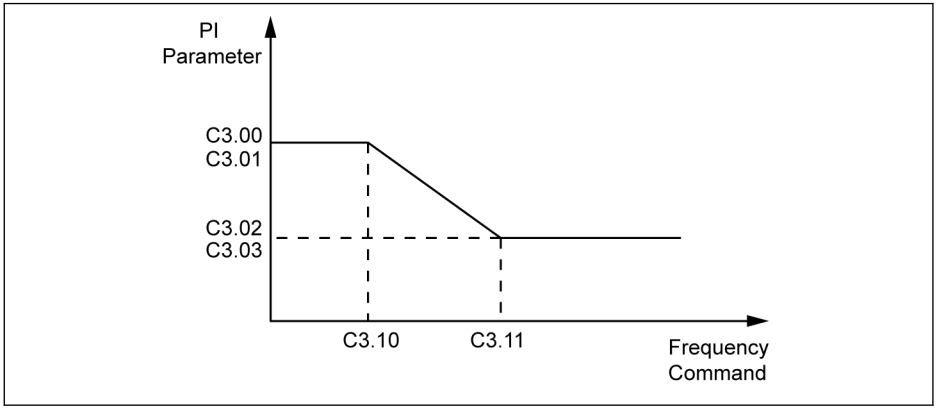



**Fig. 12-39:** PI parameters

The velocity dynamic response characteristic of vector control can be tuned by setting the proportional coefficient and integral time of speed regulator.

Increase the proportional gain or reduce the integral time can speed up the dynamic response of speed loop. But higher proportional gain or lower integral time may cause the system oscillation, it is suggested that:

If the default parameter value can not satisfy the requirement, it can be adjusted according to the actual needs based on the default value: increase the proportional gain to ensure the system dose not oscillation, then reduce the integral time, so that the system has a faster response characteristic and a smaller overshoot.

☞ If the PI parameters are not set properly, it may lead to speed excessive overshoot or overvoltage fault during overshoot drops.

### 12.5.2 Speed Observer Mode

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.12 | Speed observer mode | 0: mode 1<br>1: mode 2 | 0 | - | - | Run |
| C3.13 | Speed observer mode | 1...10 | 1 | ms | 1 | Run |

### 12.5.3 Current Loop Setting

The current loop parameters are calculated based on the motor parameter. In most cases it is not advised to change them. But if the motor is running at low frequency (under 3 Hz) but not smooth enough, the proportional gain of the current loop can be set bigger.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.05 | Current loop proportional gain | 0.1...1,000.0 | DOM | – | 0.1 | Run |
| C3.06 | Current loop integral time | 0.01...655.35 ms | DOM | ms | 0.01 | Run |

## 12.5.4 Torque Limitation

This function defines the torque limitation when the frequency converter is running in speed control mode.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.20 | Low speed torque limitation | 1...200 % | 100 | – | 1 | Stop |
| C3.44 | Torque positive limit | 0.0...200.0 % | 150.0 | – | 0.1 | Run |
| C3.45 | Torque negative limit | 0.0...200.0 % | 150.0 | – | 0.1 | Run |
| C3.47 | Torque limitation reference selection at speed control mode | 0: Parameter C3.44 and C3.45<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: Communication<br>(Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14)<br>(Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15)<br>5: EAI2 analog input | 0 | – | – | Stop |

C3.20 “low speed torque limitation” only works in sensorless vector control mode and limits the torque output at “low speed area”. Its value means the percentage of the rated torque. The “low speed area” and “high speed area” are switched by a hysteresis shown in the figure below, which is related to the rated frequency and rated voltage of the motor.

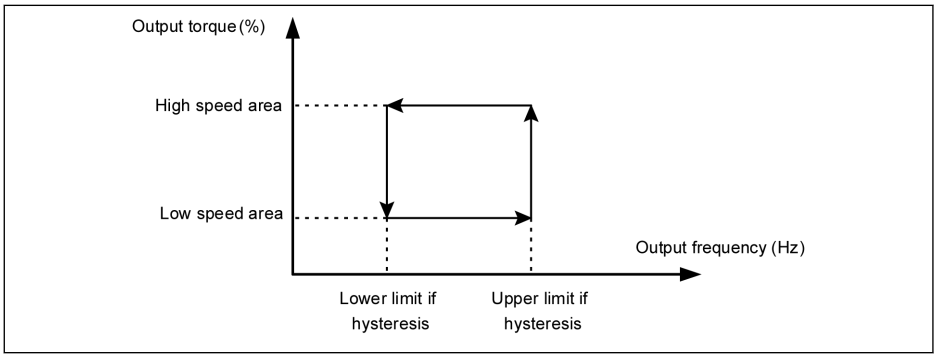



**Fig. 12-40:** Low speed torque limitation hysteresis

The hysteresis is calculated by the following equations:

- Lower limit of hysteresis = 15.2 * rated frequency / rated voltage
- Upper limit of hysteresis = 22.8 * rated frequency / rated voltage

For sensorless vector control, the output torque in “high speed area” is limited by the reference selected by C3.47.

**C3.47 setting range:**

- C3.47 = 0: Parameter C3.44 and C3.45

  C3.44 “Torque positive limit” is used to set the limit maximum value of positive torque of the frequency converter.

  C3.45 “Torque negative limit” is used to set the limit minimum value of the negative torque of the frequency converter.

  The reference torque direction will be set by [U0.00] or external terminals:

  – If [E0.01] = 0 “Operating panel”, the reference torque direction will be set by [U0.00]. [U0.00] = 0 “Forward” means the reference torque direction is positive. [U0.00] = 1 “Reverse” means the reference torque direction is negative.

  – If [E0.01] = 1 “Multi-function digital input”, the reference torque direction will be determined according to running direction which is controlled by external terminals. (“Forward” corresponding to “Positive” and “Reverse” corresponding to “Negative”.

- C3.47 = 1: AI1 analog input

  The range of AI1 corresponds to the 0.0...200.0% rated torque.

- C3.47 = 2: AI2 analog input

  The range of AI2 corresponds to the 0.0...200.0% rated torque.

- C3.47 = 3: EAI1 analog input

  The range of EAI1 corresponds to the 0.0...200.0% rated torque.

- C3.47 = 4: Communication

  Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14.

  Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15.

- C3.47 = 5: EAI2 analog input

  The range of EAI2 corresponds to the 0.0...200.0% rated torque.

## 12.5.5 Speed Monitor

The speed monitor will monitor the speed difference between setting point and actual frequency as well as of maximum frequency and actual frequency. In case of problems it will show error SPE-.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.25 | Speed monitor timeout | 0.0...6,553.5 | 5.0 | s | 0.1 | Stop |
| C3.26 | Speed monitor maximum speed difference | 0.00...655.35 | 10.00 | Hz | 0.01 | Stop |

## 12.5.6 Fieldweakening control for PMSM

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.30 | Maximum FW current factor for SM | 1...95 | 75 | % | 1 | Stop |

This parameter is the maximum allowed percent of motor rated current C1.07, it is used when PMSM runs in field weakening area, or called constant power region.

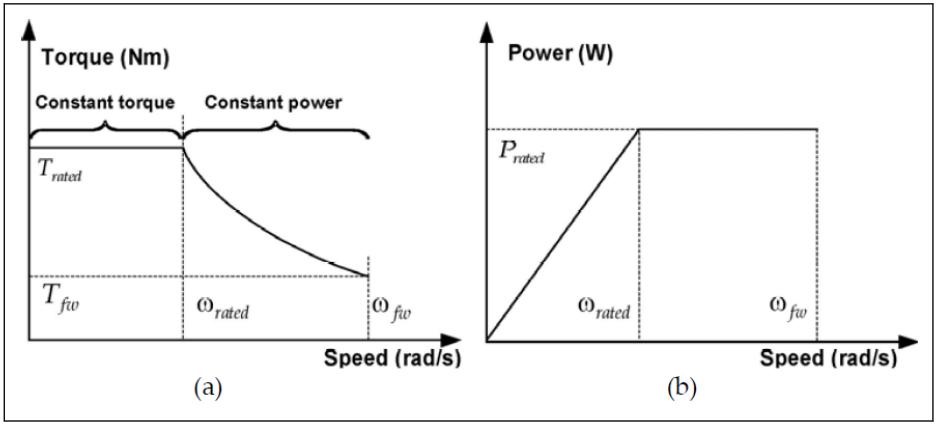



**Fig. 12-41:** Torque characteristics and power versus speed curves

In order to reach higher running speed for PMSM, field weakening control is needed to offset the effect of EMF, which occupies the main part of needed output voltage in higher speed region. With field weakening control, the regulator has more capability to regulate the output voltage to increase the running speed for PMSM, this is achieved via modifying this parameter.



In some application fields, it is NOT allowed for motor to run beyond the rated speed, so C3.30 should be set to a smaller value; For some application fields, with increasing of C3.30, the running speed can be reached at a higher level. But please be aware that higher field weakening current might lead to the irreversible demagnetizing of permanent magnet mounted on the rotor, and also higher EMF with higher running speed would lead to the damage of the drive.

## 12.5.7 Torque Control

This function is about torque control, the motor will keep the output torque as the setting value until it reaches the speed limit.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.38 | Forward frequency limitation at torque control mode | 0.00...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |
| C3.39 | Reverse frequency limitation at torque control mode | 0.00...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |
| C3.40 | Torque control mode | 0: Activated by digital inputs<br>1: Always active<br>2: Communication<br>(Bit 8 of Modbus 0x7F00)<br>(Bit 9 of extension card H0.00) | 0 | – | – | Stop |
| C3.41 | Torque reference channel | 0: AI1 analog input<br>1: AI2 analog input<br>2: Panel potentiometer<br>3: EAI1 analog input<br>4: Pulse input via DI5<br>5: Parameter setting C3.46<br>6: Communication (Modbus 0x7F02/Fieldbus extension card H0.12)<br>7: EAI2 analog input | 0 | – | – | Stop |
| C3.42 | Torque reference minimum value | 0.0 %...[C3.43] | 0.0 | – | 0.1 | Run |
| C3.43 | Torque reference maximum value | [C3.42]...200.0 % | 150.0 | – | 0.1 | Run |
| C3.46 | Digital torque reference setting | 0.0...200.0 % | 150.0 | – | 0.1 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.48 | Speed limitation reference selection at torque control mode | 0: Parameter C3.38 and C3.39<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: Communication (Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16)<br>5: EAI2 analog input | 0 | – | – | Stop |
| C3.49 | Torque command ramp | 0.0...5.0 s | 0 | s | 0.1 | Stop |

### Torque control activation mode

Parameter C3.40 'Torque control mode' is used to set the activation mode of torque control.

C3.40 setting range:

- [C3.40] = 0: Activated by digital inputs

  The corresponding parameter [E1.00] ... [E1.04], [H8.00] ... [H8.04] of the selected digital input needs to be set as 23: Torque / speed control switch. Please keep in mind that with this setting the switch can also happen when the converter is in run.

- [C3.40] = 1: Always active

  Torque control mode is selected.

- [C3.40] = 2: Communication

  -bit8 of Modbus 0x7F00 = 1: torque control enable

  -bit8 of Modbus 0x7F00 = 0: torque control disabled

  -bit9 of extension card H0.00 = 1: torque control enable

  -bit9 of extension card H0.00 = 0: torque control disabled

### Torque reference channel

Parameter C3.41 'Torque reference channel' is used to set torque reference channel.

Parameters C3.42 'Torque reference minimum value' and C3.43 'Torque reference maximum value' are used to define the curve characteristic for the torque reference.

Torque curve is defined as below:

- When [C3.41] = 0, 1, 2, 3, 4 or 7, and EAI1/EAI2 input is non -10 V to 10 V, C3.42 and C3.43 are used to define curve:

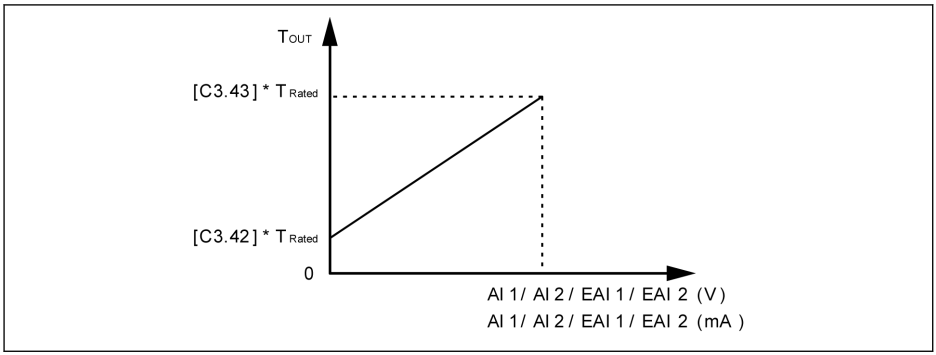



**Fig. 12-42:** Torque reference characteristic curve

- When [C3.41]=3, 7 and EAI1/EAI2 input is -10 V to 10 V, C3.43 is used to define curve:
  - [H8.06] / [H8.31] = 0 or 1

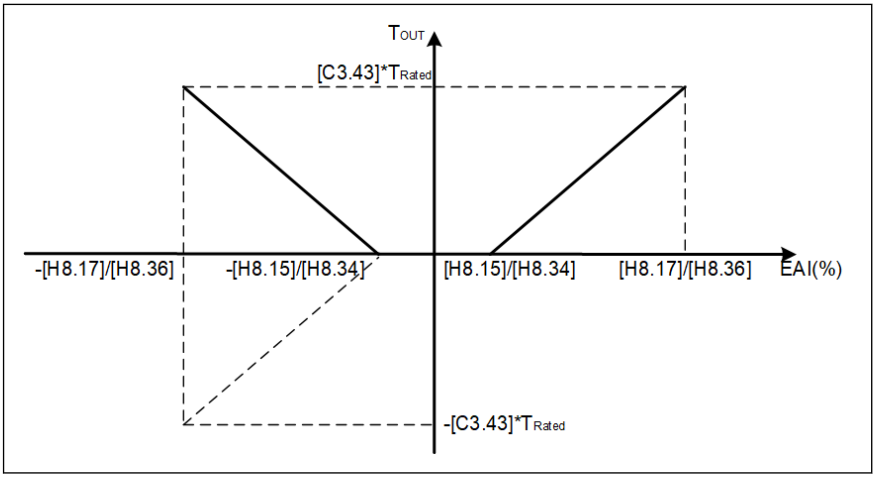



**Fig. 12-43:** Torque curve 1

  - [H8.06] / [H8.31] = 2

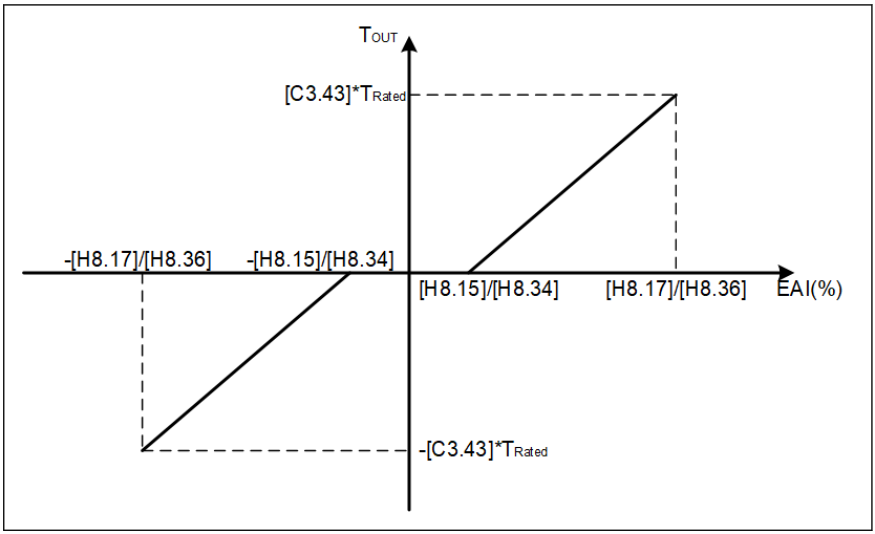



**Fig. 12-44:** Torque curve 2

### Speed limitation at torque control mode

In torque control mode the motor speed is limited by C3.48 'Speed limitation reference selection at torque control'.

C3.48 setting range:

- C3.48 = 0: Parameter C3.38 and C3.39
  C3.38: Forward frequency limitation at torque control mode
  C3.39: Reverse frequency limitation at torque control mode
- C3.48 = 1: AI1 analog input
  Analog input AI1, scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 2: AI2 analog input
  Analog input AI2, scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 3: EAI1 analog input
  Analog input EAI1 scaled to 0.00...E0.09 based on analog input curve.
- C3.48 = 4: Communication
  Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16.
- C3.48 = 5: EAI2 analog input
  Analog input EAI2, scaled to 0.00...E0.09 based on analog input curve.

### Torque command ramp setting

Torque command ramp [C3.49] is the time for torque command increase from 0 to C1.17 'motor rated torque'.

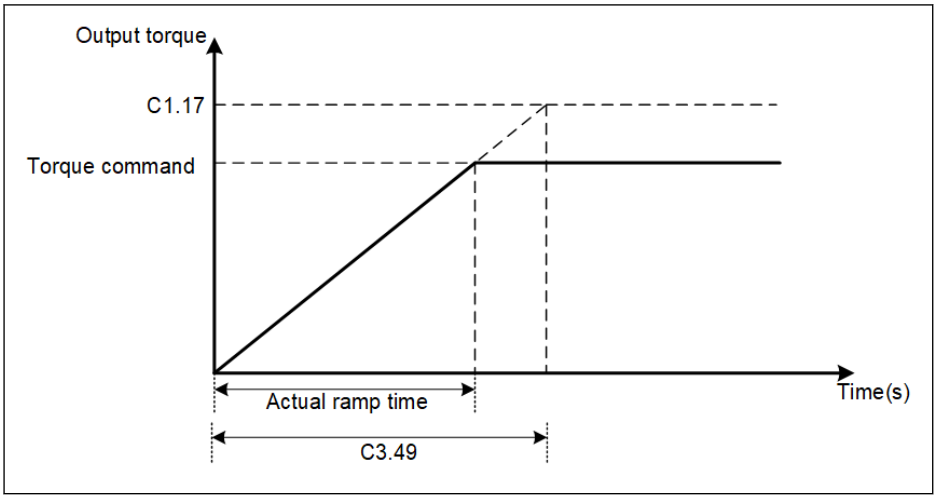



**Fig. 12-45:** Torque command ramp

## 12.5.8 Initial Angle Detection

Initial rotor angle detection is automatically checking the rotor position before the motor startup. The advantage of this function is to prevent the reverse running at the startup, the disadvantage is extended startup time with moderate amount of noises.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.50 | Initial angle detection current | 50...150 % | 80 | - | 1 | Stop |
| C3.51 | Initial angle detection mode | 0...2 | 2 | - | - | Stop |

C3.50 is to set the current value to be used for checking the rotor initial position. The smaller the current, the smaller noise generation over the time of checking. However current input too small may decrease the accuracy of the checking result.

C3.51 is to set initial position angle checking mode:

- C3.51 = 0: No detection

  Possible to have the reverse running at the startup.

- C3.51 = 1: Detection when first power on

  Applicable for small inertia systems which do NOT allow reverse running at the startup and cause no change to rotor position after the system stop.

- C3.51 = 2: Detection at every running

  Normally the checking shall be performed on the rotor initial position at each startup. Set C3.51 to '2' for the applications which do NOT allow the reverse running at startup and cause change to the rotor position after system stop.

## 12.5.9 SVC switch point

The two parameters are switching points used between low frequency area and high frequency area.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.52 | SVC regulation area lower frequency | 0.00...600 | DOM | Hz | 0.01 | Stop |
| C3.53 | SVC regulation area upper frequency | 0.00...600 | DOM | Hz | 0.01 | Stop |

C3.52: this parameter is the switching point where the high frequency area decelerate to the low frequency area.

C3.53: this parameter is the switching point where the low frequency area accelerate to the high frequency area.

## 12.5.10 Speed Damping Factor for SVC

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| C3.04 | Speed observer harmonics damping factor | 0.10...20.00 | 0.66 | - | 0.01 | Stop |
| C3.54 | SVC damp factor enhance upper frequency | DOM | DOM | Hz | 0.01 | Stop |
| C3.55 | SVC damp factor enhance coefficient | 1...20 | 1 | - | 1 | Stop |

C3.04 is a specified parameter for speed observer in sensorless vector control. It can affect the level of the harmonics, which presents in the observed speed and is caused by the offset and harmonics of the input values of the speed observer (voltage, current), especially in the speed area below 20% of the rated motor speed.

The default value of C3.04 can cover most application cases. Only if the motor runs not smoothly in SVC mode and other control parameters can't help to improve it, C3.04 can be set with a higher value by setting step size 0.3 ~ 0.5. Please note that high C3.04 has a negative influence on the loading performance.

C3.54 and C3.55 are used to enhance damping factor in the SVC low speed area. Normally, only increasing C3.54 can satisfy the need of enhancing the damping factor. But C3.54 can not be too high, otherwise speed fluctuation will occur. Now C3.55 can be used, increasing C3.55 also can enhance the damping factor.

## 12.6 d0: Basic Monitoring

This part is about basic monitoring parameters.

| Code | Name | Minimum unit | Attri. |
|---|---|---|---|
| d0.00 | Output frequency | 0.01 Hz | Read |
| d0.01 | Actual speed | 1 rpm | Read |
| d0.02 | Setting frequency | 0.01 Hz | Read |
| d0.03 | Setting speed | 1 rpm | Read |
| d0.04 | User-defined setting speed | 0.1 | Read |
| d0.05 | User-defined output speed | 0.1 | Read |
| d0.06 | Encoder frequency | 0.01 | Read |
| d0.07 | Encoder speed | 1 | Read |
| d0.09 | V/f separation setting voltage | 0.01 V | Read |
| d0.10 | Output voltage | 1 V | Read |
| d0.11 | Output current | 0.1 A | Read |
| d0.12 | Output power | 0.1 kW | Read |
| d0.13 | DC-bus voltage | 1 V | Read |
| d0.14 | Energy saving counter kWh | 0.1 kWh | Read |
| d0.15 | Energy saving counter MWh | 1 MWh | Read |
| d0.16 | Output torque | 0.1 % | Read |
| d0.17 | Setting torque | 0.1 % | Read |
| d0.18 | FWD speed limitation setting | 0.01 rpm | Read |
| d0.19 | REV speed limitation setting | 0.01 rpm | Read |
| d0.20 | Power module temperature | 1 ℃ | Read |
| d0.21 | Actual carrier frequency | 1 kHz | Read |
| d0.23 | Power stage running time | 1 h | Read |
| d0.30 | AI1 input | 0.01 V / 0.01 mA | Read |
| d0.31 | AI2 input | 0.01 V / 0.01 mA | Read |
| d0.33 | I/O card EAI1 input | 0.01 V / 0.01 mA | Read |
| d0.34 | I/O card EAI2 input | 0.01 V / 0.01 mA | Read |
| d0.35 | AO1 output | 0.01 V / 0.01 mA | Read |
| d0.37 | I/O card EAO output | 0.01 V / 0.01 mA | Read |
| d0.38 | IO plus card TSI input signal value | 0.001 V | Read |
| d0.40 | Digital input 1 | – | Read |
| d0.43 | I/O card digital input | – | Read |
| d0.45 | DO1 output | – | Read |
| d0.47 | I/O card EDO1 output | – | Read |
| d0.48 | I/O card EDO2 output | – | Read |
| d0.50 | Pulse input frequency | 0.01 kHz | Read |

| Code | Name | Minimum unit | Attri. |
|---|---|---|---|
| d0.55 | Pulse output frequency | 0.1 kHz | Read |
| d0.60 | Relay output | – | Read |
| d0.62 | I/O card relay output | – | Read |
| d0.63 | Relay card output | – | Read |
| d0.70 | PID reference engineering value | 0.1 | Read |
| d0.71 | PID feedback engineering value | 0.1 | Read |
| d0.80 | ASF Display00 | – | Read |
| d0.81 | ASF Display01 | – | Read |
| d0.82 | ASF display02 | – | Read |
| d0.83 | ASF display03 | – | Read |
| d0.84 | ASF display04 | – | Read |
| d0.85 | ASF display05 | – | Read |
| d0.86 | ASF display06 | – | Read |
| d0.87 | ASF display07 | – | Read |
| d0.88 | ASF display08 | – | Read |
| d0.89 | ASF display09 | – | Read |
| d0.98 | High resolution output current | 0.01 A | Read |
| d0.99 | Firmware version | 0.01 | Read |

## 12.7 d1: Enhanced Monitoring

This part is about enhanced monitoring parameters, which are not visible via Panel, but can be scoped in IndraWorks.

| Code | Name | Minimum unit | Attri. |
|---|---|---|---|
| d1.00 | Phase current U [A] | 0.1 A | Read |
| d1.01 | Phase current V [A] | 0.1 A | Read |
| d1.02 | Phase current W [A] | 0.1 A | Read |
| d1.05 | Current Id filtered Display | 0.01 A | Read |
| d1.06 | Current Iq filtered Display | 0.01 A | Read |
| d1.10 | Signed rotor frequency | 0.1 Hz | Read |
| d1.11 | Rotor speed | 1 rpm | Read |
| d1.12 | Signed encoder frequency | 0.1 Hz | Read |
| d1.15 | High resolution output power | 0.01 kW | Read |
| d1.20 | Encoder angle | 0.01 ° | Read |

# 12.8 E0: Set Point and Control

## 12.8.1 Frequency Setting Source

Different frequency setting sources can be selected by setting parameter E0.00 'First frequency setting source' or E0.02 'Second frequency setting source'.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 0...21 | 0 | - | - | Stop |
| E0.02 | Second frequency setting source | 0...21 | 2 | - | - | Stop |

**Setting range of E0.00, E0.02:**

- **0: Panel potentiometer**

  The setting frequency is set by adjusting the potentiometer on the operating panel. By default, the first frequency setting source is from the potentiometer on the operating panel. To adjust the output frequency, follow the instructions below:

  – Rotate the potentiometer counterclockwise (leftwards)

    The output frequency decreases, and the motor decelerates.

  – Rotate the potentiometer clockwise (rightwards)

    The output frequency increases, and the motor accelerates.

- **1: Panel button setting**

  The setting frequency is set by parameter E0.07 'Digital setting frequency'. Pressing <▼> and <▲> buttons on the operating panel will decrease and increase the output frequency respectively when the frequency converter is running.

- **2: AI1 analog input**

  The setting frequency is set by analog input AI1 input. When AI1 is used as the frequency setting source, the relationship between AI1 and the setting frequency is shown as the figure below:

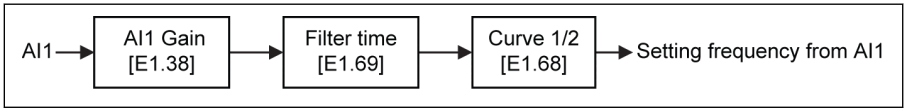



**Fig. 12-46:** AI1 setting frequency

- **3: AI2 analog input**

  The setting frequency is set by analog input AI2 input. When AI2 is used as the frequency setting source, the relationship between AI2 and the setting frequency is shown as the figure below:

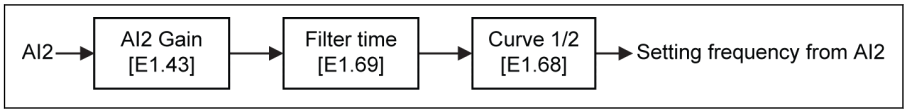



**Fig. 12-47:** AI2 setting frequency

- **4: EAI1 analog input**

  The setting frequency is set by analog input EAI1 input. When EAI1 is used as the frequency setting source, the relationship between EAI1 and the setting frequency is shown as the figure below:

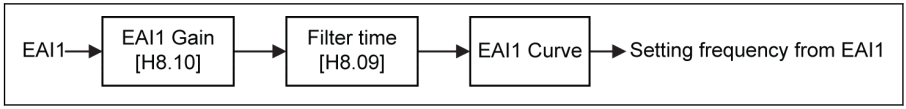



**Fig. 12-48:** EAI1 setting frequency

- **5: EAI2 analog input**

  The setting frequency is set by EAI2 analog input. When EAI2 is used as the frequency setting source, the relationship between EAI2 and the setting frequency is shown as the figure below:

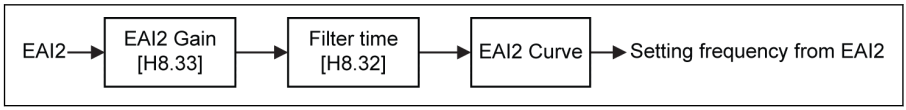



**Fig. 12-49:** EAI2 setting frequency

- **10: X5 pulse input**

  The setting frequency is set by pulse input via X5 input. When X5 pulse input is used as the frequency setting source, the setting frequency can be changed by changing the pulse frequency. The relationship between X5 pulse input and the setting frequency is shown as the figure below:




**Fig. 12-50:** X5 setting frequency

- **11: Digital input Up / Down command**

  The setting frequency is set by command of Up / Down / Reset via digital inputs. The setting frequency will increase with Up command active, decrease with Down command active, reset to '0' with Reset command active.

  Any three digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 can be set to 20 'Frequency Up command' and 21 'Frequency Down command' and 22 'Up/Down command reset' to define this function.

  For digital input Up / Down change rate and digital input Up / Down initial frequency, see parameter E1.16 and E1.17.

- **20: Communication**

The setting frequency is set by engineering software, PLC or other external device via Modbus protocol.

- **21: Multi-speed settings**

  The setting frequency is set by multi-speed settings, see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254 for details.

### Frequency setting source switching

When [E0.04] = 0, 'Frequency setting source combination' is inactive. The setting frequency can be switched between the first and second frequency setting source by setting digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 to 30 'Second frequency setting source activation'. The active / inactive of the selected digital input is triggered by voltage level, instead of the edge.

If status of the selected digital input is changed when frequency converter is running, the frequency setting source will be switched instantly and the frequency converter will accelerate / decelerate according to the actual setting frequency of respective frequency setting source.

**To use the frequency setting source switching function, take the following steps:**

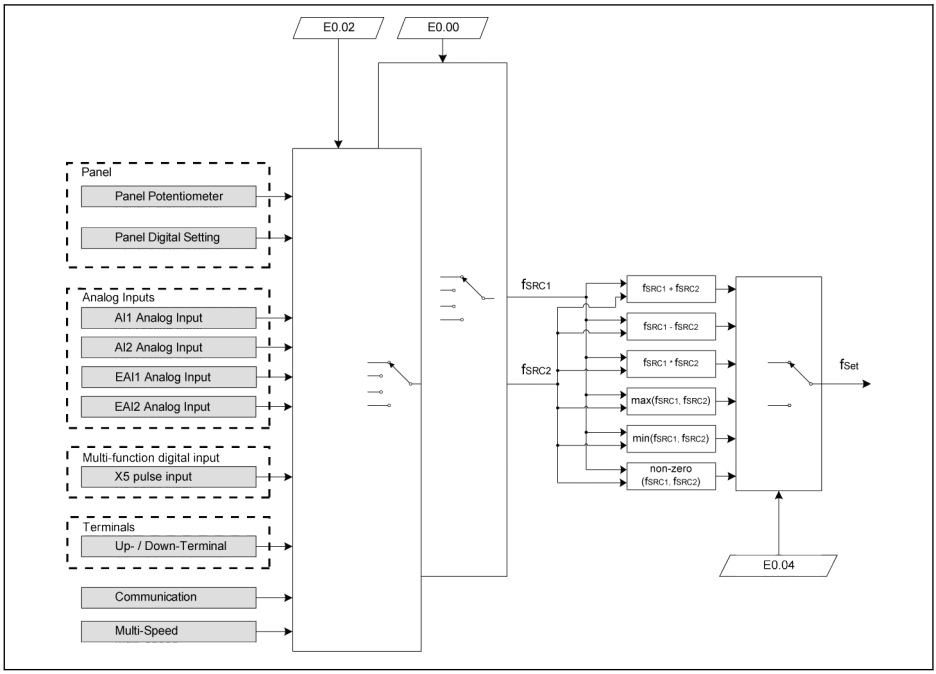
- **Step 1**: Check and be sure that [E0.04] = '0: No combination';
- **Step 2**: Select the second frequency setting source by setting parameter E0.02;
- **Step 3**: Configure the setting frequency for the selected frequency setting source;
- **Step 4**: Select a digital input terminal, and set its function to '30: Second frequency setting source activation'.

**Example**: [E0.00] = '0: Panel potentiometer', the setting frequency of the first frequency setting source is 30.00 Hz. [E0.02] = '3: AI2 analog input', the setting frequency of the second frequency setting source is 50.00 Hz. Set [E1.00] = 30, X1 is used to switch the setting frequency between the first and the second frequency sources.

- When X1 input is inactive, the actual setting frequency is 30.00 Hz set by panel potentiometer.
- When X1 input is active, the actual setting frequency is 50.00 Hz set by AI2 input and the converter accelerates from 30.00 Hz to 50.00 Hz.

### Frequency setting sources combination

It is possible to combine the two frequency setting sources for complicated applications:




$f_{SRC1}$ First frequency setting source
$f_{SRC2}$ Second frequency setting source
$f_{Set}$ Setting frequency

**Fig. 12-51:** Frequency setting sources combination

## Related parameter:

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.04 | Frequency setting source combination | 0...6 | 0 | - | - | Stop |

## Setting range of E0.04:

- **0: No combination**

  By default, actual setting frequency is set by 'First frequency setting source'. 'Second frequency setting source' can be activated by setting one of digital inputs to 30 'Second frequency setting source activation'.

- **1: First frequency setting + Second frequency setting**

  The actual setting frequency is the result of the addition operation of the first and second frequency setting sources.

- **2: First frequency setting - Second frequency setting**

  The actual setting frequency is the result of the subtraction operation of the first and second frequency setting sources.

- **3: First frequency setting * Second frequency setting**

The actual setting frequency is the result of the multiplication operation of the first and second frequency setting sources.

- **4: Bigger one of 2 sources**

  The actual setting frequency is the bigger one of the first and second frequency setting sources.

- **5: Smaller one of 2 sources**

  The actual setting frequency is the smaller one of the first and second frequency setting sources.

- **6: Valid which channel is non-zero**

  If the first frequency setting sources ≠ 0Hz and the second frequency setting sources ≠ 0Hz; then the actual setting frequency is the first frequency setting sources

  If the first frequency setting sources ≠ 0Hz and the second frequency setting sources = 0Hz; then the actual setting frequency is the first frequency setting sources

  If the first frequency setting sources = 0Hz and the second frequency setting sources ≠ 0Hz; then the actual setting frequency is the second frequency setting sources

  If the first frequency setting sources = 0Hz and the second frequency setting sources = 0Hz; then the actual setting frequency is 0Hz.

**To use the frequency setting source combination function, take the following steps:**

- **Step 1**: Be sure that no digital inputs is set to '30: Second frequency setting source activation' to deactivate the frequency setting source switching function;
- **Step 2**: Set parameter E0.00 and E0.02 to select the first and second frequency setting sources;
- **Step 3**: Set parameter E0.04 according to the actual application.



The result of the combination is always limited within the range of 0.00...[E0.09] Hz.

## 12.8.2 Run Command Source

Different run command sources can be selected by setting parameter E0.01 'First run command source' or E0.03 'Second run command source'.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.01 | First run command source | 0...2 | 0 | - | - | Stop |
| E0.03 | Second run command source | 0...2 | 1 | - | - | Stop |

**Setting range of E0.01, E0.03:**

- **0: Operating panel**

  Control the frequency converter for run and stop with <Run>, <Stop> buttons on the operating panel.

  Control the running direction by setting parameters U0.00 'Direction control by panel' and E0.17 'Direction control'.

- **1: Multi-function digital input**

  Control the frequency converter for run, stop and running direction by setting digital inputs.

- **2: Communication**

  Control the frequency converter for run, stop and running direction with Modbus communication protocol.

  The run command can be switched between the first and second frequency setting source by setting digital input parameters E1.00, E1.01, E1.02, E1.03, E1.04, H8.00, H8.01, H8.02, H8.03, H8.04 to 31 'Second run command source activation'. The active / inactive of the selected digital input is triggered by voltage level, instead of the edge.

  If status of the selected terminal is changed when converter is running, the run command source will be switched and the converter will freewheel to stop.



The priority about Run/Stop/Direction Command for different configuration is following:

First priority: PID control

Second priority: Simple PLC

Third priority: Jog function

Fourth priority: Basic command sources

### 12.8.3 Digital Setting Frequency

This function defines the digital setting frequency and four different saving modes during fine tuning of the setting frequency by using <▲> / <▼> or digital inputs, so that unexpected data loss in commissioning or actual application engineering process can be avoided.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.06 | Digital setting frequency saving mode | 0...4 | 0 | - | - | Stop |
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |

When parameter E0.00 'First frequency setting source' or E0.02 'Second frequency setting source' is set to 1 'Panel button setting', the setting frequency is set by parameter E0.07 'Digital setting frequency'. Pressing <▲> and <▼> buttons on the operating panel will decrease and increase the output frequency respectively when the frequency converter is running.

During fine tuning of the setting frequency by using <▲> / <▼> or digital inputs in the actual application engineering process, E0.06 'Digital setting frequency saving mode' defines the following saving modes:

- 0: Not saved when powered off or stopped
- 1: Not saved when powered off; saved when stopped
- 2: Saved when powered off; not saved when stopped
- 3: Saved when powered off or stopped
- 4: Not saved when powered off; memorized when stopped

## 12.8.4 Frequency Limitations

This function defines direct output frequency limitation, reverse running frequency, and behavior at low speed running.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.08 | Maximum output frequency | 50.00...400.00 Hz | 50.00 | Hz | 0.01 | Stop |
| E0.09 | Output frequency high limit | [E0.10]...[E0.08] Hz | 50.00 | Hz | 0.01 | Run |
| E0.10 | Output frequency low limit | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E0.11 | Reverse running frequency | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Stop |
| E0.15 | Low speed running setting | 0: Run with 0.00 Hz<br>1: Run with low limit frequency | 0 | - | - | Stop |
| E0.16 | Low speed frequency hysteresis | 0.00...[E0.10] Hz | 0.00 | Hz | 0.01 | Stop |

**Direct output frequency limitation:**

- **E0.08 'Maximum output frequency'**

  The allowed maximum output frequency of the frequency converter.

- **E0.09 'Output frequency high limit'**

  The allowed maximum output frequency according to the requirements in actual applications.

- **E0.10 'Output frequency low limit'**

  The allowed minimum output frequency according to the requirements in actual applications.

**E0.11 'Reverse running frequency'**

- **E0.11 'Reverse running frequency'**

  When frequency converter's running direction is "reverse", the setting frequency is decided by the value of E0.11 if the reverse running frequency parameter (E0.11) is configured to a non-zero value.



Reverse running frequency is **ONLY** active when converter is **NOT** running in multi-speed, simple PLC, or PID control mode.

**Behavior at low speed running:**

By default, the frequency converter runs at 0 Hz when the output frequency is lower than [E0.10] 'Output frequency low limit'.

- **[E0.15] = 0: Running at 0.00 Hz**

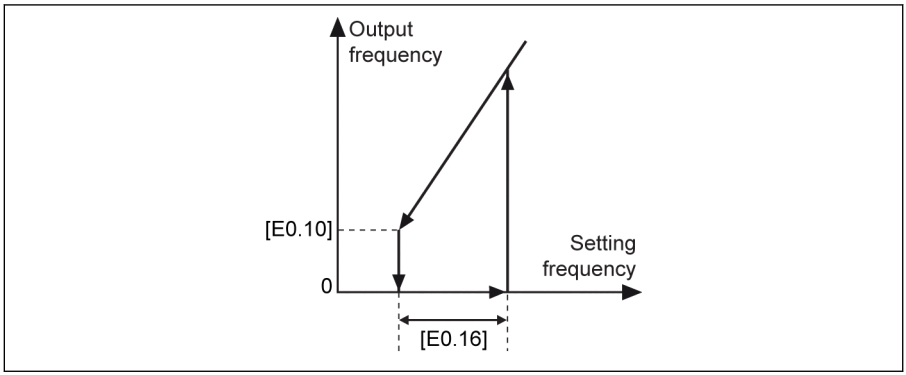



**Fig. 12-52:** Running at 0 Hz

For applications, in which the running frequency cannot be too low, define the low limit frequency running mode when the output frequency is lower than [E0.10] 'Output frequency low limit'.

- **[E0.15] = 1: Running with low limit frequency**

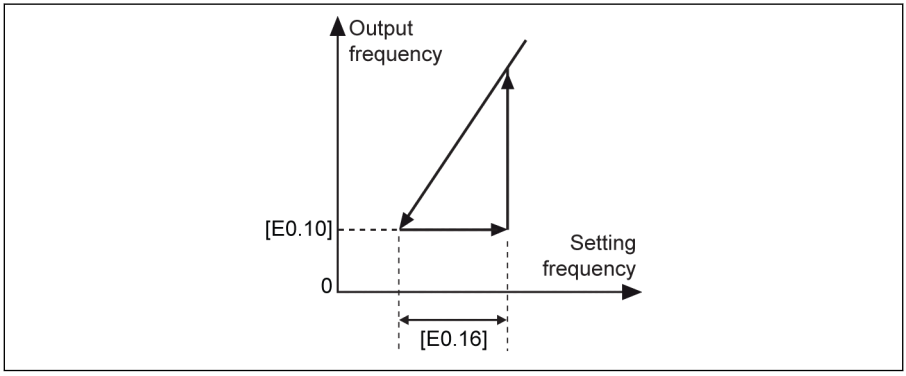



**Fig. 12-53:** Run with low limit frequency

A hysteresis band is set by [E0.16]. If actual setting frequency is higher than [E0.10] + [E0.16] again, the output frequency will accelerate from [E0.10] to the setting frequency according to the actual acceleration time.

If [E0.10] < [E0.16], [E0.16] will be set as [E0.10] automatically.

## 12.8.5 Direction Control

This function defines the rotation direction control with adjustable dead zone.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.17 | Direction control | 0: Forward / Reverse<br>1: Forward only<br>2: Reverse only<br>3: Swap default direction | 0 | - | - | Stop |
| E0.18 | Direction change dead time | 0.0...60.0 s | 1.0 | - | 0.1 | Stop |

The actual direction of converter is controlled by the configuration of parameter [U0.00] 'Direction control by panel' and [E0.17] 'Direction control'.

| | [E0.17] setting | [U0.00] setting | Actual direction |
|---|---|---|---|
| 0 | Forward / Reverse | Forward | Forward |
| | | Reverse | Reverse |
| 1 | Forward only | Forward | Forward |
| | | Reverse | Converter stop and show error code 'dir1' |
| 2 | Reverse only | Forward | Converter stop and show error code 'dir2' |
| | | Reverse | Reverse |
| 3 | Swap default direction | Forward | Reverse |
| | | Reverse | Forward |

**Tab. 12-8:** Direction configuration

A dead time exists if the direction is changed from forward / reverse to reverse / forward, which can be defined according to actual application.

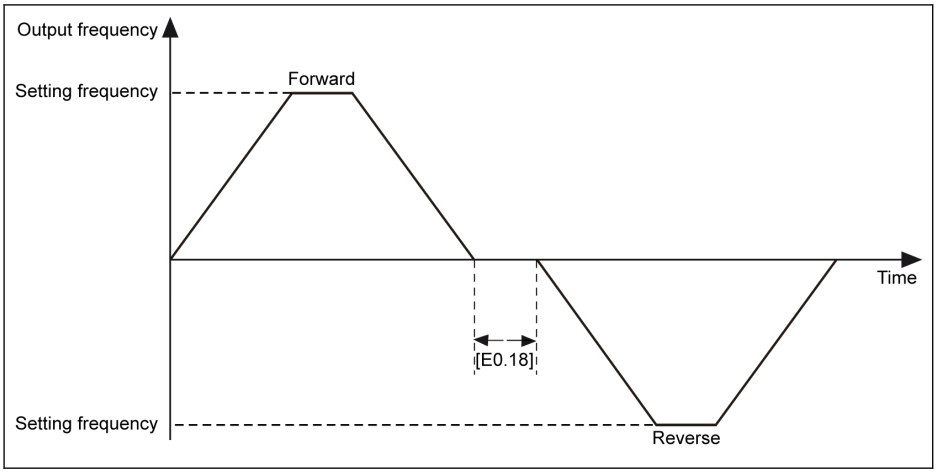



**Fig. 12-54:** Direction change dead time

## 12.8.6 Acceleration and Deceleration Setting

This function defines the configuration of acceleration and deceleration process.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.25 | Acceleration / deceleration curve mode | 0: Linear mode<br>1: S-curve | 0 | - | - | Stop |
| E0.26 | Acceleration time | 0.1...6,000.0 s | DOM | s | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6,000.0 s | DOM | s | 0.1 | Run |
| E0.28 | S-curve starting phase factor | 0.0...40.0 % | 20.0 | - | 0.1 | Stop |
| E0.29 | S-curve stopping phase factor | 0.0...40.0 % | 20.0 | - | 0.1 | Stop |

'Acceleration time' is the time for frequency increase from 0.00 Hz to [E0.08] 'Maximum output frequency'.

'Deceleration time' is the time for frequency decrease from [E0.08] 'Maximum output frequency' to 0.00 Hz.

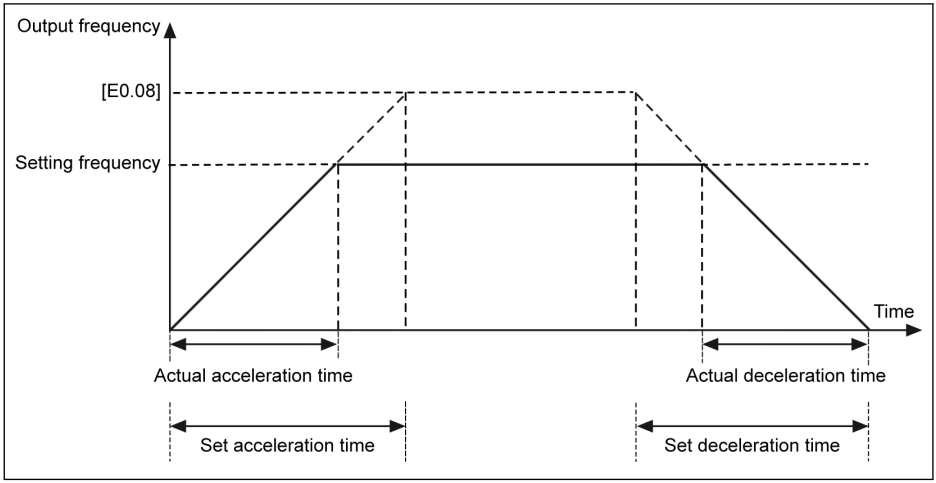



**Fig. 12-55:** Acceleration and deceleration time

There are eight groups of acceleration / deceleration time which is selected with external control terminals. Group E0.26 and E0.27 is used as default value if no acceleration / deceleration time terminal is defined. For using of other acceleration / deceleration time which is defined by E3.10...E3.23, up to three terminals of E1.00...E1.04 and H8.00...H8.04 should be selected to '10: Acceleration / deceleration time 1 activation', '11: Acceleration / deceleration time 2 activation' and '12: Acceleration / deceleration time 3 activation'. See chapter 12.11.1 "Simple PLC and Multi-Speed Setting" on page 254.

Two curve modes are available for acceleration / deceleration which is defined by [E0.25] : 'linear curve' and 'S-curve'.

- **[E0.25] = 0: Linear mode**

Linear mode is used for normal application situations:

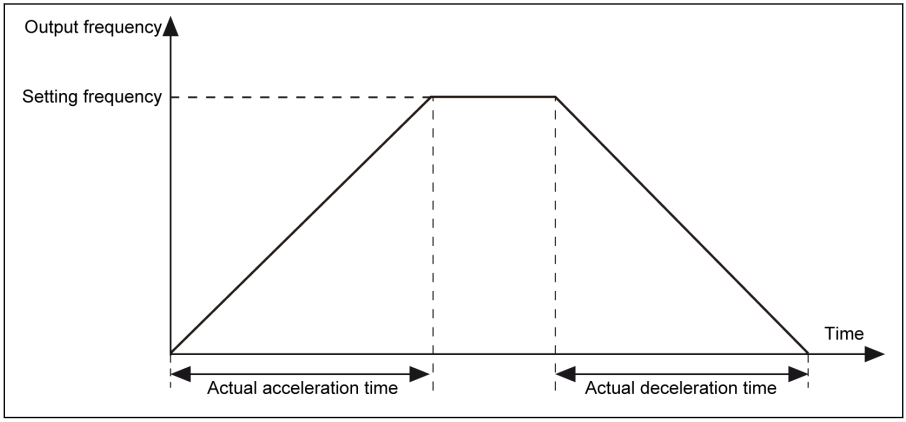
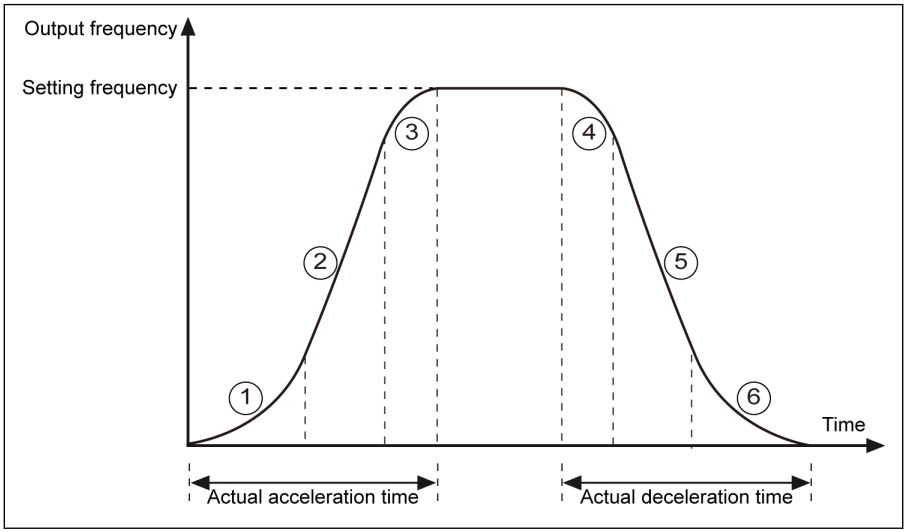



**Fig. 12-56:** Linear mode acceleration and deceleration

- **[E0.25] = 1: S-curve**

S-curve mode is used to achieve a smooth starting or stopping:




① [E0.28] Acceleration starting phase
③ [E0.29] Acceleration stopping phase
④ [E0.28] Deceleration starting phase
⑥ [E0.29] Deceleration stopping phase

**Fig. 12-57:** S-curve acceleration and deceleration

Stage ①, ③: a percentage of setting acceleration time.

Stage ④, ⑥: a percentage of setting deceleration time.

## 12.8.7 Start Mode Configuration

This function defines different start modes in different applications.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.35 | Start mode | 0: Start directly<br>1: DC-braking before start<br>2: Start with speed tracing<br>3: Automatic start / stop according to setting frequency | 0 | - | - | Stop |
| E0.36 | Start frequency | 0.00...50.00 Hz | 0.05 | Hz | 0.01 | Stop |
| E0.37 | Start frequency holding time | 0.0...20.0 s | 0.0 | s | 0.1 | Stop |
| E0.38 | Start DC-braking time | 0.0...20.0 s (0.0: Inactive) | 0.0 | s | 0.1 | Stop |
| E0.39 | Start DC-braking current | 0.0...150.0 % | 0.0 | - | 0.1 | Stop |
| E0.41 | Automatic start / stop frequency threshold | 0.01...[E0.09] Hz | 16.00 | Hz | 0.01 | Stop |
| E0.42 | Speed tracing voltage recovery ratio | 0...20 | 10 | - | 1 | Stop |
| E0.43 | Speed tracing deceleration time | 0.5...20.0s | 2.0 | s | 0.1 | Stop |

### Start directly

This mode is used in applications with high static friction torque and low load inertia. The frequency converter runs at [E0.36] 'Start frequency' for [E0.37] 'Start frequency holding time', and then accelerates/decelerates to setting frequency with defined acceleration/deceleration time.

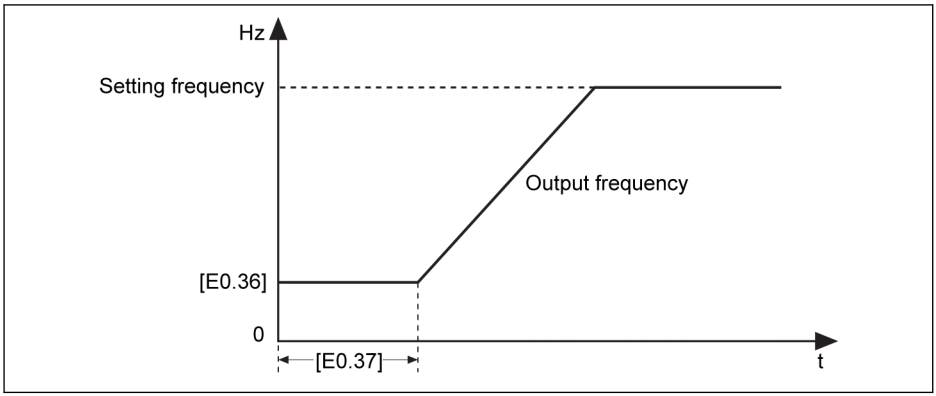



**Fig. 12-58:** Start directly

Set parameter E0.37 'Start frequency holding time' to a non-zero value when the motor needs to be started with certain start frequency.

### DC-braking before start

'DC-braking before start' is used in applications where the load may encounter forward / reverse rotation when the frequency converter is in stop mode. The larger DC-braking current, the larger braking force. However, the withstanding capability of the motor has to be considered before use the DC-braking function.

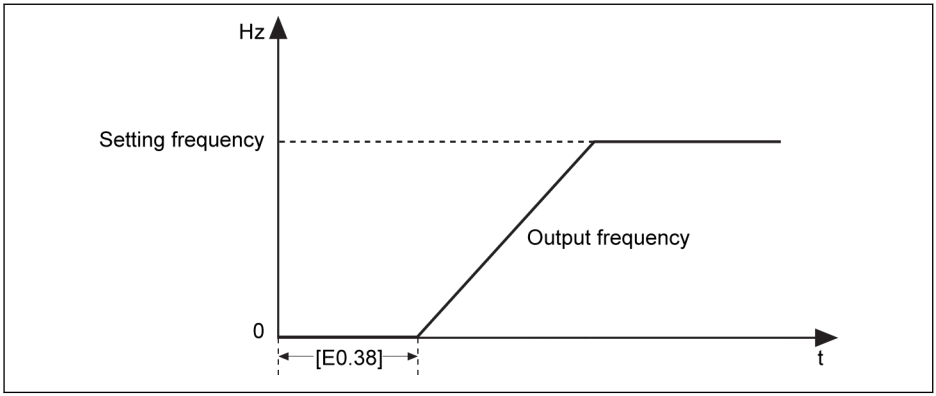



**Fig. 12-59:** DC-braking before start

- When [E0.38] ≠ 0, DC-braking will be executed before the frequency converter starting to accelerate to [E0.36] 'Start frequency', the braking current is decided by [E0.39].
- When [E0.38] = 0, the converter starts at the starting frequency.

[E0.39] 'Start DC-braking current' is the percentage of frequency converter rated current.

### Start with speed tracing

This mode is used after transient power fault in applications with a large inertia load. The frequency converter firstly identifies the rotation speed and direction of the motor, and then starts with the current frequency of the motor to realize smooth starting without shock to the rotating motor.

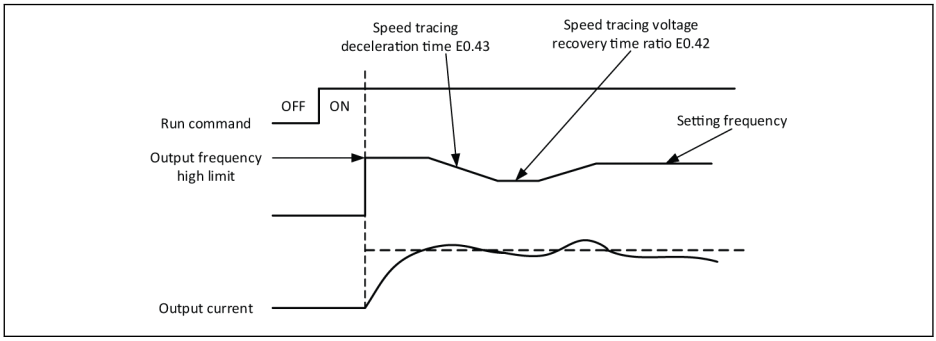



**Fig. 12-60:** Start with speed tracing

E0.42 sets the time ratio for the drive to restore the output voltage to the level specified by the V/f mode after speed tracing. The larger setting value is, the faster voltage recovery is. But the setting value is too large will cause an overcurrent. In the low-power converter this value can be set larger, in the high-power converter this value should be set smaller.

E0.43 is the deceleration time for the speed tracing.

### Automatic start / stop according to setting frequency

This function defines converter automatic start / stop according to setting frequency.

With this function, the converter starts when the setting frequency from analog input is higher than the threshold, and stops when the setting frequency from analog input is lower than the threshold. The threshold is set by parameter E0.41 'Automatic start / stop frequency threshold'.

To use this function, follow the rules below:

- The frequency setting source should be set to analog inputs.
- The first and second run command source should be set to '0: Panel'.

**Related parameters setting:**

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.35 | Starting mode | 3: Auto start / stop according to setting frequency | 0 | - | - | Stop |
| E0.00 | First frequency setting source | 2: AI1 analog input<br>3: AI2 analog input | 0 | - | - | Stop |
| E0.02 | Second frequency setting source | 4: EAI1 analog input<br>5: EAI2 analog input | 2 | - | - | Stop |
| E0.01 | First run command source | 0: Panel | 0 | - | - | Stop |
| E0.03 | Second run command source | | 1 | - | - | Stop |

The logic of automatic start or stop according to frequency threshold is shown as below:

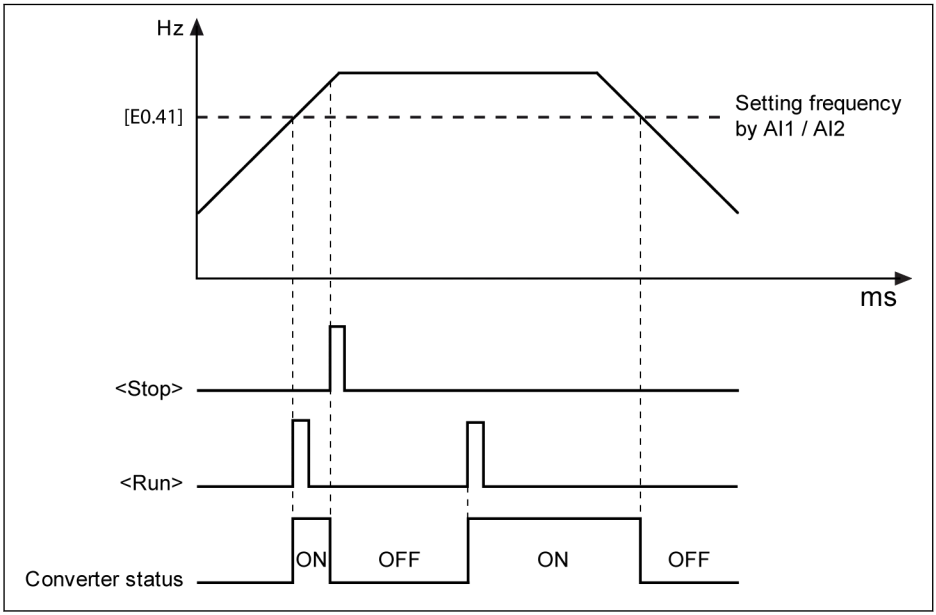



**Fig. 12-61:** Automatic start or stop according to frequency threshold

When the setting frequency is higher than [E0.41], the frequency converter starts and runs to the setting frequency automatically.

1. Pressing <**Stop**> at this time, the frequency converter stops.
2. Pressing <**Run**> again, the frequency converter runs again.

When the setting frequency is lower than [E0.41], the frequency converter stops automatically.



- If the threshold [E0.41] is set higher than the setting frequency high limit [E0.09], the threshold will be limited to the high limit [E0.09].
- Make sure that:

  1. The first and the second run command sources are both via panel.

  2. The active frequency setting source is via analog inputs.

  3. The simple PLC, PID control and jog function are deactivated.

  Otherwise, E0.35 'Starting mode' cannot be set to '3: Auto start / stop according to setting frequency'. In this case, warning code 'PrSE' will be displayed and the frequency converter keeps in stop status.

## 12.8.8 Power Loss Restart

### Power loss restart

This function allows the converter to start running automatically after power on if the converter was running before power off.

**Related parameters:**

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.45 | Power loss restart mode | 0: Inactive<br>1: Active for panel control<br>2: Active for digital input control | 0 | - | - | Stop |
| E0.46 | Power loss restart delay | 0.0...10.0 | 10.0 | s | 0.1 | Stop |

**Setting range of E0.45:**

- **E0.45=0: Inactive**

  Power loss restart feature is disabled.

- **E0.45=1: Active for panel control**

  When [E0.01]/[E0.03] = 0 (Operating panel), if the converter is running before power off, then converter will automatically start after waiting for the time of [E0.46] after power-on.

- **E0.45=2: Active for digital input control**

  When [E0.01]/[E0.03] = 1 (Multi-function digital input), if the converter is running before power off, then converter will automatically start after waiting for the time of [E0.46] after power-on.



- Power loss restart function is active for panel and digital input control only.
- When E0.45 select "1" or "2", if the power supply of frequency converter and the error "UE-1" recover within the time of [E9.01], the frequency converter will restart.

**⚠ WARNING** **The power loss restart function may cause damage to people and equipment!**

The power loss restart function can make the frequency converter run automatically after the power supply is restored, which may cause damage to people and equipment.

## 12.8.9 Stop Mode Configuration

This function defines different stop modes for different applications.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.50 | Stop mode | 0: Decelerating stop<br>1: Freewheeling stop 1<br>2: Freewheeling stop 2 | 0 | - | - | Stop |

**Setting range of E0.50:**

- **[E0.50] = 0: Decelerating stop**

  The motor decelerates to stop according to the defined deceleration time.

  In this stop mode DC-braking can be activated by parameter settings or by digital inputs.

- **[E0.50] = 1: Freewheeling stop 1**

  Once the stopping command is activated, the converter stops output and the motor mechanically freewheels to stop.

  'Freewheeling stop' can also be activated by digital inputs. When the digital input signal is active, the frequency converter freewheels to stop. If the digital input signal is inactive and a run command is active, the frequency converter resumes the previous running status.

- **[E0.50] = 2: Freewheeling stop 2**
  - When stopping command is active, the motor freewheels to stop as [E0.50] = 1.
  - When direction command is changed during running, the motor decelerates to stop according to the defined deceleration time as [E0.50] = 0.



If an error occurs due to too fast deceleration, increase the deceleration time or calculate if additional resistor braking is necessary.

## 12.8.10 Stop DC-braking

This function defines DC-braking during deceleration to stop.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.47 | Run command priority | 0: High priority<br>1: Low priority | 0 | - | - | Stop |
| E0.51 | Stop DC-braking waiting time | 0.00...100.00 s | 0.00 | s | 0.01 | Stop |
| E0.52 | Stop DC-braking initial frequency | 0.00...50.00 Hz | 0.00 | Hz | 0.01 | Stop |
| E0.53 | Stop DC-braking time | 0.0...20.0 s (0.0: Inactive) | 0.1 | s | 0.1 | Stop |
| E0.54 | Stop DC-braking current | 0.0...150.0 % | 0.0 | - | 0.1 | Stop |

**Setting range of E0.50:**

- **E0.47 = 0: High priority**

  If run command comes during stop DC braking, stop DC braking will be stopped and run command is active.

- **E0.47 = 1: Low priority**

  If run command comes during stop DC braking, run command will get active after stop DC braking finish.

**'DC-braking to stop' can be activated in two ways:**

1. **By parameter settings**

   During decelerating stop process, if 'Output frequency' is lower than [E0.52] 'Stop DC-braking initial frequency' and 'Stop DC-braking time' [E0.53] ≠ 0, then DC-braking is activated. The 'Stop DC-braking current' is decided by [E0.54]:

   - [E0.50] = 0;
   - [E0.53] > 0;
   - [E0.54] > 0;
   - [Output frequency] ≤ [E0.52].

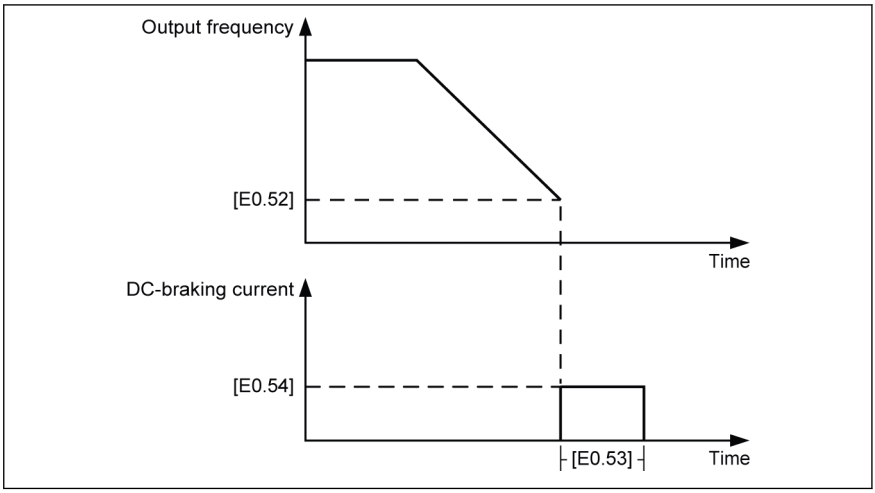



**Fig. 12-62:** Stop DC-braking_1

2. **By digital inputs**

   During decelerating stop process, if 'Output frequency' is lower than [E0.52] 'Stop DC-braking initial frequency' and the defined digital input signal is active, then DC-braking is activated:

   - Any one of digital inputs is set to '16: Stop DC-braking activation'.
   - [E0.50] = 0.
   - DC-braking starts when the defined digital input signal is active and [Output frequency] ≤ [E0.52], and stops when digital input is inactive. There is no time limitation.

**With some special cases when 'DC-braking to stop' is activated by parameter setting and meanwhile digital input active, please see figures below:**

Case 1: Xn active before the DC braking starts and inactive before [E0.53] ends.

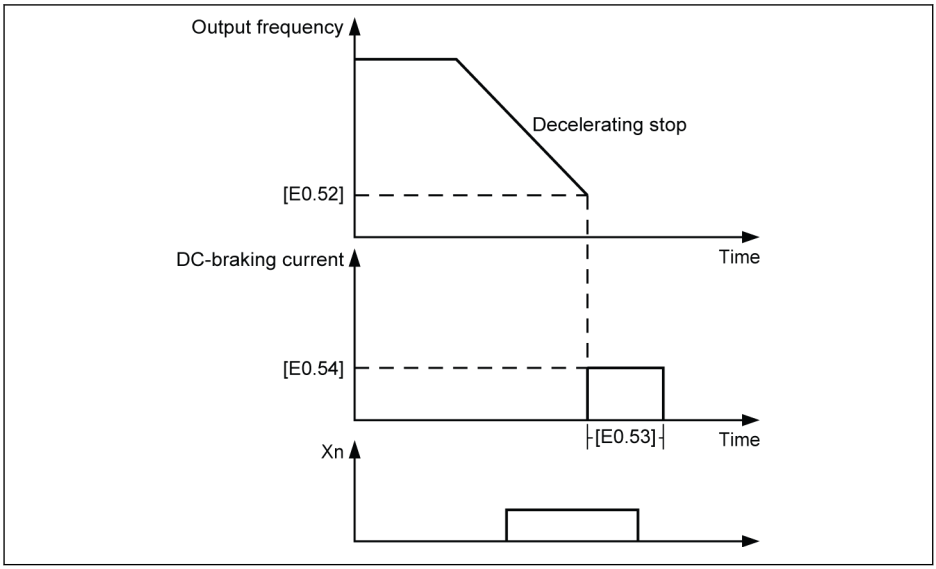



**Fig. 12-63:** Stop DC-braking_2

Case 2: Xn active after the DC braking starts and inactive before [E0.53] ends.

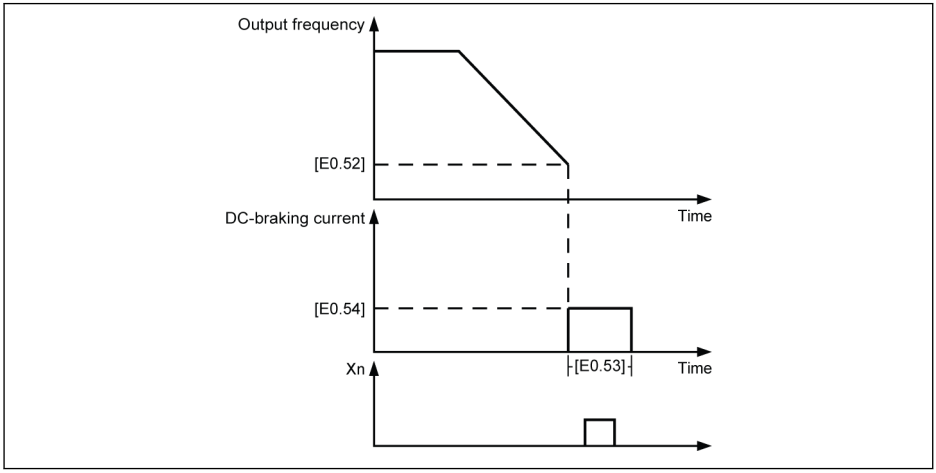



**Fig. 12-64:** Stop DC-braking_3

Case 3: Xn active before the DC braking starts and inactive after [E0.53] ends.

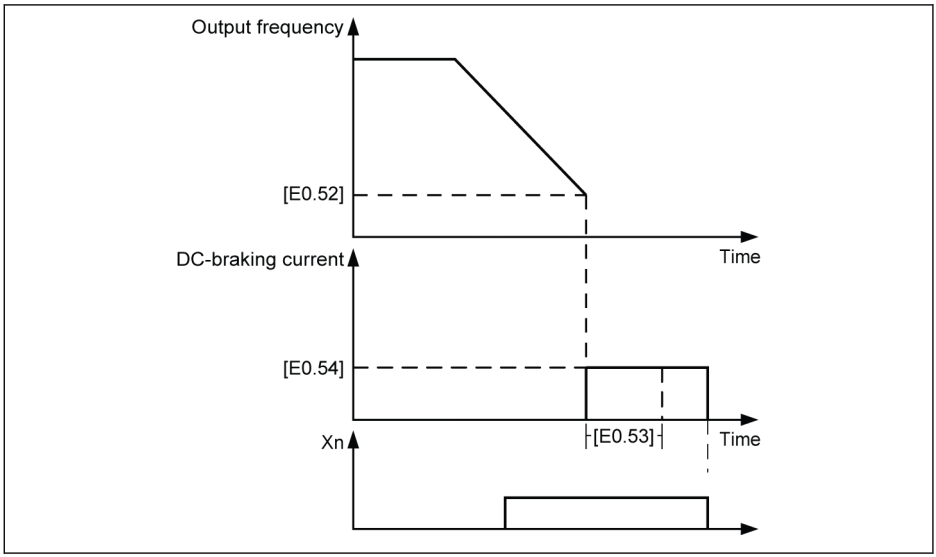



**Fig. 12-65:** Stop DC-braking_4

Case 4: Xn active after the DC braking starts and inactive after [E0.53] ends.

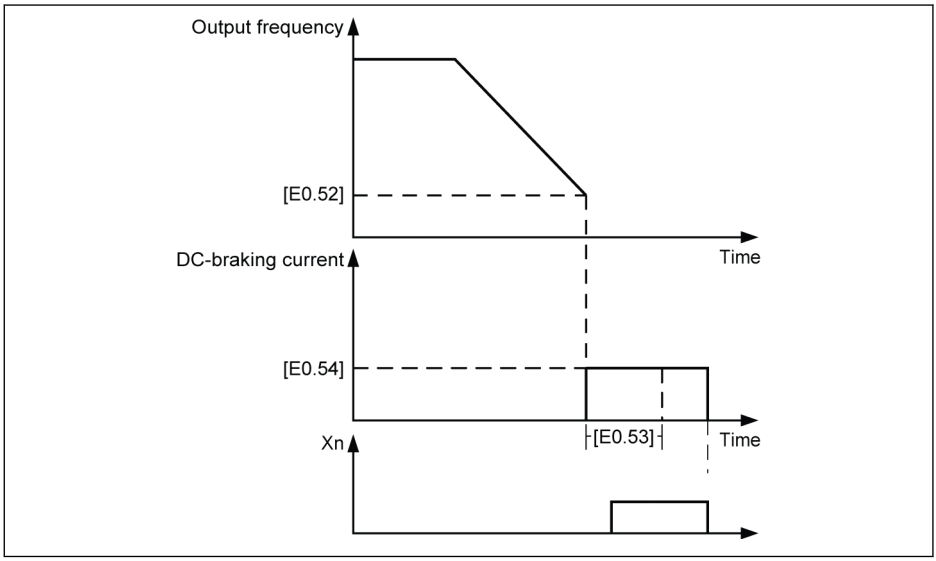



**Fig. 12-66:** Stop DC-braking_5

## 12.8.11 Overexcitation Braking

Overexcitation braking is used to obtain an optimized braking performance of the frequency converter in V/f control mode. To realize this function, increase 'Converter output voltage' by fine tuning of parameter E0.55 'Overexcitation braking factor' during deceleration process.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.55 | Overexcitation braking factor | 1.00...2.00 | 1.10 | - | 0.01 | Run |

- When [E0.55] = 1.00, 'Overexcitation braking' is inactive.
- A higher factor brings a higher braking force.

However, an excessive high factor may trigger errors of overcurrent (OC-1, OC-2, OC-3), converter overload (OL-1), motor overload (OL-2), or surge current / short circuit (SC). Reduce the setting of the factor in such cases.

## 12.8.12 Emergency Stop

This function defines the stop mode when emergency stop is activated (E-st is shown on panel) through digital input or control word via field bus.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.56 | Emergency stop action | 0: Freewheeling stop<br>1: Decelerating stop | 0 | - | - | Stop |
| E0.57 | Emergency stop deceleration time | 0.1...6,000.0 s | 5.0 | s | 0.1 | Run |

**Setting range of E0.56:**

- **[E0.56] = 0: Freewheeling stop**

  Once the emergency stop command is activated, the converter stops output and the motor mechanically freewheels to stop.

- **[E0.56] = 1: Decelerating stop**

  The motor decelerates to stop according to the deceleration time defined by E0.57 'Emergency stop deceleration time'.

## 12.8.13 Jog Function

This function is used for flexible control. When command comes, the motor runs with predefined speed, after command inactive, the motor goes back to previous status.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.60 | Jog frequency | 0.00...[E0.08] Hz | 5.00 | Hz | 0.01 | Run |
| E0.61 | Jog acceleration time | 0.1...6,000.0 s | 5.0 | s | 0.1 | Run |
| E0.62 | Jog deceleration time | 0.1...6,000.0 s | 5.0 | s | 0.1 | Run |

The 'Jog command' has a higher priority than and is independent of the 'Run / Stop command'. This function can ONLY be set by digital input or communication.

To use this function, take the following steps:

**Step 1: Select any 2 digital inputs**

Set any 2 digital inputs of E1.00...E1.04 and H8.00...H8. 04 to 37 'Forward jog' and 38 'Reverse jog'.

**Step 2: Set respective parameters**

Set Jog function parameters E0.60...E0.62 according to application.

Once the 'Jog command' is active, the frequency converter runs immediately to [E0.60] 'Jog frequency' with acceleration / deceleration time defined by 'Jog acceleration time' [E0.61] / 'Jog deceleration time' [E0.62] no matter the converter is running or not. When 'Jog command' is inactive, the motor resumes the previous status.

- Converter is at stop
  - 'Jog command' active: Accelerate to [E0.60] 'Jog frequency' according to [E0.61] 'Jog acceleration time'.
  - 'Jog command' inactive: Deceleration time is according to [E0.62] 'Jog deceleration time'.
- Converter is running
  - Output frequency' is higher than 'Jog frequency'
    - 'Jog command' active: Decelerate to [E0.60] 'Jog frequency' according to [E0.62] 'Jog deceleration time'.
    - 'Jog command' inactive: Accelerate to previous 'Setting frequency' according to [E0.26] 'Acceleration time'.
  - Output frequency' is higher than 'Jog frequency'
    - 'Jog command' active: Accelerate to [E0.60] 'Jog frequency' according to [E0.61] 'Jog acceleration time'.
    - 'Jog command' inactive: Decelerate to prior 'Setting frequency' according to [E0.27] 'Deceleration time'.

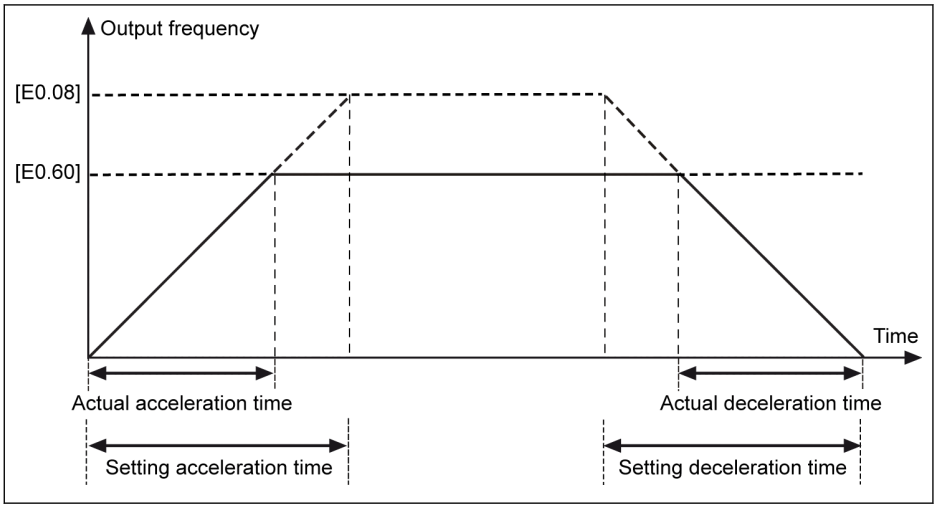



**Fig. 12-67:** Jog acceleration / deceleration time

| Forward jog | Reverse jog | Running status |
|---|---|---|
| Active | Active | Stop |
| Active | Inactive | Jog forward |
| Inactive | Active | Jog reverse |

**Tab. 12-9:** Jog configuration

If the jog command direction does not match the current jog running direction, the converter will stop according to [E0.50] 'Stop mode'.

## 12.8.14 Skip Frequency

This function is implemented to define a few skip frequencies to avoid the mechanical resonance . If the running frequency is in the hysteresis range of defined skip frequency, the frequency is set to the upper/lower limit automatically to skip this frequency area.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E0.70 | Skip frequency 1 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Stop |
| E0.71 | Skip frequency 2 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Stop |
| E0.72 | Skip frequency 3 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Stop |
| E0.73 | Skip frequency range | 0.00...30.00 Hz | 0.00 | - | 0.01 | Stop |
| E0.74 | Skip window acceleration factor | 1...100 | 1 | - | 1 | Stop |

The setting ranges of the three skip frequencies are shown in the figure below:

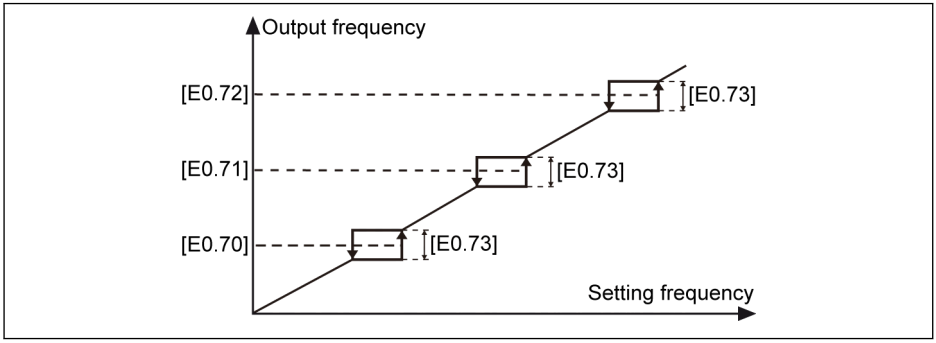



**Fig. 12-68:** Skip frequency 1

Skip frequency points are defined by parameters E0.70...E0.72. Skip frequency range or boundaries are defined by parameter E0.73 as listed below:

- [Upper boundary frequency] = [Skip frequency] + [E0.73]/2
- [Lower boundary frequency] = [Skip frequency] - [E0.73]/2

If the current 'Output frequency' is higher than the 'Upper boundary frequency', and the target 'Setting frequency' is within the 'Skip frequency range', the actual output frequency will be limited to 'Upper boundary frequency'.

If the current 'Output frequency' is lower than the 'Lower boundary frequency', and the target 'Setting frequency' is within the 'Skip frequency range', the actual output frequency will be limited to 'Lower boundary frequency'.

If the current 'Output frequency' is within the 'Skip frequency range' and the target 'Setting frequency' is also within the range, the actual output frequency is previous output frequency.

- If the lower frequency of one active skip frequency range is below zero, the lower frequency is limited to 0Hz.

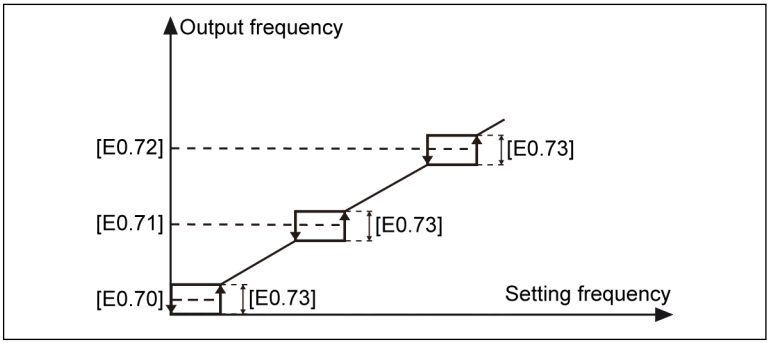



**Fig. 12-69:** Skip frequency 2

- It would be suggested to users not to make the three frequency ranges overlap or nest in each other. However, if users do set parameters like this by mistake, the following measure be considered.

  Setting range by users:

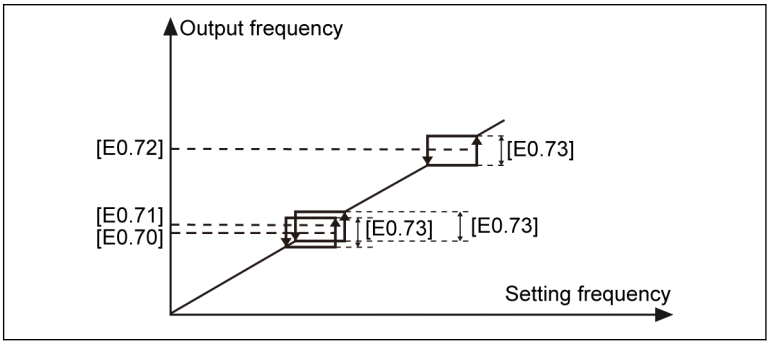



**Fig. 12-70:** Skip frequency 3

Actual skip range:

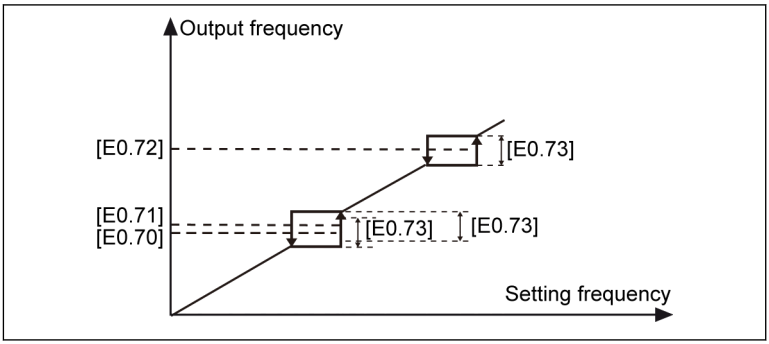



**Fig. 12-71:** Skip frequency 4

Parameter E0.74 is used to control the acceleration / deceleration speed inside the skip-window, the range for this factor is 1 (normal speed) to 100 (100 times speed of the normal speed). The actual acceleration / deceleration time for skip frequency is shorter than the setting value when the factor is higher than 1.

**Acceleration / deceleration curve mode is S-curve(E0.25 = 1) in skipping Window:**

- In the linear phase of S-curve, if E0.74 'Skip window acceleration factor' is above 1 and S-curve ramp is active, the change of acceleration will happen directly with a corner (no S-shaped curve) as long as the acceleration/ deceleration is :

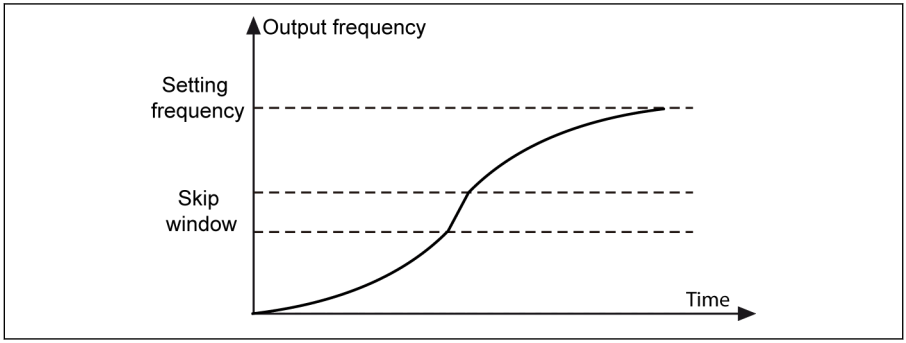



**Fig. 12-72:** Skip frequency 5

- In the start or end S-curve phase, E0.74 'Skip window acceleration factor' will not be active. There will be no higher acceleration or deceleration:

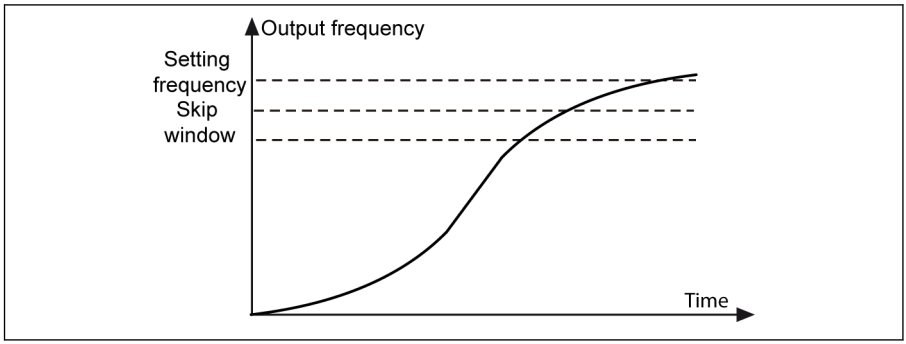



**Fig. 12-73:** Skip frequency 6

- If [E0.73] = 0.00, 'Skip frequency' function is inactive.
- If skip frequency is set to 0Hz, this skip frequency point is inactive.
- If acceleration or deceleration is stopped by stall protection (over current or over voltage), stall protection has priority. The frequency converter is running with constant output frequency inside the skip-window as long as stall protection is active.

## 12.9 E1: Input Terminal

### 12.9.1 Digital Input Configuration

This function defines 5 multi-function digital inputs with PNP and NPN wiring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.00 | X1 input | 0...52 | 35 | - | - | Stop |
| E1.01 | X2 input | | 36 | - | - | Stop |
| E1.02 | X3 input | | 0 | - | - | Stop |
| E1.03 | X4 input | | 0 | - | - | Stop |
| E1.04 | X5 input | | 0 | - | - | Stop |

Setting range of E1.00...E1.04:

- **0: Inactive**

  No function assigned.
- **1: Multi-speed control input 1**
- **2: Multi-speed control input 2**
- **3: Multi-speed control input 3**
- **4: Multi-speed control input 4**

  16 multi-speeds are available by combination of 4 terminals, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.
- **10: Acceleration / deceleration time 1 activation**
- **11: Acceleration / deceleration time 2 activation**
- **12: Acceleration / deceleration time 3 activation**

  Used to switch between 8 groups of acceleration / deceleration time, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.
- **15: Freewheeling stop activation**

  'Freewheeling stop activation' generates a stop command and forces the frequency converter to freewheel to stop regardless of the stopping mode configured by E0.50.
- **16: Stop DC-braking activation**

  This function is used when stopping mode is set with [E0.50] = '0: Decelerating stop', details see chapter 12.8.9 "Stop Mode Configuration" on page 208.
- **20: Frequency Up command**
- **21: Frequency Down command**
- **22: Up / Down command reset**

  Used to change the output frequency, details see chapter 12.9.3 "Digital Input Frequency Change Function" on page 231.
- **23: Torque / speed control switch**

Used to switch between torque control mode and speed control mode. If the defined switch is open, speed control mode is selected; If the defined switch is closed, torque control mode is selected.

- **25: 3-wire control**

  Used for the 3-wire control mode, details see chapter 12.9.2 "2- and 3-Wire Control" on page 226.

- **26: Simple PLC stop**
- **27: Simple PLC pause**

  Used for the simple PLC to stop and pause a PLC cycle, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **30: Second frequency setting source activation**

  Used for switching to the second frequency setting source, details see chapter 12.8.1 "Frequency Setting Source" on page 189.

- **31: Second run command source activation**

  Used for switching to the second run command source, details see chapter 12.8.2 "Run Command Source" on page 194.

- **32: Error signal N.O. contact input**
- **33: Error signal N.C. contact input**

  Used for receive error signal from external sources. The frequency converter stops once an external error signal is active and the error code 'E-St' will be displayed on the operating panel if one X1...X5 or EX1...EX5 input is defined as either 'Error signal N.O. contact input' or 'Error signal N.C. contact input'.

  - 32: Error signal N.O. contact input
    - If the defined switch is closed, the external error signal is active.
    - If the defined switch is open, the external error signal is inactive.
  - 33: Error signal N.C. contact input
    - If the defined switch is open, the external error signal is active.
    - If the defined switch is closed, the external error signal is inactive.

  The converter will stop when the external error signal is active, and the stop mode is defined by E0.56 'Emergency stop action', please see chapter 12.8.9 "Stop Mode Configuration" on page 208 for the detailed information.

  **Example:**

  Set [E1.00] = '32: Error signal N.O. contact input' **or**

  Set [E1.01] = '33: Error signal N.C. contact input'

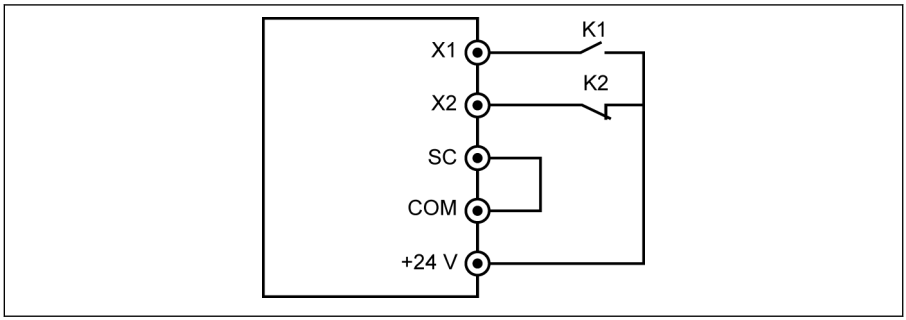



**Fig. 12-74:** Error signal

The frequency converter stops and indicates error code 'E-St' if K1 is closed.

**Or** the frequency converter stops and indicates error code 'E-St' if K2 is open.

- **34: Error reset**

  Used for error reset operation. The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset signal' is edge sensitive.
- **35: Forward running (FWD)**
- **36: Reverse running (REV)**

  Used for Run / Stop command control, details see chapter 12.8.2 "Run Command Source" on page 194.
- **37: Forward jog**
- **38: Reverse jog**

  See chapter 12.8.13 "Jog Function" on page 215.
- **39: Counter input**
- **40: Counter reset**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.
- **41: PID deactivation**

  See chapter 12.12 "E4: PID Control" on page 268.
- **46: User parameter set selection**

  Used to switch between two sets of parameters, details see chapter 12.1.4 "Parameter Set Switch" on page 116.
- **47: Pulse input mode activation (ONLY for X5 input)**

  See chapter 12.9.4 "Pulse Input Configuration" on page 233.
- **48: Motor overheating error N.O. contact input**
- **49: Motor overheating error N.C. contact input**

  Used for receive motor overheating error signal from external sources. The frequency converter stops once an external motor overheating error signal is

active and the error code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating error N.O. contact input' or 'Motor overheating error N.C. contact input'.

- 48: Motor overheating error N.O. contact input
  - If the defined switch is closed, the motor overheating error signal is active.
  - If the defined switch is open, the motor overheating error signal is inactive.
- 49: Motor overheating error N.C. contact input
  - If the defined switch is open, the motor overheating error signal is active.
  - If the defined switch is closed, the motor overheating error signal is inactive.

**Example:**

Set [E1.00] = '48: Motor overheating error N.O. contact input' or

Set [E1.01] = '49: Motor overheating error N.C. contact input'

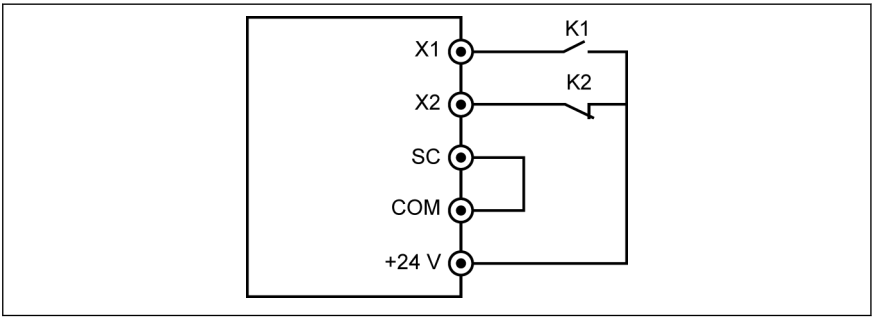



**Fig. 12-75:** Error signal

The frequency converter stops and indicates error code 'Ot' if K1 is closed. Or the frequency converter stops and indicates error code 'Ot' if K2 is open.

- **50: Motor overheating warning N.O. contact input**
- **51: Motor overheating warning N.C. contact input**

Used for receive motor overheating warning signal from external sources. Warning code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating warning N.O. contact input' or 'Motor overheating warning N.C. contact input'.

- 50: Motor overheating warning N.O. contact input
  - If the defined switch is closed, the motor overheating warning signal is active.
  - If the defined switch is open, the motor overheating warning signal is inactive.

– 51: Motor overheating warning N.C. contact input
  – If the defined switch is open, the motor overheating warning signal is active.
  – If the defined switch is closed, the motor overheating warning signal is inactive.

**Example:**

Set [E1.00] = '50: Motor overheating warning N.O. contact input' or

Set [E1.01] = '51: Motor overheating warning N.C. contact input'

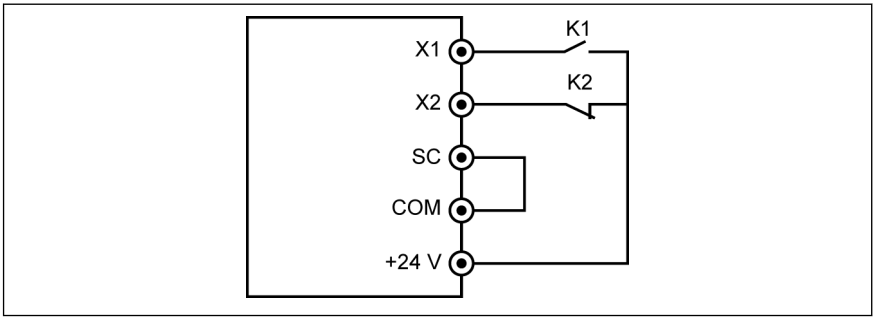



**Fig. 12-76:** Error signal

The frequency indicates warning code 'Ot' if K1 is closed. Or the frequency converter indicates warning code 'Ot' if K2 is open.

Digital input status is monitored by parameter d0.40 'Digital input 1'.

– 52: Jog with Run Command Direction

  For digital inputs, to activate Jog by taking direction from the active run command source (Panel/wire control).

  When 52 is chosen for the input and input signal is given, the frequency converter will jog, and the direction of jog is from run command.

  For example: X4=52

| X4 | Run command(Panel/DI) | Actual action |
|---|---|---|
| Closed | FWD | FWD Jog |
| Closed | REV | REV Jog |
| Opened | FWD | FWD |
| Opened | REV | REV |

## 12.9.2 2- and 3-Wire Control

This function defines 5 modes when use digital input to trigger FWD and REV running.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.15 | 2-wire/3-wire control mode | 0: 2-wire forward / stop, reverse / stop<br>1: 2-wire forward / reverse, run / stop<br>2: 3-wire control mode 1<br>3: 3-wire control mode 2<br>4: 1-wire control | 0 | - | - | Stop |

**Setting range of E1.15:**

- **0: 2-wire forward / stop, reverse / stop**

  **Step 1: Activate 2-wire control mode 1**

  Set [E1.15] = '0: 2-wire forward / stop, reverse / stop'.

  **Step 2: Define two digital inputs**

  – Set one of digital inputs as '35: Forward running (FWD)'
  – Set one of digital inputs as '36: Reverse running (REV)'

**Example:**

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)'.
Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)'.

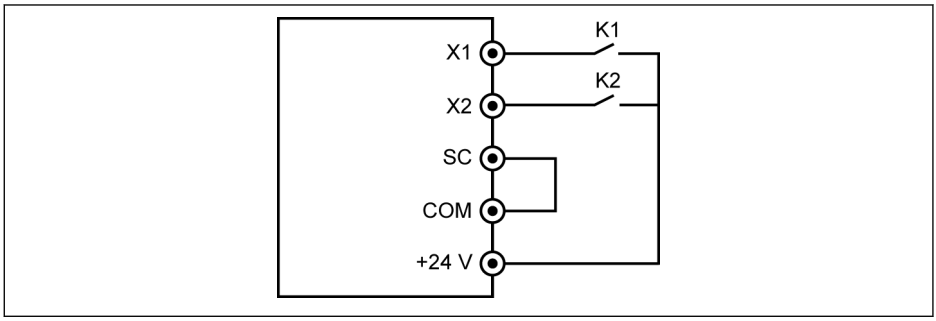



**Fig. 12-77:** 2-wire control mode 1

The control logic is shown in the table below:

| K1 | K2 | Running status |
|---|---|---|
| Open | Open | Stop |
| Closed | Open | Running forward |

| K1 | K2 | Running status |
|---|---|---|
| Open | Closed | Running reverse |
| Closed | Closed | Stop |

**Tab. 12-10:** 2-wire control mode 1 configuration



If switch K1 and K2 are closed at the same time, the frequency converter stops according to [E0.50] 'Stop mode' and both FWD and REV LED indicators are lighted during stop status.

- **1: 2-wire forward / reverse, run / stop**

  **Step 1: Activate 2-wire control mode 2**

  Set [E1.15] = '1: 2-wire forward / reverse, run / stop'.

  **Step 2: Define two digital inputs**

  – Set one of digital inputs as '35: Forward running (FWD)'
  – Set one of digital inputs as '36: Reverse running (REV)'

**Example:**

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)'.

Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)'.

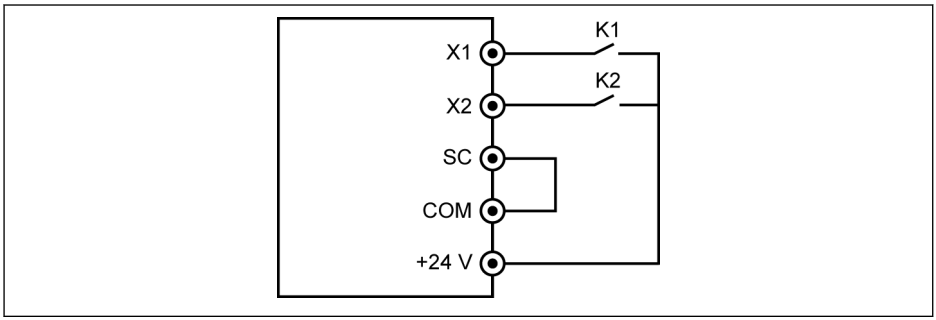



**Fig. 12-78:** 2-wire control mode 2

The control logic is shown in the table below:

| K1 | K2 | Running status |
|---|---|---|
| Open | Open | Stop |
| Closed | Open | Running forward |
| Open | Closed | Stop |
| Closed | Closed | Running reverse |

**Tab. 12-11:** 2-wire control mode 2 configuration

- **2: 3-wire control mode 1**

  **Step 1: Define 3 digital inputs**

- Set one of digital inputs as '35: Forward running (FWD)'
- Set one of digital inputs as '36: Reverse running (REV)'
- Set one of digital inputs as '25: 3-wire control'

  To use 3-wire function, define the digital inputs first, and then activate the control mode. Otherwise, warning code 'PrSE' will be displayed on the operating panel.

  To deactivate the 3-wire function, deactivate the control mode first, and then deactivate the function assignment of '25: 3-wire control'. Otherwise, warning code 'PrSE' will be displayed.

**Step 2: Activate 3-wire control 1**

Set [E1.15] = '2: 3-wire control mode 1'.

**Example:**

Connected switch K1 to X1, and set [E1.00] = '35: Forward running (FWD)', edge-sensitive.

Connected switch K2 to X2, and set [E1.01] = '36: Reverse running (REV)', level-sensitive.

Connected switch K3 to X3, and set [E1.02] = '25: 3-wire control', level-sensitive.

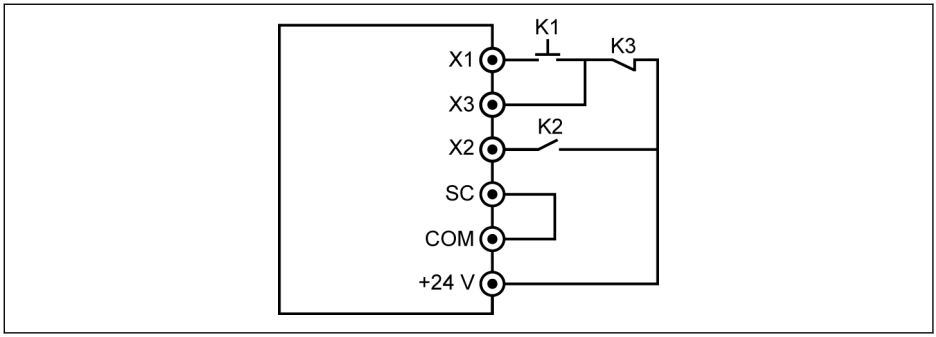



**Fig. 12-79:** 3-wire control 1

The control logic is shown in the table below:

| K3 | K1 | K2 | Running status |
|---|---|---|---|
| Open | Inactive / Edge | Open / Closed | Stop |
| Open | Inactive / Edge | Open / Closed | Stop |
| Closed | Edge | Open | Running forward |
| Closed | Inactive / Edge | Closed | Running reverse |

**Tab. 12-12:** 3-wire control configuration

- **3: 3-wire control mode 2**

  Different from the 3-wire control mode 1, 3-wire control mode 2 has an edge sensitive characteristic for direction control terminals.

  **Step 1: Define 3 digital inputs**

– Set one of digital inputs as '35: Forward running (FWD)'
– Set one of digital inputs as '36: Reverse running (REV)'
– Set one of digital inputs as '25: 3-wire control'

**Step 2: Activate 3-wire control 2**

Set [E1.15] = '3: 3-wire control mode 2'.

**Example:**

Connected K1 to X1, set [E1.00] = '35: Forward running (FWD)', edge-sensitive.
Connected K2 to X2, set [E1.01] = '36: Reverse running (REV)', edge-sensitive.
Connected K3 to X3, set [E1.02] = '25: 3-wire control', level-sensitive.

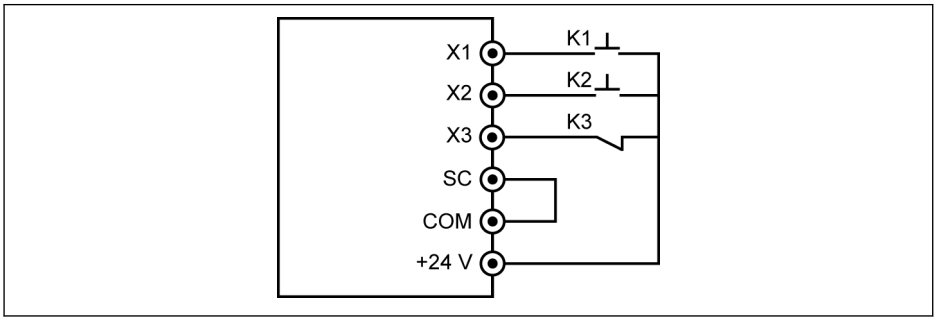



**Fig. 12-80:** 3-wire control mode 2

| K3 | K1 | K2 | Running status |
|---|---|---|---|
| Open | Edge / Inactive | Edge / Inactive | Stop |
| Closed | Edge | Inactive | Running forward |
| Closed | Inactive | Edge | Running reverse |
| Closed | Edge | Edge | No change |

**Tab. 12-13:** 3-wire control configuration

- **4: 1-wire control**

  1-wire control mode is Run /Stop mode, it is used for multi-speed function when 9 or more stages were selected.

  **Step 1: Define 1 digital input**

  Set one of digital inputs as '35: Forward running (FWD)'.

  **Step 2: Activate 1-wire control**

  Set [E1.15] = '4: 1-wire control'.

  **Example:**

  Connect K5 to X5, set [E1.04] = '35: Forward running (FWD)'.

  The control logic is shown in the table below:

| K5 | Status |
|---|---|
| Inactive | Stop |
| Active | Run |

**Tab. 12-14:** 1-wire control configuration

Detailed multi-speed information refer to chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.



In 2-wire / 3-wire running control, check and ensure that the direction setting meets the requirement in the actual application. If the direction command is changed when the frequency converter is running, [E0.18] 'direction change dead time' is active.

## 12.9.3 Digital Input Frequency Change Function

This function allows to adjust the setting frequency by digital input Up / Down command in RUN state.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.17 | Digital input Up / Down initial frequency | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E1.16 | Digital input Up / Down change rate | 0.10...100.00 Hz/s | 1.00 | Hz/s | 0.01 | Run |

The setting frequency can be adjusted with command of Up / Down / Reset, by setting the status of digital inputs. The setting frequency will increase with Up command active, decrease with Down command active, reset to '0' with Reset command active.

To use this function, take the following steps:

**Step 1: Set the frequency setting source**

Set either E0.00 'First frequency setting source' or E0.02 'Second frequency setting source' to '11: Digital input Up / Down command'. If the active frequency command input channel ([E0.00] or [E0.02]) is set to 11, the [E1.17] will be taken as the current set frequency.

**Step 2: Select any 3 digital inputs and define functions accordingly**

Set any 3 digital inputs of E1.00... E1.04 and H8.00...H8.04 to '20: Frequency Up command', '21: Frequency Down command' and '22: Up / Down command reset'.

**Step 3: Set the change rate and initial frequency for Up / Down operation**

Set E1.16 'Digital input Up / Down change rate' and E1.17 'Digital input Up / Down initial frequency' according to the application.

**Example:**

[E1.00] = 20, [E1.01] = 21, [E1.02] = 22

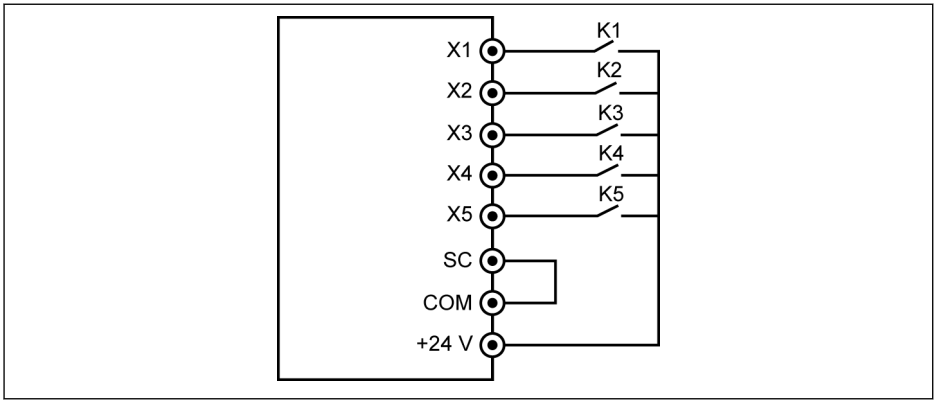



**Fig. 12-81:** External control terminals

Connect switch K1 to X1, and set [E1.00] = '20: Frequency Up command'.

Connect switch K2 to X2, and set [E1.01] = '21: Frequency Down command'.
Connect switch K3 to X3, and set [E1.02] = '22: Up / Down command reset'.
The combination of the control terminals are described in the table below:

| K1 | K2 | K3 | Response of setting frequency |
|---|---|---|---|
| Closed / Open | Closed / Open | Closed | Is reset to 0.00 Hz |
| Closed | Open | Open | Increases with the change rate defined by [E1.16] |
| Open | Closed | Open | Decreases with the change rate defined by [E1.16] |
| Open | Open | Open | No change |
| Closed | Closed | Open | No change |

**Tab. 12-15:** K1, K2, K3 settings



Up / Down / Reset command is only active when the frequency converter is running. Whether the setting frequency modified by Up / Down terminals will be saved or not after power off depends on [E0.06], see chapter 12.8.3 "Digital Setting Frequency" on page 195.

### 12.9.4 Pulse Input Configuration

The pulse input is required to be input via digital input terminal with frequency up to 50kHz, and X5 digital input is used to receive this pulse signal with a 30...70 % duty ratio.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.25 | Pulse input maximum frequency | 0.0...50.0 kHz | 50.0 | kHz | 0.1 | Run |
| E1.26 | Pulse input filter time | 0.000...2.000 s | 0.100 | s | 0.001 | Run |

This pulse input can be used in 3 purposes:

- Frequency setting source

  See chapter 12.8.1 "Frequency Setting Source" on page 189.
- PID reference
- PID feedback

  See chapter 12.12 "E4: PID Control" on page 268.

To use 'X5 pulse input' as the frequency source, take following steps:

**Step 1: Activate terminal 'X5 input' with pulse input function**

Set [E1.04] 'X5 input' to 47: Pulse input mode activation.

**Step 2: Set the maximum input frequency and filter time**

Set [E1.25] 'Pulse input maximum frequency' and [E1.26] 'Pulse input filter time' according to application.

**Step 3: Select pulse input curve**

| [E1.68] | bit 2 | bit 1 | bit 0 | Curve for AI1 | Curve for AI2 | Curve for pulse input |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 2 | 1 | 1 |
| 2 | 0 | 1 | 0 | 1 | 2 | 1 |
| 3 | 0 | 1 | 1 | 2 | 2 | 1 |
| 4 | 1 | 0 | 0 | 1 | 1 | 2 |
| 5 | 1 | 0 | 1 | 2 | 1 | 2 |
| 6 | 1 | 1 | 0 | 1 | 2 | 2 |
| 7 | 1 | 1 | 1 | 2 | 2 | 2 |

**Tab. 12-16:** Curve configuration

[E1.70]...[E1.73] are used to define characteristics of curve 1, and [E1.75]...[E1.78] are used to define characteristics of curve 2. Detailed curve setting see chapter 12.9.5 "Analog Input Configuration" on page 234.



Pulse input frequency is monitored by parameter d0.50 'Pulse input frequency'.

## 12.9.5 Analog Input Configuration

This function is implemented to configure the analog command value input of external analog input AI1 and AI2.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.35 | AI1 input mode | 0: 0...20 mA | 2 | - | – | Run |
| E1.40 | AI2 input mode | 1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V | 1 | - | – | Run |
| E1.38 | AI1 gain | 0.00...10.00 | 1.00 | - | 0.01 | Run |
| E1.43 | AI2 gain | 0.00...10.00 | 1.00 | - | 0.01 | Run |
| E1.68 | Analog input curve setting | 0...7 | 0 | - | – | Run |
| E1.69 | Analog input filter time | 0.000...2.000 s | 0.100 | s | 0.001 | Run |
| E1.70 | Input curve 1 minimum | 0.0 %...[E1.72] | 0.0 | - | 0.1 | Run |
| E1.71 | Input curve 1 minimum frequency | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E1.72 | Input curve 1 maximum | [E1.70]...100.0 % | 100.0 | - | 0.1 | Run |
| E1.73 | Input curve 1 maximum frequency | 0.00...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |
| E1.75 | Input curve 2 minimum | 0.0 %...[E1.77] | 0.0 | - | 0.1 | Run |
| E1.76 | Input curve 2 minimum frequency | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E1.77 | Input curve 2 maximum | [E1.75]...100.0 % | 100.0 | - | 0.1 | Run |
| E1.78 | Input curve 2 maximum frequency | 0.00...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |

To configure these two inputs AI1 and AI2, take the following steps:

**Step 1: Select the input mode**

Set [E1.35] to select the input mode of AI1 and [E1.40] to select the input mode of AI2.

**Step 2: Set the channel gain and filter time**

[E1.38] is for AI1 gain and [E1.43] is for AI2 gain.

Parameter [E1.69] is used to define the analog channel filtering time constant for processing of input signals. Longer filtering time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.

**Step 3: Select input curve**

There are two analog input curves that can be selected by [E1.68], AI1 and AI2 inputs can use both curve 1 and curve 2.

| [E1.68] | bit 2 | bit 1 | bit 0 | Curve for AI1 | Curve for AI2 | Curve for pulse input |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 2 | 1 | 1 |
| 2 | 0 | 1 | 0 | 1 | 2 | 1 |
| 3 | 0 | 1 | 1 | 2 | 2 | 1 |
| 4 | 1 | 0 | 0 | 1 | 1 | 2 |
| 5 | 1 | 0 | 1 | 2 | 1 | 2 |
| 6 | 1 | 1 | 0 | 1 | 2 | 2 |
| 7 | 1 | 1 | 1 | 2 | 2 | 2 |

**Tab. 12-17:** Curve configuration

[E1.70]...[E1.73] are used to define characteristics of curve 1:

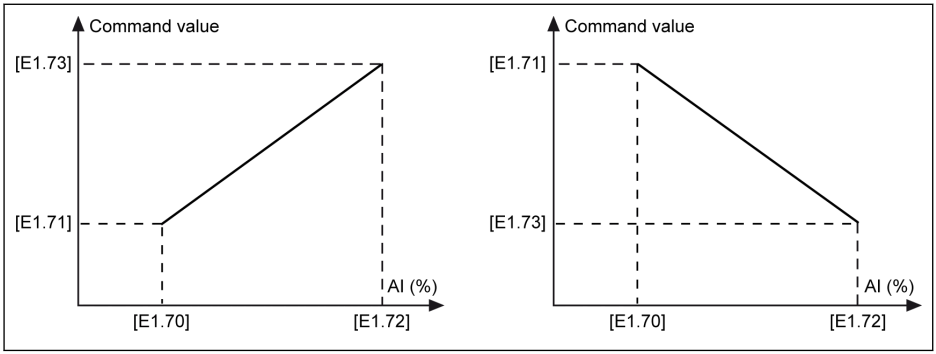



**Fig. 12-82:** Curve 1

[E1.75]...[E1.78] are used to define characteristics of curve 2:

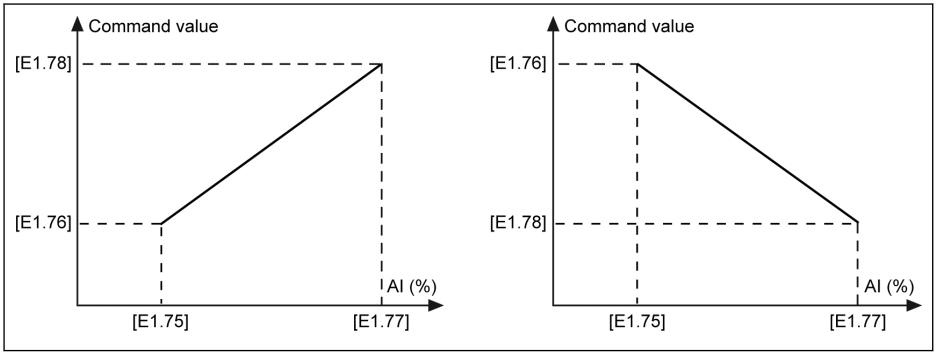



**Fig. 12-83:** Curve 2

Analog input status is monitored by parameter d0.30 'AI1 input' / d0.31 'AI2 input'.

### Analog Input Broken Wire Detection

If '4...20 mA' or '2...10 V' is selected for analog inputs (AI1, AI2 and EAI1, EAI2), then this function can detect the input missing possibly due to the cable disconnection. Once the broken wire is detected, the frequency converter can either continue running with warning (Warning code: Aib-) or stop with error (Error code: AibE), which can be configured by parameter E1.61.

Related parameter:

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.61 | Broken wire protection | 0: Inactive<br>1: Warning<br>2: Error | 0 | - | - | Stop |

**Setting range of E1.61:**

- **0: Inactive**

  There is no reaction on the output frequency (broken wire disable, no warning display and stop command).

- **1: Warning**

  There is warning reaction will be enabled and warning message will be displayed with warning code "Aib-".

- **2: Error**

  There is error reaction will be enabled, then stop command will be raised and error message will be displayed with error code of "AibE".

For 4...20 mA analog input, if the current drops below 4mA – 10% = 3.6mA, the action according to the parameter E1.61 will be performed.

For 2...10 V analog input, if the voltage drops below 2V – 7.5% = 1.85V, the action according to the parameter E1.61will be performed.

## 12.9.6 Motor Temperature Sensor Channel

This function defines the motor temperature sensor channel selection when protect the motor from overheat.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E1.60 | Motor temperature sensor channel | 0: Inactive<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: EAI2 analog input<br>5: TSI input (only for IO plus card) | 0 | - | - | Stop |

**Setting range of E1.60:**

- **0: Inactive**

  Inactivate the function of temperature monitoring with temperature sensor:
- **1: AI1 analog input**

  Motor temperature sensor channel is AI1.
- **2: AI2 analog input**

  Motor temperature sensor channel is AI2.
- **3: EAI1 analog input**

  Motor temperature sensor channel is EAI1.
- **4: EAI2 analog input**

  Motor temperature sensor channel is EAI2.
- **5: TSI input (only for IO plus card)**

  Motor temperature sensor channel is TSI when IO plus card was used.



AI1 / AI2 / EAI1 / EAI2 will be automatically set as voltage input mode when [E1.60] = 1...4.

## 12.10 E2: Output Terminal

### 12.10.1 Digital Output Configuration

This function defines the open collector output for system state monitoring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 0...25 | 1 | - | - | Stop |
| E2.20 | DO1/relay1 output values from extension card fieldbus communication | Bit0: 0 (open collector is opened); 1(open collector is closed)<br>Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed) | 0x00000 | - | - | Run |

**Setting range of E2.01:**

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 202 and chapter 12.8.9 "Stop Mode Configuration" on page 208.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.



There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 250.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 250.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 170 VDC (1P/200 VAC models) / 300 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 139.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 157.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 221 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 268.

- **19: Pulse output mode enable**

  See chapter 12.10.2 "Pulse Output Setting" on page 241.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**
  - For modbus mode, the output is defined by bit0 of register 0x7F08, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 of register 0x7F08 is '1', open collector is closed.

– For other fieldbus mode, the output is defined by bit0 of parameter E2.20, when bit0 of E2.20 is '0', open collector is opened; when bit0 of E2.20 is '1', open collector is closed.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.

---

☞ Digital output status is monitored by parameter d0.45 'DO1 output'.

---

## 12.10.2 Pulse Output Setting

This function defines pulse train output functionality up to 32 kHz for open collector output.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.02 | DO1 pulse output setting | 0: Converter output frequency<br>1: Converter output voltage<br>2: Converter output current<br>3: Setting torque<br>4: Output torque | 0 | - | - | Stop |
| E2.03 | Pulse output maximum frequency | 0.1...32.0 kHz | 32.0 | kHz | 0.1 | Run |

Before using DO1 pulse output mode, first set E2.01 to '19: Pulse output mode enable' so that pulse train output functionality is enabled through the open collector output.

**Pulse train output characteristics:**

- Frequency range: 1Hz to 32.0 kHz
- Duty cycle range: 40% ~ 60%
- Maximal pulse train output frequency: as specified by [E2.03] parameter

**Setting range of E2.02:**

- **E2.02 = 0: Converter output frequency**

  Pulse train output 1 Hz to [E2.03] corresponds to output frequency 0 to [E0.09] output frequency high limit.

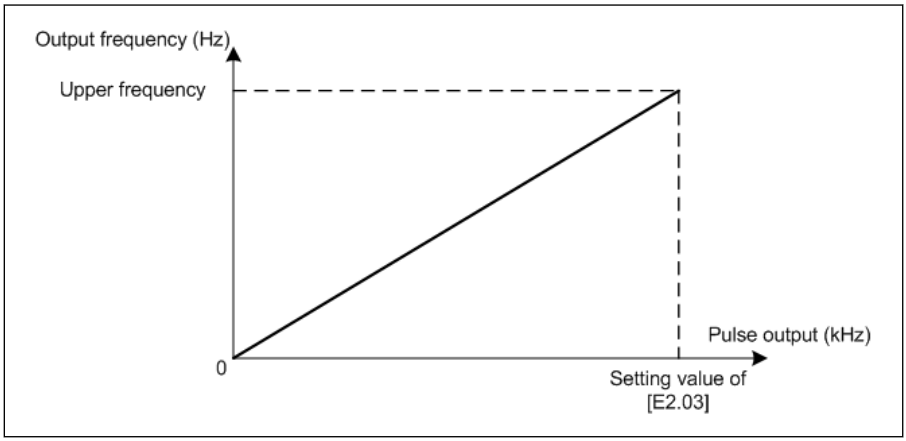



**Fig. 12-84:** Converter output frequency

- **E2.02 = 1: Converter output voltage**

Pulse train output 1 Hz to [E2.03] corresponds to output voltage 0 to max. voltage (1P200V: 250V; 3P400V: 500V).

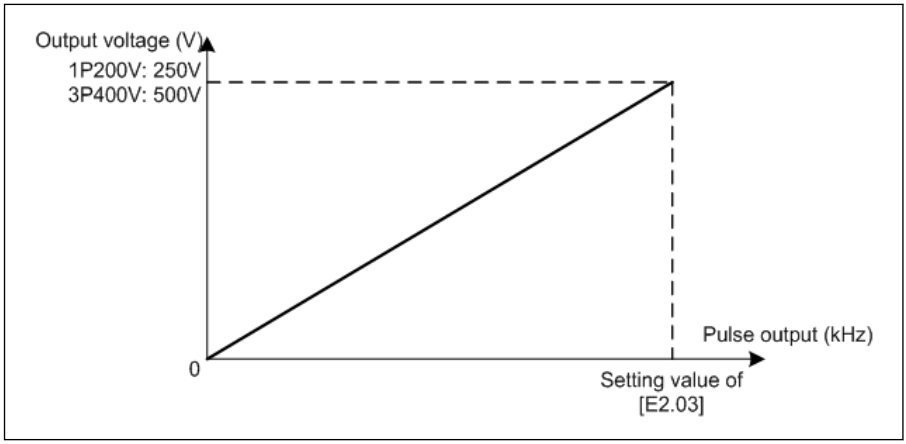



**Fig. 12-85:** Converter output voltage

- **E2.02 = 2: Converter output current**

  Pulse train output 1 Hz to [E2.03] corresponds to output current 0 to (2 * converter rated current).

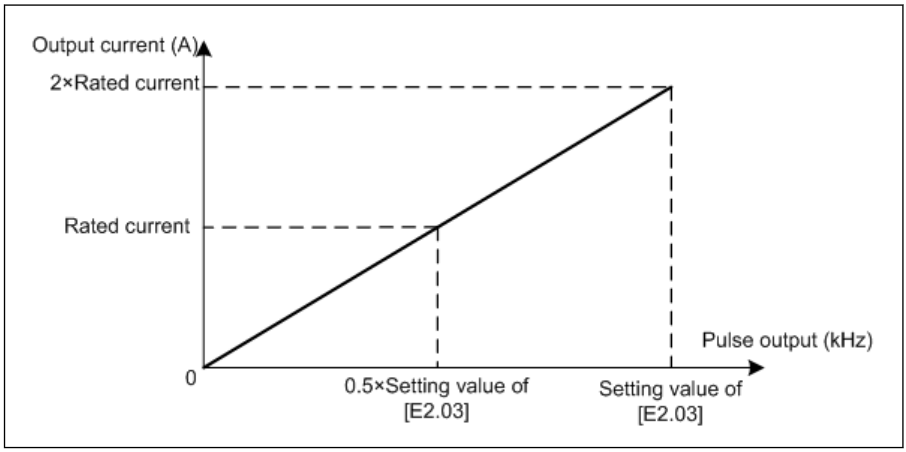



**Fig. 12-86:** Converter output current

- **E2.02 = 3: Setting torque**

  Pulse train output 1 Hz to [E2.03] corresponds to setting torque value of C3.42 to C3.43.

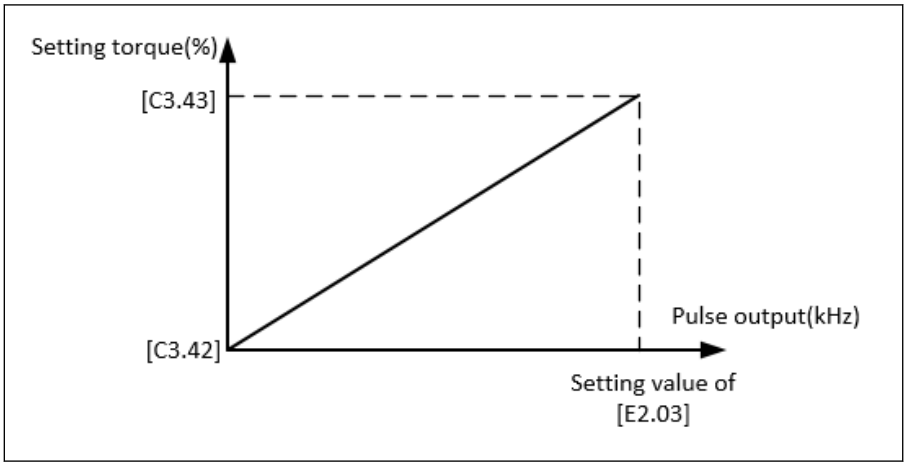



**Fig. 12-87:** Setting torque

- **E2.02 = 4: Output torque**

  Pulse train output 1 Hz to [E2.03] corresponds to output torque value of C3.42 to C3.43.

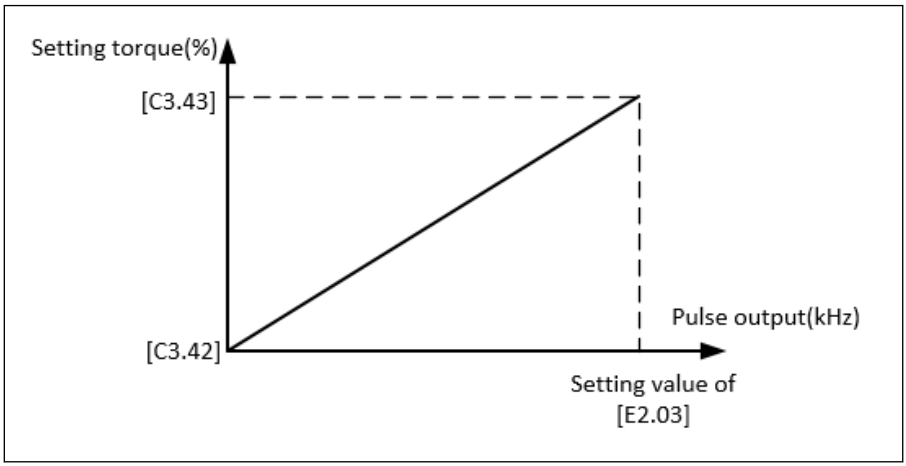



**Fig. 12-88:** Output torque

### 12.10.3 Relay Output

This function defines the relay output for system state monitoring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.15 | Relay 1 output selection | 0...25 | 1 | - | - | Stop |
| E2.20 | DO1/relay1 output values from extension card fieldbus communication | Bit0: 0 (open collector is opened); 1(open collector is closed)<br>Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed) | 0x00000 | - | - | Run |

**Setting range of E2.15:**

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 202 and chapter 12.8.9 "Stop Mode Configuration" on page 208.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.



There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 250.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 250.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 170 VDC (1P/200 VAC models) / 300 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 139.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 157.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 221 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 268.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**
  - For modbus mode, the output is defined by bit0 of register 0x7F08, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 of register 0x7F08 is '1', open collector is closed.
  - For other fieldbus mode, the output is defined by bit0 of parameter E2.20, when bit0 of E2.20 is '0', open collector is opened; when bit0 of E2.20 is '1', open collector is closed.

- **25: Converter error or warning**

The output is active when the frequency converter encounters error / warning.

The output is inactive when the frequency converter without error / warning.

 Digital output status is monitored by parameter d0.45 'DO1 output'.

## 12.10.4 Analog Output Configuration

The analog output terminal may output 0...10V voltage signals or 0...20mA current based on some system variables with adjustable gain setting.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.25 | AO1 output mode | 0: 0...10 V<br>1: 0...20 mA<br>3: 2...10V<br>4: 4...20 mA | 0 | - | - | Run |
| E2.26 | AO1 output setting | 0: Output frequency<br>1: Setting frequency<br>2: Output current<br>4: Output voltage<br>5: Output power<br>6: AI1 analog input<br>7: AI2 analog input<br>8: EAI1 analog input<br>9: EAI2 analog input<br>11: Motor temperature sensor power supply<br>12: Parameter setting from communication<br>13: Setting torque<br>14: Output torque | 0 | - | - | Run |
| E2.27 | AO1 gain | 0.00...10.00 | 1.00 | - | 0.01 | Run |
| E2.28 | AO1 value in percentage from extension card Fieldbus communication | 0.00...100.00 % | 0.00 | - | 0.01 | Run |
| E2.40 | Rated voltage | 1P 200...240 VAC | 220 | VAC | 1 | Stop |
| | | 3P 380...480 VAC | 380 | | | |
| E2.50 | Output curve 1 minimum | 0.0 %...[E2.52] | 0.0 | - | 0.1 | Run |
| E2.51 | Output curve 1 minimum value | 0.00...100.00 % | 0.00 | - | 0.01 | Run |
| E2.52 | Output curve 1 maximum | [E2.50]...100.0 % | 100.0 | - | 0.1 | Run |
| E2.53 | Output curve 1 maximum value | 0.00...100.00 % | 100.00 | - | 0.01 | Run |

**Analog output configuration step:**

- **Step 1: Set AO1 output mode**

  E2.25 is for AO1 output mode selection, 0 is for voltage mode and 1 is for current mode.

- **Step 2: Select AO1 output signal**

  E2.26 setting range:

  - **E2.26 = 0: Output frequency**

    Represents the actual output frequency between 0.00...[E0.08] Hz.

  - **E2.26 = 1: Setting frequency**

    Represents the setting frequency between 0.00...[E0.08] Hz.

  - **E2.26 = 2: Output current**

    Represents the 0...2 x [rated current].

  - **E2.26 = 4: Output voltage**

    Represents 0...1.2 x [rated voltage], which is defined by parameter E2.40.

  - **E2.26 = 5: Output power**

    Represents 0...1.2 x [rated power].

  - **E2.26 = 6: AI1 Analog input**

    Represents AI1 input value.

  - **E2.26 = 7: AI2 Analog input**

    Represents AI2 input value.

  - **E2.26 = 8: EAI1 analog input**

    Represents EAI1 analog input value from I/O card or I/O plus card.

  - **E2.26 = 9: EAI2 analog input**

    Represents EAI2 analog input value from I/O plus card.

  - **E2.26 = 11: Motor temperature sensor power supply**

    Provides current source for motor temperature sensor, see chapter 12.3.7 "Motor Thermal Sensor Selection" on page 159.

  - **E2.26 = 12: Parameter setting from communication**

    - For Modbus mode, the output is defined by register 0x7F06. The value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).
    - For other Fieldbus mode, the output is defined by parameter E2.28.

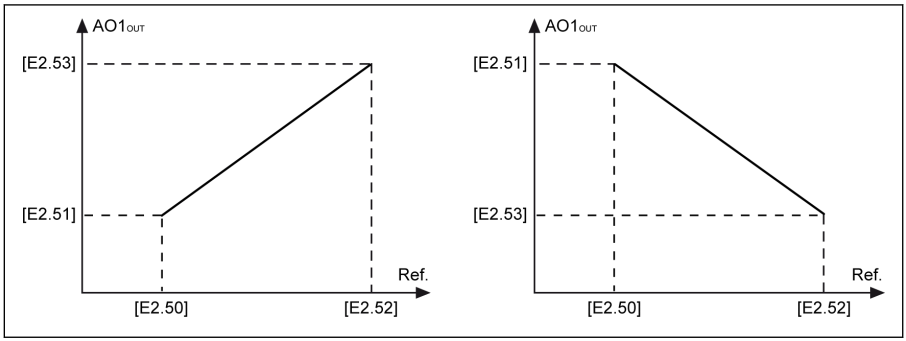
  - **E2.26 = 13: Setting torque**

    Represents range of setting torque selected using C3.42 and C3.43.

  - **E2.26 = 14: Output torque**

    Represents range of output torque selected using C3.42 and C3.43.

- **Step 3: Set AO1 filter time and output curve**




**$AO1_{OUT}$** AO1 output
**Ref.** Reference

**Fig. 12-89:** AO1 output curve

Analog output status is monitored by parameter d0.35 'AO1 output'.

## 12.10.5 Frequency Detection Function

This function is used to detect the difference between the output frequency and the setting frequency, the indication signal can be used for further engineering in the application.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.70 | Frequency detection width | 0.00...400.00 Hz | 2.50 | Hz | 0.01 | Run |
| E2.71 | Frequency detection level FDT1 | 0.00...400.00 Hz | 50.00 | Hz | 0.01 | Run |
| E2.72 | Frequency detection level FDT1 width | 0.00...[E2.71] Hz | 1.00 | Hz | 0.01 | Run |
| E2.73 | Frequency detection level FDT2 | 0.00...400.00 Hz | 25.00 | Hz | 0.01 | Run |
| E2.74 | Frequency detection level FDT2 width | 0.00...[E2.73] Hz | 1.00 | Hz | 0.01 | Run |

- **Frequency Arrival**

  Parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 can be set to '4: Speed arrival' to configure the digital outputs to show this function.

  The 'Speed arrival' signal is active on the selected output terminal when the difference between the 'Output frequency' and the 'Setting frequency' is within the range set by parameter E2.70 'Frequency detection width':

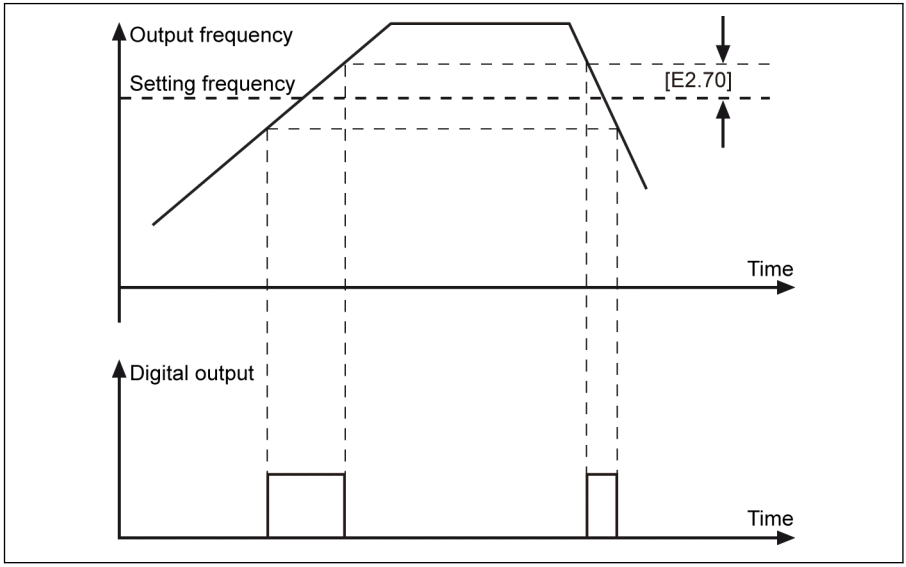



**Fig. 12-90:** Frequency arrival

- **Frequency Level Detection**

  Parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 can be set to '**5: Frequency level detection signal (FDT1)**' or '**6: Frequency level detection signal (FDT2)**' to configure the digital outputs to show this function.

  The indication signal is active when the output frequency is **HIGHER** than the frequency detection level, and inactive when the output frequency is **LOWER** than the frequency detection level minus frequency detection level width.

  The selected digital output signal and status are as below:

  – 5: Frequency level detection signal (FDT1)
    – Active when 'Output frequency' is higher than [E2.71]
    – Inactive when 'Output frequency' is lower than [E2.71] - [E2.72]
  – 6: Frequency level detection signal (FDT2)
    – Active when 'Output frequency' is higher than [E2.73]
    – Inactive when 'Output frequency' is lower than [E2.73] - [E2.74]

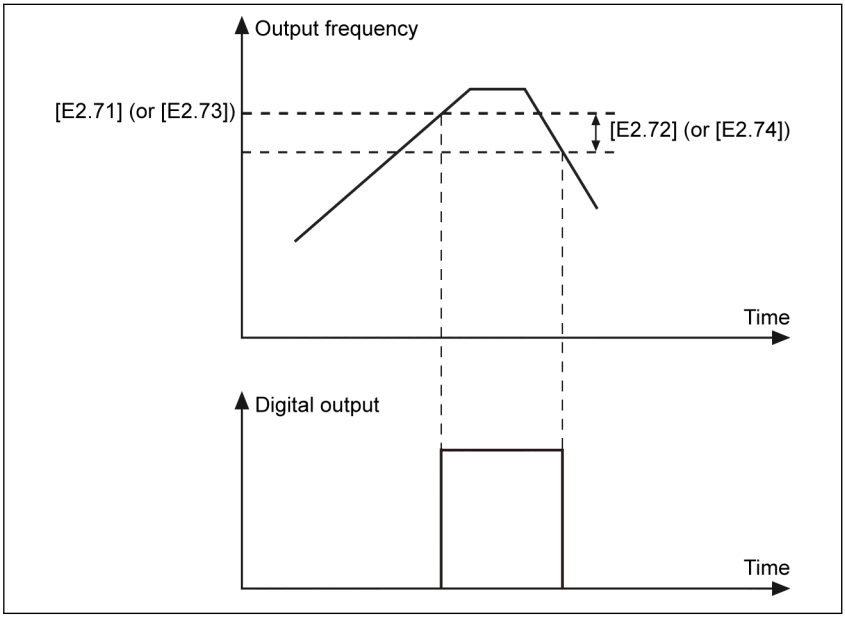



**Fig. 12-91:** Frequency level detection

## 12.10.6 Pulse Counter Function

The internal counter counts the input pulses received from 'Digital input' and compares it with the setting value of 'Counter middle value' or 'Counter target value'.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E2.80 | Counter middle value | 0...[E2.81] | 0 | - | 1 | Run |
| E2.81 | Counter target value | [E2.80]...9,999 | 0 | - | 1 | Run |

Digital input E1.00... E1.04 and H8.00...H8.04 can be set to '39: Counter input' as pulse input.

By setting parameter E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 to '16: Counter target value arrival' or '17:Counter middle value arrival' output signal will be indicated via DO or Relay output when the counter value equals to that of setting value.

The counter is cleared and the DO or Relay output signal is reset by a valid edge signal of another digital input E1.00... E1.04 and H8.00...H8.04 defined as '40:Counter reset'.

**Example:**

X1 input is defined as '39: Counter input'.

X2 input is defined as '40: Counter reset'.

The wiring is shown as the figure below:

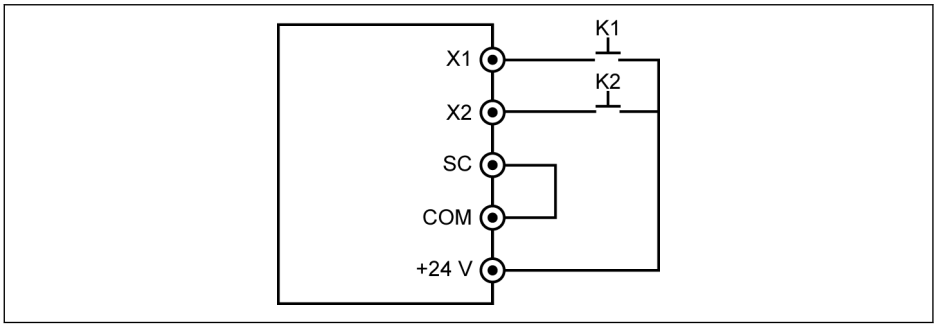



**Fig. 12-92:** Digital input configuration

Connected K1 to X1, and set [E1.00] = '39: Counter input'.

Connected K2 to X2, and set [E1.01] = '40: Counter reset'.

| K1 | K2 | Running status | Status |
|---|---|---|---|
| Inactive | Inactive | – | – |
| Edge | Inactive | Counter value = [E2.80] / [E2.81] | Internal counter value stays at [E2.80] / [E2.81]<br>Digital output is active |
| Edge | Edge | Counter is reset | Internal counter value is reset to '0'<br>Digital output is inactive |

**Tab. 12-18:** Counter function

'DO1 output' or 'Relay 1 output' signal and status are as below:

- [E2.01] / [E2.15] = '16: Counter target value arrival'

  When the internal counter receives from 'X1 input' the number of input pulse, which equals to [E2.81] 'Counter target value'.

- [E2.01] / [E2.15] = '17: Counter middle value arrival'

  When the internal counter receives from 'X1 input' the number of input pulse, which equals to [E2.80] 'Counter middle value'.

The signal is reset by the next valid edge signal of 'X2 input' which is defined as '40: Counter reset'.

**Example:**

[E2.80] = 5, [E2.81] = 8

The output behavior is described as below:

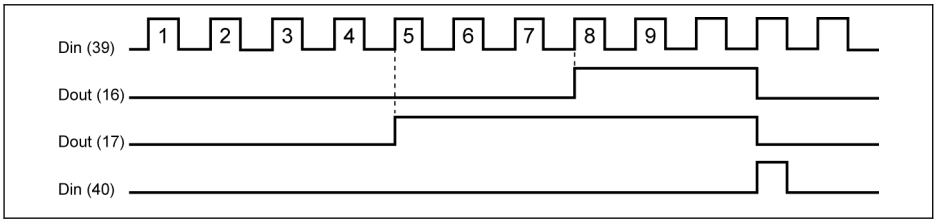



**Fig. 12-93:** Output behavior

- If the setting of any parameter E2.80, E2.81 and / or the status of the defined digital inputs is changed, the counter value will be reset and the digital outputs will be inactive immediately.
- The allowed maximum digital input frequency is 50 Hz and the allowed minimum pulse width (both active and inactive) is higher than 8 ms.

# 12.11 E3: Multi-Speed and Simple PLC

## 12.11.1 Simple PLC and Multi-Speed Setting

### Parameters

PLC is an automatic running mode according to the preset acceleration /deceleration time, running frequency, running time and rotation direction.

The multi-speed control shares some parameters with simple PLC control. If this control mode is active, the corresponding external terminals should be configured with correct values to realize this function.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.00 | Simple PLC running mode | 0: Inactive<br>1: Stop after selected cycle<br>2: Continuously cycling<br>3: Run last stage after selected cycle<br>4: Continuous cycling without decelerating to 0.00 Hz | 0 | - | – | Stop |
| E3.01 | Simple PLC time multiplier | 1...60 | 1 | - | 1 | Stop |
| E3.02 | Simple PLC cycle number | 1...1,000 | 1 | - | 1 | Stop |
| E3.10 | Acceleration time 2 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.11 | Deceleration time 2 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.12 | Acceleration time 3 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.13 | Deceleration time 3 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.14 | Acceleration time 4 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.15 | Deceleration time 4 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.16 | Acceleration time 5 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.17 | Deceleration time 5 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.18 | Acceleration time 6 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.19 | Deceleration time 6 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.20 | Acceleration time 7 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.21 | Deceleration time 7 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.22 | Acceleration time 8 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.23 | Deceleration time 8 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.40 | Multi-speed frequency 1 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.41 | Multi-speed frequency 2 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.42 | Multi-speed frequency 3 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.43 | Multi-speed frequency 4 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.44 | Multi-speed frequency 5 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.45 | Multi-speed frequency 6 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.46 | Multi-speed frequency 7 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.47 | Multi-speed frequency 8 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.48 | Multi-speed frequency 9 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.49 | Multi-speed frequency 10 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.50 | Multi-speed frequency 11 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.51 | Multi-speed frequency 12 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.52 | Multi-speed frequency 13 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.53 | Multi-speed frequency 14 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.54 | Multi-speed frequency 15 | 0.00...[E0.09] Hz | 0.00 | - | 0.01 | Run |
| E3.59 | Stage 0 frequency source | 0: Digital setting frequency<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: X5 pulse input<br>5: Communication<br>6: Panel potentiometer<br>7: Digital input up/down command<br>8: EAI2 analog input | 0 | - | – | Stop |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.60 | Stage 0 action | 011, 012, 013, 014, 015, 016 ,017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188 | 011 | - | – | Stop |
| E3.62 | Stage 1 action | | 011 | - | – | Stop |
| E3.64 | Stage 2 action | | 011 | - | – | Stop |
| E3.66 | Stage 3 action | | 011 | - | – | Stop |
| E3.68 | Stage 4 action | | 011 | - | – | Stop |
| E3.70 | Stage 5 action | | 011 | - | – | Stop |
| E3.72 | Stage 6 action | | 011 | - | – | Stop |
| E3.74 | Stage 7 action | | 011 | - | – | Stop |
| E3.76 | Stage 8 action | | 011 | - | – | Stop |
| E3.78 | Stage 9 action | | 011 | - | – | Stop |
| E3.80 | Stage 10 action | | 011 | - | – | Stop |
| E3.82 | Stage 11 action | | 011 | - | – | Stop |
| E3.84 | Stage 12 action | | 011 | - | – | Stop |
| E3.86 | Stage 13 action | | 011 | - | – | Stop |
| E3.88 | Stage 14 action | | 011 | - | – | Stop |
| E3.90 | Stage 15 action | | 011 | - | – | Stop |
| E3.61 | Stage 0 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.63 | Stage 1 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.65 | Stage 2 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.67 | Stage 3 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.69 | Stage 4 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.71 | Stage 5 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.73 | Stage 6 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.75 | Stage 7 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.77 | Stage 8 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.79 | Stage 9 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.81 | Stage 10 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.83 | Stage 11 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.85 | Stage 12 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.87 | Stage 13 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.89 | Stage 14 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |
| E3.91 | Stage 15 running time | 0.0...6,000.0 s | 20.0 | s | 0.1 | Stop |

### Multi-Speed Setting

Multi-speed function offers flexible, switchable 16 independent stages of setting frequency. The rotation direction of each stage depends on both the 'Stage action' and the 'Run command source', see the table below:

| Frequency source | Run command source | Rotation direction | Acc. / Dec. time |
|---|---|---|---|
| Multi-speed | Operating panel | [E3.60], [E3.62], [E3.64], [E3.66] | [E0.26] / [E0.27] |
| | | [E3.68], [E3.70], [E3.72], [E3.74] | [E3.10] / [E3.11] |
| | | [E3.76], [E3.78], [E3.80], [E3.82] | [E3.12] / [E3.13] |
| | | [E3.84], [E3.86], [E3.88], [E3.90] | [E3.14] / [E3.15] |
| | External terminals | 8 or less stages: 2-wire control | [E3.16] / [E3.17] |
| | | 9 or more stages: parameters | [E3.18] / [E3.19] |
| | Communication | Set by communication | [E3.20] / [E3.21] |
| | | | [E3.22] / [E3.23] |

**Tab. 12-19:** Setting frequency and multi-speed settings

To configure the multi-speed settings, take the following steps:

#### Step 1: Activate multi-speed function

Set E0.00 or E0.02 to '21: Multi-speed settings' to activate multi-speed function.

#### Step 2: Select any 4 digital inputs and define functions accordingly

Select any 4 digital inputs of E1.00...E1.04, H8.00...H8.04 to '1: Multi-speed control input 1', '2: Multi-speed control input 2', '3: Multi-speed control input 3', '4: Multi-speed control input 4'.

Assign functions to digital inputs properly when 'Acceleration / deceleration time activation' and '2-wire / 3-wire running control' are also necessary defined via digital inputs.

#### Step 3: Configure the setting frequency for each stage

If the setting frequency of next stage is lower than that of the current stage, it will decelerate to the next stage with the deceleration time of the current stage; if the setting frequency of next stage is higher than that of the current stage, it will accelerate to the next stage with the acceleration time of next stage.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.40 | Multi-speed frequency 1 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.41 | Multi-speed frequency 2 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.42 | Multi-speed frequency 3 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.43 | Multi-speed frequency 4 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.44 | Multi-speed frequency 5 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.45 | Multi-speed frequency 6 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.46 | Multi-speed frequency 7 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.47 | Multi-speed frequency 8 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.48 | Multi-speed frequency 9 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.49 | Multi-speed frequency 10 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.50 | Multi-speed frequency 11 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.51 | Multi-speed frequency 12 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.52 | Multi-speed frequency 13 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.53 | Multi-speed frequency 14 | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E3.54 | Multi-speed frequency 15 | 0.00...[E0.09] Hz | 0.00 | - | 0.01 | Run |

**Step 4: Set the acceleration time / deceleration time, rotation direction for each stage**

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.60 | Stage 0 action | 011, 012, 013, 014, 015, 016 , 017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188 | 011 | - | – | Stop |
| E3.62 | Stage 1 action | | 011 | - | – | Stop |
| E3.64 | Stage 2 action | | 011 | - | – | Stop |
| E3.66 | Stage 3 action | | 011 | - | – | Stop |
| E3.68 | Stage 4 action | | 011 | - | – | Stop |
| E3.70 | Stage 5 action | | 011 | - | – | Stop |
| E3.72 | Stage 6 action | | 011 | - | – | Stop |
| E3.74 | Stage 7 action | | 011 | - | – | Stop |
| E3.76 | Stage 8 action | | 011 | - | – | Stop |
| E3.78 | Stage 9 action | | 011 | - | – | Stop |
| E3.80 | Stage 10 action | | 011 | - | – | Stop |
| E3.82 | Stage 11 action | | 011 | - | – | Stop |
| E3.84 | Stage 12 action | | 011 | - | – | Stop |
| E3.86 | Stage 13 action | | 011 | - | – | Stop |
| E3.88 | Stage 14 action | | 011 | - | – | Stop |
| E3.90 | Stage 15 action | | 011 | - | – | Stop |
| E0.26 | Acceleration time | 0.1...6,000.0 s | DOM | s | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6,000.0 s | DOM | s | 0.1 | Run |
| E3.10 | Acceleration time 2 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.11 | Deceleration time 2 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E3.12 | Acceleration time 3 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.13 | Deceleration time 3 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.14 | Acceleration time 4 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.15 | Deceleration time 4 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.16 | Acceleration time 5 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.17 | Deceleration time 5 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.18 | Acceleration time 6 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.19 | Deceleration time 6 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.20 | Acceleration time 7 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.21 | Deceleration time 7 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.22 | Acceleration time 8 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |
| E3.23 | Deceleration time 8 | 0.1...6,000.0 s | 10.0 | s | 0.1 | Run |

The digit definition for each stage action is as the figure below:

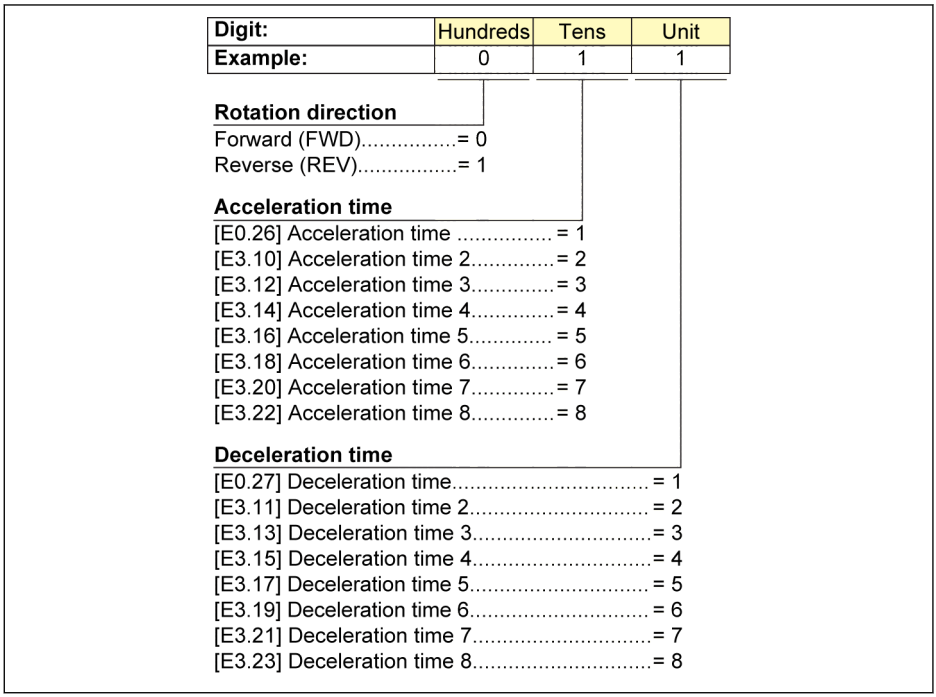



**Fig. 12-94:** Bit definition of rotation direction, acceleration and deceleration time

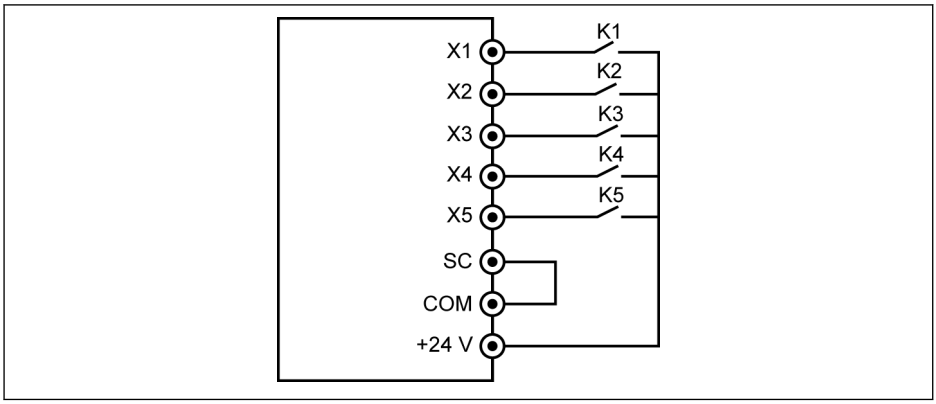



**Fig. 12-95:** Multi-speed control via digital inputs

### Case 1: 8 or less stages

Set [E1.15] = 0 or 1 first.

Connect switch K1 to X1, and set [E1.00] = '1: Multi-speed control input 1'.

Connect switch K2 to X2, and set [E1.01] = '2: Multi-speed control input 2'.

Connect switch K3 to X3, and set [E1.02] = '3: Multi-speed control input 3'.

Connect switch K4 to X4, and set [E1.03] = '35: Forward running (FWD)'.

Connect switch K5 to X5, and set [E1.04] = '36: Reverse running (REV)'.

| K3 | K2 | K1 | Setting frequency | Acc. / Dec. time |
|---|---|---|---|---|
| Open | Open | Open | [E0.07] | [E0.26] / [E0.27] |
| Open | Open | Closed | [E3.40] | [E3.10] / [E3.11] |
| Open | Closed | Open | [E3.41] | [E3.12] / [E3.13] |
| Open | Closed | Closed | [E3.42] | [E3.14] / [E3.15] |
| Closed | Open | Open | [E3.43] | [E3.16] / [E3.17] |
| Closed | Open | Closed | [E3.44] | [E3.18] / [E3.19] |
| Closed | Closed | Open | [E3.45] | [E3.20] / [E3.21] |
| Closed | Closed | Closed | [E3.46] | [E3.22] / [E3.23] |

**Tab. 12-20:** Multi-speed settings for 8 or less stages

The running logic for K4 and K5 see chapter 12.9.2 "2- and 3-Wire Control" on page 226 E1.15 = '0: 2-wire forward / stop, reverse / stop' and E1.15 = '1: 2-wire forward / reverse, run / stop'.

### Case 2: 9 or more stages

Set [E1.15] = 4 first.

Connect switch K1 to X1, and set [E1.00] = '1: Multi-speed control input 1'.

Connect switch K2 to X2, and set [E1.01] = '2: Multi-speed control input 2'.

Connect switch K3 to X3, and set [E1.02] = '3: Multi-speed control input 3'.

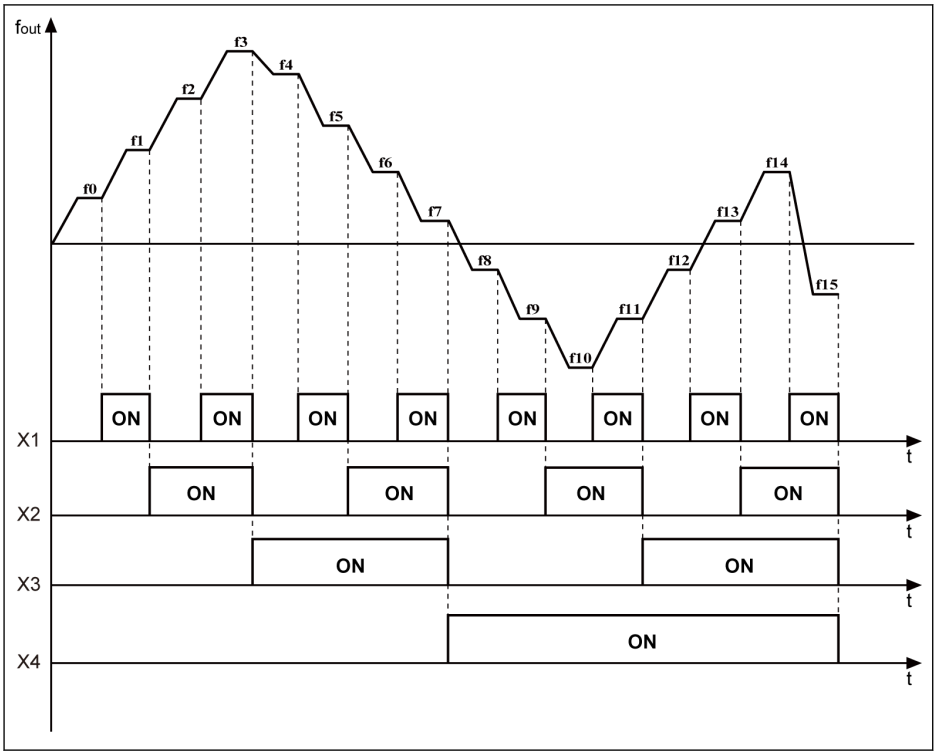
Connect switch K4 to X4, and set [E1.03] = '4: Multi-speed control input 4'.
Connect switch K5 to X5, and set [E1.04] = '35: Forward running (FWD)'.

| K4 | K3 | K2 | K1 | Setting frequency | Acc. / Dec. time |
|---|---|---|---|---|---|
| Open | Open | Open | Open | [E0.07] | [E0.26] / [E0.27] |
| Open | Open | Open | Closed | [E3.40] | [E3.10] / [E3.11] |
| Open | Open | Closed | Open | [E3.41] | [E3.12] / [E3.13] |
| Open | Open | Closed | Closed | [E3.42] | [E3.14] / [E3.15] |
| Open | Closed | Open | Open | [E3.43] | [E3.16] / [E3.17] |
| Open | Closed | Open | Closed | [E3.44] | [E3.18] / [E3.19] |
| Open | Closed | Closed | Open | [E3.45] | [E3.20] / [E3.21] |
| Open | Closed | Closed | Closed | [E3.46] | [E3.22] / [E3.23] |
| Closed | Open | Open | Open | [E3.47] | [E0.26] / [E0.27] |
| Closed | Open | Open | Closed | [E3.48] | [E3.10] / [E3.11] |
| Closed | Open | Closed | Open | [E3.49] | [E3.12] / [E3.13] |
| Closed | Open | Closed | Closed | [E3.50] | [E3.14] / [E3.15] |
| Closed | Closed | Open | Open | [E3.51] | [E3.16] / [E3.17] |
| Closed | Closed | Open | Closed | [E3.52] | [E3.18] / [E3.19] |
| Closed | Closed | Closed | Open | [E3.53] | [E3.20] / [E3.21] |
| Closed | Closed | Closed | Closed | [E3.54] | [E3.22] / [E3.23] |

**Tab. 12-21:** Multi-speed settings for 9 or more stages

| K5 | Status |
|---|---|
| Inactive | Stop |
| Active | Run |

**Tab. 12-22:** Run / Stop control via K5



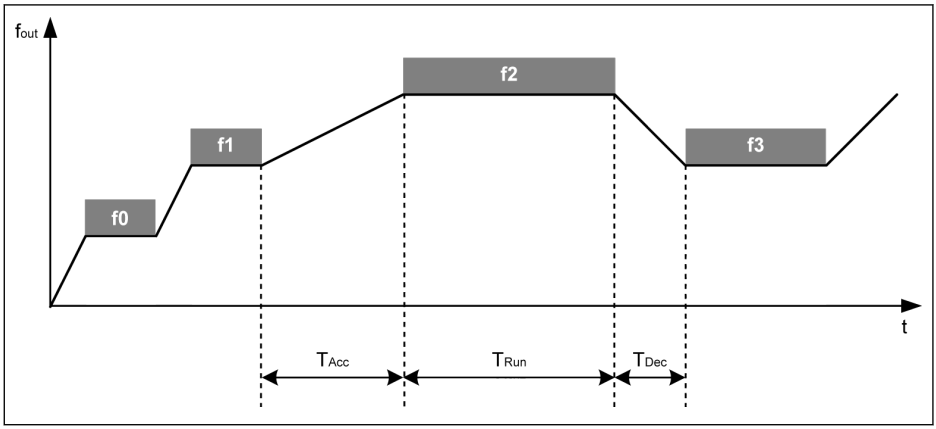

**$f_{out}$** Output frequency
**t** Time
**ON** Digital input switched on

**Fig. 12-96:** Multi-speed stage transition

## Simple PLC setting

Simple PLC is an automatic running mode based on the current acceleration / deceleration time, setting frequency, duration and rotation direction.

Simple PLC consists of 16 stages, each of which has its own settings of acceleration time, deceleration time, setting frequency, rotation direction and duration. An example of simple PLC control is shown in the figure below:




$f_{out}$ Output frequency
t Time
$T_{Acc}$ Acceleration time
$T_{Run}$ Stage running time
$T_{Dec}$ Deceleration time

**Fig. 12-97:** Example of simple PLC control

| Frequency source | Run command source | Rotation direction and Acc. / Dec. time |
|---|---|---|
| Simple PLC | Operating panel | [E3.60], [E3.62], [E3.64], [E3.66] |
| | Multi-function digital input | [E3.68], [E3.70], [E3.72], [E3.74] |
| | Communication | [E3.76], [E3.78], [E3.80], [E3.82] |
| | | [E3.84], [E3.86], [E3.88], [E3.90] |

**Tab. 12-23:** Simple PLC configuration

**Set the Simple PLC Mode:**

- **E3.00 = 0: Inactive**

  Simple PLC inactive.

- **E3.00 = 1: Stop after selected cycle**

  In this mode, the frequency converter decelerates to 0.00 Hz after the last stage of simple PLC, and then stops according to the configured stopping mode.

- **E3.00 = 2: Continuously cycling**

  In this mode, the frequency converter decelerates to 0.00 Hz after the last stage of simple PLC, and then starts a new cycle automatically.

- **E3.00 = 3: Run last stage after selected cycle**

  In this mode, the frequency converter keeps running at the setting frequency of the last stage of simple PLC.

- **[E3.00] = 4: Continuous cycling without decelerating to 0.00 Hz**

  In this mode, the frequency converter doesn't decelerate to 0.00 Hz after the last stage of simple PLC, and starts a new cycle directly.

The actual duration for each stage is defined by following equation (Take stage 0 as an example):

$T_{Run}$ = [E3.61] x [E3.01]

Based on the equation above, the maximum duration of one cycle is:

8 x 6,000.0 s x 60 = 800 hours.

☞ For the settings of acceleration time, deceleration time, setting frequency, rotation direction of each 16 stages definition, see multi-speed setting above.

☞
- If a stage running time is set to 0, simple PLC skips that stage.
- 'PID control' has a higher priority than 'Simple PLC control'. To use 'Simple PLC control', deactivate 'PID control' first.

### Stop and Pause Simple PLC Control

Active 'Simple PLC control' can be stopped or paused by configuration of digital inputs E1.00...E1.04, H8.00...H8.04 to '26: Simple PLC stop' or '27: Simple PLC pause'.

- **26: Simple PLC stop**

  The frequency converter stops output till next 'Run command' is active, and the motor freewheels to stop.

- **27: Simple PLC pause**

  'PLC control' is paused and the frequency converter decelerates to run at 0 Hz till the pause signal is inactive.

A typical simple PLC pause process is as listed in the table below:

| Step | Simple PLC pause | Run command | Converter status | Description |
|---|---|---|---|---|
| 1 | Inactive | Active | Run | Simple PLC cycles with each stage |
| 2 | Active | Active | Decelerating to 0 Hz (No stop DC-braking) | Dec. time is according to current simple PLC stage setting |
| 3 | Inactive | Active | Accelerate to previous stage | Acc. Time is according to previous simple PLC stage setting before pause |

| Step | Simple PLC pause | Run command | Converter status | Description |
|---|---|---|---|---|
| 4 | Inactive | Inactive | Stop | Stop according to [E0.50] |
| 5 | Inactive | Active | Run | Restart from 1st simple PLC stage |

**Tab. 12-24:** Typical simple PLC pause process

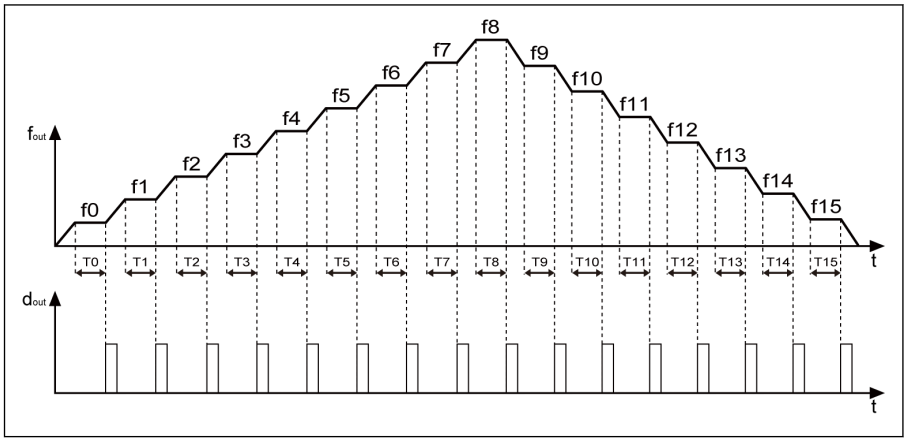
### Indication of Simple PLC Status

An indication signal is active via 'DO output' or 'Relay output' when a simple PLC cycle or stage is complete.

Define the output with respective indication signals by setting E2.01, E2.15, H8.20, H8.21, H8.22, H9.00, H9.01, H9.02, H9.03 to '7: Simple PLC stage complete' or '8: Simple PLC cycle complete'.

- **7: Simple PLC stage complete**

  When a stage is complete, a pulse signal is active for the duration of 0.5 s. Any stage with running time of 0.0 s will be skipped without pulse output.




**$f_{out}$** Output frequency **t** Time
**$d_{out}$** Digital output

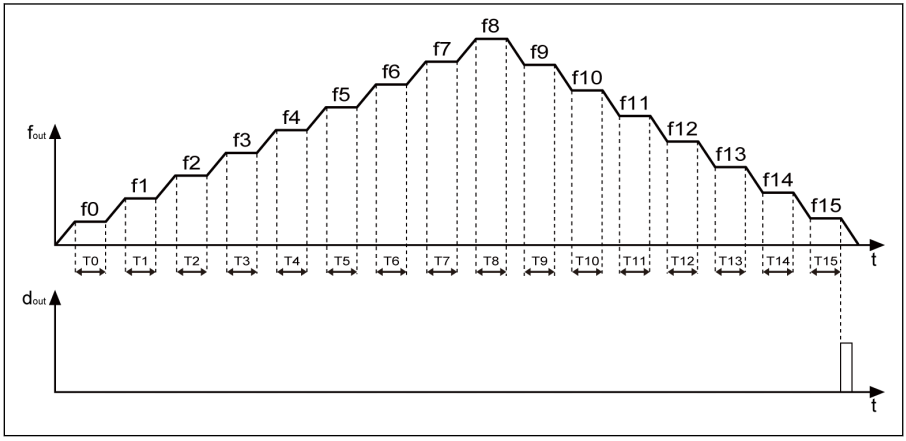
**Fig. 12-98:** Simple PLC stage complete

1. If the running time of one stage is so short that it finishes before the 'Simple PLC stage complete' signal of the previous stage is deactivated, the signal remains active and the pulse duration calculation is restarted.
2. If the setting frequency of next stage is lower than that of the current stage, the frequency converter decelerates to the next stage with the deceleration time of current stage.

3. If the setting frequency of next stage is higher than that of the current stage, the frequency converter accelerates to the next stage with the acceleration time of next stage.

- **8: Simple PLC cycle complete**

  When a cycle is complete, a pulse signal is active for the duration of 0.5 s.




**$f_{out}$** Output frequency
**$d_{out}$** Digital out
**t** Time

**Fig. 12-99:** Simple PLC cycle complete

# 12.12 E4: PID Control

## 12.12.1 PID Control Setting

### Parameters

PID control is used in process controls such as flow control, pressure control, temperature control, and in control of other engineering values. In PID control, a negative feedback system is formed with proportional, integral and derivative operations based on the differences between reference values and their feedback. In this way, the difference between the actual output and the reference is reduced.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E4.00 | PID reference channel | 0: Inactive<br>1: Panel potentiometer<br>2: Panel button<br>3: AI1 analog input<br>4: AI2 analog input<br>5: X5 pulse input<br>6: EAI1 analog input<br>7: Communication<br>8: Analog reference E4.03<br>9: Speed reference E4.04<br>10: EAI2 analog input | 0 | - | – | Stop |
| E4.01 | PID feedback channel | 0: AI1 analog input<br>1: AI2 analog input<br>2: X5 pulse input<br>3: EAI1 analog input<br>4: Encoder card speed<br>5: EAI2 analog input | 0 | - | – | Stop |
| E4.02 | PID reference / feedback factor | 0.01...100.00 | 1.00 | - | 0.01 | Run |
| E4.03 | PID engineering analog reference | 0.00...10.00 | 0.00 | - | 0.01 | Run |
| E4.04 | PID engineering speed reference | 0...30,000 rpm | 0 | rpm | 1 | Run |
| E4.05 | PID feedback polarity | 0: Positive; 1: Negative | 0 | - | – | Stop |
| E4.15 | Proportional gain - P | 0.000...60.000 | 1.500 | - | 0.001 | Run |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E4.16 | Integral time - Ti | 0.00...100.00 s<br>(0.00: no integral) | 1.50 | s | 0.01 | Run |
| E4.17 | Derivative time - Td | 0.00...100.00 s<br>(0.00: no derivative) | 0.00 | s | 0.01 | Run |
| E4.18 | Sampling period - T | 0.01...100.00 s | 0.50 | s | 0.01 | Run |
| E4.19 | PID feed forward dynamic limit | 0.00...100.00 % | 10.00 | - | 0.01 | Run |
| E4.20 | PID feed forward minimum value | 0.00...100.00 % | 0.00 | - | 0.01 | Run |
| E4.30 | PID deadband | 0.0...20.0 % | 2.0 | - | 0.1 | Run |
| E4.31 | PID regulation mode | 0, 1 | 0 | - | – | Run |
| E4.32 | PID engineering value detection width | 0.01...100.00 | 1.00 | - | 0.01 | Run |
| E4.33 | PID feed forward settings | 0: Inactive; 1: Active | 0 | - | – | Stop |

The basic control principle is shown as the figure below:

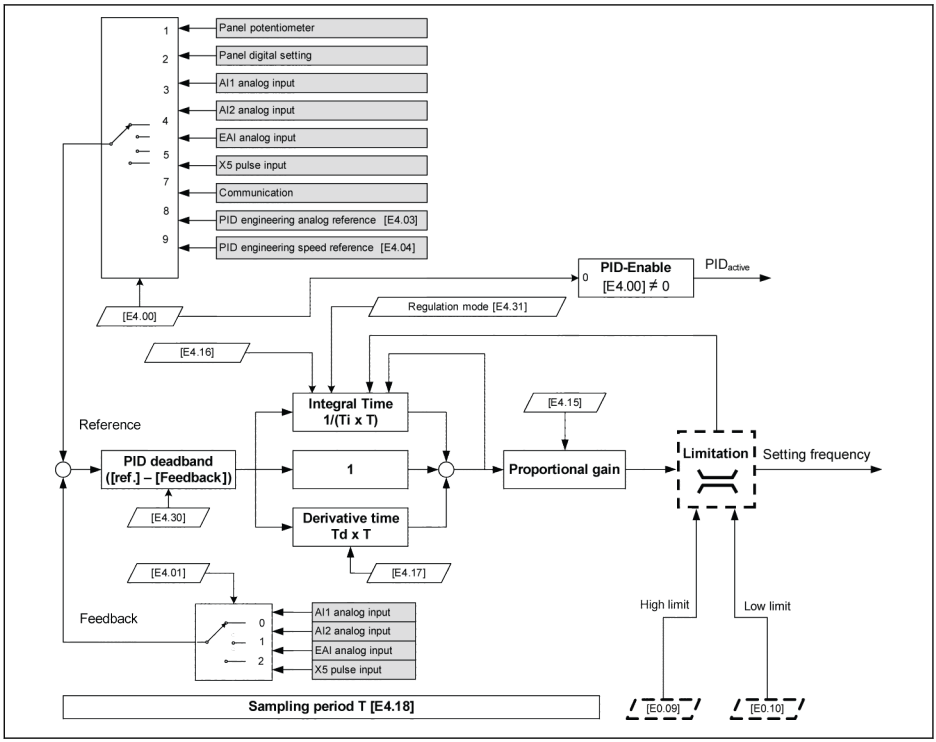



**Fig. 12-100:** PID control principle

## Selecting the Reference and Feedback

Before using PID control function make sure [E1.00]...[E1.04] ≠ '41: PID deactivation'.

Take the following steps to configure the PID reference:

### Step 1: Select the PID reference channel

- **[E4.00] = 0: Inactive**

  The PID control function is inactive.

- **[E4.00] = 1: Panel potentiometer**

  The reference value is set by adjusting the potentiometer on the operating panel.

- **[E4.00] = 2: Panel button**

  The reference value is set by E0.07 'Digital setting frequency', which can be decreased or increased by pressing the **<▼>** or **<▲>** buttons on the operating panel respectively when the frequency converter is running.

- **[E4.00] = 3: AI1 analog input**

The reference value is set by AI1 analog input.

- **[E4.00] = 4: AI2 analog input**
  The reference value is set by AI2 analog input.
- **[E4.00] = 5: X5 pulse input**
  The reference value is set by pulse signal via X5 input.
- **[E4.00] = 6: EAI1 analog input**
  The reference value is set by EAI1 analog input.
- **[E4.00] = 7: Communication**
  The reference value is set by engineering software, PLC or other external devices via Modbus or other communication.
- **[E4.00] = 8: Analog reference E4.03**
  The reference value is set by parameter E4.03.
- **[E4.00] = 9: Speed reference E4.04**
  The reference value is set by parameter E4.04.
- **[E4.00] = 10: EAI2 analog input**
  The reference value is set by EAI2 analog input.

**Step 2: Select the PID feedback channel**

- **[E4.01] = 0: AI1 analog input**
  Feedback value is set by AI1 analog input.
- **[E4.01] = 1: AI2 analog input**
  Feedback value is set by AI2 analog input.
- **[E4.01] = 2: X5 pulse input**
  Feedback value is set by X5 pulse input.
- **[E4.01] = 3: EAI1 analog input**
  Feedback value is set by EAI1 analog input.
- **[E4.01] = 4: Encoder card speed**
  Feedback value is set by encoder card speed.
- **[E4.01] = 5: EAI2 analog input**
  Feedback value is set by EAI2 analog input.

### PID feedback polarity

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E4.05 | PID feedback polarity | 0: Positive<br>1: Negative | 0 | - | - | Stop |

By default, E4.05 is ‘0: Positive’, “**Reference- Feedback**” is used for PID regulation, which is used when feedback value will **rise** when output frequency **rises**.

When E4.05 is set to '1: Negative', then "**Feedback- Reference**" is used for PID regulation, which is used when feedback value will **drop** when output frequency **rises**.

| E4.05 | PID Output | PID Feedback |
|---|---|---|
| 0: Positive | ↑ | ↑ |
| | ↓ | ↓ |
| 1:Negative | ↑ | ↓ |
| | ↓ | ↑ |

**Tab. 12-25:** PID feedback polarity

### Control Loop Configuration

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E4.15 | Proportional gain - P | 0.000...60.000 | 1.500 | - | 0.001 | Run |
| E4.16 | Integral time - Ti | 0.00...100.00 s<br>(0.00: no integral) | 1.50 | s | 0.01 | Run |
| E4.17 | Derivative time - Td | 0.00...100.00 s<br>(0.00: no derivative) | 0.00 | s | 0.01 | Run |
| E4.18 | Sampling period - T | 0.01...100.00 s | 0.50 | s | 0.01 | Run |

**Proportional gain - P: Decides the gain of deviation**

- Larger P means larger scale and faster response, but excessively large P leads to oscillation.
- P cannot eliminate deviation completely.

**Integral time - Ti: Used to eliminate the deviation**

- Smaller Ti means faster response of the frequency converter to deviation changes, but excessively small Ti leads to oscillation.
- If Ti = 0, integration is deactivated during PID control.
  - Integration stops but the integral value is kept.
  - Integration continues if Ti ≠ 0.

**Derivative time - Td: Used to respond fast to changes of deviation between reference and feedback.**

- Larger Td means faster response, but excessively large Td leads to oscillation.
- If Td = 0, derivative is deactivated during PID control.

  Derivative stops and its value is reset to '0'.

**Sampling period - T: Sampling time in PID control**

The value should match with the selected time constant Ti or Td, normally shorter than 1/5 of the time constant.

### PID Regulation Mode Setting

Parameter [E4.30] 'PID deadband' is used to set the limit of the deviation between reference and feedback value. When the difference is within the defined 'PID deadband', PID control stops to bring a stable output.

When the PID output reaches [E0.09] 'Output frequency high limit' or [E0.10]'Output frequency low limit' in PID control, following modes that is defined by Parameter [E4.31] 'PID regulation mode' are available for PID regulation:

**[E4.31] = 0: Stop integral regulation when frequency arrives at upper / lower limit**

When the difference between the reference values and the feedback values changes, the integral value follows immediately the difference. When the setting frequency reaches the limits, the integration stops, and the integral value remains unchanged. This mode is used in applications with fast change reference values.

**[E4.31] = 1: Continue integral regulation when frequency arrives at upper / lower limit**

When the PID output reaches the limits, the integral continues up to its possible numerical limit.

This mode is used in applications with stable reference values. When the difference between reference and feedback changes, more time is needed to eliminate the impact of accumulated integral regulation before the integral value can follow the change in the trend.

### PID Feedforward Control

PID feedforward controls the process item through amending the output frequency setting with the fine tuning signal of PID output. Before using this function, users need set [E4.00] ≠ 0, and E4.33 should be set refer to the following choice:

- 0: PID feedforward inactive. If [E4.00] ≠ 0, the given frequency is set by PID output.
- 1: PID feedforward activate. If [E4.00] ≠ 0, the given frequency is set by the result of PID output plus the main frequency setting; the given frequency is set by parameter E0.00 "First frequency setting source", and be obtained through Acc / Dcc module.

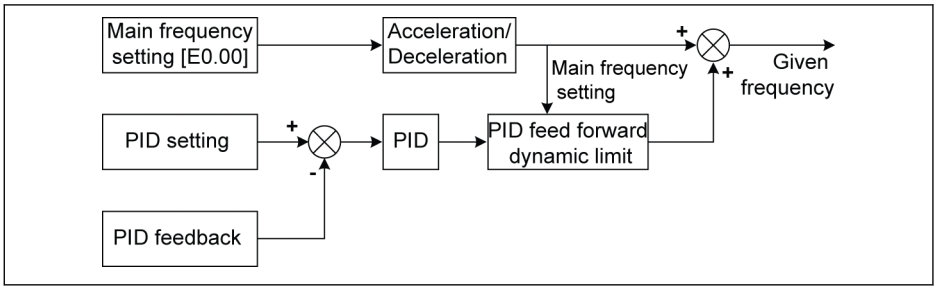



**Fig. 12-101:** PID feedforward

The parameters E4.19 and E4.20 are both used for limiting the value of PID feedforward. E4.19 is the percentage relative to the main frequency, and E4.20 is the percentage relative to E0.08.

So, the range of PID feedforward frequency is:

-Min{[E4.19] × Main frequency + [E4.20] × [E0.08], [E0.09]}...Min{[E4.19] × Main frequency + [E4.20] × [E0.08], [E0.09]}

## PID Deactivation by Digital Input

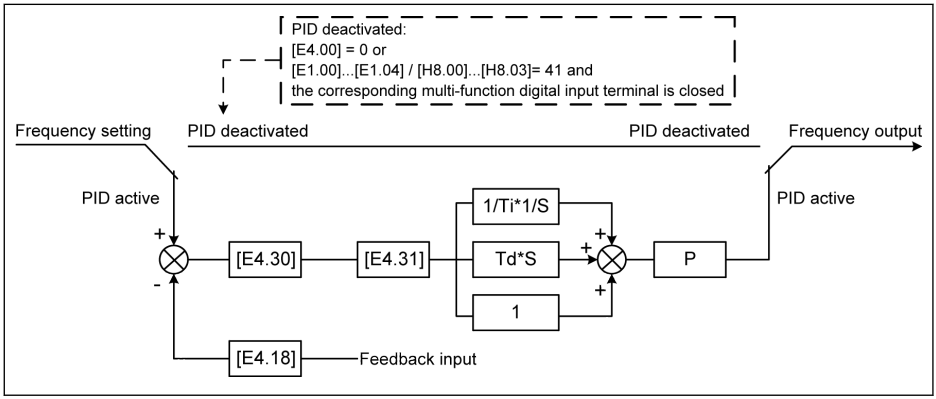



**Fig. 12-102:** PID deactivation by digital input

The PID control is deactivated in the following ways:

- 'PID reference channel' [E4.00] = '0: No PID control' or
- 'X1...X4 input' [E1.00]...[E1.04] or 'EX1...EX4 input' [H8.00]...[H8.03] = '41: PID deactivation' and respective multi-function digital input terminal is active.

## PID Status Indication

[E4.32] 'PID engineering value detection width' is used to set the tolerance window between [d0.70] 'PID reference engineering value' and [d0.71] 'PID feed-

back engineering value'. When the difference between reference and feedback is within the detection width, the value arrival signal will be active via DO1 output.

Set [E4.32] = |[d0.70] - [d0.71]|/[d0.70] x 100 %

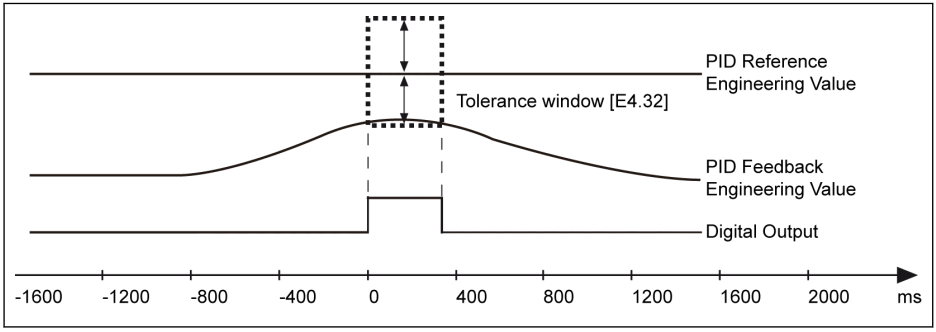



**Fig. 12-103:** PID engineering value detection width

## 12.13 E5: Extended Application Functions

### 12.13.1 High Resolution Current Display

E5.01 is used to set the time constant of dynamic output current in applications where a high resolution value with two decimals are required for monitoring or control.The high resolution output current can be monitored via d0.98.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E5.01 | High resolution output current filter time | 5...500 ms | 40 | ms | 1 | Run |

### 12.13.2 Speed Display Scaling

This function is used to display an engineering value which is convenient for the application engineering with scaling the output value.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E5.02 | User-defined speed scaling factor | 0.01...100.00 | 1.00 | - | 0.01 | Run |

Follow the equations below:

- User-defined setting speed:
  [d0.04] = [d0.02] x [E5.02]
- User-defined output speed:
  [d0.05] = [d0.00] x [E5.02]

## 12.13.3 Pump Dry and Leakage Protection

This function defines two modes of pump protection:

- Pump dry protection: Protecting the pump from running without water load (e.g., water pump without water)
- Pump leakage protection: Protecting the pump from running with leakage

Both protection modes are realized by comparing the PID feedback with the PID reference when the frequency converter is running at [E0.09] 'Output frequency high limit'.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E5.05 | Pump dry protection threshold | 0.0 %... [E5.08] | 30.0 | - | 0.1 | Run |
| E5.06 | Pump dry protection delay | 0.0...300.0 s (0.0 s: Inactive) | 0.0 | - | 0.1 | Run |
| E5.07 | Pump dry protection delay at start-up | 0.0...300.0 s | 30.0 | s | 0.1 | Run |
| E5.08 | Pump leakage protection threshold | 0.0...100.0 % | 50.0 | - | 0.1 | Run |
| E5.09 | Pump leakage protection delay | 0.0...600.0 s (0.0 s: Inactive) | 0.0 | s | 0.1 | Run |
| E5.10 | Pump leakage protection delay at start-up | 0.0...600.0 s | 60.0 | s | 0.1 | Run |

**The conditions to trigger the pump dry protection:**

- Frequency converter runs at the [E0.09] 'Output frequency high limit'
- ([PID feedback] ÷ [PID reference]) < [E5.05] 'Pump dry protection threshold'
- Duration ≥ [E5.06] 'Pump dry protection delay'

When the pump dry protection is triggered, the error code 'Pdr' will be displayed on the operating panel. The error message '24: Pdr, pump dry' can be read via parameters E9.05...E9.07.

**The conditions to trigger the pump leakage protection:**

- Frequency converter runs at the [E0.09] 'Output frequency high limit'
- ([PID feedback] ÷ [PID reference]) < [E5.08] 'Pump leakage protection threshold'
- Duration ≥ [E5.09] 'Pump leakage protection delay'

When the pump leakage protection is triggered, the warning code 'PLE' will be displayed on the operating panel.

- The 'Pump dry protection delay at start-up' E5.07 and the 'Pump leakage protection delay at start-up' E5.10 are used to prevent the two modes of protection at start-up process.
- These two modes of protection are only valid when PID control is enabled.

### 12.13.4 Sleep Function

This function is used to achieve the maximum extent of energy-saving according to type of loads in actual applications.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E5.15 | Sleep level | 0.00...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| E5.16 | Sleep delay | 0.0...3,600.0 s | 60.0 | s | 0.1 | Run |
| E5.17 | Sleep boost time | 0.0...3,600.0 s | 0.0 | s | 0.1 | Run |
| E5.18 | Sleep boost amplitude | 0.0...100.0 % | 0.0 | - | 0.1 | Run |
| E5.19 | Wake up level | 0.0...100.0 % | 0.0 | - | 0.1 | Run |
| E5.20 | Wake up delay | 0.0...60.0 s | 0.5 | - | 0.1 | Run |

E5.18 and E5.19 are the percentage of PID reference.

The frequency converter may go into the sleep mode when all the conditions below are met:

- [PID feedback] > [E5.19] 'Wake up level'
- [PID output] < [E5.15] 'Sleep level'
- [Duration] t ≥ [E5.16] 'Sleep delay'

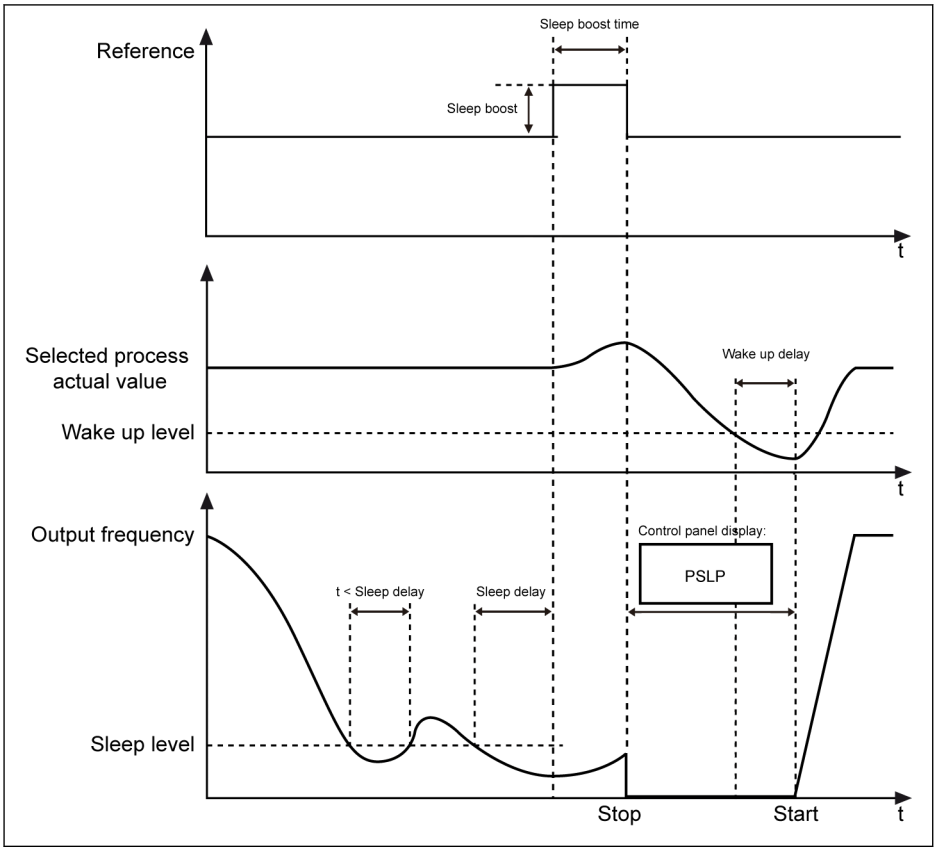



**Fig. 12-104:** Sleep and wake up process

After [E5.16] 'Sleep delay', the PID controller boosts up with [E5.18] 'Sleep boost amplitude' within [E5.17] 'Sleep boost time', and then enters to sleep mode. In sleep mode, the frequency converter stops output with 'PSLP' displayed on the operating panel.

[Sleep boost] = [E5.18] x [PID reference]

During sleeping, the frequency converter monitors the actual PID feedback and wakes up when the following two conditions are met:

- [PID feedback] < [E5.19] 'Wake up level'
- [Duration] t ≥ [E5.20] 'Wake up delay'

The frequency converter resumes to its previous running status after waking up.

## 12.14 E8: Standard Communication

### 12.14.1 Modbus Protocol

#### Brief Introduction

VFC x615 frequency converters provide standard RS485 communication interface to realize the communication between the master and slaves via Modbus protocol. With the help of a PC, a PLC or an external computer a 'single master / multiple slaves' network control can be realized (setting of frequency control command and running frequency, modification of parameters, monitoring of frequency converter running status and error messages) to address the specific requirements of applications.



User parameters of the frequency converter can be written via communication interface for 150,000 times.

#### Protocol Description

#### Protocol introduction

- Modbus is a master / slave protocol. Only one device may send commands in the network at a particular time.
- The master station manages message exchange by polling the slave stations. Unless being approved by the master station, no slave station may send message. In case of an error during data exchange, if no response is received, the master station will query the slave stations absent from the polling.
- If a slave station is unable to recognize a message from the master station, an exception response will be sent to the master station.
- Slave stations cannot communicate with each other but through the master's software which reads data from one slave station and sends them to another. There are two types of dialogs between the master station and the slave stations:
  - The master station sends a request to a slave station and waits for its response.
  - The master station sends a request to all slave stations and does not wait for their response (broadcasting).

### Transmission

The transmission is of RTU (Remote Terminal Unit) mode with frames containing no message header or end mark. A typical RTU frame format is shown below:

| Slave address | Function code | Data | CRC |
|---|---|---|---|
| 1 byte | 1 byte | 0...252 byte(s) | CRC low\|CRC high |

**Tab. 12-26:** Typical RTU frame format

- Data are transmitted in binary codes.
- CRC: Cyclic redundancy code.

- The address 0 is reserved as broadcast address.
- All slave nodes must recognize the broadcast address for writing function (no need of reply).
- The master node has no specific address, only the slave nodes must have addresses (1...247).

For RTU transmission mode, four types of character format are shown below:

- 1 start bit, 8 data bits, 1 stop bit, no parity
- 1 start bit, 8 data bits, 1 stop bit, even parity
- 1 start bit, 8 data bits, 1 stop bit, odd parity
- 1 start bit, 8 data bits, 2 stop bits, no parity

The character or byte is sent in the following sequence (from left to right):

| <-Least significant bit (LSB) | | | | | | | Most significant bit (MSB)-> | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop | – |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Even | Stop |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Odd | Stop |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop | Stop |

**Tab. 12-27:** RTU transmission mode

Message frames are separated by a silent interval of at least 3.5 characters' time. The entire frame must be transmitted as a continuous stream of bytes. If the interval of two separated frames is less than 3.5 characters' time, then the slave address of second frame will be treated as the part of first frame by mistake, due to the confusion of the frames, the CRC check will fail and lead to communication fault. If a silent interval of more than 1.5 characters' time occurs between two bytes, the message frame is regarded incomplete and discarded by the receiver.

### Modbus Interface

The Modbus communication is via RS485 interface, see descriptions on RS485+ and RS485- in chapter 8 "Frequency Converter Wiring" on page 52 and chapter 8.3.2 "Control Terminals" on page 70.

### Modbus Function and Message Format

### Supported functions

The main function of Modbus is to read and to write parameters. Different function codes decide different operation requests. Modbus functions managed by VFC x615 and their limits are shown in the table below:

| Code | Function name | Broadcast | Max. value of N |
|---|---|---|---|
| 3 = 0x03 | Read N register words | NO | 16 |
| 6 = 0x06 | Write one register word | YES | – |
| 8 = 0x08 | Diagnosis | NO | – |
| 16 = 0x10 | Write N register words | YES | 16 |
| 23 = 0x17 | Read/write N register words | NO | 16 |

**Tab. 12-28:** VFC x615 Modbus functions and limits



'Read' and 'Write' are considered from the prospect of the master station.

Modbus message formats are different according to the function codes shown below.

| Slave No. | 0x03 | Address of 1st word | Number of words | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 12-29:** Function 3_Request from the master

| Slave No. | 0x03 | Number of bytes | 1st word value | – | Last word value | CRC16 |
|---|---|---|---|---|---|---|
| | | Depends on master request | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 12-30:** Function 3_Response from the slave

| Slave No. | 0x06 | Address of word | Value of word | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 12-31:** Function 6_Master request and slave response (in same format)

| Slave No. | 0x08 | Test word 1 | Test word 2 | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 12-32:** Function 8_Master request and slave response (in same format)

| Slave No. | 0x10 | Address of 1st word | Number of words | Number of bytes | 1st word value | – | Last word value | CRC16 |
|---|---|---|---|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 12-33:** Function 16_Request from the master

| Slave No. | 0x10 | Address of 1st word | Number of words | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 12-34:** Function 16_Response from the slave

| Slave No. | 0x17 | Address of 1st word to be read | Number of words to be read | Address of 1st word to be written |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Hi \| Lo |

| Number of words to be written | Number of bytes to be written | Value of 1st word to be written | – | Value of last word to be written | CRC16 |
|---|---|---|---|---|---|
| Hi \| Lo | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 12-35:** Function 23_Request from the master

| Slave No. | 0x17 | Number of bytes | 1st word value read | – | Last word value read | CRC16 |
|---|---|---|---|---|---|---|
| | | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 12-36:** Function 23_Response from the slave

### Function example

### Function 0x03: Read N register words, range: 1...16

Example: It is necessary to read 2 continuous words starting from communication register 3000H of the slave frequency converter addressed at 01H. The frame structure is described in the tables below.

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 03H |
| Higher byte of start address | 30H |
| Lower byte of start address | 00H |
| Higher byte of data | 00H |
| Lower byte of data | 02H |
| CRC lower byte | CBH |
| CRC higher byte | 0BH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-37:** Function 0x03_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 03H |
| Bytes of data | 04H |
| Higher byte of data in register 3000H | 00H |
| Lower byte of data in register 3000H | 14H |
| Higher byte of data in register 3001H | 00H |
| Lower byte of data in register 3001H | 02H |
| CRC lower byte | 3BH |
| CRC higher byte | F6H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-38:** Function 0x03_Response from RTU slave

### Function 0x06: Write one register word

**⚠ CAUTION**

**Frequent writing may damage the internal registers!**

- When data is written into the internal registers, there is a limit on the writing times. The register address may be damaged once the writing times is beyond the writing limit. So please avoid frequent writing!
- For details of user writing permission, please see chapter 19.3.1 "Terminology and Abbreviation in Parameter List" on page 525.

Example: Write 0000H to communication register address 3002H of the slave frequency converter with address 01H. The frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 06H |
| Higher byte of write register address | 30H |
| Lower byte of write register address | 02H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 27H |
| CRC higher byte | 0AH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-39:** Function 0x06_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 06H |
| Higher byte of write register address | 30H |
| Lower byte of write register address | 02H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 27H |
| CRC higher byte | 0AH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-40:** Function 0x06_Response from RTU slave

### Function 0x08: Diagnostics

Example: To test the communication loop of 2 continuous words 1234H and 5678H with frequency converter slave address 01H, the frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-41:** Function 0x08_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-42:** Function 0x08_Response from RTU slave

### Function 0x10: Write N register words, range: 1...16

Example: To modify 2 continuous registers start from 4000H with words 0001H and 0000H with slave frequency converter address 01H. The frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 10H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of register number | 00H |
| Lower byte of register number | 02H |
| Bytes of data | 04H |
| Higher byte of data in register 4000H | 00H |
| Lower byte of data in register 4000H | 01H |
| Higher byte of data in register 4001H | 00H |
| Lower byte of data in register 4001H | 00H |
| CRC lower byte | 93H |
| CRC higher byte | ACH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-43:** Function 0x10_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 10H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of register number | 00H |
| Lower byte of register number | 02H |
| CRC lower byte | 54H |
| CRC higher byte | 08H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-44:** Function 0x10_Response from RTU slave

### Function 0x17: Read/Write N register words, range: 1...16

Example: To read data in 2 continuous registers starting from address 3000H, write 0001H and 0000H to 2 continuous registers starting from address 4000H. The frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 17H |
| Higher byte of read register start address | 30H |
| Lower byte of read register start address | 00H |
| Higher byte of read register number | 00H |
| Lower byte of read register number | 02H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of write register number | 00H |
| Lower byte of write register number | 02H |
| Bytes of data for writing | 04H |
| Higher byte of data in register 4000H | 00H |
| Lower byte of data in register 4000H | 01H |
| Higher byte of data in register 4001H | 00H |
| Lower byte of data in register 4001H | 00H |
| CRC lower byte | E6H |
| CRC higher byte | B3H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-45:** Function 0x17_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 17H |
| Bytes of read register | 04H |
| Higher byte of read register 3000H | 00H |
| Lower byte of read register 3000H | 14H |
| Higher byte of read register 3001H | 00H |
| Lower byte of read register 3001H | 02H |
| CRC lower byte | 38H |
| CRC higher byte | E2H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 12-46:** Function 0x17_Response from RTU slave

### Error code and exception code

If a slave receives the request without a communication error, but cannot handle it, the slave will return an exception response which includes error code and exception code informing the master of the nature of the error. The error code is formed by setting the MSB of the function code to 1 (i.e. function code plus with 0x80, like 0x83, 0x86, 0x90, 0x97), then the exception response has a format shown below.

| Slave No. | Error code | Exception code | CRC16 |
|---|---|---|---|
| | | | Lo \| Hi |

Exception codes for VFC x615 frequency converters:

- 1 = Parameter cannot be modify owing to user password locked
- 2 = The function requested is not recognized by the slave, i.e. not equal to 3, 6, 8, 16 or 23
- 3 = The word address indicated in the request do not exist in the slave
- 4 = The word values indicated in the request are not permissible in the slave
- 5 = Parameters cannot be modify in run mode
- 6 = Parameters are read-only that cannot be modified
- 7 = Invalid operation which is decided by the function of frequency converter(*)
- 9 = EEPROM read/write error
- B = Function code 3, read range exceeds 16



(*) includes situations listed below:

- Write operations on b0.11 'Parameter copy', U1.00 'Run monitoring display', U1.10 'Stop monitoring display' and C1.01 'Motor parameter tuning', are prohibited.
- Write operations on b0.20 'User password', b0.21 'Manufacture password' and b0.10 'Parameter initialization' only support function 6.
- Multi-function digital input terminals (E1.00...E1.04) writing operation do not permit repeated non-zero value.

## Communication Mapping Register Address Distribution

### Frequency converter parameter address

Frequency converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in frequency converter parameter registers via Modbus communication. The characteristics and scope of reading and writing function codes are in compliance with the frequency converter function code description. The address of a frequency converter parameter register is composed of a higher byte representing the function code group and a lower byte representing the index in the group. The groups are mapped as follows:

| Address high byte | 0x00 | 0x20 | 0x21 | 0x22 | 0x23 | 0x30 | 0x31 | 0x32 | 0x33 | 0x34 |
|---|---|---|---|---|---|---|---|---|---|---|
| Group | b0 | C0 | C1 | C2 | C3 | E0 | E1 | E2 | E3 | E4 |
| Address high byte | 0x35 | 0x38 | 0x39 | 0x60 | 0x61 | 0x68 | 0x69 | 0x40 | 0x41 | 0x10 |
| Group | E5 | E8 | E9 | H0 | H1 | H8 | H9 | U0 | U1 | d0 |

**Tab. 12-47:** Frequency converter parameter registers



Parameters of the monitoring group (Group d0) are always write-protected.

**Examples:**

To read out the module temperature (d0.20) of VFC x615 frequency converter, use register address 0x1014 (0x10 = Group d0, index 0x14 = 20).

To set V/f curve mode (C2.00) of VFC x615 frequency converter, use register address 0x2200 (0x22 = Group C2, index 0).

Access to a non-existing function code will be acknowledged with exception code 3 (see chapter "Modbus Function and Message Format" on page 282).

### Frequency converter register address

| Register | Address |
|---|---|
| Communication control register | 0x7F00 |
| Communication state register | 0x7FA0 |
| Additional status register | 0x7FA1 |
| STO safety status register | 0x7FA2 |
| Fault status register | 0x7FB0 |
| Communication frequency setting register | 0x7F01 |
| Torque setting register | 0x7F02 |
| Torque FWD limitation register | 0x7F03 |
| Torque REV limitation register | 0x7F04 |
| Speed limitation register | 0x7F05 |

**Tab. 12-48:** Frequency converter register address

### Communication control register (0x7F00)

The address of command word register for communication control is 0x7F00. This register is write-only. The frequency converter is controlled through writing data into the address. The definition of each bit is shown in table below:

| bit | Value | Description |
|---|---|---|
| 15...9 | – | Reserved |
| 8 | 1 | Torque control active |
| | 0 | Inactive |
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 12-49:** Communication control register (0x7F00)

If the communication frame check is successful (CRC valid), the frequency converter always accepts the content of the control word. All conflicts (e.g. run command and stop command active at the same time) are resolved by the application functionality (Run / Stop generator, jog control...). This assures that the frequency converter will always react in the same manner, independent of the run command source.

### Communication state register (0x7FA0)

The frequency converter state can be monitored by reading the register. This register is read-only. The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15 ... 8 | – | Error code (equals to [E9.05]) |
| 7 | 1 | Error |
| | 0 | No error |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 12-50:** Communication state register (0x7FA0)

### Additional status register (0x7FA1)

Additional status register is the extension of main status register(7FA0H), it stores other status information of frequency converter. This register is read-only. The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15 | 1 | Error |
| | 0 | No error |
| 14 | 1 | Warning |
| | 0 | No warning |
| 13 | - | Reserved |
| 12 | 1 | Sleep mode |
| | 0 | Normal |
| 11 | 1 | Coasting to stop |
| | 0 | Not coasting |
| 10 | 1 | Speed tracing |
| | 0 | Not tracing |
| 9 | 1 | 0 speed |
| | 0 | Not 0 speed |
| 8 | 1 | DC braking |
| | 0 | Not DC braking |
| 7 | 1 | Converter OK |
| | 0 | Converter not OK |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 12-51:** Additional status register (0x7FA1)

### STO safety status register (0x7FA2)

| bit | Value | Description |
|---|---|---|
| 15...3 | - | Reserved |
| 2 | 1 | StO-E |
| | 0 | Not in StO-E status |
| 1 | 1 | StO-r |
| | 0 | Not in StO-r status |
| 0 | 1 | StO-A |
| | 0 | Not in StO-A status |

**Tab. 12-52:** STO safety status register (0x7FA2)

### Fault status register (0x7FB0)

The fault status of frequency converter can be monitored by reading the register. This register is read-only.

| bit | HEX | Description |
|---|---|---|
| | 0 | No error |
| | 1 | OC-1, overcurrent at constant speed |
| | 2 | OC-2, overcurrent during acceleration |
| | 3 | OC-3, overcurrent during deceleration |
| | 4 | OE-1, overvoltage at constant speed |
| | 5 | OE-2, overvoltage during acceleration |
| | 6 | OE-3, overvoltage during deceleration |
| | 7 | OE-4, overvoltage during stop |
| | 8 | UE-1, undervoltage during run |
| | 9 | SC, surge current or short circuit |
| | A | IPH.L, input phase loss |
| | B | OPH.L, output phase loss |
| bit 15 | C | ESS-, soft start error |
| . | 14 | OL-1, converter overload |
| . | 15 | OH, converter over temperature |
| . | 17 | FF, fan failure |
| bit 0 | 18 | Pdr, pump dry |
| | 19 | CoL-, command value lost |
| | 1A | StO-r, safe torque off request |
| | 1B | StO-E, safe torque off error |
| | 1E | OL-2, motor overload |
| | 1F | Ot, motor over temperature |
| | 20 | t-Er, motor parameter tuning error |
| | 21 | AdE-, motor angle detection error |
| | 23 | SPE-, speed control loop error |
| | 26 | AibE, analog input broken wire detection |
| | 27 | EPS-, DC_IN power supply error |
| | 28 | dir1, forward running lock error |
| | 29 | dir2, reverse running lock error |

| bit | HEX | Description |
|---|---|---|
| bit 15<br>.<br>.<br>.<br>bit 0 | 2A | E-St, terminal error signal |
| | 2B | FFE-, firmware version mismatch |
| | 2C | rS-, modbus communication error |
| | 2D | E.Par, parameter settings invalid |
| | 2E | U.Par, unknown parameter restore error |
| | 30 | idA-, internal communication error |
| | 31 | idP-, internal parameter error |
| | 32 | IDE-, converter internal error |
| | 33 | OCd-, extension card internal error |
| | 34 | Occ, extension card PDOs configuration error |
| | 35 | Fdi-, no valid process data |
| | 36 | PcE-, remote control communication error |
| | 37 | PbrE, parameter backup / restore error |
| | 38 | PrEF, parameter restore error after firmware update |
| | 3C | ASF-, application firmware error |
| | 3D | APE1, application error 1 |
| | 3E | APE2, application error 2 |
| | 3F | APE3, application error 3 |
| | 40 | APE4, application error 4 |
| | 41 | APE5, application error 5 |

**Tab. 12-53:** Fault status register (0x7FB0)

### Communication frequency setting register (0x7F01)

The address of frequency setting register for communication control is 0x7F01. This register is for read and write. When 'First frequency setting source' [E0.00] = '20: Communication', the frequency converter can be set with writing data to this address.

### Torque setting register (0x7F02)

The address of torque setting register is 0x7F02. This register is for read and write. When 'Torque reference channel' [C3.41] = '6: Communication', the torque reference channel can be set with writing data to this address.

### Torque FWD limitation register (0x7F03)

The address of torque FWD limitation register is 0x7F03. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

### Torque REV limitation register (0x7F04)

The address of torque REV limitation register is 0x7F04. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

### Speed limitation register (0x7F05)

The address of speed limitation register is 0x7F05. This register is for read and write. When 'Speed limitation reference selection at torque control mode' [C3.48] = '4: Communication', the speed limitation reference can be set with writing data to this address.

### Modbus Communication Example

One slave address is 01H. The frequency setting of the frequency converter has been set to 'Given by communication' and the RUN command source is set to 'Inputting commands by communication'. It is required for the motor connected to the frequency converter to run with 50 Hz (forward rotation). The operation can be achieved with function 0x10 (function 16) of the Modbus protocol. The messages of the requests from the master and responses from the slave are shown in table below:

- Example 1: Start 01# frequency converter for forward rotation at frequency of 50.00 Hz (represented by 5,000 internally)

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x10 | 0x7F00 | 0x0002 | 0x04 | 0x0081<br>0x1388 | 0x8AE3 |
| Response | 0x01 | 0x10 | 0x7F00 | 0x0002 | N/A | N/A | 0x581C |

- Example 2: Read the output frequency of 01# frequency converter and output velocity

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x03 | 0x1000 | 0x0002 | N/A | N/A | C0CB |
| Response | 0x01 | 0x03 | N/A | N/A | 0x04 | 0x1388<br>0x05DC | 0x7C54 |

- Example 3: Stop 01# frequency converter according to the stopping mode with the function code

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x06 | 0x7F00 | N/A | N/A | 0x0088 | 0x9078 |
| Response | 0x01 | 0x06 | 0x7F00 | N/A | N/A | 0x0088 | 0x9078 |

### Special Notes

1. The external computer can not write to function codes b0.11 'Parameter copy', U1.00 'Run monitoring display' and U1.10 'Stop monitoring display'.
2. b0.20 'User password' and b0.10 'Parameter initialization' do not support multiple write including single write in multiple write; Motor nameplate parameters and motor physical data should not be modified simultaneously; Multi-function digital input terminals (E1.00...E0.04) writing operation do not permit repeated non-zero value.
3. If the communication protocol is changed, baud rate, data frame and local address will be restored to factory default.
4. The read response of user password and manufacture password is '0000' in case of external computer reading.
5. The external computer can set, modify or cancel user password, the specific operation is same to the situation when 'Running command source' is from the operating panel.
6. The access to control registers and state registers is not limited by user password.

## Communication Networking

### Networking

The communication network is shown in figure below, with a PC, a PLC or an external computer as the master and all frequency converters as slaves, which are connected by shielded twisted pair cables. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω, 0.25 W.

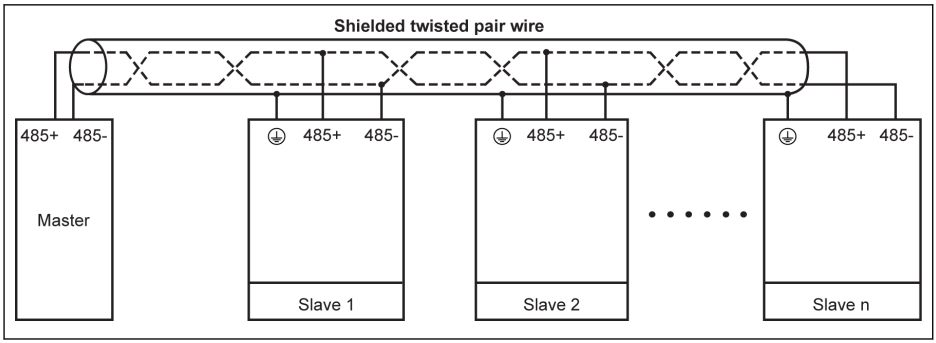



**Fig. 12-105:** Communication networking

- The maximum length of the communication cable is 300 m.
- The maximum length of the communication cable is 80 m if the number of slaves is less than 5.
- If the Modbus network cannot work successfully, check if a bias resistor has been installed for the master device and make sure that its resistance is not more than 1.5 kΩ.

**⚠ WARNING**

**Cables may only be connected when the frequency converters are switched off!**

### Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- Modbus cable should be adequately away from power cables (minimum 30 cm).
- Avoid crossing of Modbus cables and power cables and use orthogonal crossing if crossing must be used.
- The shielding layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.

- In no circumstance should ground cables constitute a loop.

### 12.14.2 Communication Selection

This function is about the selection of the Communication Protocol.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.00 | Communication protocol | 0: Modbus<br>1: Extension card | 0 | – | – | Stop |

The standard product only supports Modbus communication protocol. To use other communication protocols, optional communication cards need to be ordered additionally and parameter E8.00 and other related parameters need to be set accordingly.



For Multi-Ethernet extension card configurations, please refer to documentation R912006860.

### 12.14.3 Communication Error Reaction

This function defines the detection of the communication disruption and corresponding reaction.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.01 | Communication error detection time | 0.0...60.0 s<br>(0.0: Inactive) | 0.0 | s | 0.1 | Stop |
| E8.02 | Communication error protection mode | 0: Freewheeling stop<br>1: Keep running<br>2: Emergency stop | 1 | - | - | Stop |
| E8.03 | Communication process data loss behavior | 0: Decelerating stop<br>1: Freewheeling stop<br>2: Keep running<br>3: Keep running without warning | 0 | - | - | Stop |

When [E8.01] = 0.0 s, the disruption detection function is inactive.

If the interval between the current and next communication commands exceeds the time defined in [E8.01] 'Communication error detection time', the frequency converter will reports a communication error code and act as defined in [E8.02] 'Communication error protection mode':

- **[E8.02] = 0: Freewheeling stop**

  The motor freewheels to stop after the communication timeout no matter the settings of parameter E0.50 'Stop mode'.

- **[E8.02] = 1: Keep running**

  The motor continues running at the setting frequency, and warning code 'C-dr' will be displayed on the operating panel.

- **[E8.02] = 2: Emergency stop**

  The motor decelerate to stop after the communication timeout no matter the settings of parameter E0.56 'Emergency stop action', the deceleration time is E0.57.

E8.03 determines the behavior of the frequency converter when the communication extension card process data lost:

- **[E8.03] = 0: Decelerating stop**

  The motor decelerates to stop according to the defined deceleration time when the communication extension card process data lost.

- **[E8.03] = 1: Freewheeling stop**

  The motor freewheels to stop after the communication extension card process data lost no matter the settings of parameter E0.50 'Stop mode'.

- **[E8.03] = 2: Keep running without warning**

The motor continues running at the setting frequency, and warning code 'Fdi' will be displayed on the operating panel.

- **[E8.03] = 3: Keep running**

  The motor continues running at the setting frequency, and no any warning on the operating panel.

## 12.14.4 Modbus Settings

### Setting the Data Transmission Rate

Data transmission rate refers to the transmission rate of data between the external computer and the frequency converter.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.10 | Modbus baud rate | 0: 1,200 bps<br>1: 2,400 bps<br>2: 4,800 bps<br>3: 9,600 bps<br>4: 19,200 bps<br>5: 38,400 bps | 3 | – | – | Stop |

### Setting the Data Format

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.11 | Modbus data format | 0: 1 start bit, 8 data bits, 1 stop bit, no parity<br>1: 1 start bit, 8 data bits, 1 stop bit, even parity<br>2: 1 start bit, 8 data bits, 1 stop bit, odd parity<br>3: 1 start bit, 8 data bits, 2 stop bits, no parity | 0 | – | – | Stop |



The data format of the converter must be the same as that of the master station. Otherwise, normal communication is impossible.

### Setting the Local Address

In Modbus communication, the maximum number of frequency converters in the network is 247. Each frequency converter must have a unique local address.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.12 | Modbus local address | 1...247 | 1 | – | 1 | Stop |

### Setting Command Signal Type

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.13 | Modbus level / edge sensitivity selection | 0: Level sensitive<br>1: Edge sensitive | 1 | – | – | Stop |

Setting range of E8.13:

**E8.13 = 0: Level sensitive**

The control word is not a real edge sensitive, master should manually reset the command.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is not reset
5. Master should set bit 5 = 0 firstly, then set bit 5 = 1, the error is reset

**E8.13 = 1: Edge sensitive**

The control command is reset automatically after the activation.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is not reset

### Setting Modbus transmission mode

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E8.14 | Modbus transmission mode selection | 0: RTU transmission<br>1: ASCII transmission mode | 0 | – | – | Stop |
| E8.15 | Modbus ASCII inter-character timeout | 1.0...5.0 s | 1.0 | s | 0.1 | Stop |

E8.15 is used to set the maximum time delay allowed between 2 characters of a single ASCII frame.

# 12.15 E9: Error Log and Automatic Error Reset

## 12.15.1 Automatic Error Reset

Automatic error reset function can be used to ensure continuous running without human intervention in the case of occasional errors, such as over current and over voltage during start and running.

### Related parameters

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E9.00 | Automatic error reset attempts | 0..3 | 0 | - | 1 | Stop |
| E9.01 | Automatic error reset interval | 0.1...60.0 | 10.0 | s | 0.1 | Stop |
| E9.02 | Automatic error reset attempts restart time | 0...65535<br>0: disabled | 0 | s | 1 | Stop |

### Detailed description

Parameter E9.00 is used to set the allowed maximum times of attempts for automatic reset in case of fault.

When the fault auto reset time is set to 0, there is no auto fault reset function, only manual reset can be done.

Parameter E9.01 is used to set interval time between reset attempts.

Attention: for the hardware critical error SC (short circuit) the internal minimum error reset interval is always minimal 5.0s in cases there [E9.01] is smaller than this value.

Parameter [E9.02] can be used to reset the internal error rest attempts back to the value from [E9.00] in case there are no error events inside this restart time.

In the following case the number of reset attempts is reset to E9.00:

1. 1. The converter is stopped and restarted by a RUN command.
2. 2. The automatic fault reset sequence is interrupted by a power cycle.
3. 3. [E9.02] is set to a value different to 0 and there are no error reset events inside the interval given from this [E9.02] parameter value.

If the error is cleared successfully after some tries, the reset counter is not set back to [E9.00] It keeps its current value. Therefore, if another error happens later on, the number of possible reset attempts already has decreased.

### List of errors with automatic error reset capability

| Diagnostic Code | Diagnostic Code Name | Error Display | Hint |
|---|---|---|---|
| F5001 | Overcurrent at constant speed | OC-1 | |
| F5002 | Overcurrent during acceleration | OC-2 | |

| Diagnostic Code | Diagnostic Code Name | Error Display | Hint |
|---|---|---|---|
| F5003 | Overcurrent during deceleration | OC-3 | |
| F5004 | Overvoltage at constant speed | OE-1 | |
| F5005 | Overvoltage during acceleration | OE-2 | |
| F5006 | Overvoltage during deceleration | OE-3 | |
| F5007 | Overvoltage during stop | OE-4 | |
| F5008 | Undervoltage during run | UE-1 | |
| F5009 | Surge current or short circuit | SC | |
| F5010 | Input phase loss | IPH.L | * FW > 03V28 |
| F5011 | Output phase loss | OPH.L | * FW > 03V28 |
| F5012 | Soft start error | ESS- | |
| F5020 | Converter overload | OL-1 | |
| F5021 | Converter over temperature | OH | |
| F5025 | Command value lost | CoL- | * FW > 03V28 |
| F5030 | Motor overload | OL-2 | |
| F5033 | Motor angle detection error | AdE- | * FW > 03V28 |
| F5901 | Host communication timed out | FCd- | * FW >= 03V28 removed |
| F5902 | Fieldbus process data configuration erroneous | FPC- | * FW >= 03V28 removed |
| F5903 | RPDO Telegram Loss | FtL- | * FW >= 03V28 removed |
| F5904 | Communication platform initialization failed | FIn- | * FW >= 03V28 removed |
| F5905 | Fieldbus network configuration invalid | FnC- | * FW >= 03V28 removed |
| F5906 | Communication platform critical error | FCE- | * FW >= 03V28 removed |
| F5907 | Communication platform firmware corrupted | FnF- | * FW >= 03V28 removed |

**Tab. 12-54:** List of errors with automatic error reset capability

## 12.15.2 Error Log

Error log record the error history and detailed error code.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| E9.05 | Last error type | – | – | – | – | Read |
| E9.06 | Second last error type | – | – | – | – | Read |
| E9.07 | Third last error type | – | – | – | – | Read |
| E9.10 | Output frequency at last error | – | – | Hz | 0.01 | Read |
| E9.11 | Setting frequency at last error | – | – | Hz | 0.01 | Read |
| E9.12 | Output current at last error | – | – | A | 0.1 | Read |
| E9.13 | Output voltage at last error | – | – | V | 1 | Read |
| E9.14 | DC-bus voltage at last error | – | – | V | 1 | Read |
| E9.15 | Power module temperature at last error | – | – | ℃ | 1 | Read |
| E9.50 | Last warning type | – | – | – | – | Read |
| E9.51 | Second last warning type | – | – | – | – | Read |
| E9.52 | Third last warning type | – | – | – | – | Read |
| E9.97 | Last error detail | 00000...FFFFF | 0 | – | – | Read |
| E9.98 | Second last error detail | 00000...FFFFF | 0 | – | – | Read |
| E9.99 | Third last error detail | 00000...FFFFF | 0 | – | – | Read |

**Value range of E9.05...E9.07:**

0: No error
1: OC-1, overcurrent at constant speed
2: OC-2, overcurrent during acceleration
3: OC-3, overcurrent during deceleration
4: OE-1, overvoltage at constant speed
5: OE-2, overvoltage during acceleration
6: OE-3, overvoltage during deceleration
8: UE-1, undervoltage during run
9: SC, surge current or short circuit
10: IPH.L, input phase loss
11: OPH.L, output phase loss
12: ESS-, soft start error
20: OL-1, converter overload
21: OH, converter over temperature
23: FF, fan failure
24: Pdr, pump dry

25: CoL-, command value lost
26: StO-r, STO request
27: StO-E, STO error
30: OL-2, motor overload
31: Ot, motor over temperature
32: t-Er, motor parameter tuning error
33: AdE-, motor angle detection error
35: SPE-, speed control loop error
38: AibE, analog input broken wire detection
39: EPS-, DC_IN power supply error
40: dir1, forward running lock error
41: dir2, reverse running lock error
42: E-St, terminal error signal
43: FFE-, firmware version mismatch
44: rS-, Modbus communication error
45: E.Par, parameter settings invalid
46: U.Par, unknown parameter restore error
48: idA-, internal communication error
49: idP-, internal parameter error
50: idE-, converter internal error
51: OCd-, extension card internal error
52: OCc, extension card PDOs configuration error
54: PcE-, remote control communication error
55: PbrE, parameter backup / restore error
56: PrEF, parameter restore error after firmware update
60: ASF-, ASF system error
61: APE1, ASF customer error 1
62: APE2, ASF customer error 2
63: APE3, ASF customer error 3
64: APE4, ASF customer error 4
65: APE5, ASF customer error 5
70: ElbE, Encoder error
71: EPOE, Encoder error
72: R-SC, Encoder error
73: OS-E, Encoder error
901: FCd-, Host communication timed out

902: FPC-, Fieldbus process data configuration erroneous
903: FtL-, RPDO Telegram Loss
904: FIn-, Communication platform initialization failed
905: FnC-, Fieldbus network configuration invalid
906: FCE-, Communication platform critical error
907: FnF-, Communication platform firmware corrupted
908: Fdi-, Fieldbus data Invalid



For detailed information about above errors, please see chapter 13.4 "Error Code" on page 408.

**Value range of E9.50...E9.52:**

| Diagnostic code | Description | Display | S-0-0390 contents |
|---|---|---|---|
| 6 | Pump leakage | PLE | 0x000E5006 |
| 7 | Overvoltage during stop | OE-4 | 0x000E5007 |
| 31 | Motor over temperature | Ot | 0x000E5031 |
| 42 | Terminal Error Signal | E-St | 0x000E5042 |
| 403 | Communication disconnection | C-dr | 0x000E5403 |
| 408 | Analog input broken wire detection | Aib- | 0x000E5408 |
| 409 | Fan maintenance period expired | FLE | 0x000E5409 |
| 410 | Communication data exceeds value range | OCi | 0x000E5410 |
| 411 | Under Temperature warning | UH-A | 0x000E5411 |
| 420 | ASF customer warning 1 | APF1 | 0x000E5420 |
| 421 | ASF customer warning 2 | APF2 | 0x000E5421 |
| 422 | ASF customer warning 3 | APF3 | 0x000E5422 |
| 423 | ASF customer warning 4 | APF4 | 0x000E5423 |
| 424 | ASF customer warning 5 | APF5 | 0x000E5424 |
| 430 | UnSupported Device Configuration | USdc | 0x000E5430 |
| 440 | Speed limited by maximum Voltage | Sli- | 0x000E5440 |
| 900 | Invalid State Transition | iSt | 0x000E5900 |
| 903 | RPDO Telegram Loss | FtL | 0x000E5903 |
| 908 | Option card process data invalid | Fdi | 0x000E5908 |

**Tab. 12-55:** List of errors with automatic error reset capability

# 12.16 F0: ASF Basic Settings

## 12.16.1 ASF Status

### ASF function description

xFC x615s supply the function of ASF (Application Specific Firmware), the frequency converter can load different ASF (such as "Water supply", "Tension control" , etc.) based on different applications. This can realize flexible and fast requirement from user.

This function introduce the relevant information of ASF. For detailed information about ASF function and operation, please refer to each ASF Instruction Manual.

### ASF Parameter

The range of ASF parameter is F1.00...F5.99, each parameter and its group numbers are defined by ASF instance.

The table below lists the ASF parameters loaded by frequency converter.

| Code | Name | Setting range | Default* | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| F0.01 | ASF version | – | 0.00 | - | - | Read |
| F0.02 | ASF identifier | 0x0000 ... 0x0FFF | 0x0000 | - | - | Read |
| F0.03 | ASF API required version** | – | 0.00 | - | - | Read |
| F0.06 | ASF trial time left | 0...65,535 s | 0 | - | 1 | Read |
| F0.07 | ASF API version | – | *** | - | - | Read |
| F0.10 | ASF status | 0x0000H... 0xFFFFH | 0x0000 | - | - | Read |



- *: The default value depends on the specific ASF function.
- **: API: Application Program Interface.
- ***: The value depends on firmware version of the frequency converter.

Each bit of F0.10 defines the status information of current ASF.

| Bit | Definition |
|---|---|
| 15..14 | Reserved |
| 13 | Error-Stack overflow |
| 12 | Error-Runtime timeout |
| 11 | Reserved |
| 10 | Error-API incompatible |
| 9 | Error-Invalid |

| Bit | Definition |
|---|---|
| 8 | Error-Trial time expired |
| 7...3 | Reserved |
| 2 | ASF authenticated |
| 1 | API compatible |
| 0 | ASF activated |

**Tab. 12-56:** ASF status bit definition

When the frequency converter loaded an effective and certified ASF, the value of F0.10 is 0x0007.

## ASF Management

### Download ASF

The ASF can be managed by engineering software tool "ConverterWorks" or "IndraWorks Ds (14V14 or newer)" via USB (serial) connection only.

Open the menu of ASF management on ConverterWorks before loading the ASF, a dialog box is shown as below:

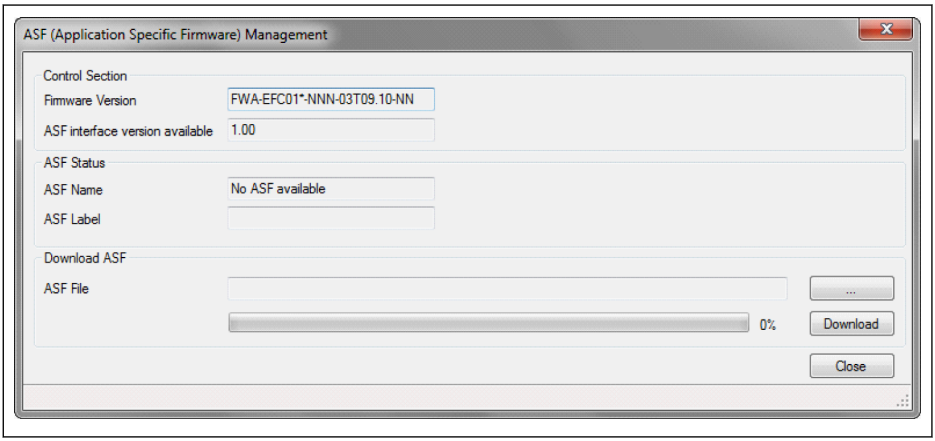



**Fig. 12-106:** ASF management menu

The first column's information on above figure depends on the frequency converter connected to PC.

Choose the target file in "Download ASF" area, then click "Download".

During the download process, "FUPd-" will be displayed on the LED panel of frequency converter.

After download is completed, the display window will show as follows.

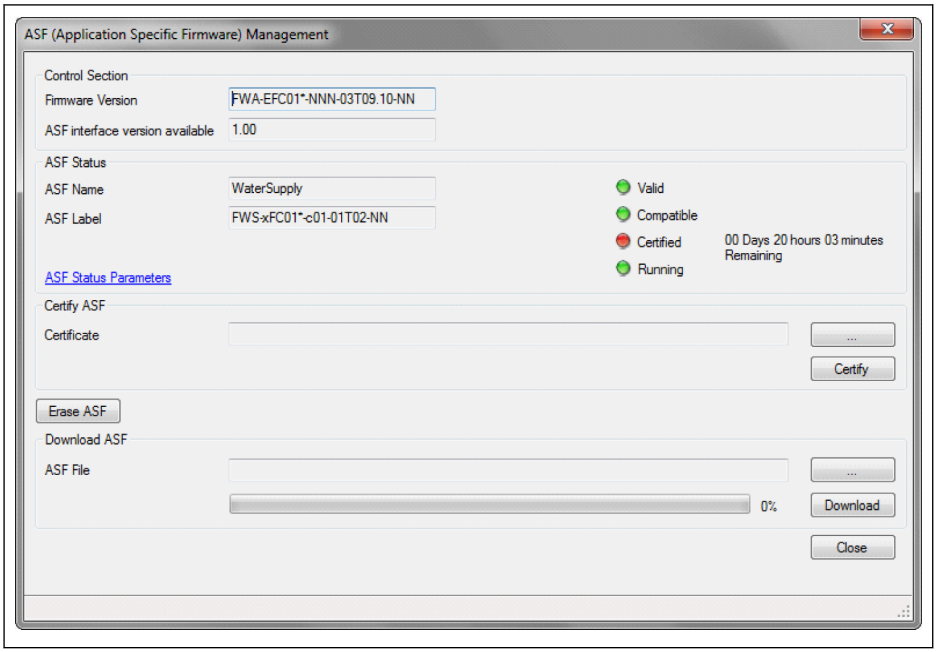



**Fig. 12-107:** ASF management window

## Certify ASF

Choose the target file in "Certify ASF" area, then click "Certify".

When the indicator light on the certified item changes from red to green, it means that the certification is successful.

## Erase ASF

Click "Erase ASF" in "ASF Management" window to delete the ASF files from the frequency converter.

## ASF Diagnosis

## ASF system error

| Error code | Display | Description |
|---|---|---|
| F8060 | ASF- | ASF error |

**Tab. 12-57:** The information of ASF system error

ASF running platform detects the ASF objects and triggers the fault when there have problems. Specific fault causes can query the parameter F0.10 bit fault information.

### ASF warning and error

Defined by specific ASF, see each ASF's Instruction Manual for detailed information.

## 12.16.2 ASF Command Values

This part is about the parameters used by ASF platform and extension card interface.

| Code | Name | Setting range | Default* | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| F0.20 | ASF command 1 | – | 0 | - | - | Read |
| F0.21 | ASF command 2 | – | 0 | - | - | Read |
| F0.22 | ASF command 3 | – | 0 | - | - | Read |
| F0.23 | ASF command 4 | – | 0 | - | - | Read |
| F0.24 | ASF command 5 | – | 0 | - | - | Read |
| F0.25 | ASF command 6 | – | 0 | - | - | Read |
| F0.26 | ASF command 7 | – | 0 | - | - | Read |
| F0.27 | ASF command 8 | – | 0 | - | - | Read |

For detailed information about the definition and operation, please refer to the Instruction Manual for extension card and specific ASF.

# 12.17 H0: Extension Card General Settings

## 12.17.1 Status and Control Words

### Extension communication card control word

[H0.00] is the content of the control word that the converter always accepts.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.00 | Control word | 0x00000...0x0FFFF | 0x00000 | - | 1 | Run |

For details on control word, see the table below:

| bit | Value | Description |
|---|---|---|
| 15...10 | – | Reserved |
| 9 | 1 | Torque control active |
| | 0 | Inactive |
| 8 | 1 | Freewheeling stop |
| | 0 | Inactive |
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 12-58:** Control word

### Status word

[H0.01] will indicate the converter status.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.01 | Status word | - | 0x00000 | - | 1 | Read |

For details on status word, see the table below:

| bit | Value | Description |
|---|---|---|
| 15 ... 8 | – | Error code (equals to [E9.05]) |
| 7 | 1 | Error |
| | 0 | No error |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 12-59:** Status word

### Extended status word

Extended status word is the extension of main status word, it stores other status information of frequency converter.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.02 | Extended status word | - | 0x00000 | - | 1 | Read |

The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15...1 | – | Reserved |
| 14 | 1 | Warning |
| | 0 | No warning |
| 13...3 | – | Reserved |
| 2 | 1 | Converter OK |
| | 0 | Converter not OK |
| 1 | 1 | Sleep mode |
| | 0 | Normal |

| bit | Value | Description |
|---|---|---|
| 0 | 1 | 24 V mode |
| | 0 | Normal mode |

**Tab. 12-60:** Extended status word

### STO safety status word

STO safety status word is used to monitor STO function state.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.03 | STO safety status word | - | 0x00000 | - | 1 | Read |

The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15...3 | – | Reserved |
| 2 | 1 | STO-E |
| | 0 | Normal |
| 1 | 1 | STO-r |
| | 0 | Normal |
| 0 | 1 | STO-A |
| | 0 | Normal |

**Tab. 12-61:** Extended status word

### Frequency command

When first or second frequency setting source is '20: Communication', the frequency command value can be set with parameter H0.10.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.10 | Frequency command | 0.00...655.35 | 0.00 | Hz | 0.01 | Run |

Frequency command is absolute frequency reference, setting value 0.00...655.35 representing 0.00...655.35 Hz.

### Torque control reference from fieldbus

H0.12 is used to set torque reference value when [C3.41] = '6: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...655.35 representing 0.0...6553.5% rated torque.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.12 | Torque control reference from fieldbus | 0.0...6553.5 | 0.0 | - | 0.1 | Run |
| C3.41 | Torque reference channel | 6: Communication (Modbus 0x7F02/ Fieldbus extension card H0.12) | 0 | - | - | Stop |
| E8.00 | Communication protocol | 1: Extension card | 0 | - | - | Stop |

### FWD torque limitation reference from fieldbus

H0.14 is used to set FWD torque limitation reference value when [C3.47] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...6553.5 representing 0.00...6553.5% rated torque.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.14 | FWD torque limitation reference from fieldbus | 0.0...6553.5 | 0.0 | % | 0.1 | Run |
| C3.47 | Torque limitation reference selection at speed control mode | 4: Communication (Torque FWD limitation register: Modbus 0x7F03/ Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/ Fieldbus extension card H0.15) | 0 | - | - | Stop |
| E8.00 | Communication protocol | 1: Extension card | 0 | - | - | Stop |

### REV torque limitation reference from fieldbus

H0.15 is used to set REV torque limitation reference value when [C3.47] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.0...6553.5 representing 0.00...6553.5% rated torque.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.15 | REV torque limitation reference from fieldbus | 0.0...6553.5 | 0.0 | % | 0.1 | Run |
| C3.47 | Torque limitation reference selection at speed control mode | 4: Communication (Torque FWD limitation register: Modbus 0x7F03/ Fieldbus extension card H0.14) (Torque REV limitation register: Modbus 0x7F04/ Fieldbus extension card H0.15) | 0 | - | - | Stop |
| E8.00 | Communication protocol | 1: Extension card | 0 | - | - | Stop |

### Speed limitation at torque control mode from fieldbus

H0.16 is used to set Speed limitation at torque control mode when [C3.48] = '4: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.00...655.35 representing 0.00...655.35Hz.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.16 | Speed limitation at torque control mode from fieldbus | 0.00...655.35 | 0.00 | - | 0.01 | Run |
| C3.48 | Speed limitation reference selection at torque control mode | 4: Communication (Speed limitation register: Modbus 0x7F05/Fieldbus extension card H0.16) | 0 | - | - | Stop |
| E8.00 | Communication protocol | 1: Extension card | 0 | - | - | Stop |

### Fieldbus voltage command

H0.50 is used to set V/f separation output voltage when [C2.08] = '20: Communication' and when communication protocol [E8.00] = '1: Extension card', setting value 0.00...100.00 representing 0.00...100.00% rated voltage.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.50 | Fieldbus voltage command | 0.00...100.00 % | 0.00 | % | 0.01 | Run |
| C2.08 | V/f separation output voltage source selection | 20: Communication (Modbus 0x7F0B/ Fieldbus extension card H0.50) | 22 | - | - | Stop |
| E8.00 | Communication protocol | 1: Extension card | 0 | - | - | Stop |

## 12.17.2 Extension Card Identification

This part is about the information that be transferred from option card to frequency converter for user checking after the communication between frequency converter and option card established.

### Extension card interface version

H0.18 and H0.19 are read only parameters and will display the interface version of the option card used in which slot.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.18 | Opt 1 active interface version | - | - | - | 0.01 | Read |
| H0.19 | Opt 2 active interface version | - | - | - | 0.01 | Read |

### Extension card type

H0.20 and H0.30 are read only parameters and will represent which type of card is connected in which slot.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.20 | Extension card 1 type | 0: None<br>1: PROFIBUS card<br>2: CANopen card | - | - | 0.01 | Read |
| H0.30 | Extension card 2 type | 8: I/O card<br>9: Relay card<br>10: IO plus card | - | - | 0.01 | Read |

### Extension card firmware version

H0.23 and H0.33 are read only parameters and will display the firmware version of the option card used in which slot.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H0.23 | Extension card 1 firmware version | - | - | - | 0.01 | Read |
| H0.33 | Extension card 2 firmware version | - | - | - | 0.01 | Read |

## 12.18 H1: PROFIBUS Settings

### 12.18.1 PROFIBUS Basic Settings

This function is used to set parameter or read parameters when use PROFIBUS communication extension card.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H1.00 | PROFIBUS local address | 0...126 | 1 | - | 1 | Stop |
| H1.01 | Present baud rate | 0: None<br>1: 9.6 kbps<br>2: 19.2 kbps<br>3: 45.45 kbps<br>4: 93.75 kbps<br>5: 187.5 kbps<br>6: 500 kbps<br>7: 1,500 kbps<br>8: 3,000 kbps<br>9: 6,000 kbps<br>10: 12,000 kbps | - | - | - | Read |
| H1.02 | Present telegram type | 1: PPO1<br>2: PPO2<br>3: PPO3<br>4: PPO4<br>5: PPO5<br>6: PPO6<br>7: PPO7<br>8: PPO8 | - | - | - | Read |

- H1.00 'PROFIBUS local address' is unique station address definition and needs to be set as equal to master configuration.
- H1.01 'Present baud rate' will display auto-detected baud rate.
- H1.02 'Present telegram type' indicates telegram type selected for communication network.
- Both H1.01 and H1.02 will be automatically checked after communication between master and frequency converter established successfully.

## 12.18.2 PROFIBUS Card LED

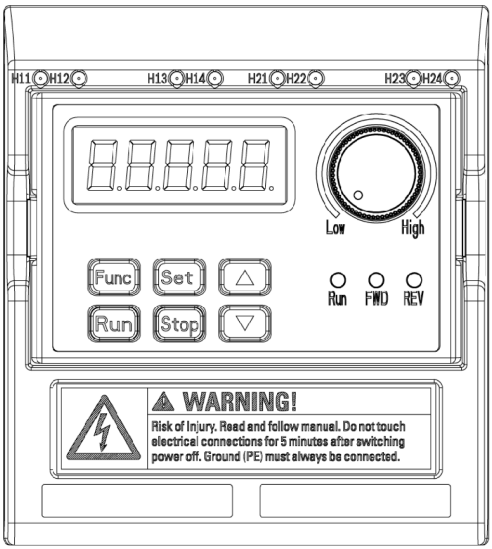



**Fig. 12-108:** PROFIBUS card LED

| LED | Color | Function | Status | Description |
|---|---|---|---|---|
| H11/H21① | Green | PROFIBUS card configuration status | Fast blinking<br>0.4 s per cycle | Data exchanging |
| | | | ON | Communication established<br>PROFIBUS card successfully parameterized and configured<br>=> Everything OK |
| H12/H22① | Red | PROFIBUS card error indication | OFF | PROFIBUS card OK |
| | | | Slow Blinking<br>1 s per cycle | PROFIBUS card error |

**Tab. 12-62:** PROFIBUS card LED

① :

- H11 and H12 are available when the PROFIBUS card is installed on the left card slot
- H21 and H22 are available when the PROFIBUS card is installed on the right card slot

### 12.18.3 PROFIBUS Output PZD Setting

This function defines the configuration of output PZD word which received by frequency converter.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H1.10 | Output PZD 1 | 0: Not used | 1 | - | - | Stop |
| H1.11 | Output PZD 2 | 1: Control word | 2 | - | - | Stop |
| H1.12 | Output PZD 3 | 2: Frequency command | 0 | - | - | Stop |
| H1.13 | Output PZD 4 | | 0 | - | - | Stop |
| H1.14 | Output PZD 5 | 3: Empty PZD | 0 | - | - | Stop |
| H1.15 | Output PZD 6 | 4: ASF command 1 | 0 | - | - | Stop |
| H1.16 | Output PZD 7 | 5: ASF command 2 | 0 | - | - | Stop |
| H1.17 | Output PZD 8 | 6: ASF command 3 | 0 | - | - | Stop |
| H1.18 | Output PZD 9 | 7: ASF command 4 | 0 | - | - | Stop |
| H1.19 | Output PZD 10 | 8: ASF command 5<br>9: ASF command 6<br>10: ASF command 7<br>11: ASF command 8<br>12: Torque command<br>13: Forward torque limit<br>14: Reverse torque limit<br>15: Speed limit in torque mode<br>16: DO1/relay1 output values (see parameter E2.20)<br>17: AO1 value in percentage (see parameter E2.28)<br>18: EDO values (see parameter H8.23)<br>19: EAO value in percentage (see parameter H8.28)<br>20: Relay card output values (see parameter H9.10)<br>21: V/f separation voltage command in percentage (see parameter H0.50) | 0 | - | - | Stop |

Output PZD 1...Output PZD 10 are the process data containers for data transferring from PROFIBUS master to slave.

## 12.18.4 Input PZD Setting

This function defines the configuration of input PZD word which sent by frequency converter.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H1.30 | Input PZD 1 | 0: Not used<br>1: Status word<br>2: Extended status word<br>3: Empty PZD<br>100: d0.00 (Output frequency)<br>101...199: d0.01...d0.99 (Monitoring values) | 1 | - | - | Stop |
| H1.31 | Input PZD 2 | | 100 | - | - | Stop |
| H1.32 | Input PZD 3 | | 0 | - | - | Stop |
| H1.33 | Input PZD 4 | | 0 | - | - | Stop |
| H1.34 | Input PZD 5 | | 0 | - | - | Stop |
| H1.35 | Input PZD 6 | | 0 | - | - | Stop |
| H1.36 | Input PZD 7 | | 0 | - | - | Stop |
| H1.37 | Input PZD 8 | | 0 | - | - | Stop |
| H1.38 | Input PZD 9 | | 0 | - | - | Stop |
| H1.39 | Input PZD 10 | | 0 | - | - | Stop |

Input PZD 1...Input PZD 10 are the process data containers for data transferring from PROFIBUS slave to master.

## 12.18.5 PROFIBUS Protocol

### Protocol Description

PROFIBUS is an open serial communication standard, which enables data exchange among various automation control devices. PROFIBUS mainly includes three types: PROFIBUS-FMS (Fieldbus Message Specifications), PROFIBUS-DP (Distributed Peripheral Equipment) and PROFIBUS-PA (Process Automation). Frequency Converter VFCx615 supports PROFIBUS-DP Protocol.

PROFIBUS is widely used in various industries such as manufacturing automation and process automation, building, transportation, electric power, etc. Through PROFIBUS, automation equipments from different manufacturers can be easily connected into the same network for data exchange. The frame structure of data information in PROFIBUS network is shown in table below.

| Protocol frame | User data | Protocol frame |
|---|---|---|
| (header) | (control message/status message) | (end) |

**Tab. 12-63:** PROFIBUS frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100...1,200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller, which is able to select the nodes responsive to commands from the master.

 PROFIBUS protocol is described in details in standard EN 50170.

### PROFIBUS Function

The PROFIBUS DP communication network is able to realize the following functions:

- Sending control commands to the frequency converter (such as start, stop, jog, etc.).
- Sending messages (e.g. setting frequency) to the frequency converter.
- Reading operating status message from the frequency converter (such as run, rotation direction, rotation speed, error message, etc.).
- Reading or modifying frequency converter parameters.
- Resetting the frequency converter in case of error.

### Requirements for PROFIBUS Link Cable

Cables used in PROFIBUS are shielded twisted pair cables. The shielding is able to improve electromagnetic compatibility (EMC) ability. Unshielded twisted pair cable may be used if there is less electromagnetic interference (EMI). Impedance of the cable should be within 100...200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥ 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

| Cable data | Type A | Type B |
|---|---|---|
| Impedance | 135...165 Ω (f = 3...20 MHz) | 100...130 Ω (f > 100 kHz) |
| Capacity | < 30 pF/m | < 60 pF/m |
| Resistance | ≤ 110 Ω/km | ≤ 110 Ω/km |
| Conductor cross section | ≥ 0.34 (22 AWG) | ≥ 0.22 (24 AWG) |

**Tab. 12-64:** Type of PROFIBUS cable



Standard Siemens PROFIBUS cable is (MLFB) 6XV1830-0EH10 (Type A), and connector is 6ES7972-0BA12-0XA0.

### Relationship between Communication Rate and Cables

Relationship between communication rate and cable length is described in table below.

| Baud rate | Maximum length for each cable in [m] (Type A) | Maximum length for each cable in [m] (Type B) |
|---|---|---|
| 9.6...93.75 kbps | 1,000 | 1,000 |
| 187.5 kbps | 1000 | 600 |
| 500 kbps | 400 | 200 |
| 1.5 Mbps | 200 | 200 |
| 3...12 Mbps | 100 | 100 |

**Tab. 12-65:** Relationship between communication rate and cable length

### EMC Measures

The following EMC measures needs to be taken in order to improve the stability of PROFIBUS communication network:

- The shielding layer of the communication cables must be well grounded at all stations; a large area is required for the connection of the shielding layer to obtain a low impedance.
- A certain wiring distance (≥ 20 cm) must be kept between the communication cables and the power cables.
- Communication cables and power cables must be orthogonal in case of crossing.
- All stations in the network must be grounded to the same grounding network.

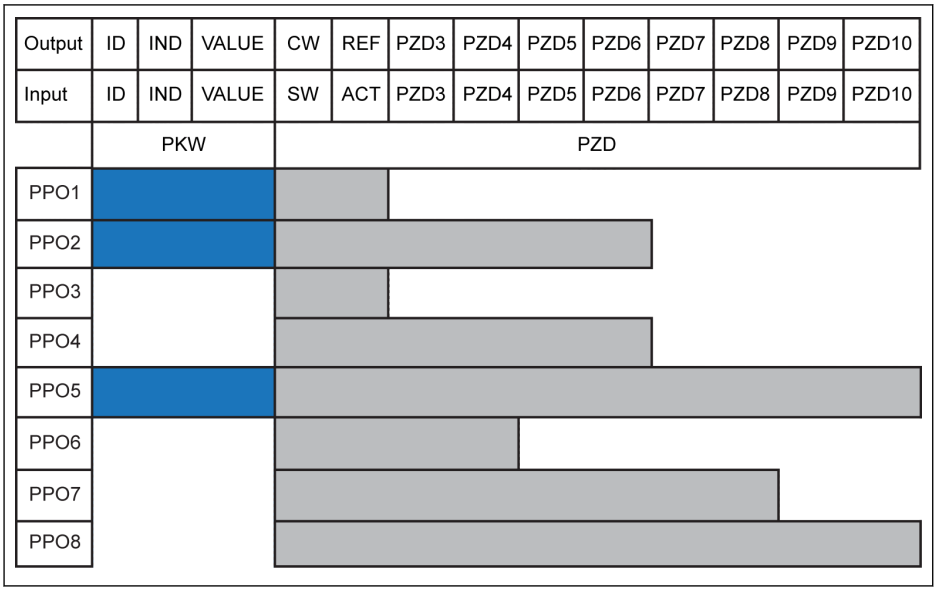
### Periodical Data Communication

### PPO telegram type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). Frequency Converter VFCx615 supports 8 PPO telegram types shown in figure below. PPO message is divided into two data areas in terms of transmission data contents:

Parameter area (PKW area): read or write a parameter of a slave.

Process data area (PZD area): including control word and set frequency, etc. (data flow from master to slave), or status word, actual output frequency and other status monitoring values of slave (data flow from slave to master). For detailed descriptions of PKW parameter area and PZD process data area, please refer to descriptions below.




**Output** Master output
**Input** Master input
**ID** Parameter identifier
**IND** Parameter index mark
**VALUE** Parameter value

**CW** Control word
**SW** Status word
**REF** Reference / Setting frequency
**ACT** Actual output frequency

**Fig. 12-109:** PPO telegram type

## PKW parameter area

### PKW parameter area description

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a parameter of a frequency converter, but only one parameter can be read or modified each time. When master sends request and slave responds, bit definition for each specific word in PKW area is shown in the tables below. If a frequency converter fails to execute PKW area request command, an error code will be returned to the master in VALUE_low. Refer to tab. 12-68 "PKW area error codes" on page 335 for details.

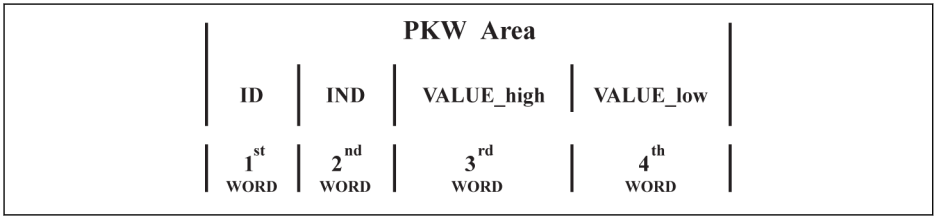



**Fig. 12-110:** PKW area data format

### Request data frame in PKW area

| Word | Identifier | bit | Value | Description |
|---|---|---|---|---|
| 1st | ID | 15...8 | 00H | Reserved |
| | | 7...0 | 00H | No request |
| | | | 01H | Read |
| | | | 02H | Write |
| 2nd | IND | 15...8 | xxH | Group No. for parameter |
| | | 7...0 | xxH | Index No. of function code within the group |
| 3rd | VALUE_high | 15...0 | 00H | Reserved |
| 4th | VALUE_low | 15...0 | xxxxH | For a read request: Not used<br>For a write request: Parameter value |

**Tab. 12-66:** Request data frame in PKW area_from master to slave

### Response data frame in PKW area

| Word | Identifier | bit | Value | Description |
|---|---|---|---|---|
| 1st | ID | 15...8 | 00H | Reserved |
| | | 7...0 | 00H | No request |
| | | | 01H | Successful read |
| | | | 02H | Successful write |
| | | | 07H | Error |
| 2nd | IND | 15...8 | xxH | Group No. for parameter |
| | | 7...0 | xxH | Index No. of function code within the group |
| 3rd | VALUE_high | 15...0 | 00H | Reserved |
| 4th | VALUE_low | 15...0 | xxxxH | For a successful request: Parameter value<br>Read or write error: Error code<br>For no request situation: 0 |

**Tab. 12-67:** Response data frame in PKW area_from slave to master

### Error message after execution failure in PKW area

| Error code | Meaning | Reason |
|---|---|---|
| 1 | Password locked | User password is locked |
| 2 | Invalid command code | Command codes (bit 7...bit 0 of ID) are not 0, 1 or 2. |
| 3 | Invalid parameter address | Invalid function group or index number of the function group, or insufficient access/rights |
| 4 | Invalid parameter value | Data to write out of range |
| 5 | Forbid write in running mode | Frequency converter is running |
| 6 | Parameter read-only | Parameter are read-only, can not be written |
| 7 | Invalid operation | Function code does not support write or multiple write via external computer |

**Tab. 12-68:** PKW area error codes

### Example of parameter operation in PKW area

### Example description

In applications, the master and the frequency converters communicate with messages in PPO structure. Among the 8 PPOs stated in fig. 12-109 "PPO telegram type" on page 333, PPO1, PPO2 and PPO5 apply both PKW area and PZD area. In following examples, PKW area data frames are taken from complete PPO message to describe its request and response data frames.

The following examples are all based on Frequency Converter VFC5615 and PROFIBUS card.

### Example 1

Reading value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0001 | 0x301A | 0x0000 | 0x0000 |
| Response data frame of PKW area | 0x0001 | 0x301A | 0x0000 | 0x0032 |

**Tab. 12-69:** Example 1_request and response data frames of PKW area

### Example 2

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0x0064, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0x0064 |
| Response data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0x0064 |

**Tab. 12-70:** Example 2_request and response data frames of PKW area

### Example 3

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0xFFFF, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0xFFFF |
| Response data frame of PKW area | 0x0007 | 0x301A | 0x0000 | 0x0064 |

**Tab. 12-71:** Example 3_request and response data frames of PKW area

## PZD process data area

### PZD process data area description

The data in PZD process data area can be configured freely for periodical data exchange between the master and slaves. The request telegram type for sending message from master to slaves is decided by H1.30...H1.39; the request telegram type for returning message response from slaves to the master is decided by H1.30...H1.39 (number of PZD is decided by PPO telegram type). See parameters in group H1 chapter 19.3.6 "Group H: Extension Card Parameters" on page 559.

For details on control word, status word and extended status word see the tables below:

| bit | Value | Description |
|---|---|---|
| 15...10 | – | Reserved |
| 9 | 1 | Torque control active |
| | 0 | Inactive |
| 8 | 1 | Freewheeling stop |
| | 0 | Inactive |
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 12-72:** Control word

| bit | Value | Description |
|---|---|---|
| 15 ... 8 | – | Error code (equals to [E9.05]) |
| 7 | 1 | Error |
| | 0 | No error |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 12-73:** Status word

| bit | Value | Description |
|---|---|---|
| 15...1 | – | Reserved |
| 0 | 1 | 24 V mode |
| | 0 | Normal mode |

**Tab. 12-74:** Extended status word

For details on parameter addresses, see chapter 12.14.1 "Modbus Protocol" on page 280.

## Examples for operation of PZD process data area

### Example 1

The master communicates with the slave via PPO4, see fig. 12-109 "PPO telegram type" on page 333.

If we need to start frequency converter for forward rotation at 50.00 Hz (0×1388). When the parameters in group H1 are kept as defaults, complete PPO request and response messages are shown in table below.

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|---|---|---|---|---|---|---|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0081 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0xxx02 | 0x1388 | | | | |

**Tab. 12-75:** Example 1 for PZD process data area_request and response messages of PPO



The higher byte of the status word is the latest error code (0x00 means no error).

### Example 2

When the frequency converter forward runs at 50 Hz, to stop the frequency converter as parameter settings, please refer to example 1.

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|---|---|---|---|---|---|---|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0088 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0xxx00 | 0x0000 | | | | |

**Tab. 12-76:** Example 2 for PZD process data area_request and response messages of PPO

## Communication parameter configuration

### Communication related parameter settings

| Parameter | Name | Parameter settings |
|---|---|---|
| E0.00 | First frequency setting source | 20: Communication |
| E0.01 | First run command source | 2: Communication |
| E0.02 | Second frequency setting source | 20: Communication |
| E0.03 | Second run command source | 2: Communication |
| E8.00 | Communication protocol | 1: Extension card |
| E8.03 | Communication process data loss behavior | Depends on parameter setting① |
| H0.12 | Torque control reference from fieldbus | 6: Communication |
| H0.14 | FWD torque limitation reference from fieldbus | 4: Communication |
| H0.15 | REV torque limitation reference from fieldbus | 4: Communication |
| H0.16 | Speed limitation at torque control mode from fieldbus | 4: Communication |
| H1.00 | PROFIBUS local address | Depends on parameter setting① |
| H1.01 | Present baud rate | (Read only) |
| H1.02 | Present telegram type | |

| Parameter | Name | Parameter settings |
|---|---|---|
| H1.10 | Output PZD 1 | Depends on parameter setting① |
| H1.11 | Output PZD 2 | |
| H1.12 | Output PZD 3 | |
| H1.13 | Output PZD 4 | |
| H1.14 | Output PZD 5 | |
| H1.15 | Output PZD 6 | |
| H1.16 | Output PZD 7 | |
| H1.17 | Output PZD 8 | |
| H1.18 | Output PZD 9 | |
| H1.19 | Output PZD 10 | |
| H1.30 | Input PZD 1 | |
| H1.31 | Input PZD 2 | |
| H1.32 | Input PZD 3 | |
| H1.33 | Input PZD 4 | |
| H1.34 | Input PZD 5 | |
| H1.35 | Input PZD 6 | |
| H1.36 | Input PZD 7 | |
| H1.37 | Input PZD 8 | |
| H1.38 | Input PZD 9 | |
| H1.39 | Input PZD 10 | |

**Tab. 12-77:** PROFIBUS-DP communication parameters



①: See fig. 12-109 "PPO telegram type" on page 333 for details.

In the operation controlled by communication, if the frequency converter is stopped by the **Stop** key on the operating panel, the frequency converter stops responding to the control commands by communication. To enable the control by communication, re-power the frequency converter or send **Stop** command to the frequency converter by communication.

### Parameter configuration of master

For master related parameter configuration, refer to descriptions for master. The address configured for slave in the master should be consistent with the parameter address configured for the slave. Communication baud rate and PPO telegram type are determined by the master.

### GSD file

Users may log on the website of the company at www.boschrexroth.com to download or contact sales personnel to obtain the GSD file BRFC0112.GSD. For

installation and PROFIBUS system configuration method, please refer to respective instructions of system configuration software.



The GSD file adapts to the PROFIBUS master which supports GSD revision 2 or above.

## 12.19 H2: CANopen Card Parameters

### 12.19.1 General Introduction

CANopen is a high-level communication protocol which is based on CAN (Controller Area Network) bus. As one of fieldbus commonly used in the industrial control field, CANopen can realize the interconnection of multiple industrial devices. CANopen adopts Open Systems Interconnection (OSI) model and implements media access control and physical signal transmission on basis of CAN technology. Its design is based on three sub-protocols, i.e. DS102 CAN physical layer for industrial applications, DS 301 CANopen communication profile for industrial systems and DSP 402 device profile for drives and motion control. CANopen operates in master-slave structure or distributed control structure which is based on peer-to-peer communication. Up to 127 slave nodes can be supported. CANopen card of the slave node is powered from frequency converter, and all slave nodes are connected to the same bus. CANopen defines corresponding configuration files for devices in specific classes. For other devices, a specific class must be defined to ensure the compatibility with CANopen system.

### 12.19.2 LED Status Introduction

The CiA-303-3 provides a standardized way for state indication of a CANopen device. There is an error LED and a run LED. The run LED is green and indicates the CANopen state. The error LED is red and shows errors of the physical layer.

| LED | State | Color | Description |
|---|---|---|---|
| ERROR LED | No error | Off | The device is in working condition. |
| | Warning limit reached | Single flash | At least one of the error counters of the CAN controller has reached or exceeded the warning limit. (CAN Passive Error) |
| | Error control event | Double flash | A guard event (NMT slave or NMT master) or a Heartbeat event has occurred. |
| | Bus off | Red light on | The CAN controller is bus-off. |

| LED | State | Color | Description |
|---|---|---|---|
| RUN LED | OFF | Off | The CANopen controller is in “OFF” state. |
| | NMT stopped | Single flash | The device is in NMT STOPPED state. |
| | NMT pre-operational | Blinking green | The device is in NMT PRE-OPERATIONAL state. |
| | NMT operational | Green light on | The device is in NMT OPERATIONAL state. |

**Tab. 12-78:** Description of various LED states

## 12.19.3 Converter Configuration

### Overview

Communication with the frequency converter in CANopen is achieved via Service Data Objects (SDOs), Process Data Objects (PDOs) and Network Management (NMT).

Users can download the EDS file through the following steps:

1. Click on http://www.boschrexroth.com/dcc.
2. Choose “Frequency converter -> VFC 3610 (or VFC 5610)” from the navigation bar on left side of the operation interface.
3. Choose “Download area” tab from right side of the interface.
4. Click on “EDS_XFCX610.ZIP” to download the EDS file.

### COB-Identifiers

Each communication object has a unique identity (COB-ID) comprising the function code and the node ID (node address) shown as follows.

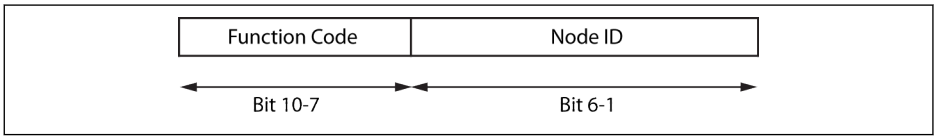



**Fig. 12-111:** COB-ID

### Object Dictionary

The object dictionary is essentially a grouping of objects accessible via the network in an ordered predefined fashion. Each object within the object dictionary is addressed using a 16-bit index and an 8-bit sub-index. The object dictionary contains collection of all the data items which have an influence on the behaviour of the application objects, the communication objects and the state machine used on this device.

| Index range (Hex) | Object group |
|---|---|
| 1000h...1FFFh | Communication profile |
| 2000h...5FFFh | Vendor specific objects |
| 6000h...9FFFh | Standard device profiles |

**Tab. 12-79:** CANopen object groups

The table below gives an overview of the objects prescribed for CANopen:

| Object | Index | Name |
|---|---|---|
| General objects | 1000h | Device type |
| | 1001h | Error register |
| | 1002h | Manufacturer status register |
| | 1008h | Manufacturer device name |
| | 1009h | Manufacturer hardware version |
| | 100Ah | Manufacturer software version |
| | 1010h | Store parameter field |
| | 1011h | Restore default parameters |
| | 1018h | Identity object |
| Error control protocol | 100Ch | Guard time |
| | 100Dh | Life time factor |
| | 1014h | COB-ID EMCY |
| | 1015h | Inhibit time emergency |
| | 1016h | Heartbeat consumer entries |
| | 1017h | Producer heartbeat time |
| | 1029h | Error behaviour |
| SDO | 1200h | Server SDO parameter 1 |

| Object | Index | Name |
|---|---|---|
| PDO objects | 1400h | Receive PDO communication parameter 1 |
| | 1401h | Receive PDO communication parameter 2 |
| | 1402h | Receive PDO communication parameter 3 |
| | 1403h | Receive PDO communication parameter 4 |
| | 1600h | Receive PDO mapping parameter 1 |
| | 1601h | Receive PDO mapping parameter 2 |
| | 1602h | Receive PDO mapping parameter 3 |
| | 1603h | Receive PDO mapping parameter 4 |
| | 1800h | Transmit PDO communication parameter 1 |
| | 1801h | Transmit PDO communication parameter 2 |
| | 1802h | Transmit PDO communication parameter 3 |
| | 1803h | Transmit PDO communication parameter 4 |
| | 1A00h | Transmit PDO mapping parameter 1 |
| | 1A01h | Transmit PDO mapping parameter 2 |
| | 1A02h | Transmit PDO mapping parameter 3 |
| | 1A03h | Transmit PDO mapping parameter 4 |
| Manufacturer specific objects | 2000h...3000h | Function code mapping |
| | 4000h...5FFFh | Reserved for future enhancements |
| Device profiles | 6000h...9FFFh | Used for CANopen drive profile CiA-402 |

**Tab. 12-80:** Object dictionary

For CANopen drive profile CiA-402 velocity mode, the following objects are supported:

| | | |
|---|---|---|
| Device profile segment | 603Fh | Error code |
| | 6040h | Control word |
| | 6041h | Status word |
| | 6042h | Target velocity |
| | 6043h | vl Target velocity |
| | 6044h | vl Velocity demand |
| | 6046h | vl Velocity actual value |
| | 6048h | vl Velocity min max amount |
| | 6049h | vl Velocity acceleration |
| | 604Dh | vl Velocity deceleration |
| | 6060h | vl Pole number (needed for conversion velocity vs. output frequency) |
| | 6061h | Modes of operation display |

**Tab. 12-81:** CANopen drive profile CiA-402 velocity mode objects

Let H.L be the High and Low byte, respectively of the numerical representation of a function code, where H is the simple decimal interpretation of the hexadecimal encoding of the function class.

Example: Frequency converter class “d” is encoded by 0x10. The simple decimal interpretation of “0x10” then is “10”. (Hint: this simple trick closes the unused gap in frequency converter class encoding between 0x0A and 0x0F in order to get all frequency converters mapped into CANopen index manufacturer parameters ranged between 0x2000 and 0x5FFF.)

Then the index of the corresponding “Manufacturer specific objects” is: I = 0x2000 + H x 100 + L.

Function code Yx.z, where Y ϵ {b,d,C,E,U,F,H}, x ϵ {0...9}, z ϵ {0...99}

That means:

Function code → H.L range (DEC) → FC index (DEC) → CAN index (HEX)

bx.z → {00...09}.{0...99} → {0000...0999} → {0x2000...0x23E7}

dx.z → {10...19}.{0...99} → {1000...1999} → {0x23E8...0x27CF}

Cx.z → {20...29}.{0...99} → {2000...2999} → {0x27D0...0x2BB7}

Ex.z → {30...39}.{0...99} → {3000...3999} → {0x2BB8...0x2F9F}

Ux.z → {40...49}.{0...99} → {4000...4999} → {0x2FA0...0x3387}

Fx.z → {50...59}.{0...99} → {5000...5999} → {0x3388...0x376F}

Hx.z → {60...69}.{0...99} → {6000...6999} → {0x3770...0x3B57}

### Manufacturer specific objects (2000h...3FFFh)

All function codes (16 bit) can be reached through the manufacturer specific objects. The structure of the manufacturer specific objects is as follows:

| Sub-index | Description |
|---|---|
| 1 | Access to data (parameter set 0) |
| 2...8 | Reserved (parameter set 1...7) |
| 9 | Reserved (parameter set 1...7) |
| 10 | Index of the list pointer |
| 11 | List element to which the element 10 points (only in case of parameters in the list) |
| 12...18 | Reserved (for parameter sets) |
| 21 | Parameter name |
| 22...28 | Reserved (for parameter sets) |
| 31 | Parameter attribute |
| 32...38 | Reserved (for parameter sets) |
| 41 | Parameter unit |
| 41...48 | Reserved (for parameter sets) |
| 51 | Minimum value of the parameter |

| Sub-index | Description |
|---|---|
| 52...58 | Reserved (for parameter sets) |
| 61 | Maximum value of the parameter |
| 62...68 | Reserved (for parameter sets) |
| 71 | Maximum length of the parameters in the list |
| 72...78 | Reserved (for parameter sets) |
| 81 | Actual length of the parameter in the list |
| 82...88 | Reserved (for parameter sets) |

**Tab. 12-82:** Manufacturer specific objects

As evident from the table, with the help of the sub-index, besides the date (sub-index 1), even other information (minimum value, maximum value ...) of the function codes can be read out.

### List access

The complete list of a list parameter can be read or written via the access to the operating date of the parameter.

To access individual elements in the list, there is an option to set a list index (sub-index 10), and then to access the respective list element of the list index via sub-index 11 (up to sub-index 18). For every access via sub-index 11 (up to sub-index 18), the list index is incremented by one element. With this, in case of multiple access to sub-index 11 (up to sub-index 18), a related section of a list is processed.

The list index is reset to the first element if one of the actions listed below occurs:

- Change in the parameter
- Abort of the connection

Therefore the list index should be set for each list element access which does not start from the first element.

If the length of the list has to be changed, this can be corrected by changing the actual length of the list parameter (sub-indices 81...88). The maximum list length can be read out using the sub-indices 71...78.

The parameter value is stored if writing to the last element occurs.

In case of failure of the control voltage, the changes are discarded.

### Process Data Objects (PDO)

PDOs represent real-time process data with high priority. It is only possible if node is in “operational” state.

The CANopen option card features four sets of predefined PDOs:

- The first set of PDOs is automatically enabled when CiA-402 drive profile is active and it is fixed (static) mapping:
  - One received PDO (RPDO1), is used to control (Control word) the drive.
  - One transmitted PDO (TPDO1), is used to monitor (Status word) the drive.



- The TPDO1 with transmission type of 255 shall only be triggered when the mapped drive status word is changing (event), other mapped objects shall not cause a PDO transmission.
- The TPDO1 with transmission type of 0 shall be transmitted after the occurrence of the SYNC but acyclic (not periodically), i.e. only if the drive status word is changed (event) before the occurrence of SYNC.

- The second set of PDOs (PDO2 for CiA-402 drive profile) includes: The second set of PDOs is initially disabled and the user has to enable it. The default mapping configuration is for supporting CiA-402 velocity mode.
  - One received PDO (RPDO2), is used to control the drive (Control word and velocity reference). In addition, it can be configured to include two additional objects/parameters. Control word and velocity reference can also be replaced with any two other objects which have write access rights via PDO.
  - One transmitted PDO (TPDO2), is used to monitor the drive (Status word and velocity actual value). In addition, it can be configured to include two additional objects which have read access via PDO. Status word and velocity actual value can also be replaced with any two other objects which have read access rights via PDO.
- The third set of PDOs (PDO3 for Rexroth drive profile) includes: The default mapping configuration enables the drive to be commanded by frequency input and Rexroth drive control word.
  - One received PDO (RPDO3), is used to control the drive (Control word and frequency command). In addition, it can be configured to include two additional objects/parameters. Control word and frequency command can also be replaced with any two other objects which have write access rights via PDO.
  - One transmitted PDO (TPDO3), is used to monitor the drive (Status word and actual output frequency). In addition, it can be configured to include two additional objects which have read access via PDO. Status word and actual output frequency can also be replaced with any two other objects which have read access rights via PDO.

- The fourth set of PDOs are initially disabled and no default mapping configuration is done. And the PDO information is freely deployed by the user.



- For TPDO2 with transmission type of 255 no internal profile specific event is defined for triggering PDO transmission. So for this transmission type of 255/254 (asynchronous) only event timer will trigger PDO transmission.
- PDO2 does not support transmission type of 0 (synchronous acyclic).

### Process Data Objects (PDO) Configuration

The following configuration shall be executed.

- PDO1 mapping is static and hence it cannot be changed.
- The default PDO mapping configuration is shown as below for Rexroth drive profile.

| RPDO No. | Mapping object index | Mapping object name | Comment |
|---|---|---|---|
| 1 | 0x6040 | Control word | Controls the CiA-402 state machine |
| 2 | 0x6040<br>0x6042 | Control word<br>Target velocity (vl) | Controls the state machine and the nominal speed (vl) |
| 3 | 0x3770<br>0x377A | Drive control word<br>Frequency command | Controls the drive system state machine and setting frequency |
| 4 | 0x0000 | - | - |
| **TPDO No.** | **Mapping object index** | **Mapping object name** | **Comment** |
| 1 | 0x6041 | Status word | Shows the drive status |
| 2 | 0x6041<br>0x6044 | Status word<br>vl control effort | Shows status and the current speed (vl) |
| 3 | 0x3771<br>0x23EA | Drive status word<br>Output frequency | Shows the drive status and the current output frequency |
| 4 | 0x0000 | - | - |

**Tab. 12-83:** PDO communication parameter structure for CiA-402 profile

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1400 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x80000200 + Node-ID** |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time (not implemented) | 0 |
| | 4 | Reserved | - |
| | 5 | Event timer | 0 |
| 0x1600 | 0 | Number of mapped objects | 1 |
| | 1 | Control word | 0x60400010 |

**Tab. 12-84:** RPDO1



**: When CiA-402 is enabled, the RPDO1 is enabled, so COB-ID gets changed to 0x80000200 + Node-ID. RPDO1 is disabled in Rexroth Profile. If enabled then it's erroneous.

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1401 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x80000300 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time (not implemented) | 0 |
| | 4 | Reserved | - |
| | 5 | Event timer | 0 |
| 0x1601 | 0 | Number of mapped objects | 2 |
| | 1 | Control word | 0x60400010 |
| | 2 | Target velocity (vl) | 0x60420010 |

**Tab. 12-85:** RPDO2

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1402 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x00000400 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time (not implemented) | 0 |
| | 4 | Reserved | - |
| | 5 | Event timer | 0 |
| 0x1602 | 0 | Number of mapped objects | 2 |
| | 1 | Drive control word | 0x37700010 |
| | 2 | Frequency command | 0x377A0010 |

**Tab. 12-86:** RPDO3

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1404 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x80000500 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time (not implemented) | 0 |
| | 4 | Reserved | - |
| | 5 | Event timer | 0 |
| 0x1604 | 0 | Number of mapped objects | 0 |
| | 1...4 | - | 0x00000000 |

**Tab. 12-87:** RPDO4

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1800 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x00000180 + Node-ID** |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time | 50 (100us) |
| | 4 | Reserved | - |
| | 5 | Event timer | 100 (1ms) |
| 0x1A00 | 0 | Number of mapped objects | 1 |
| | 1 | Status word | 0x60400010 |

**Tab. 12-88:** TPDO1

**: When CiA-402 is enabled, the TPDO1 is enabled, so COB-ID gets changed to 0x00000180 + Node-ID. TPDO1 is disabled in Rexroth Profile. If enabled then it's erroneous.

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1801 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x80000280 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time | 50 (100us) |
| | 4 | Reserved | - |
| | 5 | Event timer | 100 (1ms) |
| 0x1A01 | 0 | Number of mapped objects | 2 |
| | 1 | Status word | 0x60410010 |
| | 2 | vl control effort | 0x60440010 |

**Tab. 12-89:** TPDO2

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1802 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x00000380 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time | 50 (100us) |
| | 4 | Reserved | - |
| | 5 | Event timer | 100 (1ms) |
| 0x1A02 | 0 | Number of mapped objects | 2 |
| | 1 | Drive status word | 0x37710010 |
| | 2 | Output frequency | 0x23EA0010 |

**Tab. 12-90:** TPDO3

| Index | Sub | Name | Default value |
|---|---|---|---|
| 0x1805 | 0 | Number of entries | 5 |
| | 1 | COB-ID used by PDO | 0x80000480 + Node-ID |
| | 2 | Transmission type | 255 |
| | 3 | Inhibit time | 50 (100us) |
| | 4 | Reserved | - |
| | 5 | Event timer | 100 (1ms) |
| 0x1A05 | 0 | Number of mapped objects | 0 |
| | 1...4 | - | 0x00000000 |

**Tab. 12-91:** TPDO4

1. PDO mapping configuration is not supported in NMT operational state. PDO mapping has to be done in NMT pre-operation state only. If PDO configuration is done in operational state, then CANopen option card automatically enters into pre-operation state.
2. [b8.61]: Field bus option card producer list defines all those parameters which can be mapped to TPDO.
3. [b8.62]: Field bus option card consumer list defines all those parameters which can be mapped to RPDO.

### Service Data Objects (SDO)

SDO telegrams are used for configuration and setup.

The SDO services listed below are supported:

- **Initiate SDO Download** for writing maximum 4 byte data in the VFCx615, also for initiating the writing of more than 4 byte data in the VFCx615 (the data length is determined during "Initiate" process).
- **Download SDO Segment** for transmitting a fragment with data in theVFCx615 Initiate SDO.
- **Upload** for transmitting maximum 4 byte data from VFCx615 to the master, also for initiating the transmission of more than 4 byte data from VFCx615 to the master (VFCx615 informs master the length of the response data).
- **Upload SDO Segment** for transmitting a fragment with data from the VFCx615 to the master.
- **Abort SDO Transfer** for reporting errors and to abort SDO accesses.

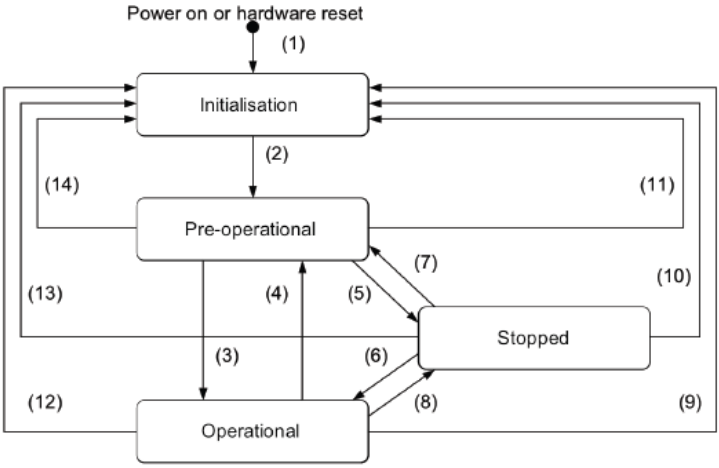
| SDO abort code | Description |
|---|---|
| 05040000h | SDO protocol timed out |
| 05040001h | Client/server command specifier not valid or unknown |
| 05040005h | Out of memory |
| 06010001h | Attempt to read a write only object |
| 06010002h | Attempt to write a read only object |
| 06020000h | Object does not exist in the object dictionary |
| 06040041h | Object cannot be mapped to the PDO |
| 06040042h | The number and length of the objects to be mapped would exceed PDO length |
| 06040043h | General parameter incompatibility reason |
| 06060000h | Access failed due to an hardware error |
| 06070010h | Data type does not match, length of service parameter does not match |
| 06090011h | Sub-index does not exist |
| 06090030h | Value range of parameter exceeded (only for write access) |
| 06090031h | Value of parameter written too high |
| 06090032h | Value of parameter written too low |
| 060A0023h | No resources available |
| 08000000h | General error |
| 08000020h | Data cannot be transferred or stored to the application |
| 08000022h | Data cannot be transferred or stored to the application because of the present device state |
| 08000024h | No data available |

**Tab. 12-92:** SDO abort codes

## Network Management Objects (NMT)

NMT functions monitor the network stability and include synchronization, detection of faults and emergency message transmission.

The NMT state machine determines the behaviour of the communication function.




| | |
|---|---|
| (1) | At Power on the NMT state initialisation is entered autonomously |
| (2) | NMT state Initialisation finished - enter NMT state Pre-operational automatically |
| (3) | NMT service start remote node indication or by local control |
| (4),(7) | NMT service enter pre-operational indication |
| (5),(8) | NMT service stop remote node indication |
| (6) | NMT service start remote node indication |
| (9),(10),(11) | NMT service reset node indication |
| (12),(13),(14) | NMT service reset communication indication |

**Fig. 12-112:** NMT state diagram of CANopen device

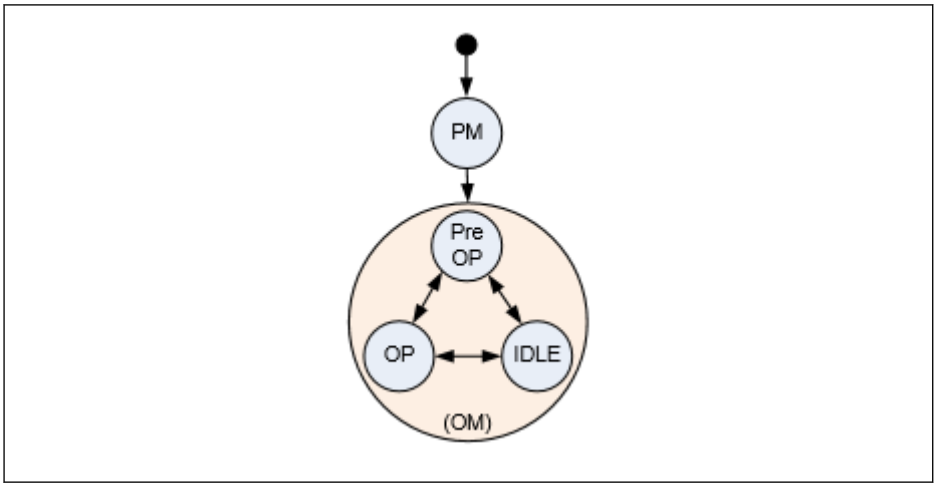



**Fig. 12-113:** Option card communication states and transitions

| State | Description |
|---|---|
| PM | Parameterization mode (no exchange of process data) |
| Pre-OP | Pre-operation mode, however, no exchange of process data |
| OP | Operation mode, exchange of process data, process data is valid |
| IDLE | Operation mode, exchange of process data, process data is invalid |

**Tab. 12-93:** Option card communication states description

- The communication status between option card and host system is transferred cyclically.
- The coupling between option card and NMT state machine is defined in the table below.

| NMT – state | Option card state |
|---|---|
| Pre-OP / STOPPED | Pre-OP |
| OP | OP / IDLE<br>IDLE state is entered on two cases:<br>1. Field-bus Data is Invalid (CAN is in ERROR PASSIVE, BUS OFF or INIT state and NMT is in OP state).<br>2. IDLE state is entered whenever the PDO configuration is invalid. |

**Tab. 12-94:** Option card communication states description

### Emergency Service (EMCY)

When an error occurs or is cleared, an EMCY telegram is transmitted. The EMCY telegram transports 8-byte data.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Error code | | Error register | Manufacturer specific bytes | | | | |
| Object: 0x603F<br>This object provides the error code of the last error occurred in the drive device. | | Object: 0x1001<br>The error register is a field of 8 bits, each for a certain error type. If an error occurs the bit has to be set. | [b6.91]<br>Least 2 significant bytes | | [b6.91] Least 3 significant bytes | | |
| Error code = 0xFF00 (for all manufacturer specific)<br>Error code -> CiA 301/402 specific error codes | | Bit meaning<br>0: Generic error<br>1: Current<br>2: Voltage<br>3: Temperature<br>4: Communication error (overrun, error state)<br>5: Device profile specific<br>6: Reserved<br>7: Manufacturer specific | E.g. If [b6.91] = 0xF5001<br>Man_fact[3] = 0x01<br>Man_fact[4]= 0x50 | | Man_fact[5] = 0x01<br>Man_fact[6] = 0x50<br>Man_fact[7] = 0x0F | | |

**Tab. 12-95:** Error telegram

- Emergency telegram is triggered whenever a critical error is detected in either option card or error condition occurs in Host.
- EMCY Frame with error code 0x8120 is sent when CAN is in error passive state.
- EMCY Frame with error code 0x8140 is sent after CAN recovers from BUS-OFF error condition.
- Supported CiA-301 and CiA-402 error codes:

| | |
|---|---|
| No Error | 0x0000 |
| Generic error | 0x1000 |
| Generic communication error | 0x8100 |
| CAN overrun | 0x8110 |
| CAN in passive error | 0x8120 |
| Heart beat or node guarding error | 0x8130 |
| Protocol error | 0x8200 |
| CAN recovered from bus-off | 0x8140 |
| Continuous over current (device output side) | 0x2310 |

| | |
|---|---|
| Continuous over current no.1 | 0x2311 |
| 2312h continuous over current no.2 | 0x2312 |
| Continuous over current no.3 | 0x2313 |
| DC link over-voltage | 0x3210 |
| Over-voltage no. 1 | 0x3211 |
| Over-voltage no. 2 | 0x3212 |
| DC link under-voltage | 0x3220 |
| Over-voltage no. 1 | 0x3211 |
| Over-voltage no. 2 | 0x3212 |
| DC link under-voltage | 0x3220 |
| Short circuit (device internal) | 0x2250 |
| Phase failure | 0x3130 |
| Load error | 0x3230 |
| Excess temperature drive | 0x4310 |
| Too low temperature drive | 0x4320 |
| Parameter error | 0x6320 |
| Any other manufacturer specific error | 0xFF00 |
| Any other manufacturer specific warning | 0xFF01 |

**Tab. 12-96:** CiA-301 and CiA-402 error codes

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Error code | | Error register | Manufacturer Specific Bytes (last occurred error diagnostic code) | | | | |
| 0x0000 | | Object: 0x1001 | [b6.91] Least 2 significant bytes | | [b6.91] Least 3 significant bytes | | |

**Tab. 12-97:** Error-cleared telegram

### Synchronisation Service (SYNC)

#### Overview

SYNC object is used to provide synchronous modes of communication of the CANopen slaves.



- PDO1 supports synchronous cyclic and synchronous acyclic modes.
- PDO2, PDO3 and PDO4 support only synchronous cyclic modes.

#### Error Control Services

The error control services are used to detect failures within a CAN-based network.

The CANopen option card supports the following error control protocols:

1. Heartbeat object
2. Node guarding object



- Either one of the error control protocol i.e. heartbeat or node guarding can be enabled at a time.
- Whenever failures are detected an error “FnC-” (Network Setup Error) is set and an EMCY telegram is sent.

### Non-Volatile Storage

The following objects are implemented:

1. 0x1010: Store Parameter Field
2. 0x1011: Restore Default Parameter



- Saving the contents of object (parameter) data value happens whenever it is written and the already saved data value is different. Saving of objects in EEPROM is handled.
- Only communication and device profile objects of CANopen option card parameters are restored to default values upon command to object 0x1011.
- Manufacturer specific parameter/objects are not restored to default values upon command to object 0x1011.
- The following CANopen option card parameters are not restored to default values upon command to object 0x1011:
  - [H2.00] – Node Address
  - [H2.01] – CAN Baudrate
  - [H2.02] – CANopen Device Profile Selection
  - [H2.98] – CANopen Termination Resistor Switch

## Device Profile

### Overview

1. Communication profile:

   The communication profile of xFC01 CANopen option card is based on:

   - Physical layer is as per CAN 2.0A standards.
   - The CANopenfi specification CiA-301(Version: 4.2.0).

2. Function profile:

   The functional profile of xFC01 CANopen option card complies with:

   - "Device profile for drives and motion control" (DSP-402 V2.0, velocity mode).
   - Bosch Rexroth VFCx615 drive profile.

**Profile Selection Option:** For controlling the drive two profiles are provided. The parameter [H2.02] is defined for profile selection. The two profiles are:

0. Rexroth Drive Profile

1. CiA-402 Drive Profile

### Rexroth Drive Profile

Rexroth Drive Profile: Set the parameter [H2.02] to 0 and activate Rexroth profile; the CANopen option card automatically disables RPDO1 and TPDO1.

| Bit | Value | Description |
|---|---|---|
| 15...8 | - | Reserved |
| 7 | 1 | Active |
| | 0 | Control word inactive |
| 6 | 1 | Stop acceleration/deceleration active (stop the internal acc/dec ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 12-98:** VFCx615 drive control word

| Bit | Value | Description |
|---|---|---|
| 15...8 | - | Fault code (equal to [E9.05]) |
| 7 | 1 | Fault |
| | 0 | No fault |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |

| Bit | Value | Description |
|---|---|---|
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 12-99:** VFCx615 drive status word

### CiA-402 Drive Profile

Set the parameter [H2.02] to 1 and activate CiA-402 Drive Profile; the CANopen option card automatically enables RPDO1 and TPDO1.



After device profile selection option is changed to CiA-402 the CANopen master should send NMT reset application command.

### Device control:

The device control function block controls all functions of the drive (drive function and power section). It is divided into:

- Device control of the state machine.
- Operation mode function.

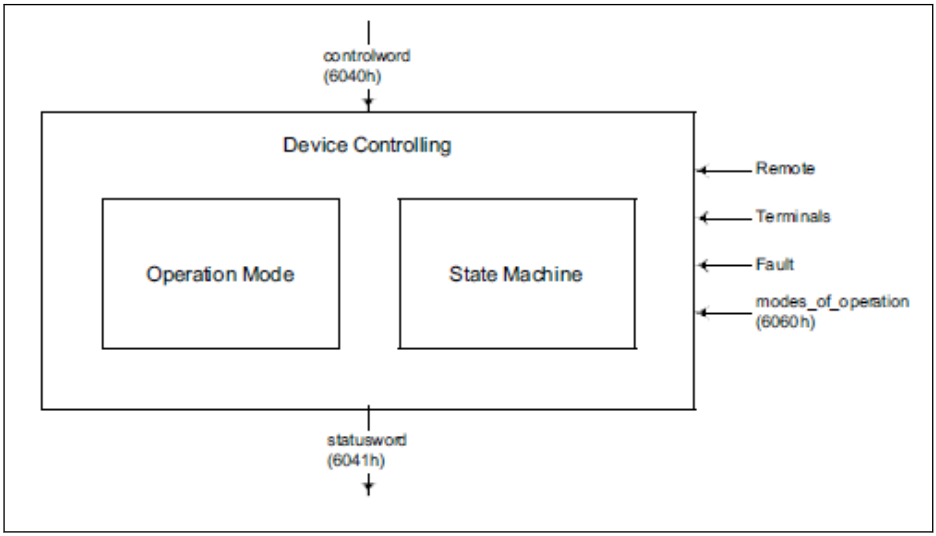



**Fig. 12-114:** Device control

The state of the drive can be controlled by the control word.

The state of the drive is shown in the status word.

### Remote mode:

In remote mode the device is controlled directly from the CANopen network by PDO and SDO.

The state machine is controlled externally by the control word and external signals.

The write access to the control word is controlled by the optional hardware signal "Remote".

The state machine is also controlled by internal signals like faults and modes of operation.

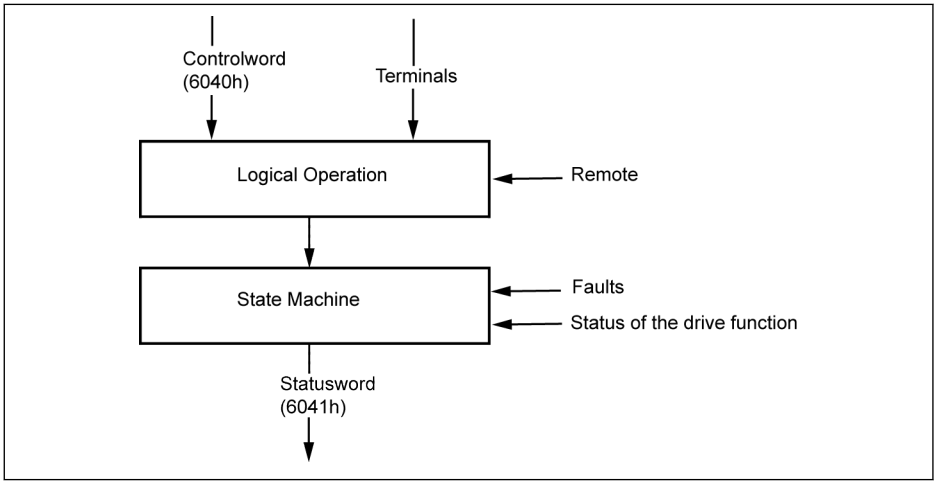



**Fig. 12-115:** Remote mode

From VFCx615 drive's perspective, when the Run command source is from communication and the communication protocol is CANopen then remote mode is enabled. This remote mode is reflected in the status word: Remote Bit (set when active).

[E0.01]: First run command source

[E0.02]: Second run command source

[E8.00]: Communication protocol

### CiA-402 State Machine:

The state machine describes the device status and the possible control sequence of the drive. A single state represents a special internal or external behaviour. The state of the drive also determines which commands are accepted. States may be changed using the control word and/or according to internal events. The current state can be read using the status word. The state machine describes the state machine of the device with respect to control of the power electronics as a result of user commands and internal drive faults.

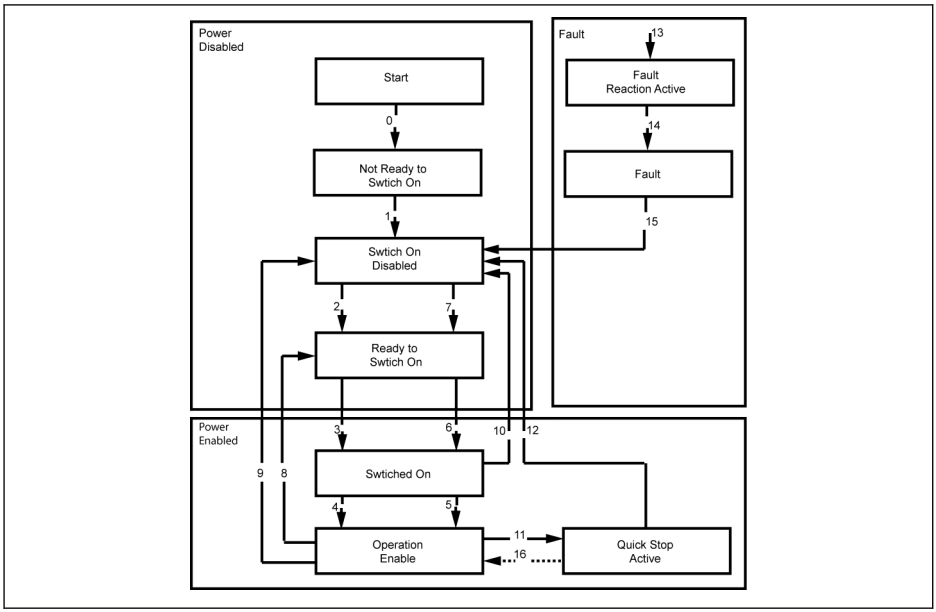



**Fig. 12-116:** CiA-402 state machine

Note:

- Some of the CiA-402 states cannot be directly mapped to drive's internal system state machine. More-over direct control of the drive's power section by option card is not feasible. The states defined in the CiA-402 state machine are simplified and mapped as follows.

| CiA-402 state | Drive status |
|---|---|
| Not ready to switch on | Initialization phase |
| Switch on disabled / Ready to switch on / Switched on | Stop |
| Operation enable | Run |
| Quick stop active | Run -> Stop transition |
| Fault reaction active / Fault | When error is set |

**Tab. 12-100:** The state mapping of CiA-402 state machine

- Quick stop object option code (0x605A) is not implemented.
- Transition 16 is not supported.
- Upon reception of Quick stop command the drive automatically transits (12) to "Switch On Disabled" state when the drive stops.
- Illegal state transition request is handled as follows:

In order to control the drive, the state transitions have to be done in a proper sequence. If the requested state transition is not appropriate (as defined in the state chart) then it is termed as “Illegal transition”.

When this occurs, suitable handling or indication will be given to the user/ master.

**Examples:**

-> Trying to directly move to “Operation Enabled” from “Switch On Disabled”.

-> Giving fault reset command in “Operation Enabled” state.

**SDO Access:**

If SDO is used to control the drive, then on occurrence of an illegal transition, the control word is rejected with abort code 0609 0030, “Invalid value for parameter”. The drive state is not affected.

**PDO Access:**

If RPDO is used to control the drive, then on occurrence of an illegal transition the drive state is not affected, but the following indication is given:

1. Warning is set and this is indicated on panel by displaying “ISt” (Invalid State Transition) and also in the CiA-Statusword warning bit (7) is set.
2. Emergency telegram is sent with error code 0x8200(protocol error).
3. The warning will be cleared only when the CANopen master gives a new valid state transition command(CiA-Controlword ) either via SDO or PDO.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Error code<br>Object: 0x603F | | Error register<br>Object: 0x1001 | Manufacturer Specific Bytes | | | | |
| 0x8200<br>(Protocol error ) | | 0x21 | [b6.91]<br>0x5900 | | [b6.91]<br>0xE5900 | | |

**Tab. 12-101:** CiA-Statusword warning bit

**CiA-402 Controlword:**

Object 6040h: Control word

The control word consists of bits for:

- The controlling of the state
- The controlling of operating modes
- Manufacturer specific options

| Bit No. | Functionality | Description |
|---|---|---|
| 0 | Switch on | Active |
| 1 | Enable voltage | Active |
| 2 | Quick stop | Active |
| 3 | Enable operation | Active |

| Bit No. | Functionality | Description |
|---|---|---|
| 4 | Operation mode specific | Inactive (No need to consider on bit) |
| 5 | Operation mode specific | Inactive (No need to consider on bit) |
| 6 | Operation mode specific | Inactive (No need to consider on bit) |
| 7 | Fault reset | Active on Rising edge 0->1 |
| 8 | Halt | Active |
| 9 | Reserved | Reserved (No need to consider on bit) |
| 10 | Reserved | Reserved (No need to consider on bit) |
| 11 | Manufacturer specific | Reserved (No need to consider on bit) |
| 12 | Manufacturer specific | Reserved (No need to consider on bit) |
| 13 | Manufacturer specific | Reserved (No need to consider on bit) |
| 14 | Manufacturer specific | Reserved (No need to consider on bit) |
| 15 | Manufacturer specific | Reserved (No need to consider on bit) |

**Tab. 12-102:** Definition of control word bits

Device control commands are triggered by the following bit patterns in the control word:

| Command | Bit of the control word | | | | | Transitions |
|---|---|---|---|---|---|---|
| | Fault reset | Enable operation | Quick stop | Enable voltage | Switch on | |
| Shutdown | 0 | X | 1 | 1 | 0 | 2, 6, 8 |
| Switch on | 0 | 0 | 1 | 1 | 1 | 3* |
| Switch on | 0 | 1 | 1 | 1 | 1 | 3** |
| Disable voltage | 0 | X | X | X | X | 7, 9, 10, 12 |
| Quick stop | 0 | X | 0 | 1 | X | 7, 10, 11 |
| Disable operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Enable operation | 0 | 1 | 1 | 1 | 1 | 4, 16 |
| Fault reset | ⌐ | X | X | X | X | 15 |

**Tab. 12-103:** Device control commands

Halt-Bit (8): Drive stops when halt bit is set and enters “Switch on Disabled State”.

CiA-402 Statusword:

Object 6041h: status word

The status word indicates the current state of the drive. No bits are latched. The status word consists of bits for:

- The current state of the drive
- The operating state of the mode
- Manufacturer specific options

| Bit No. | Functionality | Description |
|---|---|---|
| 0 | Ready to switch on | Active |
| 1 | Switched on | Active |
| 2 | Operation enabled | Active |
| 3 | Fault | Active |
| 4 | Voltage enabled | Active |
| 5 | Quick stop | Active |
| 6 | Switch on disabled | Active |
| 7 | Warning | Active |
| 8 | Manufacturer specific | Set to 0 |
| 9 | Remote | Active |
| 10 | Target reached | Defined as drive transient* status |
| 11 | Internal limit active | Active |
| 12 | Operation mode specific | Set to 0 |
| 13 | Operation mode specific | Set to 0 |
| 14 | Manufacturer specific | Set to 0 |
| 15 | Manufacturer specific | Set to 0 |

**Tab. 12-104:** Definition of status word bits

| Value (Binary) | State |
|---|---|
| xxxx xxxx x0xx 0000 | Not ready to switch on |
| xxxx xxxx x1xx 0000 | Switch on disabled |
| xxxx xxxx x01x 0001 | Ready to switch on |
| xxxx xxxx x01x 0011 | Switched on |
| xxxx xxxx x01x 0111 | Operation enabled |
| xxxx xxxx x00x 0111 | Quick stop active |
| xxxx xxxx x0xx 1111 | Fault reaction active |
| xxxx xxxx x0xx 1000 | Fault |

**Tab. 12-105:** Device state bits

### Warning Bit (7):

Drive warnings are indicated on CiA-402 status word Bit-7. No emergency telegram is triggered for warning conditions detected from the Host. In case of

warnings the Object 0x603F contains the warning code. If the warning is signaled from the Host then the corresponding error code object's (0x603F) data value is 0xFF01.

### Target Reached Bit (10):

This bit detects whether drive is in transient* status or not. Target reached bit is set when the target velocity is reached and this is determined by checking the acceleration and deceleration status of the drive. An internal delay of 30ms is taken before validating and setting this bit in the CiA-Statusword. This is required because drive does not accelerate immediately after RUN command is issued. Approximately 8ms delay time is required for enabling the power-section and entering into RUN state.

### Simple Velocity Mode:

Velocity mode is composed of the following sub-functions:

- Reference calculation
- Factor function, Reverse factor function
- Percentage function, Reverse percentage function
- Pole number function, Reverse pole number function
- Velocity limit function
- Velocity motor limit function
- Ramp function
- Ramp min function
- Closed open loop control function

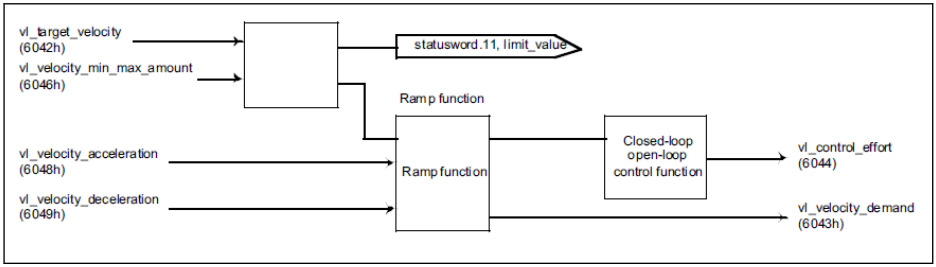



**Fig. 12-117:** Velocity mode with mandatory objects only

- **Rotation direction** is changed with positive and negative values of object 0x6042:

  Target velocity in RPM. The range of velocity command is from: -32768 RPM to +32767 RPM.

- In velocity mode: Acceleration is defined as: $\frac{\Delta\ Speed}{\Delta\ Time}$

  Whenever Delta speed or time changes, [E0.26] will be calculated and updated in the control board.

  $$[E0.26] = \frac{[E0.08] \times \Delta\ Time \times 120}{\Delta\ Speed \times Poles}$$

  Unit of acceleration is RPM/s.

- In velocity mode: Deceleration is defined as: $\frac{\Delta\ Speed}{\Delta\ Time}$.

  Whenever Delta speed or time changes, [E0.27] will be calculated and updated in the control board.

  $$[E0.27] = \frac{[E0.08] \times \Delta\ Time \times 120}{\Delta\ Speed \times Poles}$$

  [E0.08] -> Maximum output frequency

  Unit of deceleration is RPM/s.

**Parameter dependency relation in CiA-402 velocity mode profile:**

When CiA-402 drive profile is selected, a watch-list of parameters is prepared in the CANopen option card. So when these watch-list parameters are modified, then the associated dependent parameters are calculated and written back to Host (Control board) by CANopen option card automatically.

| Main parameter (Watch list) | Associated dependent parameters and drive profile objects |
|---|---|
| [C1.11]: Motor Poles | 1. [E0.26]: Acceleration Time<br>2. [E0.27]: Deceleration Time<br>3. [E0.10]: Output Frequency Low Limit*<br>4. [E0.09]: Output Frequency High Limit* |
| [E0.08]: Maximum Frequency | 1. [E0.26]: Acceleration Time<br>2. [E0.27]: Deceleration Time<br>3. 0x6046: vl Velocity Min Max amount |
| [E0.09]: Output Frequency High Limit | 0x6046-02: vl Velocity Max amount |
| [E0.10]: Output Frequency Low Limit | 0x6046-01: vl Velocity Min amount |
| [E0.26]: Acceleration Time | Not writable when CiA-402 Profile is Active and NMT is in Operational State |
| [E0.27]: Deceleration Time | Not writable when CiA-402 Profile is Active and NMT is in Operational State |

**Tab. 12-106:** List of dependent parameters



*: The Low and High limits of frequency are calculated based on the velocity limits as defined in the object 0x6046 : vl Velocity Min Max amount

- When node is in NMT operational state, it is not possible to write parameters [E0.26] and [E0.27] directly by Converter Works/SDO (“Protected by others” error is thrown).
- When node is in NMT pre-operation state, it is possible to write parameters [E0.26] and [E0.27] directly by Converter Works/SDO; but the moment the NMT state transits from pre-operation to operation, the calculated acceleration/deceleration times based on the objects 0x6048 and 0x6049 are written back to [E0.26] and [E0.27].
- If motor poles [C1.11] or maximum frequency [E0.08] parameter is changed when node is in operational state then the dependent parameters are re-calculated and updated automatically.

## Related Communication Parameters

| Parameter | Name | Modify | Function | Value |
|---|---|---|---|---|
| E0.00 | First frequency setting source | Stop | Setting frequency selection source | 20: Communication |
| E0.01 | First run command source | Stop | Run command selection source | 2: Communication |
| E8.00 | Communication protocol | Stop | Field bus protocol selection | 0: Modbus*<br>1: Option card |
| E8.03 | Communication process data loss behaviour | Stop | Selecting the drive behaviour when the CANopen node switches to Pre-Op during RUN | 0: Decelerating stop<br>1: Freewheeling stop<br>2: Keep running |
| H0.00 | Control word | Run | VFCx615 drive control word | - |
| H0.01 | Status word | Read | VFCx615 Drive Status Word | - |
| H0.10 | Frequency command | Run | Setting frequency | 0...400 Hz<br>(0...65535)<br>Default: 0 |
| H0.20 | Option card 1 type | Read | Shows the option card type in slot 1 detected by frequency converter | 0: Inactive*<br>1: PROFIBUS card<br>2: CANopen card<br>3: Multi-Ethernet card<br>8: I/O card<br>9: Relay card |
| H0.21 | Option card1 hardware label | Read | - | - |
| H0.22 | Option card1 firmware string | Read | - | - |
| H0.23 | Option card 2 Type | Read | Shows the option card type detected in slot 2 by frequency converter | 0: Inactive*<br>1: PROFIBUS card<br>2: CANopen card<br>3: Multi-Ethernet card<br>8: I/O card<br>9: Relay card |
| H0.24 | Option card2 hardware label | Read | - | - |
| H0.25 | Option card2 firmware string | Read | - | - |

**Tab. 12-107:** Definition of status word bits

☞ * : Factory default

## CANopen Option Card Parameters

| Parameter | Mapped object in MO/CO/DPO | Name | Modify | Function | Value |
|---|---|---|---|---|---|
| H2.00 | MO: 0x3838 | CANopen address | Stop | Selects the address for CANopen Node | 1...127<br>Default: 1 |
| H2.01 | MO: 0x3839 | CAN baudrate | Stop | Sets the speed of CANopen communication | 0...6<br>Default: 3<br>0: 10 kbits/s<br>1: 20 kbits/s<br>2: 50 kbits/s<br>3: 125 kbits/s<br>4: 250 kbits/s<br>5: 500 kbits/s<br>6: 1 Mbit/s |
| H2.02 | MO: 0x383A | CANopen device profile selection | Stop | To switch between different drive profiles | 0...1<br>Default:<br>0-> Rexroth Drive Profile<br>1-> CiA- 402 Drive Profile |
| H2.98 | MO: 0x389A | CANopen termination resistor switch | Stop | Selects the state of the termination resistor | 0:Disabled (Default)<br>1: Enabled |

**Tab. 12-108:** CANopen option card parameters



MO: Manufacturer Objects

## 12.20 H8: IO&IO Plus Card Parameters

### 12.20.1 IO & IO Plus Card Analog Input Configuration

This function is implemented to configure the external analog input EAI1 and EAI2, which is provided in IO and IO plus extension card.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.05 | EAI1 input mode | 0: 0...20 mA<br>1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V<br>5: -10...10 V | 0 | – | – | Stop |
| H8.06 | EAI1 input polarity setting | 0: Polarity inactive<br>1: Polarity active without direction control<br>2: Polarity active with direction control<br>3. Combination direction control | 1 | – | – | Stop |
| H8.07 | EAI1 dead zone filter value | 0.0...30.0 % | 0.0 | % | 0.1 | Run |
| H8.09 | EAI1 filter time | 0.000...2.000 | 0.100 | s | 0.001 | Run |
| H8.10 | EAI1 gain | 0.00...10.00 | 1.00 | - | 0.01 | Run |
| H8.15 | EAI1 curve minimum | -120.0 %... [H8.17] | 0.0 | % | 0.1 | Run |
| H8.16 | EAI1 curve minimum value | -[E0.09]...[E0.09] Hz | 0.00 | Hz | 0.01 | Run |
| H8.17 | EAI1 curve maximum | [H8.15]...120.0 % | 100.0 | % | 0.1 | Run |
| H8.18 | EAI1 curve maximum value | -[E0.09]...[E0.09] Hz | 50.00 | Hz | 0.01 | Run |
| H8.30 | EAI2 input mode | 0: 0...20 mA<br>1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V<br>5: -10...10 V | 0 | – | – | Stop |

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.31 | EAI2 input polarity setting | 0: Polarity inactive<br>1: Polarity active without direction control<br>2: Polarity active with direction control<br>3. Combination direction control | 1 | – | – | Stop |
| H8.32 | EAI2 filter time | 0.000...2.000 | 0.100 | s | 0.001 | Run |
| H8.33 | EAI2 gain | 0.00...10.00 | 1.00 | - | 0.01 | Run |
| H8.34 | EAI2 curve minimum | -120.0 %... [H8.36] | 0.0 | % | 0.1 | Run |
| H8.35 | EAI2 curve minimum value | -[E0.09]...[E0.09] | 0.00 | Hz | 0.01 | Run |
| H8.36 | EAI2 curve maximum | [H8.34]...120.0 % | 100.0 | % | 0.1 | Run |
| H8.37 | EAI2 curve maximum value | -[E0.09]...[E0.09] | 50.00 | Hz | 0.01 | Run |
| H8.38 | EAI2 dead zone filter value | 0.0...30.0 % | 0.0 | % | 0.1 | Run |

Except for an additional option of '-10...10 V', EAI1 / EAI2 is the same as AI1 and AI2.

In order to use '-10...10 V', set [H8.05] (or [H8.30])= '-10...10 V' firstly.

Unlike other analog inputs, EAI1 / EAI2 will not have multiple curve selection. There are dedicated curves defined for EAI1 and EAI2. Parameters H8.15...H8.18 defines EAI1 curve, parameters H8.34...H8.37 defines EAI2 curve. Both the curve functionalities are similar, hence all the below descriptions mentioned are applicable to both curves.

H8.06 'EAI1 input polarity setting' (or H8.31 'EAI2 input polarity setting' ) defines how the input polarity information can be used for operation.

- **[H8.06] / [H8.31] = 0: Polarity inactive**

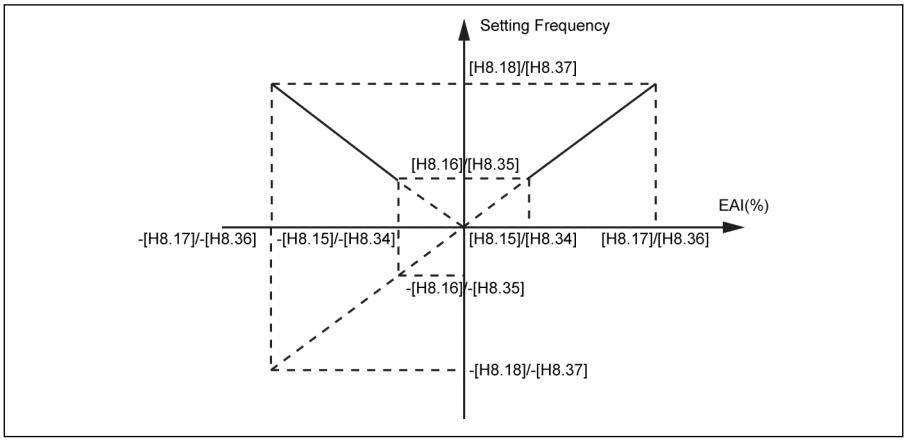



**Fig. 12-118:** Polarity inactive

- Setting frequency will be always positive irrespective of H8.16 / H8.18 parameter setting.
- Direction control is not active in this mode, which means even if negative frequency command is generated it will result in FWD direction only.
- When frequency source combination is used, the setting frequency from EAI will be only positive, and can be used in the addition and subtraction operation.

- **[H8.06] / [H8.31] = 1: Polarity active without direction control**

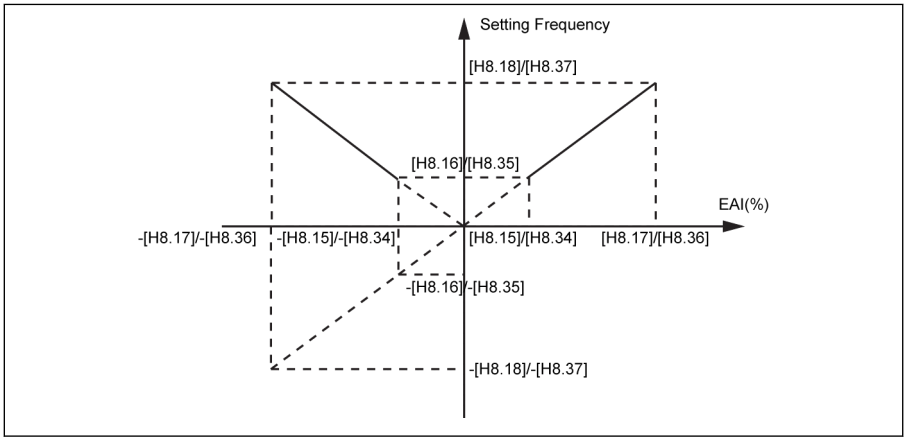



**Fig. 12-119:** Polarity active without direction control

- When frequency source combination is NOT used, the setting frequency will still be positive value even with negative EAI1 / EAI2 input, like the absolute value, and rotation direction will not be influenced by negative EAI1 / EAI2 input.

– When frequency source combination is used, the setting frequency from EAI1 / EAI2 can be positive / negative, and be used in the addition and subtraction operation.

- **[H8.06] / [H8.31] = 2: Polarity active with direction control**

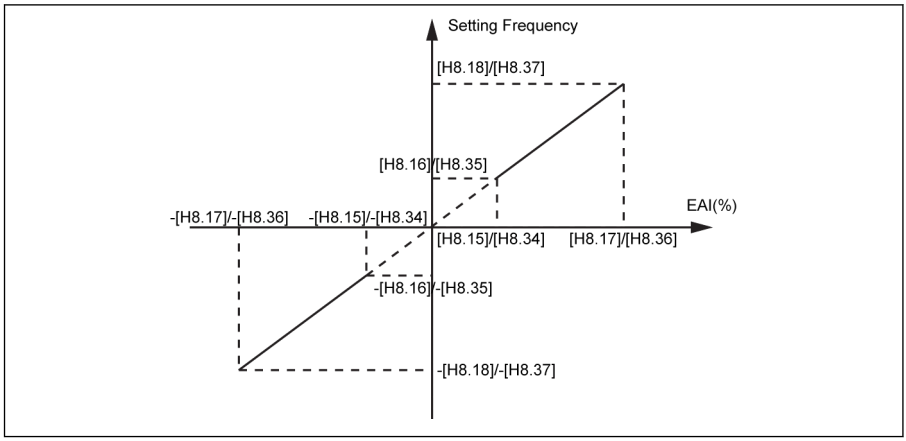



**Fig. 12-120:** Polarity active with direction control

– Direction control is active in this mode, which means negative frequency command will result in REV direction and positive frequency command will result in FWD direction.

– Frequency source combination operation cannot be enabled. As direction control from EAI is active.

– EAI1 / EAI2 as direction control has a higher priority than actual panel and terminal setting. For example, the terminal control is giving a FWD signal, but during the running process, the EAI1 / EAI2 's input is becoming negative, then the final direction would be changed to negative. If the command is from panel, then U1.00 will be inactive if polarity is used to control the direction. And the priorities of all other existing direction command sources (Ex: Simple PLC, Multi-Speed Control) if it is higher than panel and terminal setting then it remains higher than priority of EAI1 / EAI2 direction command also.

- **[H8.06] / [H8.31] = 3: Combination of EAI and Run command**

  This option will enable direction combination of EAI polarity and active run command source (Panel, DI, except communication as run command source)

| E0.01/E0.03=0: run command is panel | | |
|---|---|---|
| H8.05/H8.31=3: Combination of EAI and Run command | | |
| U0.00 decides original direction set | Polarity of EA1 | Direction |
| FWD | + | FWD |
| REV | + | REV |

| | | |
|---|---|---|
| FWD | - | REV |
| REV | - | FWD |

| E0.01/E0.03=1: run command is digital input | | |
|---|---|---|
| H8.05/H8.31=3: Combination of EAI and Run command | | |
| DI decides original direction set | Polarity of EA1 | Direction |
| FWD | + | FWD |
| REV | + | REV |
| FWD | - | REV |
| REV | - | FWD |

**Example for EAI1, when H8.05 = 5:**

1. H8.06 = 0, H8.15 = -100.0, H8.16 = 0.0, H8.17 = 100.0, H8.18 = 50.0

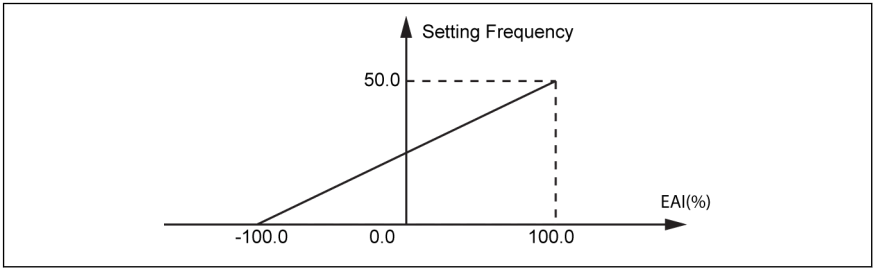



**Fig. 12-121:** EAI1 example 1

2. H8.06 = 1, H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

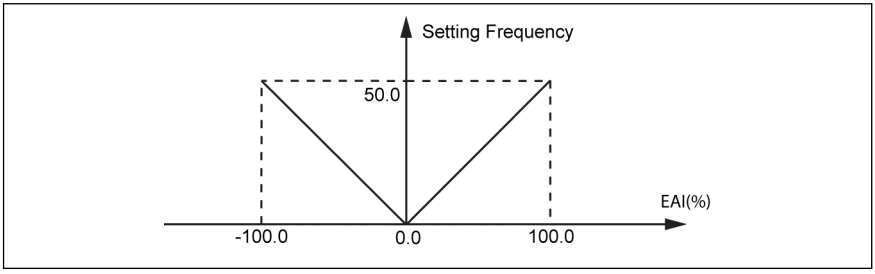



**Fig. 12-122:** EAI1 example 2

3. H8.06 = 2, H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

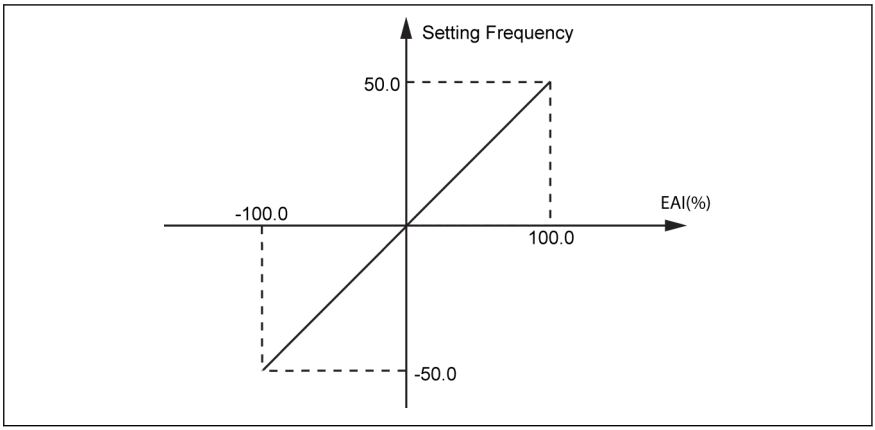



**Fig. 12-123:** EAI1 example 3

### Frequency setting source combination with polarity of EAI1 / EAI2

- When H8.06 / H8.31 'EAI input polarity setting' is set to '0' or '1', and frequency source combination is selected, then the negative value of EAI1 / EAI2 will be treated normally.

  E.g: 5 V from AI1 and -2 V from EAI1, then the combination result will be 7 V with subtraction operation, and 3V with addition operation.

- When frequency source combination function is selected (either addition or subtraction), the H8.06 / H8.31 'EAI input polarity setting' will be limited to '1' or '0', and the combination result will always be limited to 0.00...[E0.09] Hz. When frequency combination is selected (addition / subtraction), then if polarity with direction control is already enabled (H8.06 / H8.31 = 2) 'PrSE' will be displayed.

---

When [H8.05] = '5: -10...10 V' and [H8.06] / [H8.31] = '2: Polarity active with direction control', the priority of direction command from EAI1 / EAI2 is

- higher than the direction command from communication or digital inputs
- lower than the direction command from simple PLC or Multi-Speed

---

### Dead zone filter for external analog input -10 ...+10 V

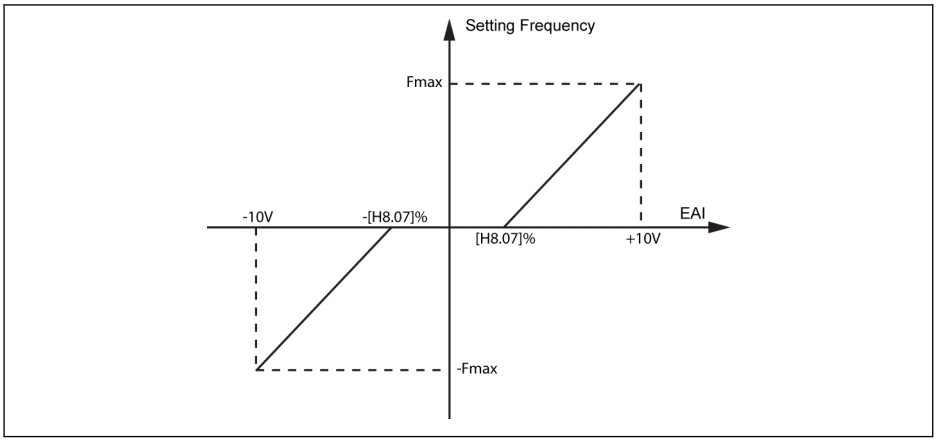



**Fig. 12-124:** Dead zone filter for external analog input

If [H8.05] / [H8.30] = 5, parameter H8.07 / H8.38 can be used to define the forward and reverse rotation dead zone of the motor, i.e. the range for treating input signals as zero, as shown in the above figure. For example, if [H8.07] / [H8.38] = 10.0 % when [H8.05] / [H8.30] = 5, analog input signals within the range of -1...1 V will be treated as zero, 1...10 V corresponds to 0 Hz to maximum frequency, -1...-10 V corresponds to 0 Hz to minus maximum frequency. The dead zone range is -1...+1 V in this case.

Dead zone filter will be active only for -10...+10 V mode when polarity control for that channel is enabled. i.e., when H8.05 / H8.30 = 5 and H8.06 / H8.31 = 1 or 2. And when dead zone filter is active, curve mode configurations will be inactive.



IO & IO plus card analog input status are monitored by parameter d0.33 'I/O card EAI1 input' or d0.34 'I/O card EAI2 input'.

## 12.20.2 IO & IO Plus Card Analog output Configuration

The EAO analog output terminal may output voltage or current signals based on some system variables with adjustable gain setting.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.25 | EAO output mode | 0: 0...10 V<br>1: 0...20 mA<br>2: -10...10 V (only for IO plus card)<br>3 : 2....10V<br>4 : 4.....20mA | 0 | – | – | Run |
| H8.26 | EAO output selection | 0: Output frequency<br>1: Set frequency<br>2: Output current<br>4: Output voltage<br>5: Output power<br>6: AI1 analog input<br>7: AI2 analog input<br>8: EAI1 analog input<br>9: EAI2 analog input<br>11: Motor temperature sensor power<br>12: Parameter setting from communication<br>13: Setting torque<br>14: Output torque | 0 | – | – | Run |
| H8.27 | EAO gain | 0.00...10.00 | 1.00 | – | 0.01 | Run |
| H8.28 | EAO value in percentage from extension card fieldbus communication | 0.00...100.00% | 0.00 | % | 0.01 | Stop |
| H8.39 | EAO curve minimum | -100.0 %...[H8.41] | 0.0 | % | 0.1 | Run |
| H8.40 | EAO curve minimum value | -100.0...100.0 % | 0.00 | % | 0.01 | Run |
| H8.41 | EAO curve maximum | [H8.39]...100.0 % | 100.0 | % | 0.1 | Run |
| H8.42 | EAO curve maximum value | -100.0...100.0 % | 100.0 | % | 0.1 | Run |

**Analog Output Configuration step:**

- **Step 1: Set EAO output mode**

  H8.25 is for AO1 output mode selection, when IO plus card is connected, then H8.25 can be set to '2: -10 V...+10 V' mode. Depending upon the configuration of H8.26, EAO will be in '-10 V...+10 V' range.

For example: If H8.26 = 0 (output frequency), then

0...50 Hz (FWD): 0...+10 V

0...50 Hz (REV): 0...-10 V

- **Step 2: Select EAO output signal**

**Setting range of H8.26:**

| | |
|---|---|
| H8.26 = 0: Output frequency | Represents the actual output frequency between 0.00...[E0.08] Hz. |
| H8.26 = 1: Setting frequency | Represents the setting frequency between 0.00...[E0.08] Hz. |
| H8.26 = 2: Output current | Represents the 0...2 x [rated current]. |
| H8.26 = 4: Output voltage | Represents 0...1.2 x [rated voltage], which is defined by parameter E2.40. |
| H8.26 = 5: Output power | Represents 0...1.2 x [rated power]. |
| H8.26 = 6: AI1 Analog input | Represents AI1 input value. |
| H8.26 = 7: AI2 Analog input | Represents AI2 input value. |
| H8.26 = 8: EAI1 analog input | Represents EAI1 analog input value from IO or I/O plus card. |
| H8.26 = 9: EAI2 analog input | Represents EAI2 analog input value from I/O plus card. |
| H8.26 = 11: Motor temperature sensor power supply | Provides current source for motor temperature sensor, see chapter 12.3.7 "Motor Thermal Sensor Selection" on page 159. |
| H8.26 = 12: Parameter setting from communication | • For modbus mode, the output is defined by register 0x7F07, the value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).<br>• For other fieldbus mode, the output is defined by parameter H8.28. |
| H8.26 = 13: Setting torque | Represents range of setting torque selected using C3.42 and C3.43. |
| H8.26 = 14: Output torque | Represents range of output torque selected using C3.42 and C3.43. |

- **Step 3: Set AO1 filter time and output curve**

EAO curve for H8.25 = 0 & 1:

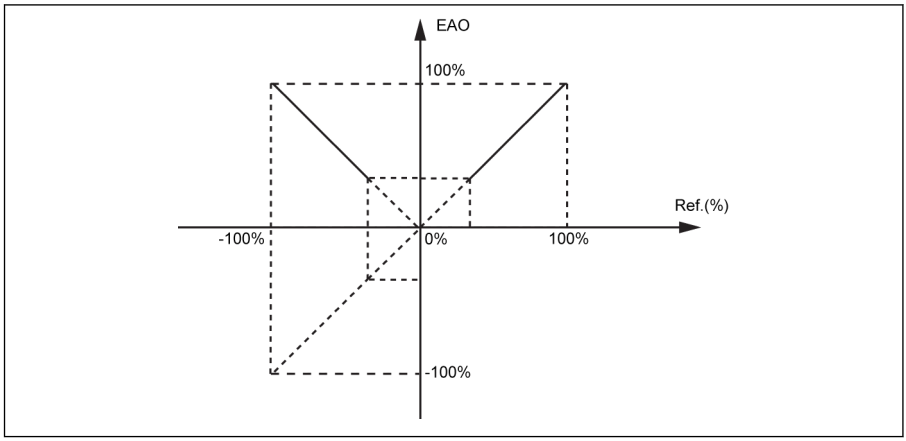



**Fig. 12-125:** EAO curve 1

EAO curve for H8.25 = 2:

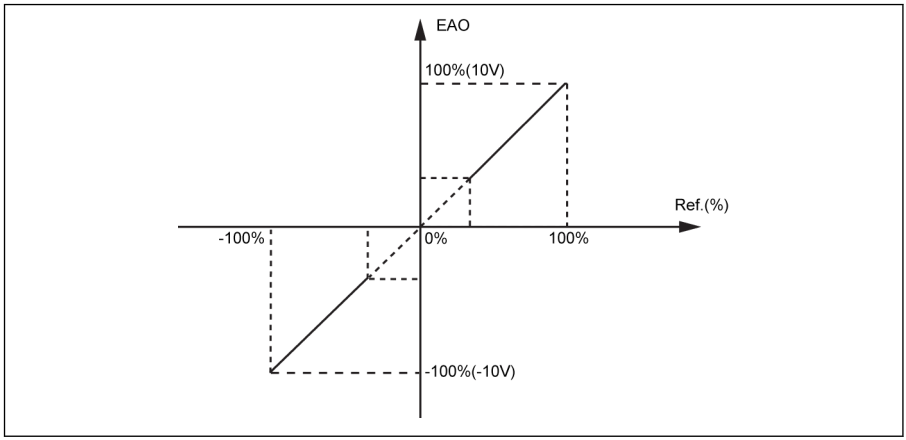



**Fig. 12-126:** EAO curve 2

- EAO analog output status is monitored by parameter d0.37 'I/O card EAO output'.
- Since mode 2 for H8.25 is valid only for IO plus card, when back-up is done with H8.25 = 2 and if restore is done with IO card, then 'E.par' would be displayed since mode 2 is not applicable for IO card.

### 12.20.3 IO & IO Plus Card Digital Input Configuration

This function defines 5 multi-function digital inputs with PNP and NPN wiring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.00 | EX1 input | 1...52 | 0 | – | – | Stop |
| H8.01 | EX2 input | | 0 | – | – | Stop |
| H8.02 | EX3 input | | 0 | – | – | Stop |
| H8.03 | EX4 input | | 0 | – | – | Stop |
| H8.04 | EX5 input | | 0 | – | – | Stop |

**Setting range of H8.00...H8.04:**

- **0: Inactive**

  No function assigned.
- **1: Multi-speed control input 1**
- **2: Multi-speed control input 2**
- **3: Multi-speed control input 3**
- **4: Multi-speed control input 4**

  16 multi-speeds are available by combination of 4 terminals, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.
- **10: Acceleration / deceleration time 1 activation**
- **11: Acceleration / deceleration time 2 activation**
- **12: Acceleration / deceleration time 3 activation**

  Used to switch between 8 groups of acceleration / deceleration time, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.
- **15: Freewheeling stop activation**

  'Freewheeling stop activation' generates a stop command and forces the frequency converter to freewheel to stop regardless of the stopping mode configured by E0.50.
- **16: Stop DC-braking activation**

  This function is used when stopping mode is set with [E0.50] = '0: Decelerating stop', details see chapter 12.8.9 "Stop Mode Configuration" on page 208.
- **20: Frequency Up command**
- **21: Frequency Down command**
- **22: Up / Down command reset**

  Used to change the output frequency, details see chapter 12.9.3 "Digital Input Frequency Change Function" on page 231.
- **23: Torque / speed control switch**

  Used to switch between torque control mode and speed control mode. If the defined switch is open, speed control mode is selected; If the defined switch is closed, torque control mode is selected.

- **25: 3-wire control**

  Used for the 3-wire control mode, details see chapter 12.9.2 "2- and 3-Wire Control" on page 226.
- **26: Simple PLC stop**
- **27: Simple PLC pause**

  Used for the simple PLC to stop and pause a PLC cycle, details see chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.
- **30: Second frequency setting source activation**

  Used for switching to the second frequency setting source, details see chapter 12.8.1 "Frequency Setting Source" on page 189.
- **31: Second run command source activation**

  Used for switching to the second run command source, details see chapter 12.8.2 "Run Command Source" on page 194.
- **32: Error signal N.O. contact input**
- **33: Error signal N.C. contact input**

  Used for receive error signal from external sources. The frequency converter stops once an external error signal is active and the error code 'E-St' will be displayed on the operating panel if one X1...X5 or EX1...EX5 input is defined as either 'Error signal N.O. contact input' or 'Error signal N.C. contact input'.
  - **32: Error signal N.O. contact input**
    - If the defined switch is closed, the external error signal is active.
    - If the defined switch is open, the external error signal is inactive.
  - **33: Error signal N.C. contact input**
    - If the defined switch is open, the external error signal is active.
    - If the defined switch is closed, the external error signal is inactive.

    The converter will stop when the external error signal is active, and the stop mode is defined by E0.56 'Emergency stop action', please see chapter 12.8.9 "Stop Mode Configuration" on page 208 for the detailed information.

    **Example:**

    Set [E1.00] = '32: Error signal N.O. contact input' **or**

    Set [E1.01] = '33: Error signal N.C. contact input'

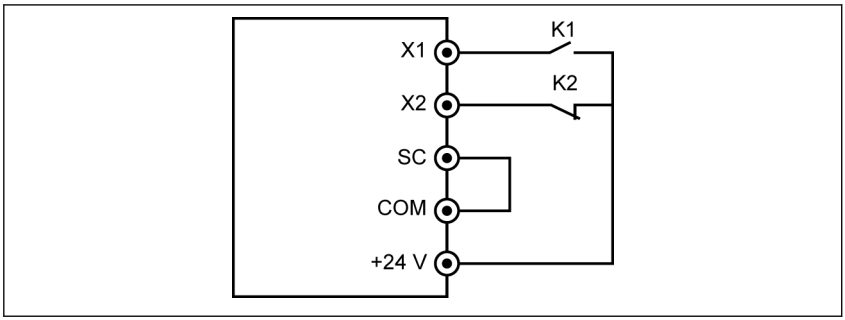



**Fig. 12-127:** Error signal 1

The frequency converter stops and indicates error code 'E-St' if K1 is closed.

**Or** the frequency converter stops and indicates error code 'E-St' if K2 is open.

- **34: Error reset**

  Used for error reset operation. The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset signal' is edge sensitive.

- **35: Forward running (FWD)**
- **36: Reverse running (REV)**

  Used for Run / Stop command control, details see chapter 12.8.2 "Run Command Source" on page 194.

- **37: Forward jog**
- **38: Reverse jog**

  See chapter 12.8.13 "Jog Function" on page 215.

- **39: Counter input**
- **40: Counter reset**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **41: PID deactivation**

  See chapter 12.12 "E4: PID Control" on page 268.

- **46: User parameter set selection**

  Used to switch between two sets of parameters, details see chapter 12.1.4 "Parameter Set Switch" on page 116.

- **48: Motor overheating error N.O. contact input**
- **49: Motor overheating error N.C. contact input**

  Used for receive motor overheating error signal from external sources. The frequency converter stops once an external motor overheating error signal is active and the error code 'Ot' will be displayed on the operating panel if one

of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating error N.O. contact input' or 'Motor overheating error N.C. contact input'.

- **48: Motor overheating error N.O. contact input**
  - If the defined switch is closed, the motor overheating error signal is active.
  - If the defined switch is open, the motor overheating error signal is inactive.
- **49: Motor overheating error N.C. contact input**
  - If the defined switch is open, the motor overheating error signal is active.
  - If the defined switch is closed, the motor overheating error signal is inactive.

  **Example:**

  Set [E1.00] = '48: Motor overheating error N.O. contact input' **or**

  Set [E1.01] = '49: Motor overheating error N.C. contact input'

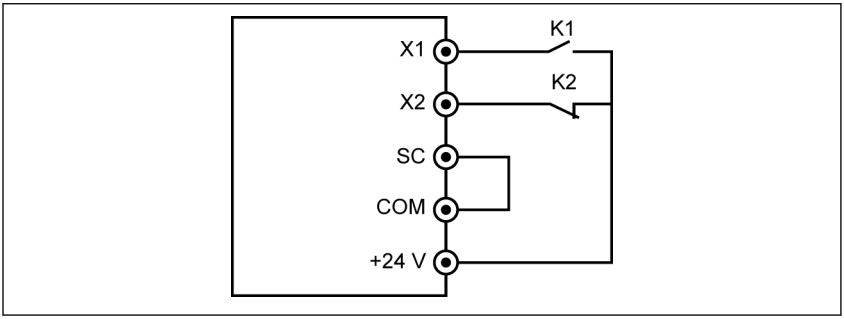



**Fig. 12-128:** Error signal 2

The frequency converter stops and indicates error code 'Ot' if K1 is closed.

**Or** the frequency converter stops and indicates error code 'Ot' if K2 is open.

- **50: Motor overheating warning N.O. contact input**
- **51: Motor overheating warning N.C. contact input**

Used for receive motor overheating warning signal from external sources. Warning code 'Ot' will be displayed on the operating panel if one of X1...X5 or EX1...EX5 input is defined as either 'Motor overheating warning N.O. contact input' or 'Motor overheating warning N.C. contact input'.

- **50: Motor overheating warning N.O. contact input**
  - If the defined switch is closed, the motor overheating warning signal is active.
  - If the defined switch is open, the motor overheating warning signal is inactive.

- **51: Motor overheating warning N.C. contact input**
  - If the defined switch is open, the motor overheating warning signal is active.
  - If the defined switch is closed, the motor overheating warning signal is inactive.

  **Example:**

  Set [E1.00] = '50: Motor overheating warning N.O. contact input' **or**

  Set [E1.01] = '51: Motor overheating warning N.C. contact input'

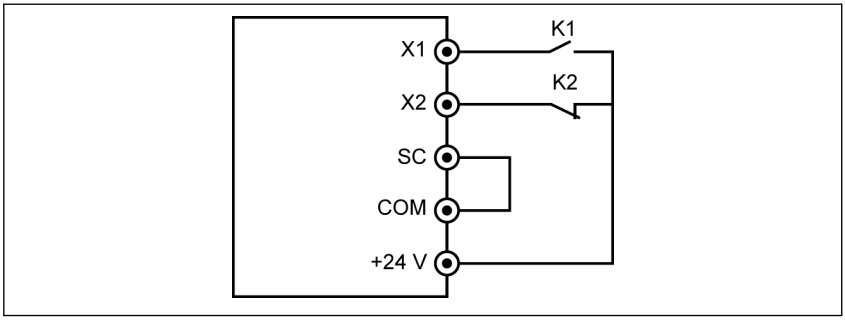



**Fig. 12-129:** Error signal 2

The frequency indicates warning code 'Ot' if K1 is closed.

**Or** the frequency converter indicates warning code 'Ot' if K2 is open.

- **52: Jog with Run Command Direction**



I/O card digital input status is monitored by parameter d0.43 'I/O card digital input'.

## 12.20.4 IO & IO Plus Card Digital Output Configuration

This function defines the IO and IO plus extension card open collector output for system state monitoring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.20 | EDO1 output selection | 0...25 | 1 | – | – | Stop |
| H8.22 | EDO2 output selection | | 1 | – | – | Stop |
| H8.23 | Extended digital output value from extension card fieldbus communication | Bit0: EDO1 (IO / IO plus card)<br>Bit1: EDO2 (IO plus card)<br>Bit8: Erelay (IO card) | 0 | – | – | Stop |

**Setting range of H8.20, H8.22:**

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 202 and chapter 12.8.9 "Stop Mode Configuration" on page 208.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.



There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 250.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 250.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 139.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 157.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 221 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 268.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**

  For modbus mode,

  – The output of EDO1 is defined by bit0 of register 0x7F09. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.

  – The output of EDO2 is defined by bit1 of register 0x7F09. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.

  For other fieldbus mode,

  – The output of EDO1 is defined by bit0 of H8.23. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.

– The output of EDO2 is defined by bit1 of H8.23. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.



- Digital output status is monitored by parameter d0.47 'I/O card EDO1 output' and d0.48 'I/O card EDO2 output'.
- EDO2 is only for IO plus card.

## 12.20.5 IO Card Relay Output Configuration

This function defines the IO extension card extended relay output for system state monitoring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H8.21 | Extended relay output selection | 0...25 | 1 | – | – | Stop |
| H8.23 | Extended digital output value from extension card fieldbus communication | Bit0: EDO1 (IO / IO plus card)<br>Bit1: EDO2 (IO plus card)<br>Bit8: Erelay (IO card) | 0 | – | – | Stop |

**Setting range of H8.21:**

- **0: Converter ready**

  After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 202 and chapter 12.8.9 "Stop Mode Configuration" on page 208.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.



There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 250.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 250.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **10: Converter undervoltage**

The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 139.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 157.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 221 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 268.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**
  - For modbus mode, the output extended relay is defined by bit8 of register 0x7F09. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.
  - For other fieldbus mode, the output of extended relay is defined by bit8 of H8.23. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

The output is inactive when the frequency converter without error / warning.



IO card relay output status is monitored by parameter d0.60 'Relay output'.

## 12.20.6 I/O & I/O plus card diagnosis

This function is used to perform the self-test function of I/O & I/O plus card.

| Code | Name | Setting range | Default | Unit | Step | Attri. | Device |
|---|---|---|---|---|---|---|---|
| H8.87 | I/O card output channel diagnosis | 0: Inactive<br>1: EAO diagnosis<br>2: EDO diagnosis<br>ERO diagnosis/EDO2 diagonis<br>All output diagnosis | 0 | - | - | Stop | xFCx610 |

**Setting range of H8.87:**

- **0: Inactive**

  The test is complete. All outputs are restored to default settings.

- **1: EAO diagnosis**

  The analog output of I/O & I/O plus card outputs 10 V.

- **2: EDO diagnosis**

  For I/O card, the open collector output of I/O card will have "Logic 1(High)" output state.

  For I/O plus card, the open collector output 1 of I/O plus card will have "Logic 1(High)" output state.

- **3: ERO diagnosis/EDO2 diagnosis**

  For I/O card, the relay output of I/O card is closed.

  For I/O plus card, the open collector output 2 of I/O plus card will have "Logic 1(High)" output state.

- **4: All output diagnosis**

  EAO, ERO, EDO are all tested with the above methods.

## 12.21 H9: Relay Card Parameters

### 12.21.1 Relay Card Output Configuration

This function defines the 4 relays output in relay extension card for system state monitoring.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| H9.00 | Extended relay 1 output selection | 0...25 | 0 | – | – | Stop |
| H9.01 | Extended relay 2 output selection | | 0 | – | – | Stop |
| H9.02 | Extended relay 3 output selection | | 0 | – | – | Stop |
| H9.03 | Extended relay 4 output selection | | 0 | – | – | Stop |
| H9.10 | Relay output setting value | Relay1 is defined by bit0, when bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed<br>Relay2 is defined by bit1, when bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed<br>Relay3 is defined by bit2, when bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed<br>Relay4 is defined by bit3, when bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed | 0 | – | – | Run |
| H9.97 | Relay card output channel diagnosis | 0: Inactive<br>1: Relay1 diagnosis<br>2: Relay2 diagnosis<br>3: Relay3 diagnosis<br>4: Relay4 diagnosis<br>5: All output diagnosis | 0 | – | – | Stop |

**Setting range of H9.00...H9.03:**

- **0: Converter ready**

After power on, when no error happens, no run command, output active indicates that the converter is ready for running.

- **1: Converter running**

  The output is active when the frequency converter is running and has frequency output (including 0.00 Hz).

- **2: Converter DC-braking**

  The output is active when the converter is in the DC braking process at starting or stopping process. See chapter 12.8.7 "Start Mode Configuration" on page 202 and chapter 12.8.9 "Stop Mode Configuration" on page 208.

- **3: Converter running at zero speed**

  The output is active when the frequency converter is running at zero speed.



There is no output for this selection during dead zone time of rotation direction change.

- **4: Speed arrival**

  This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in [E2.70], see chapter 12.10.5 "Frequency Detection Function" on page 250.

- **5: Frequency level detection signal (FDT1)**
- **6: Frequency level detection signal (FDT2)**

  See chapter 12.10.5 "Frequency Detection Function" on page 250.

- **7: Simple PLC stage complete**
- **8: Simple PLC cycle complete**

  See chapter 12.11 "E3: Multi-Speed and Simple PLC" on page 254.

- **10: Converter undervoltage**

  The output is active when DC-bus voltage is lower than 230 VDC (1P 200 VAC models) / 430 VDC (3P 400 VAC models). The output will be inactive when DC-bus voltage resumes and becomes stable.

  In addition, this digital output will be activated by any soft start error.

- **11: Converter overload pre-warning**

  See chapter 12.2.12 "Converter Overload Pre-Warning" on page 139.

- **12: Motor overload pre-warning**

  See chapter 12.3.6 "Motor Overload Pre-Warning" on page 157.

- **13: Converter stop by external error**

  This signal is activated when the error "E.-St" is generated and deactivated when this error is reset. See chapter 12.9.1 "Digital Input Configuration" on page 221 when digital input is set to '32: Error signal N.O. contact input' and '33: Error signal N.C. contact input'.

- **14: Converter error**

  The output is active when an error occurs, inactive when the error is reset.

- **15: Converter OK**

  The output is inactive when the frequency converter is powered off or encounters error / warning.

  The output is active when the frequency converter is powered on but not running, or the frequency converter is running without error / warning.

- **16: Counter target value arrival**
- **17: Counter middle value arrival**

  See chapter 12.10.6 "Pulse Counter Function" on page 252.

- **18: PID reference engineering value arrival**

  Used for PID function, see chapter 12.12 "E4: PID Control" on page 268.

- **20: Torque control mode**

  The output is active when the frequency converter is in torque control mode.

  The output is inactive when the frequency converter is not in torque control mode.

- **21: Parameter setting from communication**

  For modbus mode,

  – The output of parameter H9.00 is defined by bit0 of register 0x7F0A. When bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed.

  – The output of parameter H9.01 is defined by bit1 of register 0x7F0A. When bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed.

  – The output of parameter H9.02 is defined by bit2 of register 0x7F0A. When bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed.

  – The output of parameter H9.03 is defined by bit3 of register 0x7F0A. When bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed.

  For other fieldbus mode, the output is defined by parameter H9.10.

- **25: Converter error or warning**

  The output is active when the frequency converter encounters error / warning.

  The output is inactive when the frequency converter without error / warning.

**H9.97 is used to perform the self-test function of relay card:**

| | |
|---|---|
| H9.97 = 0: Inactive | All relays are restored to default settings. |
| H9.97 = 1: Relay1 diagnosis | Relay1 is closed. |
| H9.97 = 2: Relay2 diagnosis | Relay2 is closed. |
| H9.97 = 3: Relay3 diagnosis | Relay3 is closed. |

| | |
|---|---|
| H9.97 = 4: Relay4 diagnosis | Relay4 is closed. |
| H9.97 = 5: All output diagnosis | All relays are closed. |

## 12.22 U0: General Panel Parameters

This function contains the basic panel parameters.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| U0.00 | Direction control by panel | 0: Forward<br>1: Reverse | 0 | – | – | Run |
| U0.01 | Stop button control | 0: Active only for panel control<br>1: Valid for all control methods | 1 | – | – | Run |
| U0.99 | Panel firmware version | 0.00...655.35 | – | – | 0.01 | Read |

### Direction control via operation panel

The actual direction is controlled by the configuration of parameter [U0.00] 'Direction control by panel' and [E0.17] 'Direction control', see chapter 12.8.5 "Direction Control" on page 198.

### Stop command via panel <Stop> button

U0.01 'Stop button control' is used to define the function of <Stop> button on the operating panel:

- 0: Stop command is active only for panel control
- 1: Stop command is Valid for all control methods

### Panel board FW version

The Panel board FW version U0.99 is a number of the format **vv.rr**

- **vv** firmware version number
- **rr** firmware release number

Example: 2.03

This parameter is usable outside engineering tool to get FW version info over the panel or field bus.

## 12.23 U1: LED Panel Parameters

This function contains the LED panel parameters.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| U1.00 | Run monitoring display | 0...99 | 0 | – | – | Run |
| U1.10 | Stop monitoring display | | 2 | – | – | Run |

**Setting range of U1.00, U1.10:**

0: Output frequency; 1: Actual speed
2: Setting frequency; 3: Setting speed
4: User-defined setting speed; 5: User-defined actual speed
9: V/f separation setting voltage; 10: Output voltage; 11: Output current
12: Output power; 13: DC-bus voltage
14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04
85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08; 89: ASF Display09
98: High resolution output current; 99: Firmware version

## 12.24 U2: LCD Panel Parameters

This function contains the LCD panel parameters.

| Code | Name | Setting range | Default | Unit | Step | Attri. |
|---|---|---|---|---|---|---|
| U2.01 | Backlight mode setting | 0: Energy saving<br>1: Always on | 1 | – | – | Run |
| U2.02 | Panel lock setting | 0: Unlock<br>1: Lock | 0 | – | – | Run |
| U2.03 | Remote / Local setting | 0: Remote<br>1: Local | 0 | – | – | Stop |
| U2.04 | Language selection | 0: English<br>1: Chinese<br>2: Germany<br>3: French<br>4: Russian<br>5: Spanish<br>6: Portugal<br>7: Italian<br>8: Korean | 0 | – | – | Stop |
| U2.09 | Permanent monitoring | 0...99 | 0 | – | – | Run |
| U2.10 | Run monitoring items 1 | | 0 | – | – | Run |
| U2.20 | Stop monitoring items 1 | | 0 | – | – | Run |
| U2.11 | Run monitoring items 2 | 0...100 | 2 | – | – | Run |
| U2.12 | Run monitoring items 3 | | 11 | – | – | Run |
| U2.13 | Run monitoring items 4 | | 13 | – | – | Run |
| U2.14 | Run monitoring items 5 | | 16 | – | – | Run |
| U2.15 | Run monitoring items 6 | | 17 | – | – | Run |
| U2.21 | Stop monitoring items 2 | | 2 | – | – | Run |
| U2.22 | Stop monitoring items 3 | | 11 | – | – | Run |
| U2.23 | Stop monitoring items 4 | | 13 | – | – | Run |
| U2.24 | Stop monitoring items 5 | | 16 | – | – | Run |
| U2.25 | Stop monitoring items 6 | | 17 | – | – | Run |

**Setting range of U2.09...U2.25:**

0: Actual output frequency; 1: Actual speed

2: Setting frequency; 3: Setting speed

4: User-defined setting speed; 5: User-defined output speed

9: V/f separation setting voltage; 10: Output voltage; 11: Output current

12: Output power; 13: DC-bus voltage
14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04
85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08
89: ASF Display09; 98: High resolution output current
99: Firmware version; 100: Inactive

# 13 Diagnosis

## 13.1 Display of LED Characters

| Character | A | b | C | d | E | F | H | I | L |
|---|---|---|---|---|---|---|---|---|---|
| Display |  |  |  |  |  |  |  |  |  |
| Character | n | O | o | P | r | S | t | U | – |
| Display |  |  |  |  |  |  |  |  |  |

**Tab. 13-1:** Display of LED characters

## 13.2 Status Code

| Code | Description |
|---|---|
| 8.8.8.8.8. | Displayed at power on, detecting the operating panel |
| '-''--''---''----''-----' | During parameter backup... |
| P.oFF | Displayed only at power down / drop in stop state |
| tUnE | Motor parameter tuning |

| Code | Description |
|---|---|
| PSLP | PID sleeping |
| StO-A | Safe torque off enabled |
| PAr1 | Parameter Set change from Set2 to Set1 |
| PAr2 | Parameter Set change from Set1 to Set2 |
| S.Err | Parameter change blocked |
| PrSE | Parameter setting contradiction, parameter password protected |

## 13.3 Warning Code

| Code | Description |
|---|---|
| PLE | Pump leakage |
| OE-4 | Overvoltage during stop |
| Ot | Motor over temperature |
| E-St | Terminal Error Signal |
| C-dr | Communication disconnection |
| Aib- | Analog input broken wire detection |
| FLE | Fan maintenance period expired |
| OCi | Communication data exceeds value range |
| UH-A | Under Temperature warning |
| APF1-APF5 | ASF customer warning 1<br>ASF customer warning 2<br>ASF customer warning 3<br>ASF customer warning 4<br>ASF customer warning 5 |
| USdc | UnSupported Device Configuration |
| Sli- | Speed limited by maximum Voltage |
| iSt | Invalid State Transition |
| FtL | RPDO Telegram Loss |
| Fdi | Option card process data invalid |

## 13.4 Error Code

### 13.4.1 Error 1 (OC-1), Error 2 (OC-2), Error 3 (OC-3) : Overcurrent

| Possible reason | Solution |
|---|---|
| The motor has been damaged due to overheating or the motor insulation is damaged | Check the insulation resistance. If it is damaged, replace the motor. |
| Magnetic contactor (MC) on the output side of the drive has turned on or off | Set up the operation sequence so that the MC is not tripped while the drive is outputting current |
| Drive fails to operate properly due to interference | Review the possible solutions provided for handling interference, check the section on handling interference and the control circuit lines, main circuit lines, and ground wiring |
| One of the motor cables has shorted out or there is a grounding problem | • Check the motor cables, remove the short circuit and power the drive back up<br>• Check the resistance between the motor cables and the ground terminal, replace damaged cables |
| The control mode and motor do not match | Check which control mode the drive is set to (C0.00)<br>• For SM, set C0.00 = 1, 2<br>• For ASM, set C0.00 = 0, 1, 2 |
| Excessively short acceleration/deceleration time | Increase acceleration time (E0.26)/deceleration time (E0.27) |
| Excessive start-up frequency | Reduce start frequency (E0.36) |
| Excessive load rotation inertia or impact | Increase acceleration time (E0.26), reduce sudden load change |
| Running command active while motor is coasting | Restart after motor stop or start with speed capture (E0.35) |
| Wrong setting of user-defined V/f curve parameters | Adjust setting of user-defined V/f curve parameters |
| Wrong motor parameters setting | • Check motor nameplate parameters<br>• Motor parameters retuning |
| Excessive torque boost | Reduce torque boost setting (C2.21, C2.22) |
| Phase-phase or line-to-ground short circuit | Check if phase-phase or line-to-ground short circuit, if short circuit exists, then the transistor is damaged, please contact service |
| Excessive overexcitation braking factor | Reduce [E0.55] |
| Load change in run mode | Reduce occurrence and scale of change |
| Low mains voltage | Check input power supply |
| The motor cable is too long | • Decrease the carrier frequency (C0.05)<br>• Use a frequency converter with larger power |

### 13.4.2 Error 4 (OE-1), Error 5 (OE-2), Error 6 (OE-3) : Overvoltage

| Possible reason | Solution |
|---|---|
| Surge voltage from power supply | Check input power supply |
| Motor to earth short circuit causes DC-bus capacitors overcharged | Check motor connection |
| Direct start during motor running | Restart after motor stop or start with speed capture (E0.35) |
| Excessively short acceleration time | Increase acceleration time (E0.26) or use S-curve (E0.25, E0.28, E0.29) |
| Wrong setting of speed tracing parameters | Adjust setting of speed tracing parameters(E0.42, E0.43) |
| Encoder cable is disconnected or wiring is wrong | Check the wring of encoder |
| Deceleration time is too short | • Increase deceleration time(E0.27)<br>• Add braking resistor |

### 13.4.3 Error 8 (UE-1): Undervoltage during Run

| Possible reason | Solution |
|---|---|
| Power failure during running | • Check if the main circuit drive input power is disconnected or wired incorrectly<br>• Check if one of the drive input power wiring terminals is loose<br>• Check the voltage from the drive input power<br>• Check if the power has been interrupted |
| The soft start relay or contactor is damaged | Cycle power on and power off the drive and see if the fault reoccurs, if the problem continues, replace either the control board or the converter. For instructions on replacing the control board, please contact service. |

### 13.4.4 Error 9 (SC): Surge Current or Short Circuit

| Possible reason | Solution |
|---|---|
| Multiple motors are driven by one frequency converter in V/f mode | Increase capacity of frequency converter or decrease number of motors |
| Surge current | Increase the acceleration time (E0.26), reduce the overexcitation braking factor (E0.55) |
| Drive fails to operate properly due to interference | Review the list of possible solutions provided for controlling interference, review the section on handling interference and check the control circuit lines, main circuit lines, and ground wiring |

### 13.4.5 Error 10 (IPH.L): Input Phase Loss

| Possible reason | Solution |
|---|---|
| Abnormal, omitted or broken connections of frequency converter power supply | Check power supply connections, remove omitted or broken connections |
| Broken fuse | Check fuse |
| Imbalance in the three phases of input power supply | Check if the imbalance situation exceeds converter withstand capability |
| Wiring of input power supply is not fastened | Check if the input wiring is reliable |
| Main circuit capacitor deterioration | Contact with service |

### 13.4.6 Error 11 (OPH.L): Output Phase Loss

| Possible reason | Solution |
|---|---|
| Abnormal, omitted or broken connections of frequency converter outputs | Check the connections of frequency converter outputs, remove omitted or broken connections |
| Imbalance in the three phases of outputs | Check if the transistor is damaged |

### 13.4.7 Error 12 (ESS-): Soft Start Error

| Possible reason | Solution |
|---|---|
| Power failure | Check the input power supply |
| Input phase loss occurs during start-up (3 phase) | Remove the input phase loss |

### 13.4.8 Error 20 (OL-1): Converter Overload

| Possible reason | Solution |
|---|---|
| Long time overload | Reduce overload time, reduce load |
| Wrong settings of V/f curve parameters | Adjust settings of V/f curve parameters |
| Overload happens at lower speed | • Reduce load at lower speed<br>• Reduce the carrier frequency (C0.05)<br>• Use a frequency converter with larger power |
| Excessive load, excessive short Acc. / Dec. time or cycle | • Adjust load, acceleration/deceleration time or cycle<br>• Use a frequency converter with larger power |
| Low mains voltage | Check input power supply |
| Excessive torque compensation | Reduce torque compensation setting (C2.21, C2.22) |
| Excessive overexcitation braking factor | Reduce [E0.55] |

| Possible reason | Solution |
|---|---|
| Input phase loss | Check the power supply for phase loss |
| Acceleration/deceleration or cycle times are too short | Increase the settings for acceleration/deceleration or cycle times |
| The capacity of frequency converter is too small | Replace the frequency converter with a larger model |
| Wrong setting of speed tracing parameters | Adjust setting of speed tracing parameters(E0.42, E0.43) |
| Temperature is too high | • Check if the environment temperature is too high<br>• Check if the fan is work normally |

## 13.4.9 Error 21 (OH): Converter over Temperature

| Possible reason | Solution |
|---|---|
| Frequency converter (heat sink) temperature is higher than max. allowable temperature<br>Max. allowable temperature:<br>• 0.4...90kW: 95 °C<br>• 110...315kW: 100 °C | • Check the temperature surrounding the drive<br>– Improve the air circulation within the enclosure panel<br>– Install a fan or air conditioner to cool the surrounding area<br>– Remove anything near the drive that might be producing excessive heat<br>• Load is too heavy<br>– Reduce load if necessary<br>– Reduce carrier frequency (C0.05)<br>• Temperature detection circuit error, contact with service |

## 13.4.10 Error 23 (FF): Fan Failure

| Possible reason | Solution |
|---|---|
| Fan defect | • Check if the fan is blocked, clear the fan or replace it<br>• Fan control circuit error, replace the circuit board or converter, contact with service |

## 13.4.11 Error 24 (Pdr): Pump Dry

| Possible reason | Solution |
|---|---|
| PID feedback is excessively low while converter is running at output frequency high limit | • Check if the feedback signal is valid<br>• If the PID control is used for controlling a water pump, check if the pump is running without water |

## 13.4.12 Error 25 (CoL-): Command Value Lost

| Possible reason | Solution |
|---|---|
| Panel potentiometer frequency setting command value los | • Check if the panel is installed stably, Reinstall the panel<br>• Check if the extended line for the panel is broken, replace the extended line for the panel<br>• The panel is broken, contact with service |

## 13.4.13 Error 30 (OL-2): Motor Overload

| Possible reason | Solution |
|---|---|
| Motor locked | Prevent motor lock |
| Normal motor runs long time with large load at low speed | • Increase frequency converter output frequency<br>• Reduce load<br>• Use variable frequency motor or set zero speed load (C1.76) to a higher value<br>• Set correct motor thermal model protection time constant (C1.74) |
| Low mains voltage | Check input power supply |
| Wrong settings of V/f curve related parameters | Adjust settings of V/f curve related parameters |
| Excessive sudden load change | Check load |
| Wrong input of rated motor current | Correct rated motor current in (C1.07) |
| Multiple motors are driven by one frequency converter | Connect only one motor to the frequency converter |
| Excessive overexcitation braking factor | Reduce [E0.55] |
| Wrong motor protection parameter settings | Adjust settings of C1.74, C1.75 and C1.76 according to actual motor situations |
| Output current imbalance due to input phase loss | Check if input phase loss |

### 13.4.14 Error 31 (Ot): Motor over Temperature

| Possible reason | Solution |
|---|---|
| Excessive load or bad cooling | • Check load<br>• Provide a better cooling condition |
| Temperature sensor defect | Check the motor temperature sensor feedback signal |
| Wrong motor protection parameter settings | Different motor with different maximum temperature, set motor protection parameters according to actual protection circuits (C1.72, C1.73, C1.74) |

### 13.4.15 Error 32 (t-Er): Motor Parameter Tuning Error

| Possible reason | Solution |
|---|---|
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Wrong setting of motor parameters | Correct motor parameters setting according to motor nameplate |
| No connection of converter and motor | Check motor cable connections |

### 13.4.16 Error 33 (AdE-): Motor Angle Detection Error

| Possible reason | Solution |
|---|---|
| Internal error occurs during motor angle detection | • Check the motor wring<br>• Check if output phase loss<br>• Check if the motor is blocked<br>• Adjust the value of [C3.50] and [C3.51]<br>• The converter can not receive the encoder signal<br>– Check the encoder card<br>– Check the wring between the converter and encoder<br>– Check the encoder |

## 13.4.17 Error 35 (SPE-): Speed Control Loop Error

| Possible reason | Solution |
|---|---|
| The speed loop difference is outside [C3.26] over a time of [C3.25] | • Set appropriate C3.25 and C3.26 according to actual working condition<br>• Check motor nameplate parameters(C1 group)<br>• Check if the torque limitation level is too low<br>• Motor control loop parameters error<br>– Motor parameter tuning<br>– Set relevant C3 group parameters according to actual working condition |

## 13.4.18 Error 38 (AibE): Analog Input Broken Wire Detection

| Possible reason | Solution |
|---|---|
| Analog input wire is disconnected | • Check the setting of analog input broken wire protection E1.61<br>• The converter not receive analog input signal<br>– Check the wring of AI1, AI2, EAI1 and EAI2<br>– Check analog input signal source<br>– Analog input port broken, replace the control board or converter, contact with service |

## 13.4.19 Error 39 (EPS-): DC_IN Power Supply Error

| Possible reason | Solution |
|---|---|
| DC_IN power supply voltage is out of range 20...28 V | • Check the voltage supply on DC_IN terminal and make sure the voltage is within the range of 20...28 V<br>Control board detection circuit of 24V is broken, replace the control board or converter, contact with service |

## 13.4.20 Error 40 (dir1): Forward Running Lock Error

| Possible reason | Solution |
|---|---|
| Direction control [E0.17] = '1: Forward only'<br>Direction command is reverse | Correct the parameter setting |

## 13.4.21 Error 41 (dir2): Reverse Running Lock Error

| Possible reason | Solution |
|---|---|
| Direction control [E0.17] = '2: Reverse only'<br>Direction command is forward | Correct the parameter setting |

## 13.4.22 Error 42 (E-St): Terminal Error Signal

| Possible reason | Solution |
|---|---|
| External error caused by input signals via external terminals | Check external terminals status |
| Wrong wiring / setting of multi-function external terminals | Ensure the right external signals have been connected correctly to the right multi-function external terminals which are assigned for external error input ([E1.00]...[E1.04] = 32, 33) |
| Converter stop caused by E-Stop active command via Modbus communication | Check the stop command via Modbus communication (0X0088: stop according to parameter setting; 0X0090: E-stop active). If converter receives 0X0090 , E-St will be displayed |

## 13.4.23 Error 43 (FFE-): Firmware Version Mismatch

| Possible reason | Solution |
|---|---|
| Operating panel may be placed to the frequency converter with older/newer firmware | Use the panel that firmware is compatible with the converter firmware |
| Extension card may be installed to the frequency converter with older/newer firmware | Update firmware of the extension card or converter |
| Converter firmware is not support the used extension card | Update the converter firmware |

## 13.4.24 Error 44 (rS-): Modbus Communication Error

| Possible reason | Solution |
|---|---|
| Modbus communication disconnection | • Check communication error detection parameters E8.01 and E8.02<br>• Check the device communication wring<br>• Check status of communication target |

### 13.4.25 Error 45 (E.Par): Parameter Settings Invalid

| Possible reason | Solution |
|---|---|
| Parameter settings are invalid after firmware update or extension card removed or parameter copy | • Check parameter group '-EP-' and modify the parameter values appeared in '-EP-'<br>• Initialize all parameters |

### 13.4.26 Error 46 (U.Par): Unknown Parameter Restore Error

| Possible reason | Solution |
|---|---|
| If one or more parameters in the backup were not found in the device, they will be skipped during parameter restore | Check the differences between the different firmware versions |

### 13.4.27 Error 48 (idA-): Internal Communication Error

| Possible reason | Solution |
|---|---|
| Internal error caused by communication | • Check if there is interference<br>1. Check the ground wiring<br>2. Check if there is strong interference source around the device<br>• Converter internal circuit board connection is loosen due to vibration<br>• Contact with service |

### 13.4.28 Error 49 (idP-): Internal Parameter Error

| Possible reason | Solution |
|---|---|
| Internal error caused by parameter handling | • Hint to check fan, Fan total running time(C0.51) exceeds 30000 hours<br>– Check the Fan works normally or not<br>– Update to latest version firmware and set C0.53=1<br>• Check if there is interference<br>– Check the ground wiring<br>– Check if there is strong interference source around the device<br>• Contact with service |

## 13.4.29 Error 50 (idE-): Converter Internal Error

| Possible reason | Solution |
|---|---|
| Internal error occurs | • If E9.05=50, E9.97=53/54, then external analog input mode is not match with the parameter setting, check E1.35, E1.40, H8.05 and H8.30 setting<br>• If E9.05=50, E9.97=0xA0, then firmware version of the control board is incompatible with the power board, update the control board and power board to the same firmware version<br>• If E9.05=50, E9.97=6/35, then MCU is in protection mode<br>– Check the ground wiring<br>– Check if there is strong interference source around the device<br>• If E9.05=50, E9.97=52, then power control board power source failure<br>– Check the ground wiring<br>– Check if there is strong interference source around the device<br>– Power control board error, replace power control board or converter, contact with service<br>• Contact with service |

## 13.4.30 Error 51 (OCd-): Extension Card Internal Error

| Possible reason | Solution |
|---|---|
| Extension card was successfully detected by the device at startup, but the communication failed afterwards | • Check if there is interference<br>– Check the ground wiring<br>– Check if there is strong interference source around the device<br>• Check if the extension card is installed reliably<br>• Contact with service |

## 13.4.31 Error 52 (OCc): Extension Card PDOs Configuration Error

| Possible reason | Solution |
|---|---|
| Internal communication error between communication card and converter control board | • Update firmware version<br>• Contact with service |

### 13.4.32 Error 53 (Fdi-): No Valid Process Data

| Possible reason | Solution |
|---|---|
| No valid process data is received from remote communication server, the remote communication server may be turned off | Check remote communication server |
| Communication protocol configured incorrectly | • Check whether the communication card is not inserted<br>• Check whether the communication protocol is configured correctly |

### 13.4.33 Error 54 (PcE-): Remote Control Communication Error

| Possible reason | Solution |
|---|---|
| Error if communication to IndraWorks Ds/ConverterWorks is lost during remote control | • Check communication status between frequency converter and IndraWorks Ds/ConverterWorks<br>• Contact with service |

### 13.4.34 Error 55 (PbrE): Parameter Backup / Restore Error

| Possible reason | Solution |
|---|---|
| Error occurs during parameter backup/ restore process | • Parameter backup/restore process is interrupted, restart backup/restore process<br>• Converter firmware version which is back up is incompatible with the version which is restored |

### 13.4.35 Error 56 (PrEF): Parameter Restore Error after Firmware Update

| Possible reason | Solution |
|---|---|
| Error occurs if parameter settings cannot be restored after firmware update | Parameters recover failed after firmware update from low version to high version<br>Reset the error, set customer parameters again after initialization |

### 13.4.36 Error 60 (ASF-): Application Firmware Error

| Possible reason | Solution |
|---|---|
| Error message if the application firmware was not loaded correctly or trail use is over | • Currently converter firmware is not support this application firmware<br>– Reload the application firmware version which is supported by the converter<br>– Update the converter firmware to the version which support this application firmware<br>• The application firmware is not certificated, certificate this application firmware |

### 13.4.37 Error 61...65 (APE1...APE5): Application Error

| Possible reason | Solution |
|---|---|
| Application error | Error which can be thrown by the application, description in application manual |

## 13.5 Error Handling

### 13.5.1 Restarting after Power Loss

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.45 | Power loss restart mode | 0: Inactive<br>1: Active for panel control<br>2: Active only for 2-wire control | 0 | – | Stop |
| E0.46 | Power loss restart delay | 0.0...10.0 | 1.0 | 0.1 | Stop |

[E0.45] decides the restart behavior after power loss:

If option 1 is selected, then converter will run automatically when AC power resumes, if the run command source is set to 'panel'.

If option 2 is selected, then converter will run automatically when AC power resumes, if the run command source is set to 'multi-function digital input'.

The power loss restart procedure will be performed after [E0.46] 'Power loss restart delay'.



- If the frequency converter was running in 3-wire mode before power loss, the restart of the frequency converter is decided by the status of this 3-wire terminal after power on.
- If the power loss was caused by power supply interference, an error code 'UE-1' will be displayed on the operating panel in undervoltage situation, and the frequency converter will not restart automatically after power on even setting [E0.45] is 'Active'.
- If the run command is from communication, the frequency converter **ONLY** restarts after sending a stop command first and then sending a run command by communication.
- When E0.45 select "1" or "2", if the power supply of frequency converter and the error "UE-1" recover within the time of [E9.01], the frequency converter will restart; if the error "UE-1" always exists during the time of [E9.01], the frequency converter will not restart.

## 13.5.2 Automatic Error Reset

Automatic error reset function is used to ensure continuous running without human intervention in the case of occasional errors, such as overcurrent or overvoltage at start or in the run mode. This function can be activated by setting [E9.00] ≠ 0.

When an error occurs, the frequency converter stops the output and the related error code is displayed at the same time. The system remains in idle mode for delay time [E9.01]. Then the error will automatically be reset and a run command will be generated to restart the frequency converter. This sequence will be performed [E9.00] times. If the error still exists, the frequency converter remains in idle mode and no longer performs automatic restart attempts. In this case, a manual error reset is required to resume the operation.

Automatic error reset is valid for the following errors: OC-1, OC-2, OC-3, OE-1, OE-2, OE-3, OE-4, OL-1, OL-2, UE-1*****, E-St, OH and UH.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E9.00 | Automatic error reset attempts | 0...3 (0: Inactive) | 0 | – | Stop |
| E9.01 | Automatic error reset interval | 0.1...60.0 s | 10.0 | 0.1 | Stop |
| E9.02 | Automatic error reset attempts restart time | 0...65,535 | 0 | 1 | Stop |

Parameter E9.02 can be used to reset the internal error rest attempts back to the value from [E9.00] in case there are no error events inside this restart time. The number of reset attempts is reset to [E9.00] when E9.02 is set to a value different to 0 and there are no error reset events inside the interval given from the value of parameter E9.02.



*****:

1. If [E9.00] ≠ 0 and [E0.45] = 0, every time error ‘UE-1’ resets, the remaining times of automatic reset would decrease.
2. If [E9.00] ≠ 0 and [E0.45] ≠ 0, then reset time of error "UE-1" is without limitation.
3. If [E9.00] = 0 and [E0.45] ≠ 0, then reset time of error "UE-1" is without limitation.

### 13.5.3 Error Reset by Digital Input

The error reset input can be defined with one digital input. This function works in the same manner as the panel error reset function does, which allows remote error reset. 'Error reset' is edge sensitive.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 34: Error reset | 0 | – | Stop |
| E1.01 | X2 input | | 0 | – | Stop |
| E1.02 | X3 input | | 0 | – | Stop |
| E1.03 | X4 input | | 0 | – | Stop |
| E1.04 | X5 input | | 0 | – | Stop |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

Set the respective parameter of any digital input as '34: Error reset'. For wiring diagram, please refer to chapter "Digital input NPN / PNP wiring" on page 73.

# 14 Communication

## 14.1 Brief Introduction

VFC x615 frequency converters provide standard RS485 communication interface to realize the communication between the master and slaves via Modbus protocol. With the help of a PC, a PLC or an external computer a 'single master / multiple slaves' network control can be realized (setting of frequency control command and running frequency, modification of parameters, monitoring of frequency converter running status and error messages) to address the specific requirements of applications.



User parameters of the frequency converter can be written via communication interface for 150,000 times.

## 14.2 Basic Communication Settings

### 14.2.1 Selection of the Communication Protocol

The standard product only supports Modbus communication protocol. To use other communication protocols, optional communication cards need to be ordered additionally and parameter E8.00 and other related parameters need to be set accordingly.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.00 | Communication protocol | 0: Modbus<br>1: Extension card | 0 | – | Stop |

### 14.2.2 Setting the Data Transmission Rate

Data transmission rate refers to the transmission rate of data between the external computer and the frequency converter.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.10 | Modbus baud rate | 0: 1,200 bps<br>1: 2,400 bps<br>2: 4,800 bps<br>3: 9,600 bps<br>4: 19,200 bps<br>5: 38,400 bps | 3 | – | Stop |

### 14.2.3 Setting the Data Format

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.11 | Modbus data format | 0...3 | 0 | – | Stop |

- 0: 1 start bit, 8 data bits, 1 stop bit, no parity
- 1: 1 start bit, 8 data bits, 1 stop bit, even parity
- 2: 1 start bit, 8 data bits, 1 stop bit, odd parity
- 3: 1 start bit, 8 data bits, 2 stop bits, no parity



The data format of the converter must be the same as that of the master station. Otherwise, normal communication is impossible.

### 14.2.4 Setting the Local Address

In Modbus communication, the maximum number of frequency converters in the network is 247. Each frequency converter must have a unique local address.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.12 | Modbus local address | 1...247 | 1 | 1 | Stop |

### 14.2.5 Setting Command Signal Type

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.13 | Modbus level / edge sensitivity selection | 0: Level sensitive<br>1: Edge sensitive | 1 | – | Stop |

**Level sensitive (default situation):** The control word is not a real edge sensitive, master should manually reset the command.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is not reset
5. Master should set bit 5 = 0 firstly, then set bit 5 = 1, the error is reset

**Edge sensitive (selectable):** The control command is reset automatically after the activation.

For example:

1. Simulate an error
2. Set bit 5 = 1, the error is reset
3. Simulate an error again
4. Set bit 5 = 1, the error is reset

## 14.2.6 Communication Disruption and Response

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.01 | Communication error detection time | 0.0...60.0 s (0.0: Inactive) | 0.0 | 0.1 | Stop |
| E8.02 | Communication error protection mode | 0, 1 | 1 | – | Stop |

- When [E8.01] = 0.0 s, the disruption detection function is inactive.
- If the interval between the current and next communication commands exceeds the time defined in [E8.01] 'Communication error detection time', the frequency converter will reports a communication error code and act as defined in [E8.02] 'Communication error protection mode':
  - [E8.02] = 0: Freewheeling stop

    The motor freewheels to stop after the communication timeout no matter the settings of parameter E0.50 'Stop mode'.
  - [E8.02] = 1: Keep running

    The motor continues running at the setting frequency, and warning code 'C-dr' will be displayed on the operating panel.

## 14.3 Modbus Protocol

### 14.3.1 Protocol Description

**Brief introduction**

- Modbus is a master / slave protocol. Only one device may send commands in the network at a particular time.
- The master station manages message exchange by polling the slave stations. Unless being approved by the master station, no slave station may send message. In case of an error during data exchange, if no response is received, the master station will query the slave stations absent from the polling.
- If a slave station is unable to recognize a message from the master station, an exception response will be sent to the master station.
- Slave stations cannot communicate with each other but through the master's software which reads data from one slave station and sends them to another. There are two types of dialogs between the master station and the slave stations:
  - The master station sends a request to a slave station and waits for its response.
  - The master station sends a request to all slave stations and does not wait for their response (broadcasting).

### Transmission

The transmission is of RTU (Remote Terminal Unit) mode with frames containing no message header or end mark. A typical RTU frame format is shown below:

| Slave address | Function code | Data | CRC |
|---|---|---|---|
| 1 byte | 1 byte | 0...252 byte(s) | CRC low\|CRC high |

**Tab. 14-1:** Typical RTU frame format

- Data are transmitted in binary codes.
- CRC: Cyclic redundancy code.

- The address 0 is reserved as broadcast address.
- All slave nodes must recognize the broadcast address for writing function (no need of reply).
- The master node has no specific address, only the slave nodes must have addresses (1...247).

For RTU transmission mode, four types of character format are shown below:

- 1 start bit, 8 data bits, 1 stop bit, no parity
- 1 start bit, 8 data bits, 1 stop bit, even parity
- 1 start bit, 8 data bits, 1 stop bit, odd parity
- 1 start bit, 8 data bits, 2 stop bits, no parity

The character or byte is sent in the following sequence (from left to right):

| <-Least significant bit (LSB) | | | | | | | Most significant bit (MSB)-> | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop | – |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Even | Stop |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Odd | Stop |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop | Stop |

**Tab. 14-2:** RTU transmission mode

Message frames are separated by a silent interval of at least 3.5 characters' time. The entire frame must be transmitted as a continuous stream of bytes. If the interval of two separated frames is less than 3.5 characters' time, then the slave address of second frame will be treated as the part of first frame by mistake, due to the confusion of the frames, the CRC check will fail and lead to communication fault. If a silent interval of more than 1.5 characters' time occurs between two bytes, the message frame is regarded incomplete and discarded by the receiver.

### 14.3.2 Modbus Interface

The Modbus communication is via RS485 interface, see descriptions on RS485+ and RS485- in chapter 8.1 "Wiring Diagram" on page 52 and chapter 8.3.2 "Control Terminals" on page 70.

### 14.3.3 Modbus Function and Message Format

#### Supported functions

The main function of Modbus is to read and to write parameters. Different function codes decide different operation requests. Modbus functions managed by VFC x615 and their limits are shown in the table below:

| Code | Function name | Broadcast | Max. value of N |
|---|---|---|---|
| 3 = 0x03 | Read N register words | NO | 16 |
| 6 = 0x06 | Write one register word | YES | – |
| 8 = 0x08 | Diagnosis | NO | – |
| 16 = 0x10 | Write N register words | YES | 16 |
| 23 = 0x17 | Read/write N register words | NO | 16 |

**Tab. 14-3:** VFC x615 Modbus functions and limits



'Read' and 'Write' are considered from the prospect of the master station.

Modbus message formats are different according to the function codes shown below.

| Slave No. | 0x03 | Address of 1st word | Number of words | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 14-4:** Function 3_Request from the master

| Slave No. | 0x03 | Number of bytes | 1st word value | – | Last word value | CRC16 |
|---|---|---|---|---|---|---|
| | | Depends on master request | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 14-5:** Function 3_Response from the slave

| Slave No. | 0x06 | Address of word | Value of word | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 14-6:** Function 6_Master request and slave response (in same format)

| Slave No. | 0x08 | Test word 1 | Test word 2 | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 14-7:** Function 8_Master request and slave response (in same format)

| Slave No. | 0x10 | Address of 1st word | Number of words | Number of bytes | 1st word value | – | Last word value | CRC16 |
|---|---|---|---|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 14-8:** Function 16_Request from the master

| Slave No. | 0x10 | Address of 1st word | Number of words | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Tab. 14-9:** Function 16_Response from the slave

| Slave No. | 0x17 | Address of 1st word to be read | Number of words to be read | Address of 1st word to be written |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Hi \| Lo |

| Number of words to be written | Number of bytes to be written | Value of 1st word to be written | – | Value of last word to be written | CRC16 |
|---|---|---|---|---|---|
| Hi \| Lo | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 14-10:** Function 23_Request from the master

| Slave No. | 0x17 | Number of bytes | 1st word value read | – | Last word value read | CRC16 |
|---|---|---|---|---|---|---|
| | | | Hi \| Lo | – | Hi \| Lo | Lo \| Hi |

**Tab. 14-11:** Function 23_Response from the slave

### Function example

### Function 0x03: Read N register words, range: 1...16

Example: It is necessary to read 2 continuous words starting from communication register 3000H of the slave frequency converter addressed at 01H. The frame structure is described in the tables below.

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 03H |
| Higher byte of start address | 30H |
| Lower byte of start address | 00H |
| Higher byte of data | 00H |
| Lower byte of data | 02H |
| CRC lower byte | CBH |
| CRC higher byte | 0BH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-12:** Function 0x03_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 03H |
| Bytes of data | 04H |
| Higher byte of data in register 3000H | 00H |
| Lower byte of data in register 3000H | 14H |
| Higher byte of data in register 3001H | 00H |
| Lower byte of data in register 3001H | 02H |
| CRC lower byte | 3BH |
| CRC higher byte | F6H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-13:** Function 0x03_Response from RTU slave

### Function 0x06: Write one register word

**⚠ CAUTION**

**Frequent writing may damage the internal registers!**

- When data is written into the internal registers, there is a limit on the writing times. The register address may be damaged once the writing times is beyond the writing limit. So please avoid frequent writing!
- For details of user writing permission, please see chapter 19.3.1 "Terminology and Abbreviation in Parameter List" on page 525.

Example: Write 0000H to communication register address 3002H of the slave frequency converter with address 01H. The frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 06H |
| Higher byte of write register address | 30H |
| Lower byte of write register address | 02H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 27H |
| CRC higher byte | 0AH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-14:** Function 0x06_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 06H |
| Higher byte of write register address | 30H |
| Lower byte of write register address | 02H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 27H |
| CRC higher byte | 0AH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-15:** Function 0x06_Response from RTU slave

### Function 0x08: Diagnostics

Example: To test the communication loop of 2 continuous words 1234H and 5678H with frequency converter slave address 01H, the frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-16:** Function 0x08_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-17:** Function 0x08_Response from RTU slave

### Function 0x10: Write N register words, range: 1...16

Example: To modify 2 continuous registers start from 4000H with words 0001H and 0000H with slave frequency converter address 01H. The frame structure is described in the tables below:

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 10H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of register number | 00H |
| Lower byte of register number | 02H |
| Bytes of data | 04H |
| Higher byte of data in register 4000H | 00H |
| Lower byte of data in register 4000H | 01H |
| Higher byte of data in register 4001H | 00H |
| Lower byte of data in register 4001H | 00H |
| CRC lower byte | 93H |
| CRC higher byte | ACH |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-18:** Function 0x10_Request from RTU master

| | |
|---|---|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| Modbus function code | 10H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of register number | 00H |
| Lower byte of register number | 02H |
| CRC lower byte | 54H |
| CRC higher byte | 08H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-19:** Function 0x10_Response from RTU slave

### Function 0x17: Read/Write N register words, range: 1...16

Example: To read data in 2 continuous registers starting from address 3000H, write 0001H and 0000H to 2 continuous registers starting from address 4000H. The frame structure is described in the tables below:

| Message start | Transmission time for 3.5 bytes |
|---|---|
| Slave address | 01H |
| Modbus function code | 17H |
| Higher byte of read register start address | 30H |
| Lower byte of read register start address | 00H |
| Higher byte of read register number | 00H |
| Lower byte of read register number | 02H |
| Higher byte of write register start address | 40H |
| Lower byte of write register start address | 00H |
| Higher byte of write register number | 00H |
| Lower byte of write register number | 02H |
| Bytes of data for writing | 04H |
| Higher byte of data in register 4000H | 00H |
| Lower byte of data in register 4000H | 01H |
| Higher byte of data in register 4001H | 00H |
| Lower byte of data in register 4001H | 00H |
| CRC lower byte | E6H |
| CRC higher byte | B3H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-20:** Function 0x17_Request from RTU master

| Message start | Transmission time for 3.5 bytes |
|---|---|
| Slave address | 01H |
| Modbus function code | 17H |
| Bytes of read register | 04H |
| Higher byte of read register 3000H | 00H |
| Lower byte of read register 3000H | 14H |
| Higher byte of read register 3001H | 00H |
| Lower byte of read register 3001H | 02H |
| CRC lower byte | 38H |
| CRC higher byte | E2H |
| Message end | Transmission time for 3.5 bytes |

**Tab. 14-21:** Function 0x17_Response from RTU slave

### Error code and exception code

If a slave receives the request without a communication error, but cannot handle it, the slave will return an exception response which includes error code and exception code informing the master of the nature of the error. The error code is formed by setting the MSB of the function code to 1 (i.e. function code plus with 0x80, like 0x83, 0x86, 0x90, 0x97), then the exception response has a format shown below.

| Slave No. | Error code | Exception code | CRC16 |
|---|---|---|---|
| | | | Lo \| Hi |

Exception codes for VFC x615 frequency converters:

- 1 = Parameter cannot be modify owing to user password locked
- 2 = The function requested is not recognized by the slave, i.e. not equal to 3, 6, 8, 16 or 23
- 3 = The word address indicated in the request do not exist in the slave
- 4 = The word values indicated in the request are not permissible in the slave
- 5 = Parameters cannot be modify in run mode
- 6 = Parameters are read-only that cannot be modified
- 7 = Invalid operation which is decided by the function of frequency converter(*)
- 9 = EEPROM read/write error
- B = Function code 3, read range exceeds 16



(*) includes situations listed below:

- Write operations on b0.11 'Parameter copy', U1.00 'Running monitoring display', U1.10 'Stop monitoring display' and C1.01 'Motor parameter tuning', are prohibited.
- Write operations on b0.20 'User password', b0.21 'Manufacture password' and b0.10 'Parameter initialization' only support function 6.
- Multi-function digital input terminals (E1.00...E1.04) writing operation do not permit repeated non-zero value.

## 14.3.4 Communication Mapping Register Address Distribution

### Frequency converter parameter address

Frequency converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in frequency converter parameter registers via Modbus communication. The characteristics and scope of reading and writing function codes are in compliance with the frequency converter function code description. The address of a frequency converter parameter register is composed of a higher byte representing the function code group and a lower byte representing the index in the group. The groups are mapped as follows:

| Address high byte | 0x00 | 0x20 | 0x21 | 0x22 | 0x23 | 0x30 | 0x31 | 0x32 | 0x33 | 0x34 |
|---|---|---|---|---|---|---|---|---|---|---|
| Group | b0 | C0 | C1 | C2 | C3 | E0 | E1 | E2 | E3 | E4 |
| Address high byte | 0x35 | 0x38 | 0x39 | 0x60 | 0x61 | 0x68 | 0x69 | 0x40 | 0x41 | 0x10 |
| Group | E5 | E8 | E9 | H0 | H1 | H8 | H9 | U0 | U1 | d0 |

**Tab. 14-22:** Frequency converter parameter registers



Parameters of the monitoring group (Group d0) are always write-protected.

**Examples:**

To read out the module temperature (d0.20) of VFC x615 frequency converter, use register address 0x1014 (0x10 = Group d0, index 0x14 = 20).

To set V/f curve mode (C2.00) of VFC x615 frequency converter, use register address 0x2200 (0x22 = Group C2, index 0).

Access to a non-existing function code will be acknowledged with exception code 3 (see chapter 14.3.3 "Modbus Function and Message Format" on page 428).

### Frequency converter register address

| Register | Address |
|---|---|
| Communication control register | 0x7F00 |
| Communication state register | 0x7FA0 |
| Additional status register | 0x7FA1 |
| Fault status register | 0x7FB0 |
| Communication frequency setting register | 0x7F01 |
| Torque setting register | 0x7F02 |
| Torque FWD limitation register | 0x7F03 |
| Torque REV limitation register | 0x7F04 |
| Speed limitation register | 0x7F05 |

**Tab. 14-23:** Frequency converter register address

### Communication control register (0x7F00)

The address of command word register for communication control is 0x7F00. This register is write-only. The frequency converter is controlled through writing data into the address. The definition of each bit is shown in table below:

| bit | Value | Description |
|---|---|---|
| 15...8 | – | Reserved |
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 14-24:** Communication control register (0x7F00)

If the communication frame check is successful (CRC valid), the frequency converter always accepts the content of the control word. All conflicts (e.g. run command and stop command active at the same time) are resolved by the application functionality (Run / Stop generator, jog control...). This assures that the frequency converter will always react in the same manner, independent of the run command source.

### Communication state register (0x7FA0)

The frequency converter state can be monitored by reading the register. This register is read-only. The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15 ... 8 | – | Error code (equals to [E9.05]) |
| 7 | 1 | Error |
| | 0 | No error |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 14-25:** Communication state register (0x7FA0)

### Additional status register (0x7FA1)

Additional status register is the extension of main status register(7FA0H), it stores other status information of frequency converter. This register is read-only. The definition of each bit is shown in the table below:

| bit | Value | Description |
|---|---|---|
| 15 | 1 | Error |
| | 0 | No error |
| 14 | - | Reserved |
| 13 | - | Reserved |
| 12 | - | Reserved |
| 11 | 1 | Coasting to stop |
| | 0 | Not coasting |
| 10 | 1 | Speed tracing |
| | 0 | Not tracing |
| 9 | 1 | 0 speed |
| | 0 | Not 0 speed |
| 8 | 1 | DC braking |
| | 0 | Not DC braking |
| 7 | - | Reserved |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 14-26:** Additional status register (0x7FA1)

### Fault status register (0x7FB0)

The fault status of frequency converter can be monitored by reading the register. This register is read-only.

| bit | HEX | Description |
|---|---|---|
| | 0 | No error |
| | 1 | OC-1, overcurrent at constant speed |
| | 2 | OC-2, overcurrent during acceleration |
| | 3 | OC-3, overcurrent during deceleration |
| | 4 | OE-1, overvoltage at constant speed |
| | 5 | OE-2, overvoltage during acceleration |
| | 6 | OE-3, overvoltage during deceleration |
| | 7 | OE-4, overvoltage during stop |
| | 8 | UE-1, undervoltage during run |
| | 9 | SC, surge current or short circuit |
| | A | IPH.L, input phase loss |
| | B | OPH.L, output phase loss |
| bit 15 | C | ESS-, soft start error |
| . | 14 | OL-1, converter overload |
| . | 15 | OH, converter over temperature |
| . | 17 | FF, fan failure |
| bit 0 | 18 | Pdr, pump dry |
| | 19 | CoL-, command value lost |
| | 1A | StO-r, safe torque off error |
| | 1B | StO-E, safe torque off hardware error |
| | 1E | OL-2, motor overload |
| | 1F | Ot, motor over temperature |
| | 20 | t-Er, motor parameter tuning error |
| | 21 | AdE-, synchronous motor angle detection error |
| | 26 | AibE, analog input broken wire detection |
| | 27 | EPS-, DC_IN power supply error |
| | 28 | dir1, forward running lock error |
| | 29 | dir2, reverse running lock error |

| bit | HEX | Description |
|---|---|---|
| bit 15<br>.<br>.<br>.<br>bit 0 | 2A | E-St, terminal error signal |
| | 2B | FFE-, firmware version mismatch |
| | 2C | rS-, modbus communication error |
| | 2D | E.Par, parameter settings invalid |
| | 2E | U.Par, unknown parameter restore error |
| | 30 | idA-, internal communication error |
| | 31 | idP-, internal parameter error |
| | 32 | IDE-, converter internal error |
| | 33 | OCd-, extension card internal error |
| | 34 | Occ, extension card PDOs configuration error |
| | 35 | Fdi-, no valid process data |
| | 36 | PcE-, remote control communication error |
| | 37 | PbrE, parameter backup / restore error |
| | 38 | PrEF, parameter restore error after firmware update |
| | 3C | ASF-, application firmware error |
| | 3D | APE1, application error 1 |
| | 3E | APE2, application error 2 |
| | 3F | APE3, application error 3 |
| | 40 | APE4, application error 4 |
| | 41 | APE5, application error 5 |

**Tab. 14-27:** Fault status register (0x7FB0)

### Communication frequency setting register (0x7F01)

The address of frequency setting register for communication control is 0x7F01. This register is for read and write. When 'First frequency setting source' [E0.00] = '20: Communication', the frequency converter can be set with writing data to this address.

### Torque setting register (0x7F02)

The address of torque setting register is 0x7F02. This register is for read and write. When 'Torque reference channel' [C3.41] = '6: Communication', the torque reference channel can be set with writing data to this address.

### Torque FWD limitation register (0x7F03)

The address of torque FWD limitation register is 0x7F03. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

### Torque REV limitation register (0x7F04)

The address of torque REV limitation register is 0x7F04. This register is for read and write. When 'Torque limitation reference selection at speed control mode' [C3.47] = '4: Communication', the torque limitation reference can be set with writing data to this address.

### Speed limitation register (0x7F05)

The address of speed limitation register is 0x7F05. This register is for read and write. When 'Speed limitation reference selection at torque control mode' [C3.48] = '4: Communication', the speed limitation reference can be set with writing data to this address.

### 14.3.5 Modbus Communication Example

One slave address is 01H. The frequency setting of the frequency converter has been set to 'Given by communication' and the RUN command source is set to 'Inputting commands by communication'. It is required for the motor connected to the frequency converter to run with 50 Hz (forward rotation). The operation can be achieved with function 0x10 (function 16) of the Modbus protocol. The messages of the requests from the master and responses from the slave are shown in table below:

- Example 1: Start 01# frequency converter for forward rotation at frequency of 50.00 Hz (represented by 5,000 internally)

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x10 | 0x7F00 | 0x0002 | 0x04 | 0x0081<br>0x1388 | 0x8AE3 |
| Response | 0x01 | 0x10 | 0x7F00 | 0x0002 | N/A | N/A | 0x581C |

- Example 2: Read the output frequency of 01# frequency converter and output velocity

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x03 | 0x1000 | 0x0002 | N/A | N/A | C0CB |
| Response | 0x01 | 0x03 | N/A | N/A | 0x04 | 0x1388<br>0x05DC | 0x7C54 |

- Example 3: Stop 01# frequency converter according to the stopping mode with the function code

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|---|---|---|---|---|---|---|---|
| Request | 0x01 | 0x06 | 0x7F00 | N/A | N/A | 0x0088 | 0x9078 |
| Response | 0x01 | 0x06 | 0x7F00 | N/A | N/A | 0x0088 | 0x9078 |

### 14.3.6 Special Notes

1. The external computer can not write to function codes b0.11 'Parameter copy', U1.00 'running monitoring display' and U1.10 'Stop monitoring display'.
2. b0.20 'User password' and b0.10 'Parameter initialization' do not support multiple write including single write in multiple write; Motor nameplate parameters and motor physical data should not be modified simultaneously; Multi-function digital input terminals (E1.00...E0.04) writing operation do not permit repeated non-zero value.
3. If the communication protocol is changed, baud rate, data frame and local address will be restored to factory default.
4. The read response of user password and manufacture password is '0000' in case of external computer reading.
5. The external computer can set, modify or cancel user password, the specific operation is same to the situation when 'Running command source' is from the operating panel.
6. The access to control registers and state registers is not limited by user password.

## 14.3.7 Communication Networking

### Networking

The communication network is shown in figure below, with a PC, a PLC or an external computer as the master and all frequency converters as slaves, which are connected by shielded twisted pair cables. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω, 0.25 W.

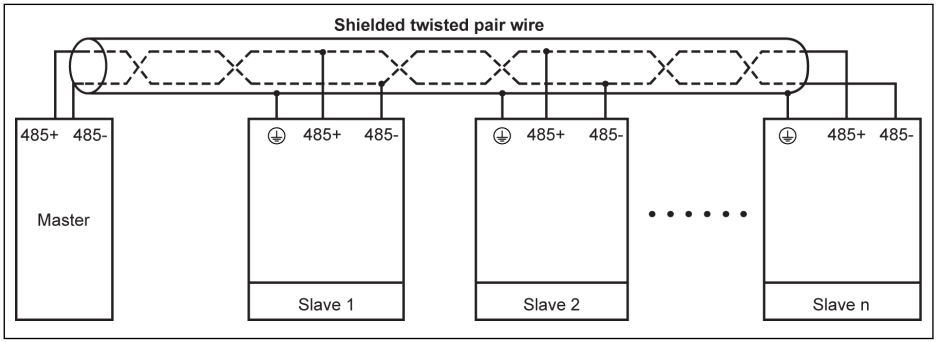



**Fig. 14-1:** Communication networking

- The maximum length of the communication cable is 300 m.
- The maximum length of the communication cable is 80 m if the number of slaves is less than 5.
- If the Modbus network cannot work successfully, check if a bias resistor has been installed for the master device and make sure that its resistance is not more than 1.5 kΩ.

**⚠ WARNING**

**Cables may only be connected when the frequency converters are switched off!**

### Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- Modbus cable should be adequately away from power cables (minimum 30 cm).
- Avoid crossing of Modbus cables and power cables and use orthogonal crossing if crossing must be used.
- The shielding layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.
- In no circumstance should ground cables constitute a loop.

## 14.4 PROFIBUS Protocol

### 14.4.1 Protocol Description

PROFIBUS is an open serial communication standard, which enables data exchange among various automation control devices. PROFIBUS mainly includes three types: PROFIBUS-FMS (Fieldbus Message Specifications), PROFIBUS-DP (Distributed Peripheral Equipment) and PROFIBUS-PA (Process Automation). Frequency Converter VFC x615 supports PROFIBUS-DP protocol.

PROFIBUS is widely used in various industries such as manufacturing automation and process automation, building, transportation, electric power, etc. Through PROFIBUS, automation equipments from different manufacturers can be easily connected into the same network for data exchange. The frame structure of data information in PROFIBUS network is shown in table below.

| Protocol frame | User data | Protocol frame |
|---|---|---|
| (header) | (control message/status message) | (end) |

**Tab. 14-28:** PROFIBUS frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100...1,200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller, which is able to select the nodes responsive to commands from the master.

 PROFIBUS protocol is described in details in standard EN 50170.

### 14.4.2 PROFIBUS Function

The PROFIBUS DP communication network is able to realize the following functions:

- Sending control commands to the frequency converter (such as start, stop, jog, etc.).
- Sending messages (e.g. setting frequency) to the frequency converter.
- Reading operating status message from the frequency converter (such as run, rotation direction, rotation speed, error message, etc.).
- Reading or modifying frequency converter parameters.
- Resetting the frequency converter in case of error.

### 14.4.3 Requirements for PROFIBUS Link

Cables used in PROFIBUS are shielded twisted pair cables. The shielding is able to improve electromagnetic compatibility (EMC) ability. Unshielded twisted pair cable may be used if there is less electromagnetic interference (EMI). Impedance of the cable should be within 100...200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥ 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

| Cable data | Type A | Type B |
|---|---|---|
| Impedance | 135...165 Ω (f = 3...20 MHz) | 100...130 Ω (f > 100 kHz) |
| Capacity | < 30 pF/m | < 60 pF/m |
| Resistance | ≤ 110 Ω/km | ≤ 110 Ω/km |
| Conductor cross section | ≥ 0.34 (22 AWG) | ≥ 0.22 (24 AWG) |

**Tab. 14-29:** Type of PROFIBUS cable



Standard Siemens PROFIBUS cable is (MLFB) 6XV1830-0EH10 (Type A), and connector is 6ES7972-0BA12-0XA0.

### 14.4.4 Relationship between Communication Rate and Cables

Relationship between communication rate and cable length is described in table below.

| Baud rate | Maximum length for each cable in [m] (Type A) | Maximum length for each cable in [m] (Type B) |
|---|---|---|
| 9.6...93.75 kbps | 1,000 | 1,000 |
| 187.5 kbps | 1000 | 600 |
| 500 kbps | 400 | 200 |
| 1.5 Mbps | 200 | 200 |
| 3...12 Mbps | 100 | 100 |

**Tab. 14-30:** Relationship between communication rate and cable length

### 14.4.5 EMC Measures

The following EMC measures needs to be taken in order to improve the stability of PROFIBUS communication network:

- The shielding layer of the communication cables must be well grounded at all stations; a large area is required for the connection of the shielding layer to obtain a low impedance.
- A certain wiring distance (≥ 20 cm) must be kept between the communication cables and the power cables.
- Communication cables and power cables must be orthogonal in case of crossing.
- All stations in the network must be grounded to the same grounding network.

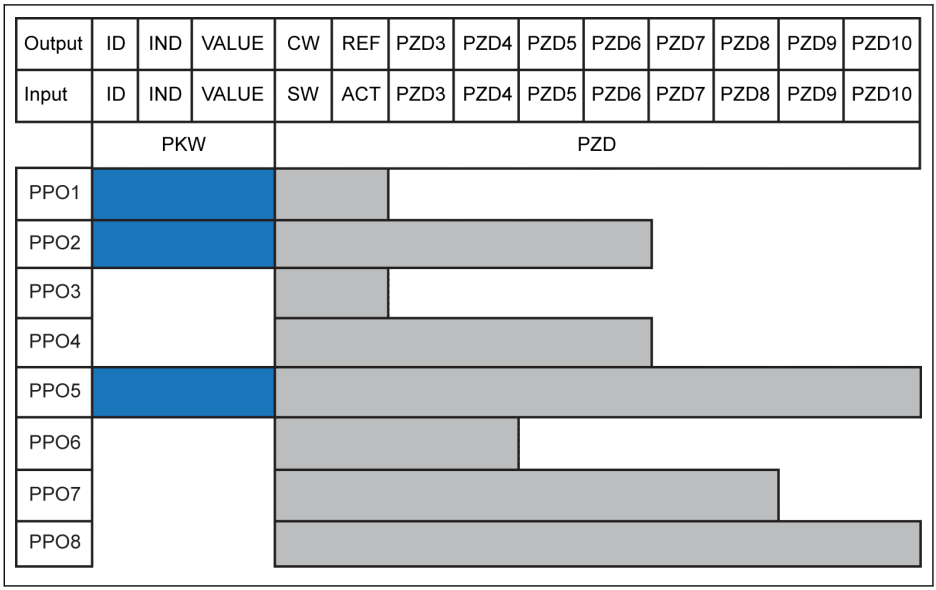
### 14.4.6 Periodical Data Communication

#### PPO telegram type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). Frequency Converter VFC x615 supports 8 PPO telegram types shown in figure below. PPO message is divided into two data areas in terms of transmission data contents:

Parameter area (PKW area): read or write a parameter of a slave.

Process data area (PZD area): including control word and set frequency, etc. (data flow from master to slave), or status word, actual output frequency and other status monitoring values of slave (data flow from slave to master). For detailed descriptions of PKW parameter area and PZD process data area, please refer to descriptions follow.




**Output** Master output
**Input** Master input
**ID** Parameter identifier
**IND** Parameter index mark
**VALUE** Parameter value
**CW** Control word
**SW** Status word
**REF** Reference / Setting frequency
**ACT** Actual output frequency

**Fig. 14-2:** PPO telegram type

## PKW parameter area

### PKW parameter area description

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a parameter of a frequency converter, but only one parameter can be read or modified each time. When master sends request and slave responds, bit definition for each specific word in PKW area is shown in the tables below. If a frequency converter fails to execute PKW area request command, an error code will be returned to the master in VALUE_low. Refer to tab. 14-33 "PKW area error codes" on page 452 for details.

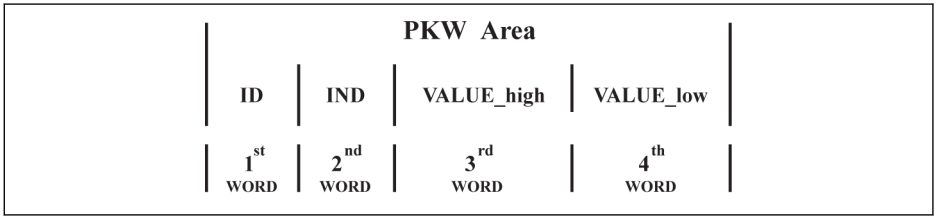



**Fig. 14-3:** PKW area data format

### Request data frame in PKW area

| Word | Identifier | bit | Value | Description |
|---|---|---|---|---|
| 1st | ID | 15...8 | 00H | Reserved |
| | | 7...0 | 00H | No request |
| | | | 01H | Read |
| | | | 02H | Write |
| 2nd | IND | 15...8 | xxH | Group No. for parameter |
| | | 7...0 | xxH | Index No. of function code within the group |
| 3rd | VALUE_high | 15...0 | 00H | Reserved |
| 4th | VALUE_low | 15...0 | xxxxH | For a read request: Not used<br>For a write request: Parameter value |

**Tab. 14-31:** Request data frame in PKW area_from master to slave

### Response data frame in PKW area

| Word | Identifier | bit | Value | Description |
|---|---|---|---|---|
| 1st | ID | 15...8 | 00H | Reserved |
| | | 7...0 | 00H | No request |
| | | | 01H | Successful read |
| | | | 02H | Successful write |
| | | | 07H | Error |
| 2nd | IND | 15...8 | xxH | Group No. for parameter |
| | | 7...0 | xxH | Index No. of function code within the group |
| 3rd | VALUE_high | 15...0 | 00H | Reserved |
| 4th | VALUE_low | 15...0 | xxxxH | For a successful request: Parameter value<br>Read or write error: Error code<br>For no request situation: 0 |

**Tab. 14-32:** Response data frame in PKW area_from slave to master

### Error message after execution failure in PKW area

| Error code | Meaning | Reason |
|---|---|---|
| 1 | Password locked | User password is locked |
| 2 | Invalid command code | Command codes (bit 7...bit 0 of ID) are not 0, 1 or 2 |
| 3 | Invalid parameter address | Invalid function group or index number of the function group, or insufficient access/rights |
| 4 | Invalid parameter value | Data to write out of range |
| 5 | Forbid write in running mode | Frequency converter is running |
| 6 | Parameter read-only | Parameter are read-only, can not be written |
| 7 | Invalid operation | Function code does not support write or multiple write via external computer |

**Tab. 14-33:** PKW area error codes

### Example of parameter operation in PKW area

### Example description

In applications, the master and the frequency converters communicate with messages in PPO structure. Among the 8 PPOs stated in fig. 14-2 "PPO telegram type" on page 450, PPO1, PPO2 and PPO5 apply both PKW area and PZD area. In following examples, PKW area data frames are taken from complete PPO message to describe its request and response data frames.

The following examples are all based on Frequency Converter VFC 5615 and PROFIBUS card.

### Example 1

Reading value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0001 | 0x301A | 0x0000 | 0x0000 |
| Response data frame of PKW area | 0x0001 | 0x301A | 0x0000 | 0x0032 |

**Tab. 14-34:** Example 1_request and response data frames of PKW area

### Example 2

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0x0064, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0x0064 |
| Response data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0x0064 |

**Tab. 14-35:** Example 2_request and response data frames of PKW area

### Example 3

Modifying value of parameter E0.26 'Acceleration time'. 0x30 is the parameter group, 0x1A is the index No. of the function code within the parameter group. If the modifying value is 0xFFFF, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---|---|---|---|---|
| Request data frame of PKW area | 0x0002 | 0x301A | 0x0000 | 0xFFFF |
| Response data frame of PKW area | 0x0007 | 0x301A | 0x0000 | 0x0064 |

**Tab. 14-36:** Example 3_request and response data frames of PKW area

## PZD process data area

### PZD process data area description

The data in PZD process data area can be configured freely for periodical data exchange between the master and slaves. The request telegram type for sending message from master to slaves is decided by H1.30...H1.39; the request telegram type for returning message response from slaves to the master is decided by H1.30...H1.39 (number of PZD is decided by PPO telegram type). See parameters in group H1 chapter "H1: PROFIBUS card parameters" on page 560.

For details on control word, status word and extended status word see the tables below:

| bit | Value | Description |
|---|---|---|
| 15...10 | – | Reserved |
| 9 | 1 | Torque control active |
| | 0 | Inactive |
| 8 | 1 | Freewheeling stop |
| | 0 | Inactive |

| bit | Value | Description |
|---|---|---|
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

**Tab. 14-37:** Control word

| bit | Value | Description |
|---|---|---|
| 15 ... 8 | – | Error code (equals to [E9.05]) |
| 7 | 1 | Error |
| | 0 | No error |
| 6 | 1 | Stall over current |
| | 0 | Normal |
| 5 | 1 | Stall over voltage |
| | 0 | Normal |
| 4 | 1 | Decelerating |
| | 0 | Not in deceleration |
| 3 | 1 | Accelerating |
| | 0 | Not in acceleration |
| 2 | 1 | Jogging |
| | 0 | Not in jog |
| 1 | 1 | Running |
| | 0 | Stop |

| bit | Value | Description |
|---|---|---|
| 0 | 1 | Reverse |
| | 0 | Forward |

**Tab. 14-38:** Status word

| bit | Value | Description |
|---|---|---|
| 15...1 | – | Reserved |
| 0 | 1 | 24 V mode |
| | 0 | Normal mode |

**Tab. 14-39:** Extended status word

For details on parameter addresses, see chapter 14.3 "Modbus Protocol" on page 426.

## Examples for operation of PZD process data area

### Example 1

The master communicates with the slave via PPO4, see fig. 14-2 "PPO telegram type" on page 450.

If we need to start frequency converter for forward rotation at 50.00 Hz (0×1388). When the parameters in group H1 are kept as defaults, complete PPO request and response messages are shown in table below.

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|---|---|---|---|---|---|---|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0081 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0xxx02 | 0x1388 | | | | |

**Tab. 14-40:** Example 1 for PZD process data area_request and response messages of PPO



The higher byte of the status word is the latest error code (0x00 means no error).

### Example 2

When the frequency converter forward runs at 50 Hz, to stop the frequency converter as parameter settings, please refer to example 1.

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|---|---|---|---|---|---|---|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0088 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0xxx00 | 0x0000 | | | | |

**Tab. 14-41:** Example 2 for PZD process data area_request and response messages of PPO

## 14.4.7 Communication parameter configuration

### Communication related parameter settings

| Parameter | Name | Parameter settings |
|---|---|---|
| E0.00 | First frequency setting source | 20: Communication |
| E0.01 | First run command source | 2: Communication |
| E0.02 | Second frequency setting source | 20: Communication |
| E0.03 | Second run command source | 2: Communication |
| E8.00 | Communication protocol | 1: Extension card |
| E8.03 | Communication process data loss behavior | Depends on parameter setting① |
| H0.12 | Torque control reference from fieldbus | 6: Communication |
| H0.14 | FWD torque limitation reference from fieldbus | 4: Communication |
| H0.15 | REV torque limitation reference from fieldbus | 4: Communication |
| H0.16 | Speed limitation at torque control mode from fieldbus | 4: Communication |
| H1.00 | PROFIBUS local address | Depends on parameter setting① |
| H1.01 | Present baud rate | (Read only) |
| H1.02 | Present telegram type | |

| Parameter | Name | Parameter settings |
|---|---|---|
| H1.10 | Output PZD 1 | Depends on parameter setting① |
| H1.11 | Output PZD 2 | |
| H1.12 | Output PZD 3 | |
| H1.13 | Output PZD 4 | |
| H1.14 | Output PZD 5 | |
| H1.15 | Output PZD 6 | |
| H1.16 | Output PZD 7 | |
| H1.17 | Output PZD 8 | |
| H1.18 | Output PZD 9 | |
| H1.19 | Output PZD 10 | |
| H1.30 | Input PZD 1 | |
| H1.31 | Input PZD 2 | |
| H1.32 | Input PZD 3 | |
| H1.33 | Input PZD 4 | |
| H1.34 | Input PZD 5 | |
| H1.35 | Input PZD 6 | |
| H1.36 | Input PZD 7 | |
| H1.37 | Input PZD 8 | |
| H1.38 | Input PZD 9 | |
| H1.39 | Input PZD 10 | |

**Tab. 14-42:** PROFIBUS-DP communication parameters



①: See chapter "H1: PROFIBUS card parameters" on page 560 for details.

In the operation controlled by communication, if the frequency converter is stopped by the **Stop** key on the operating panel, the frequency converter stops responding to the control commands by communication. To enable the control by communication, re-power the frequency converter or send **Stop** command to the frequency converter by communication.

### Parameter configuration of master

For master related parameter configuration, refer to descriptions for master. The address configured for slave in the master should be consistent with the parameter address configured for the slave. Communication baud rate and PPO telegram type are determined by the master.

### GSD file

Users may log on the website of the company at www.boschrexroth.com to download or contact sales personnel to obtain the GSD file BRFC0112.GSD. For installation and PROFIBUS system configuration method, please refer to respective instructions of system configuration software.



The GSD file adapts to the PROFIBUS master which supports GSD revision 2 or above.

# 15 Accessories

## 15.1 Optional Accessories

| Optional accessory | Type | Descriptions |
|---|---|---|
| **Operating panel:** | | |
| - LED panel | FPCC02.1-VANN-7P-NNNN | – |
| - LCD panel | FPCC02.1-VANN-LP-NNNN | – |
| - Dust cover | FPCC02.1-VANN-NN-NNNN | – |
| **Panel mounting plate** | FEAM02.1-VA-NN-NNNN | Cabinet mounting |
| **Communication cable for cabinet control** | FRKS0002/002,0 | 2 m |
| | FRKS0002/003,0 | 3 m |
| | FRKS0002/005,0 | 5 m |
| **Extension card module** | FEAE02.1-VA-NNNN | – |
| **I/O module:** | | |
| - I/O card | FEAE04.1-IO1-NNNN | – |
| - Relay card | FEAE04.1-IO2-NNNN | – |
| - I/O plus card | FEAE04.1-IO3-NNNN | – |
| **Communication module:** | | |
| - PROFIBUS card | FEAE03.1-PB-NNNN | – |
| - CANopen card | FEAE03.1-CO-NNNN | – |
| **Brake Chopper** | FEAE07.1-VA1-NNNN | – |
| | FEAE07.1-VA2-NNNN | – |
| **Plug-in connector for control section** | FEAE05.1-B2-NNNN | For control terminals |
| **External mains EMC filter** | FCAF01.1A-A□□□-E-□□□□-□-0□-NNNN | See Appendix II |
| **External brake resistor**① | – | See Appendix II |

| Optional accessory | Type | Descriptions |
|---|---|---|
| Shielding connector | FEAM03.2-001-NN-NNNN | For **B, C, D** housing |
| | FEAM03.2-002-NN-NNNN | For **E, F, G** housing |
| | FEAM03.2-003-NN-NNNN | For **H** housing |
| | FEAM03.2-004-NN-NNNN | For **I, J** housing |
| | FEAM03.2-005-NN-NNNN | For **K** housing |
| | FEAM03.2-006-NN-NNNN | For **L** housing |

**Tab. 15-1:** Optional accessories

- For definition of model and type in the following sub-chapters, see chapter 19.2 "Appendix II: Type Coding" on page 518.
- ①: The external brake resistor is not provided as the accessory, only technical data is listed for type selection.

## 15.2 Operating Panel

For details on operating panel, see chapter 10 "Operating Panel and Dust Cover" on page 97.

## 15.3 Panel Mounting Plate

### 15.3.1 Function Description

With the operating panel mounted at the control cabinet, the user can operate and control the frequency converter from the outside of the control cabinet conveniently. To realize this function, the user needs order the panel mounting plate and its accessories additionally.

### 15.3.2 Recommended Opening Dimensions at Control Cabinet

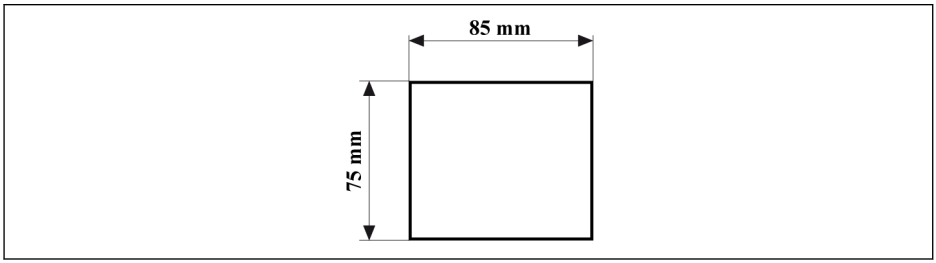



**Fig. 15-1:** Recommended opening dimensions at control cabinet

### 15.3.3 Mounting the Plate and the Operating Panel

#### Step 1

Push the mounting plate into the opening at the control cabinet:

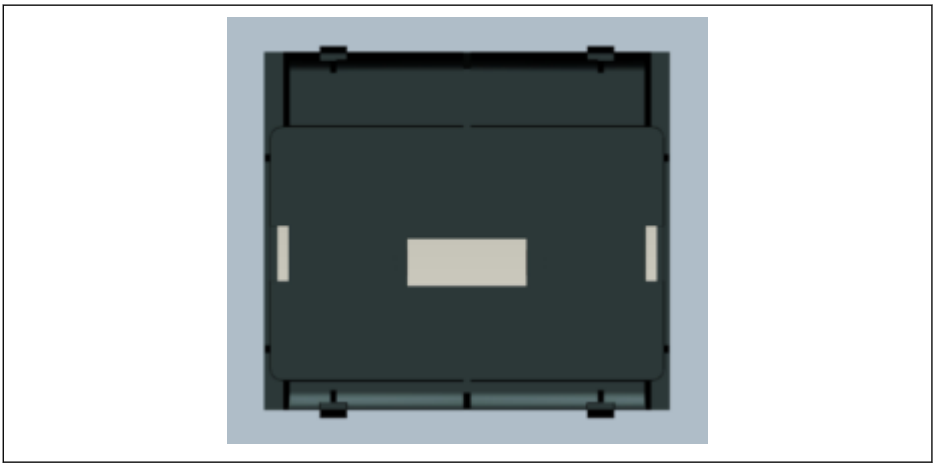


**Fig. 15-2:** Push the mounting plate into the opening (back view)

#### Step 2

Fix the mounting plate with a metal bar and 2 M4x8 screws:

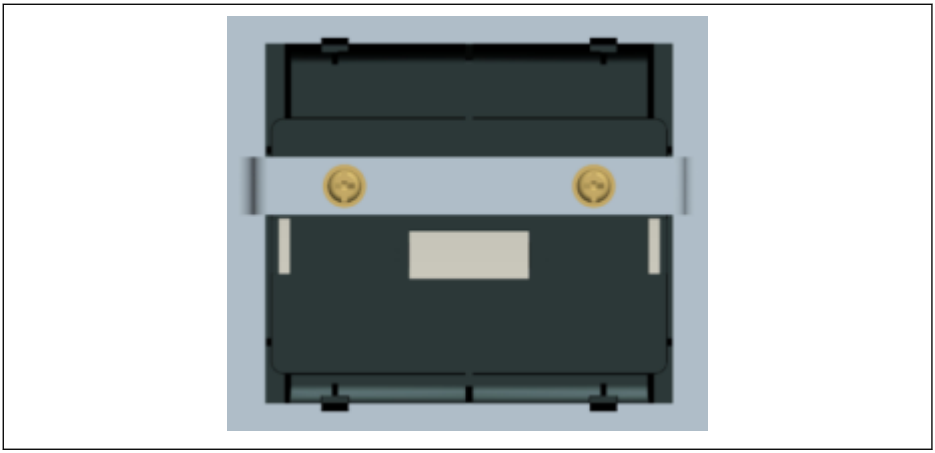


**Fig. 15-3:** Fix the mounting plate (back view)

#### Step 3

Push the operating panel in the direction perpendicular to the mounting plate:




**Fig. 15-4:** Mount the operating panel (front view)

### Step 4

Connect the operating panel to the frequency converter with the connection cable and fix the cable connector on the mounting plate with 2 M3x10 screws:

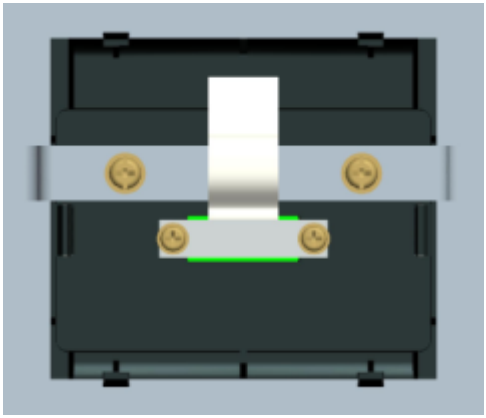


**Fig. 15-5:** Connect and fix the cable (back view)

## 15.4 Communication Cable for Control Cabinet

2 m long cable FRKS0002/002,0, 3 m long cable FRKS0002/003,0 or 5 m long cable FRKS0002/005,0 can be used for the connection of the operating panel.

## 15.5 Extension Card Module

### 15.5.1 Dimensions of Extension Card Module

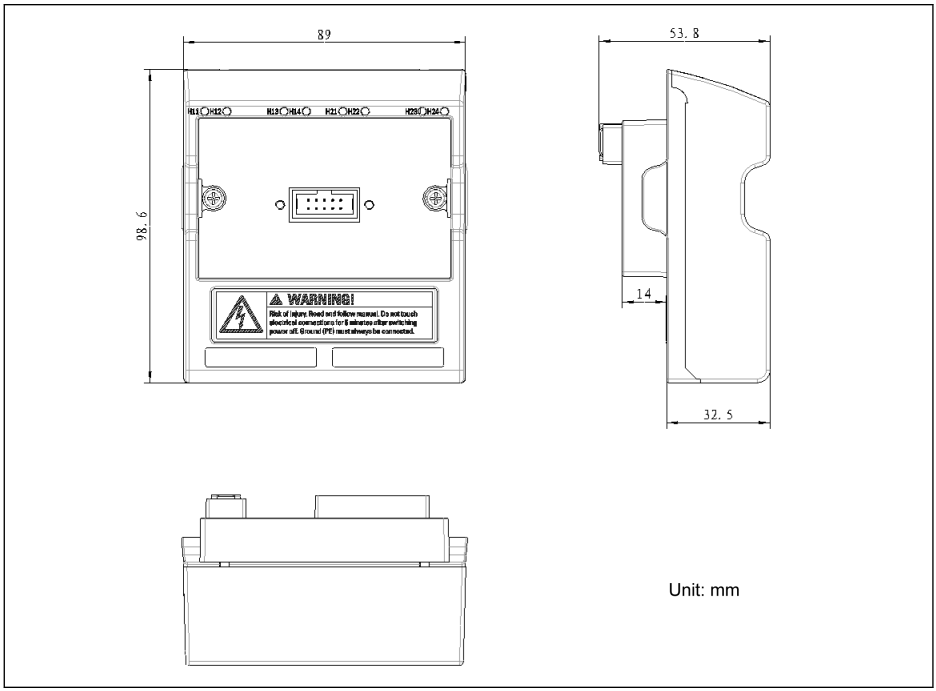



**Fig. 15-6:** Dimensions of Extension Card Module

### 15.5.2 Extension Card Module Mounting

***NOTICE***

Please make sure the power supply has been switched off before mounting the extension card module onto the frequency converter.

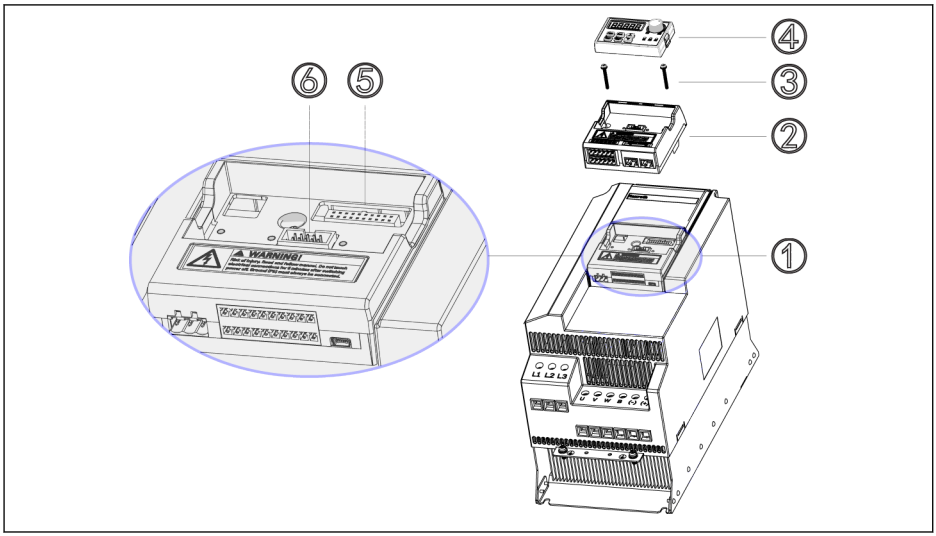



**Fig. 15-7:** Extension card module mounting

1. Remove operating panel ④ from Control & Terminal module ①.
2. Mount extension card module with extension cards ② into Control & Terminal module ①.
3. Tighten two screws ③(screw torque to 0.4 Nm) to fix carrier for option modules ② in Control & Terminal module ①.
4. Push operating panel ④ into carrier for option modules ②.

⑤: Control & Terminal module connector
⑥: Connector for operating panel

## 15.5.3 Extension Module Mounting

**⚠ CAUTION** **Risk of device damage!**

Do not mount the extension card when frequency converter is powered on, otherwise it will cause damage to the extension card.

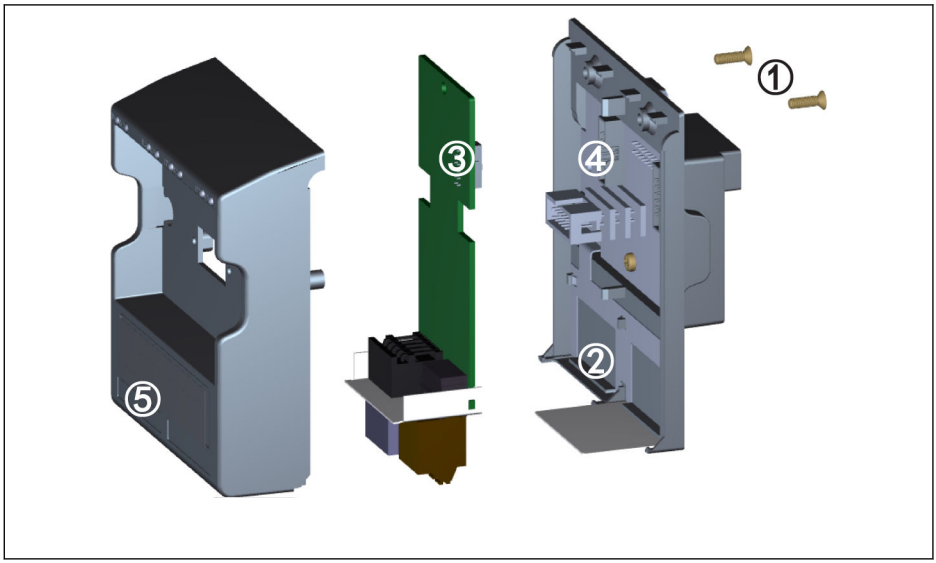



**Fig. 15-8:** Extension module mounting

1. Remove 2-M3 screws ① on back of the extension card module.
2. Remove the front cover of the extension card module.
3. Insert one extension card into the card slot with the metal plate beside the extension card terminals placed in ②.
4. Push the extension card to achieve a stable connection of connector ③ (on the back side of the extension card) with connector ④ (on the extension card module).
5. Mount the front cover of the extension card module.
6. Tighten 2-M3 screws ① of the extension card module.
7. Attach an appropriate terminal label on the label indentation ⑤ located at the lower section of the front cover. Terminal labels for various extension cards are delivered together with each extension card.

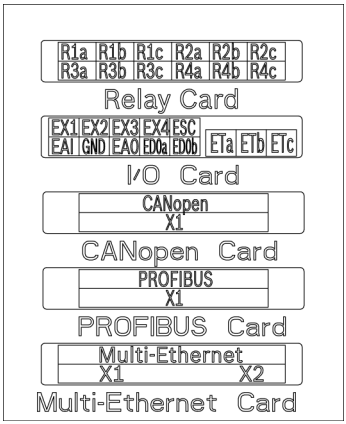



**Fig. 15-9:** Terminal labels of extension cards

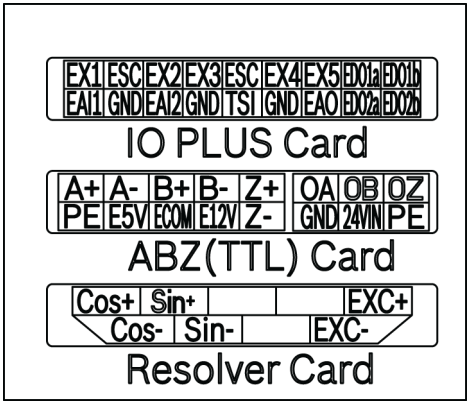



**Fig. 15-10:** Terminal labels of extension cards

- Maximum two extension cards can be mounted in one extension card module.
- Extension cards in the two card slots **CANNOT** be the same.
- **ONLY ONE** type of communication card can be mounted in one extension card module.
- MEP card **ONLY** for VFCx615 series. TTL and Resolver card **ONLY** for VFC5615 series.

# 15.6 I/O Module

## 15.6.1 I/O Card

### I/O card terminals label




**Fig. 15-11:** I/O card terminals label

### I/O card terminals descriptions

| Terminal | Signal requirement | Description |
|---|---|---|
| EX1...EX4 | Multi-function digital inputs:<br>24 VDC, 8 mA / 12 VDC, 4 mA<br>with opto-electric couplers | See Group H8 |
| ESC | – | Isolation opto-electric couplers shared connection |
| EAI | Voltage input range: -10...10 V*<br>Voltage input impedance: > 20 kΩ<br>Resolution: 1/1,000<br>Current input range: 0/4...20 mA<br>Current input impedance: < 500 Ω<br>Resolution: 1/1,000 | The power supply is +5 V and +10 V from the frequency converter<br>See Group H8 |
| GND | – | Analog terminals shared connection, isolated from ESC |
| EAO | Voltage output range: 0...10 V<br>Voltage output load impedance: > 2 kΩ<br>Current output range: 0...20 mA<br>Current output load impedance: < 500 Ω | See Group H8 |
| EDOa, EDOb | Open collector output:<br>Max. 30 VDC, 50 mA | See Group H8<br>ESC is reference |
| ETa, ETc | Rated capacity of relay outputs:<br>250 VAC, 3 A; 30 VDC, 3 A | See Group H8 |
| ETb | | ETb is the relay outputs shared connection |

* For -10 V input, external power supply must be provided. A frequency converter **ONLY** provides +5 V and +10 V

## I/O card terminals wiring

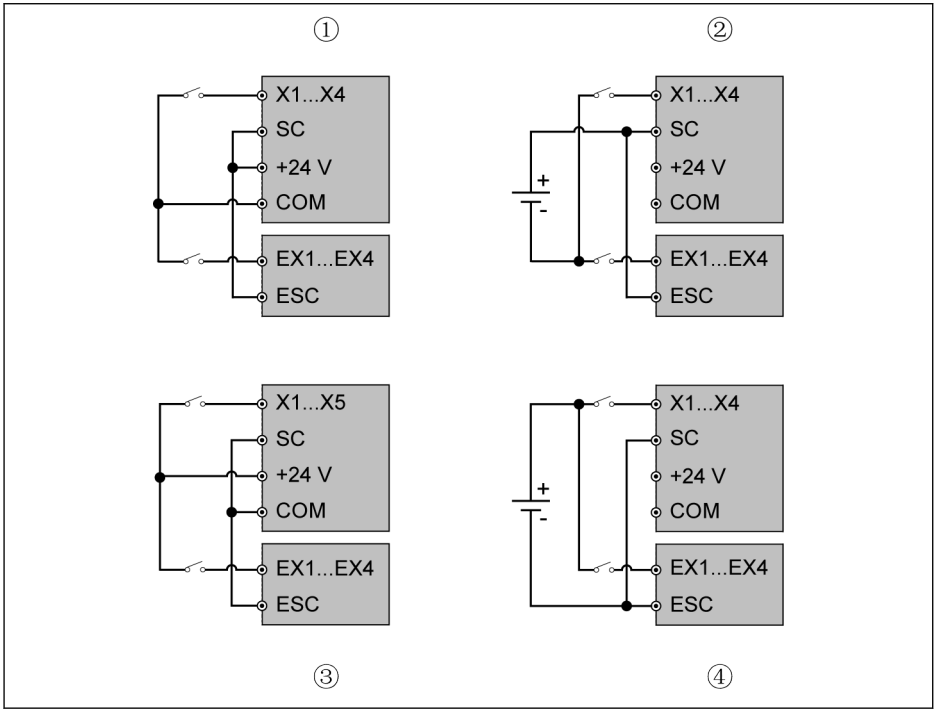



**Fig. 15-12:** I/O card terminals wiring

①: NPN with internal power supply

②: NPN with external power supply

③: PNP with internal power supply

④: PNP with external power supply

X1...X5, SC, +24 V, COM are control terminals of the frequency converter, EX1...EX4, ESC are control terminals of the I/O card.

## 15.6.2 Relay Card

### Relay card terminals label




**Fig. 15-13:** Relay card terminals label

### Relay card terminals descriptions

| Terminal | Signal requirement | Description |
|---|---|---|
| R1a, R1c, R1b | Rated capacity:<br>250 VAC, 3 A<br>30 VDC, 3 A | See Group H9<br>R1b, R2b, R3b, R4b are relay outputs shared connections |
| R2a, R2c, R2b | | |
| R3a, R3c, R3b | | |
| R4a, R4c, R4b | | |

### Relay card terminals wiring

For details on relay terminals wiring, see chapter "Relay output terminals" on page 75.

## 15.6.3 I/O Plus Card

### Terminals Mapping

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EX1 | ESC | EX2 | EX3 | ESC | EX4 | EX5 | EDO1a | EDO1b |
| EAI1 | GND | EAI2 | GND | TSI | GND | EAO | EDO2a | EDO2b |

**Fig. 15-14:** Terminals Mapping

### Terminals Description

| Terminal | Signal function | Description |
|---|---|---|
| EX1...EX5 | Multi-function digital inputs:<br>24 VDC, 8 mA / 12 VDC, 4 mA<br>with optocouplers isolation | See parameter group H8 |
| ESC | - | Isolation optocouplers shared connection |

| Terminal | Signal function | Description |
|---|---|---|
| EAI1 / EAI2 | Analog voltage / current inputs<br>Voltage input range: -10...10 V *<br>Input impedance: > 20 kΩ<br>Resolution: 1/1,000<br><br>Current input range: 0/4...20 mA<br>Input impedance: < 500 Ω<br>Resolution: 1/1,000 | The power supply is +5 V and +10 V from the frequency converter<br>See parameter group H8 |
| TSI | Supported sensor types:<br>KTY 84/130, PT100, PT1000, TDK G1551_8320 (NTC) | GND is reference |
| GND | - | Analog terminals shared connection, isolated from ESC |
| EAO | Analog voltage / current outputs<br>Voltage output range: -10...10 V<br>Output load impedance: > 500 Ω<br><br>Current output range: 0...20 mA<br>Output load impedance: < 500 Ω | See parameter group H8 |
| EDO1a,<br>EDO1b,<br>EDO2a,<br>EDO2b | Open collector output:<br>Max. 30 VDC, 500 mA | See parameter group H8 |

* For -10 V input, external power supply must be provided. A frequency converter **ONLY** provides +5 V and +10 V

## Wiring

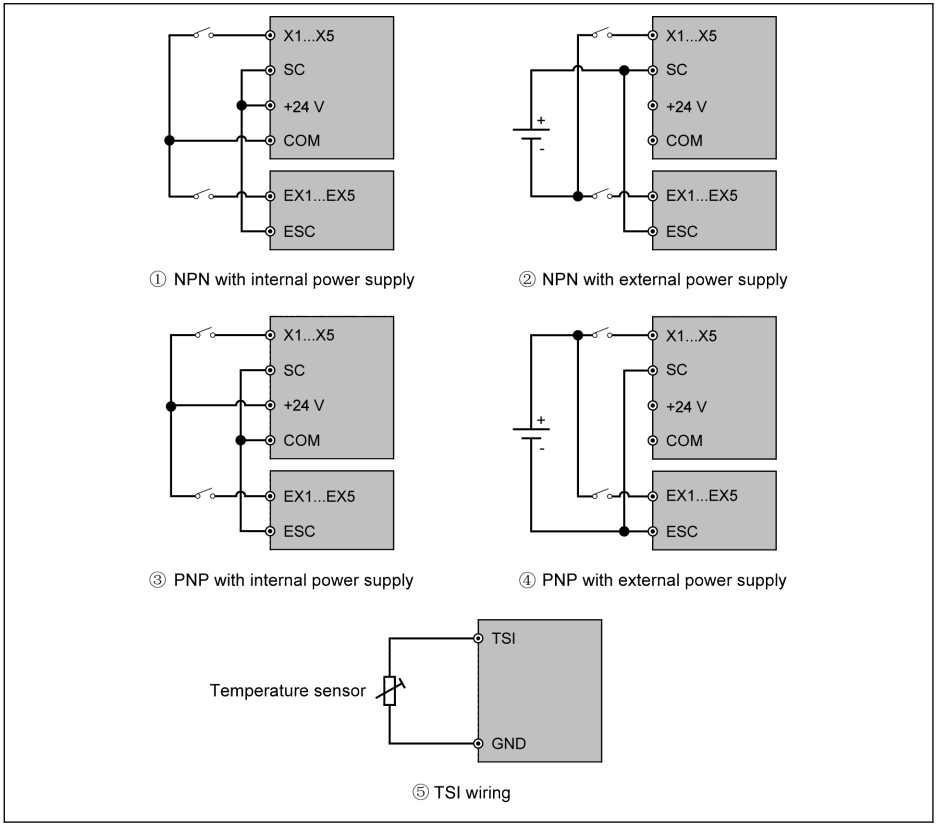



**Fig. 15-15:** I/O Plus Card Wiring

X1...X5, SC, +24V, and COM are control terminals of frequency converter.

EX1...EX4, ESC are control terminals of I/O Plus Card.

## 15.7 Communication Module

### 15.7.1 PROFIBUS Interface

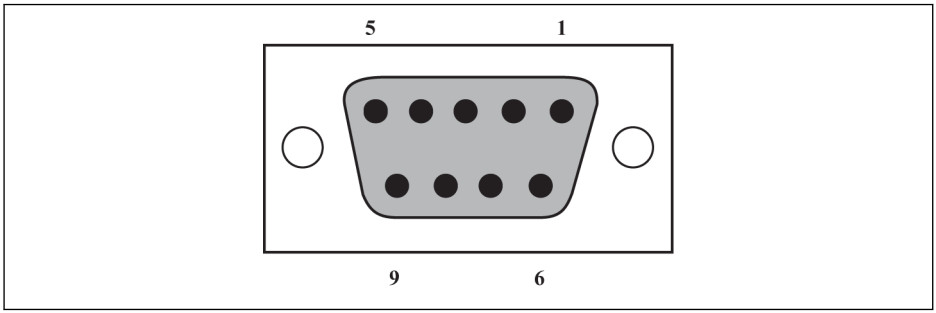



**Fig. 15-16:** PROFIBUS DB9 interface

| Pin | Terminal sign | Terminal name | Function description |
|---|---|---|---|
| 1 | NC | – | Reserved |
| 2 | NC | – | Reserved |
| 3 | PROFIBUS_B | PROFIBUS terminal_B | PROFIBUS data cable B |
| 4 | RTS | Request for signal sending | – |
| 5 | GND | Power- | – |
| 6 | Vcc | Power+ | – |
| 7 | NC | – | Reserved |
| 8 | PROFIBUS_A | PROFIBUS terminal_A | PROFIBUS data cable A |
| 9 | NC | – | Reserved |

**Tab. 15-2:** Pin definition of PROFIBUS DB9 interface

## 15.7.2 PROFIBUS Card LED

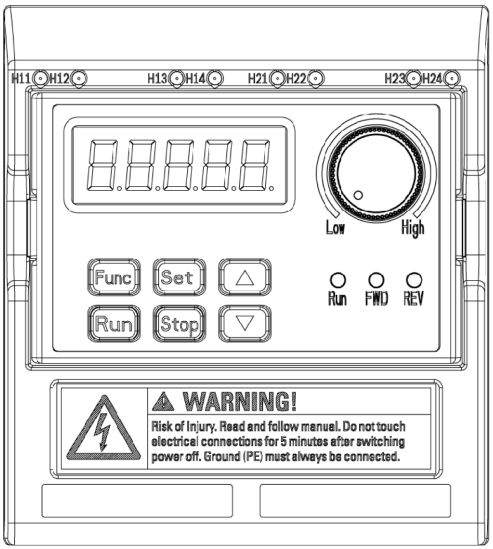



**Fig. 15-17:** PROFIBUS card LED

| LED | Color | Function | Status | Description |
|---|---|---|---|---|
| H11/H21① | Green | PROFIBUS card configuration status | Fast blinking<br>0.4 s per cycle | Data exchanging |
| | | | ON | Communication established<br>PROFIBUS card successfully parameterized and configured<br>=> Everything OK |
| H12/H22① | Red | PROFIBUS card error indication | OFF | PROFIBUS card OK |
| | | | Slow Blinking<br>1 s per cycle | PROFIBUS card error |

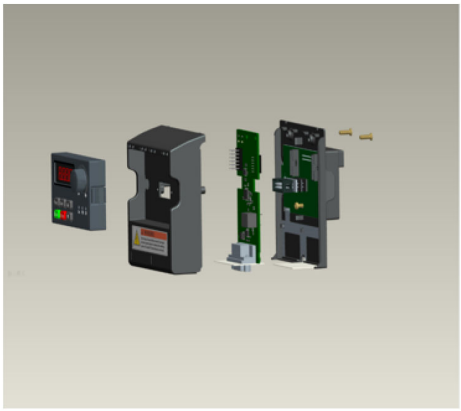
**Tab. 15-3:** PROFIBUS card LED

①:

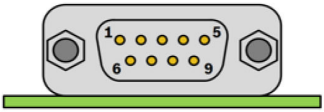
- H11 and H12 are available when the PROFIBUS card is installed on the left card slot
- H21 and H22 are available when the PROFIBUS card is installed on the right card slot

## 15.7.3 CANopen Card

### Interface Introduction



Pins of the DB9 connectors




Connector Pin Description

| Pin # | Signal | Description |
|---|---|---|
| 1 | --- | Reserved |
| 2 | CAN_L | CAN_L Bus line (dominant low) |
| 3 | CAN_V- | External bus power GND |
| 4 | --- | Reserved |
| 5 | Earth | CAN cable shield |
| 6 | CAN_V- | External bus power GND |
| 7 | CAN_H | CAN_H Bus line (dominant high) |
| 8 | --- | Reserved |
| 9 | --- | Reserved |
| 10 | Earth | CAN cable shield |

**Fig. 15-18:** Interface data

## Cable and Connection

Please select CANopen cable type in accordance with the following instructions.

| Baudrate | Max. cable length | Resistance [mΩ/m] | Cable cross section [mm²/AWG] | Termination resistor |
|---|---|---|---|---|
| 1,000 kbps | 25m | <70 | 0.25...0.34 / AWG23...AWG22 | 120 Ω |
| 500 kbps | 100 m | < 60 | 0.34...0.6 / AWG22...AWG20 | |
| 250 kbps | 250 m | < 40 | 0.5...0.6 / AWG20 | |
| 125 kbps | 500 m | | | |
| 50 kbps | 1,000 m | < 26 | 0.75...0.8 / AWG18 | |
| 20 kbps | 1,000 m | | | |
| 10 kbps | 1,000 m | | | |

**Tab. 15-4:** Cable data

It is not suitable to connect frequency converter with “flat cable” and other unscreened cable types. With regards to the connection of the cable screen, it is recommended to connect to the ground at both ends of the cable at every CANopen slave node. Low impedance ground connection of high frequency screen is very important. This can be achieved by connecting to the ground with a cable clamp or a conductive cable device, such as converter shielding kit.

## 15.8 Plug-in Connector for Control Section

The plug-in connector kit (FEAE05.1-B2-NNNN) is used for the wiring of control terminals. This kit contains the following two sub-components.

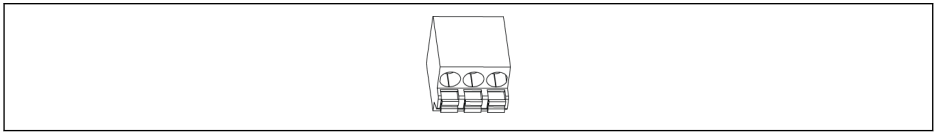


**Fig. 15-19:** Relay terminal connector

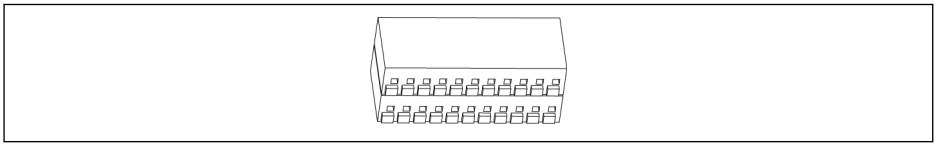


**Fig. 15-20:** IO terminal connector

For the connection diagram of control terminal connector and frequency converter, see fig. 8-11 "Control circuit terminals" on page 70.

## 15.9 External Mains EMC Filter

### 15.9.1 External Mains EMC Filter Type

| VFC x615 model | External mains EMC filter type |
|---|---|
| 0K40-1P2 | FCAF01.1A-A050-E-0010-N-03-NNNN (0010-N-03) |
| 0K75-1P2 | |
| 1K50-1P2 | FCAF01.1A-A050-E-0020-N-03-NNNN (0020-N-03) |
| 2K20-1P2 | FCAF01.1A-A050-E-0025-N-03-NNNN (0025-N-03) |
| 0K40-3P4 | FCAF01.1A-A050-E-0008-A-05-NNNN (0008-A-05) |
| 0K75-3P4 | |
| 1K50-3P4 | |
| 2K20-3P4 | |
| 3K00-3P4 | FCAF01.1A-A050-E-0020-N-05-NNNN (0020-N-05) |
| 4K00-3P4 | |
| 5K50-3P4 | FCAF01.1A-A050-E-0036-A-05-NNNN (0036-A-05) |
| 7K50-3P4 | |
| 11K0-3P4 | |
| 15K0-3P4 | FCAF01.1A-A050-E-0050-A-05-NNNN (0050-A-05) |
| 18K5-3P4 | |
| 22K0-3P4 | FCAF01.1A-A050-E-0066-A-05-NNNN (0066-A-05) |
| 30K0-3P4 | FCAF01.1A-A050-E-0090-A-05-NNNN (0090-A-05) |

| VFC x615 model | External mains EMC filter type |
|---|---|
| 37K0-3P4 | FCAF01.1A-A100-E-0120-A-05-NNNN (0120-A-05) |
| 45K0-3P4 | |
| 55K0-3P4 | FCAF01.1A-A100-E-0250-N-05-NNNN (0250-N-05) |
| 75K0-3P4 | |
| 90K0-3P4 | FCAF01.1A-A100-E-0320-N-05-NNNN (0320-N-05) |
| 110K-3P4 | |
| 132K-3P4 | FCAF01.1A-A100-E-0400-N-05-NNNN (0400-N-05) |
| 160K-3P4 | |
| 185K-3P4 | |
| 200K-3P4 | |
| 220K-3P4 | FCAF01.1A-A150-E-0600-N-05-NNNN (0600-N-05) |
| 250K-3P4 | |
| 280K-3P4 | |
| 315K-3P4 | |
| 355K-3P4 | FCAF01.1A-A150-E-01000-N-05-NNNN (01000-N-05) |
| 400K-3P4 | FCAF01.1A-A150-E-01000-N-05-NNNN (01000-N-05) |

**Tab. 15-5:** External mains EMC filter type

- Only mount the external mains EMC filter FCAF vertically. Keep at least 80 mm above the top and below the bottom of the external mains EMC filter free from mounted parts.
- For EMC performance with the external mains EMC filter, see chapter 6.2.3 "Maximum Length of Motor Cables" on page 35.

## 15.9.2 Technical Data

### Dimensions

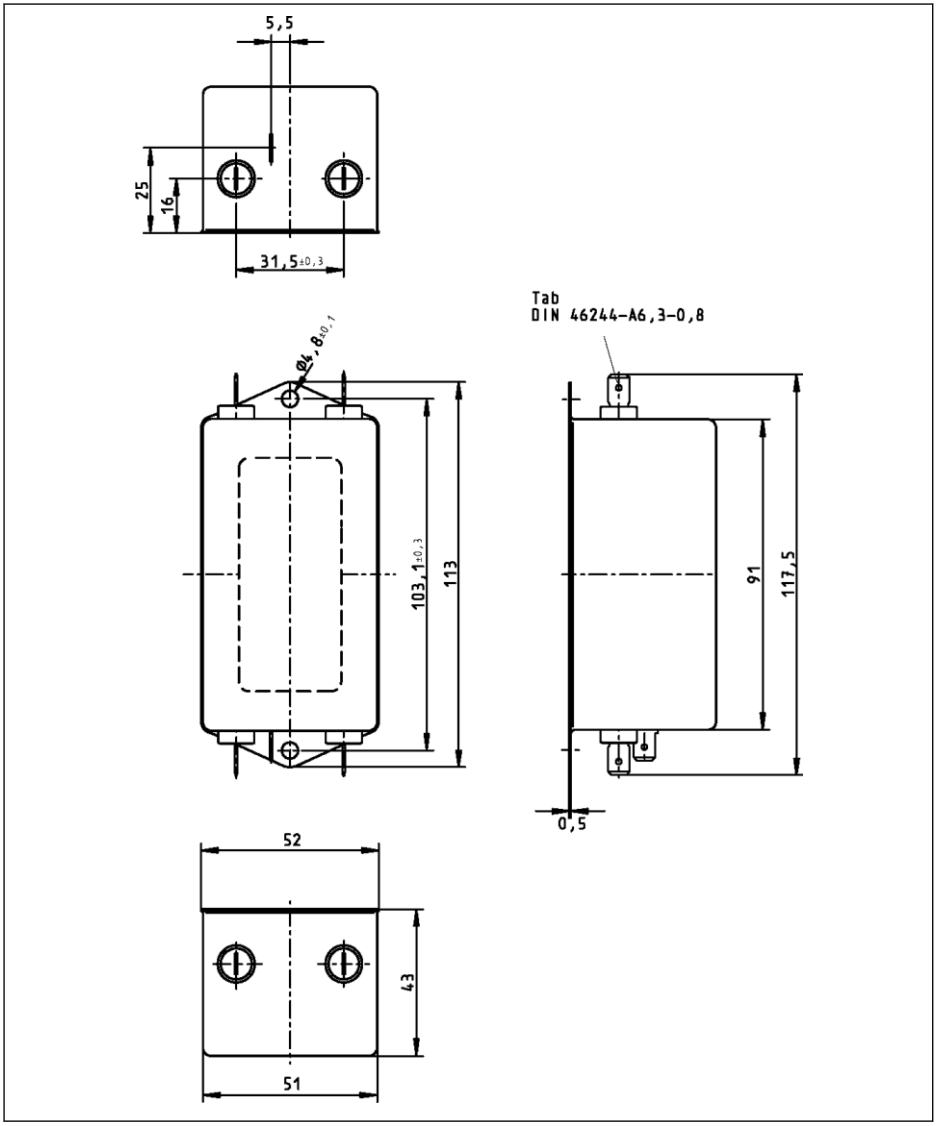



**Fig. 15-21:** 0010-N-03

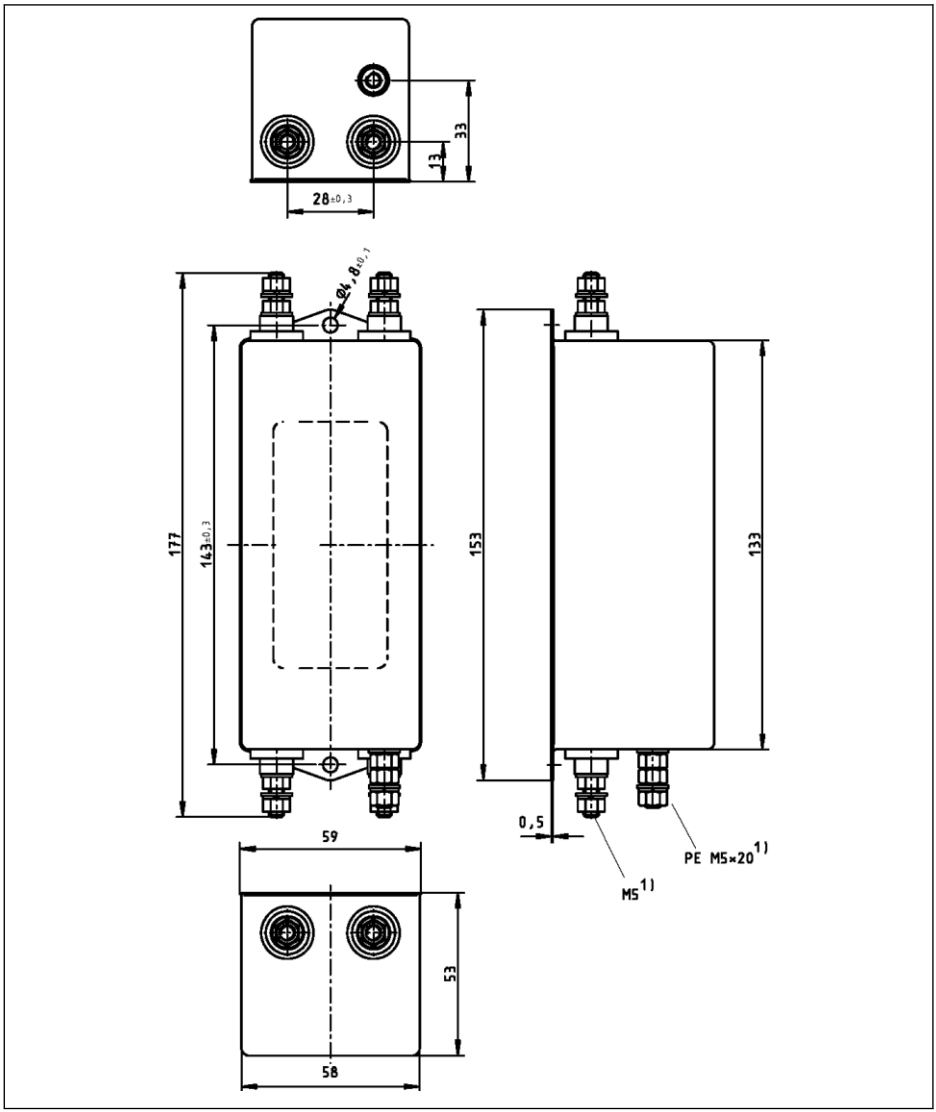



**Fig. 15-22:** 0020-N-03, 0025-N-03

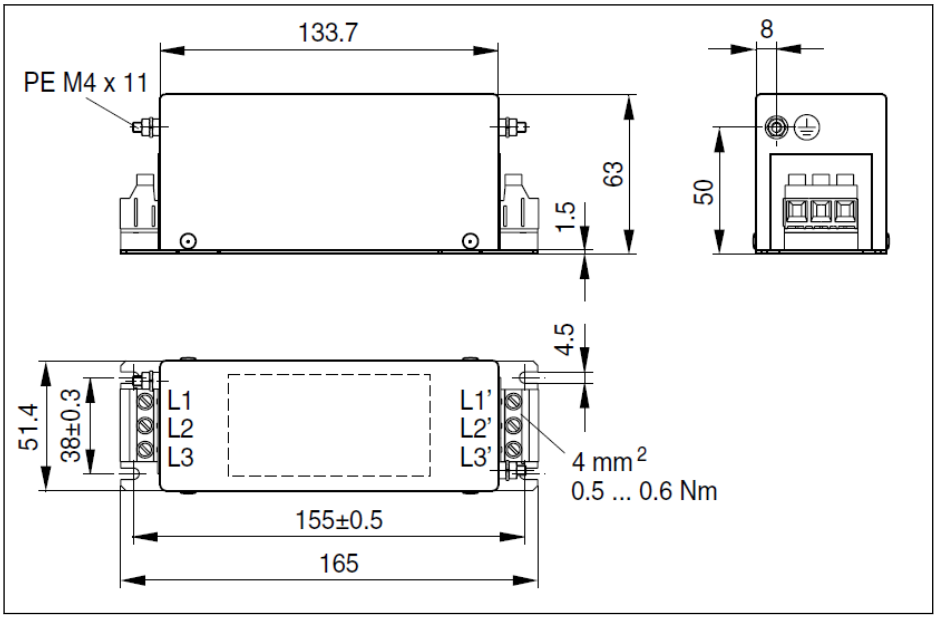



**Fig. 15-23:** 0008-A-05

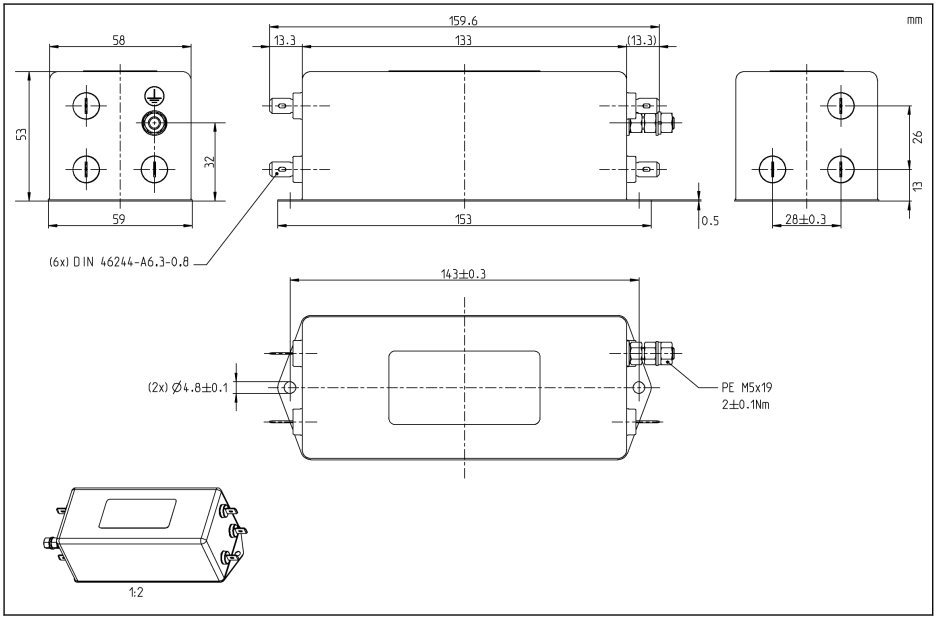



**Fig. 15-24:** 0020-N-05

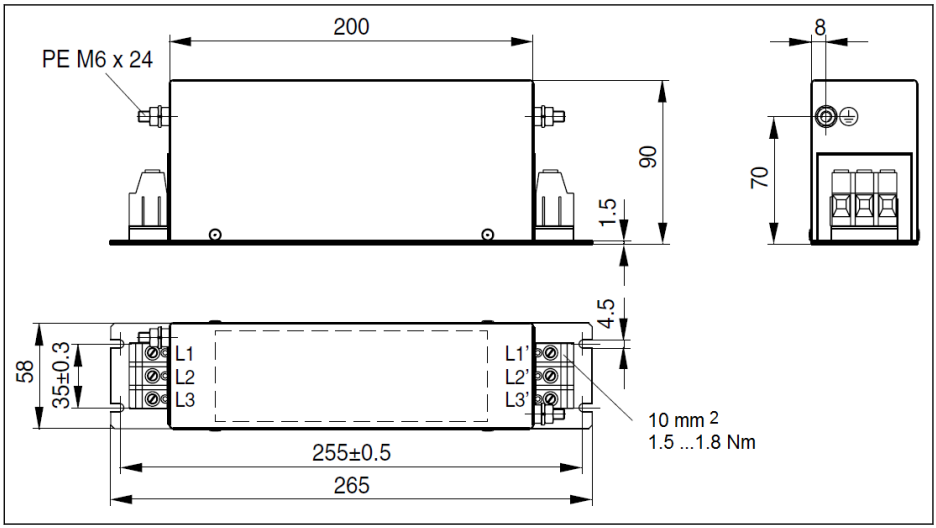



**Fig. 15-25:** 0036-A-05, 0050-A-05

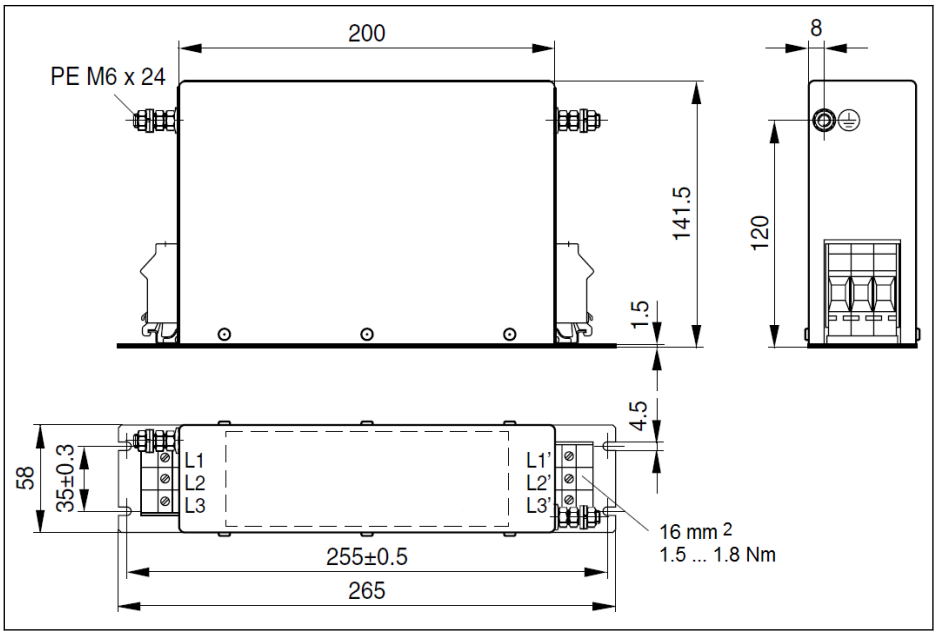



**Fig. 15-26:** 0066-A-05

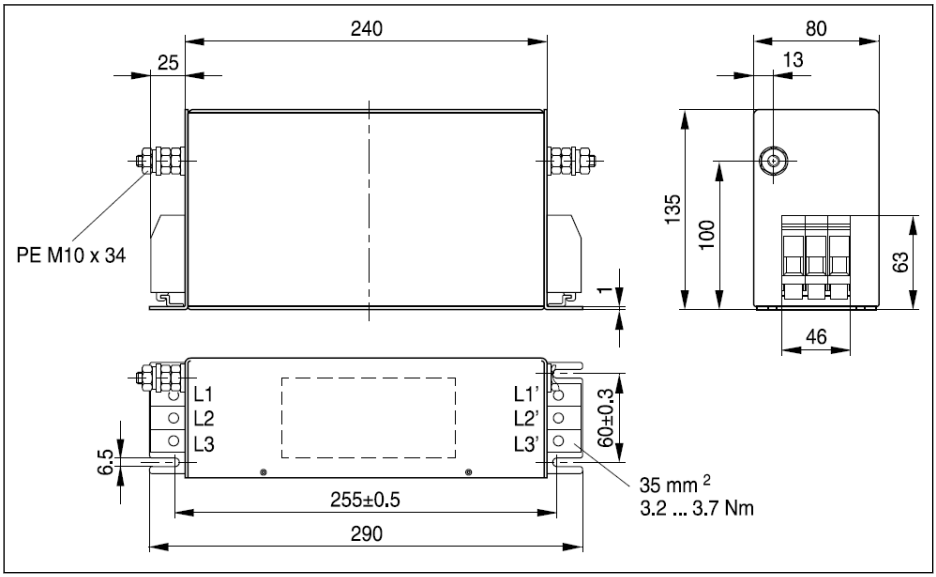



**Fig. 15-27:** 0090-A-05

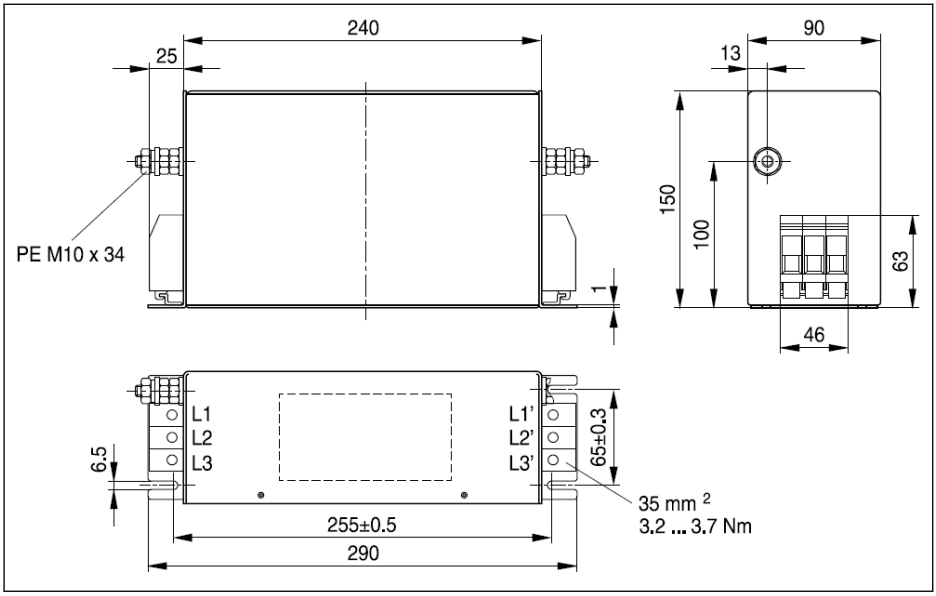



**Fig. 15-28:** 0120-A-05

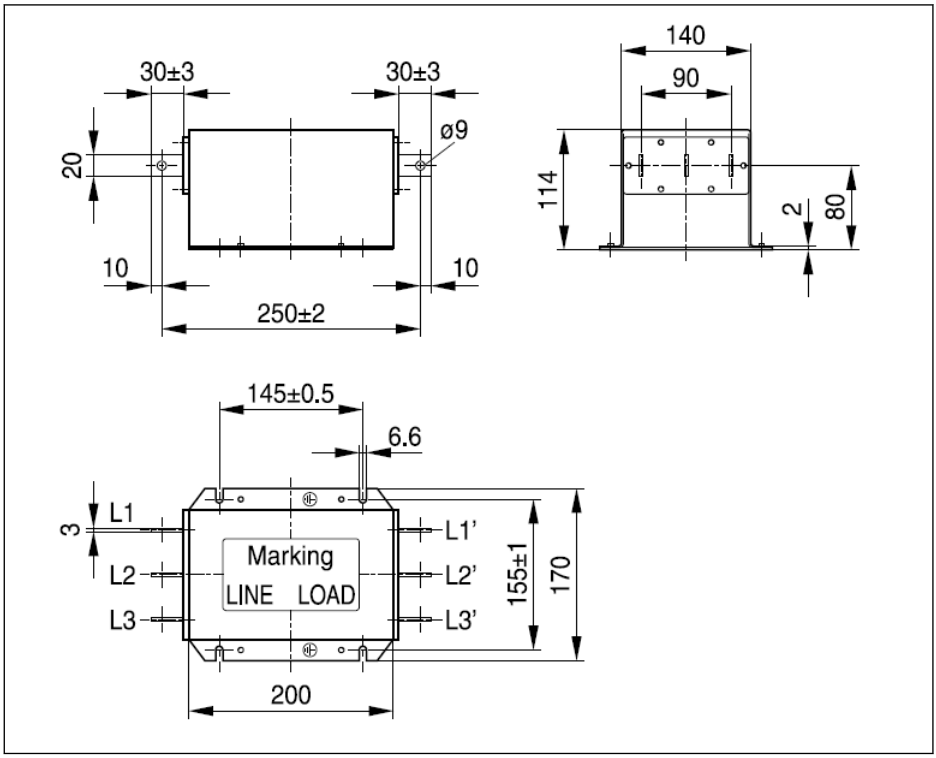



**Fig. 15-29:** 0250-N-05

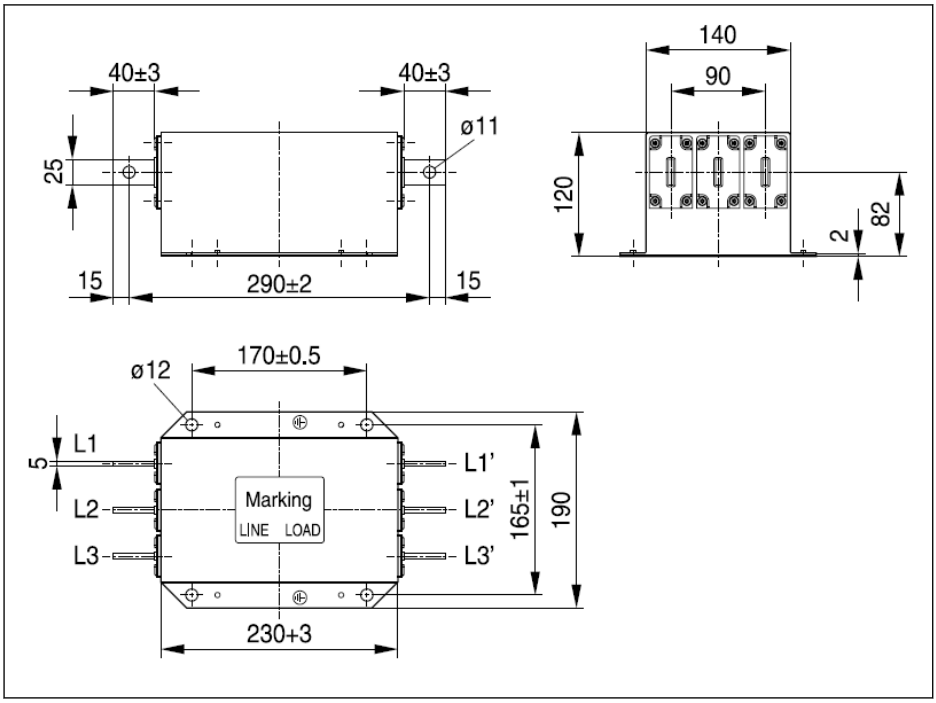



**Fig. 15-30:** 0320-N-05, 0400-N-05

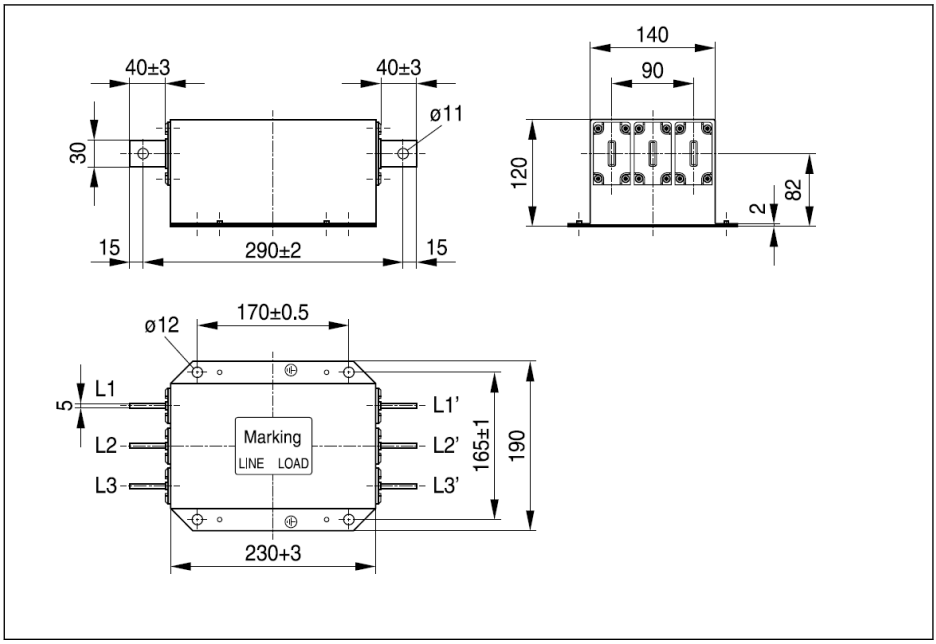



**Fig. 15-31:** 0600-N-05

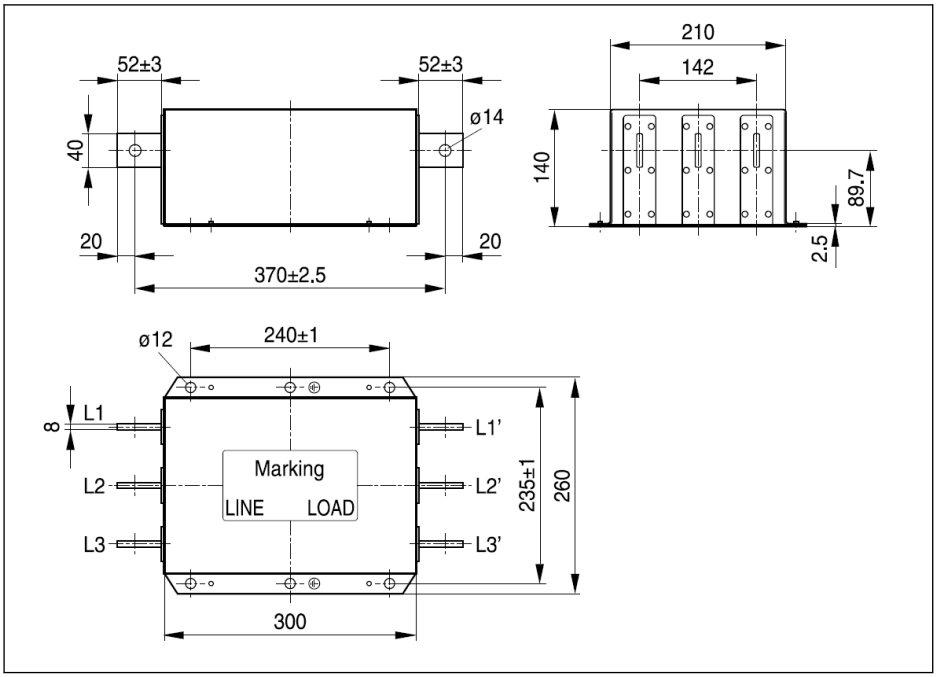



**Fig. 15-32:** 01000-N-05

## Electric data

### Electric data of EMC filter for 1P 200 VAC models

When using EMC filters in **mains grounded via outer conductor**, use an isolating transformer between mains and EMC filter.

| Description | Symbol | Unit | 0010-N-03 | 0020-N-03 | 0025-N-03 |
|---|---|---|---|---|---|
| Degree of protection according to IEC 60529 | – | – | IP 20 | | |
| Listing according to UL standard (UL) | – | – | UL 1283 | | |
| Listing according to CSA standard (UL) | – | – | C22.2 No.8 | | |
| Mass (weight) | m | kg | 0.42 | 0.86 | 0.87 |
| Mains voltage at TN-S, TN-C, TT mains | $U_{LN}$ | V | 200...240 | | |

| Description | Symbol | Unit | 0010-N-03 | 0020-N-03 | 0025-N-03 |
|---|---|---|---|---|---|
| Mains voltage at Corner- grounded-Delta mains | $U_{LN}$ | V | Not allowed | | |
| Mains voltage at IT mains | $U_{LN}$ | V | Not allowed | | |
| Tolerance $U_{LN}$ (UL) | – | – | -10...+10 % | | |
| Input frequency (UL) | $f_{LN}$ | Hz | 50...60 | | |
| Nominal current | $I_{L_cont}$ | A | 10 | 20 | 25 |
| Calculation of leakage current | $I_{leak}$ | mA | < 0.5 | < 3.5 | < 3.5 |
| Required wire size according to IEC 60364-5-52; at $I_{L_cont}$ | $A_{LN}$ | $mm^2$ | 2 | 3.5 | 5.3 |

**Tab. 15-6:** 1P 200 VAC electric data

## Electric data of EMC filter for 3P 380 VAC models

| Description | Symbol | Unit | 0008-A-05 | 0020-N-05 | 0036-A-05 | 0050-A-05 | 0066-A-05 | 0090-A-05 |
|---|---|---|---|---|---|---|---|---|
| Degree of protection according to IEC 60529 | – | – | IP 20 | | | | | |
| Listing according to UL standard (UL) | – | – | UL 1283 | | | | | |
| Listing according to CSA standard (UL) | – | – | C22.2 No.8 | | | | | |
| Mass (weight) | m | kg | 0.58 | 0.75 | 1.75 | 1.75 | 2.70 | 4.20 |
| Mains voltage at TN-S, TN-C, TT mains | $U_{LN}$ | V | 380...480 | | | | | |
| Mains voltage at Corner-grounded-Delta mains | $U_{LN}$ | V | Not allowed | | | | | |
| Mains voltage at IT mains | $U_{LN}$ | V | Not allowed | | | | | |
| Tolerance $U_{LN}$ (UL) | – | – | -15...+10 % | | | | | |
| Input frequency (UL) | $f_{LN}$ | Hz | 50...60 | | | | | |
| Nominal current | $I_{L_cont}$ | A | 8 | 20 | 36 | 50 | 66 | 90 |
| Calculation of leakage current | $I_{leak}$ | mA | 4.1 | 3.1 | 4.7 | 4.7 | 4.7 | 5 |
| Required wire size according to IEC 60364-5-52; at $I_{L_cont}$ | $A_{LN}$ | $mm^2$ | 4 | 5 | 10 | 10 | 16 | 35 |

**Tab. 15-7:** 3P 380 VAC electric data

| Description | Symbol | Unit | 0120-A-05 | 0250-N-05 | 0320-N-05 | 0400-N-05 | 0600-N-05 | 01000-N-05 |
|---|---|---|---|---|---|---|---|---|
| Degree of protection according to IEC 60529 | – | – | IP 20 | | | | | |
| Listing according to UL standard (UL) | – | – | UL 1283 | | | | | |
| Listing according to CSA standard (UL) | – | – | C22.2 No.8 | | | | | |
| Mass (weight) | m | kg | 4.90 | 5.00 | 7.20 | 7.50 | 7.8 | 18.5 |
| Mains voltage at TN-S, TN-C, TT mains | $U_{LN}$ | V | 380...480 | | | | | |
| Mains voltage at Corner-grounded-Delta mains | $U_{LN}$ | V | Not allowed | | | | | |

| Description | Symbol | Unit | 0120-A-05 | 0250-N-05 | 0320-N-05 | 0400-N-05 | 0600-N-05 | 01000-N-05 |
|---|---|---|---|---|---|---|---|---|
| Mains voltage at IT mains | $U_{LN}$ | V | Not allowed | | | | | |
| Tolerance $U_{LN}$ (UL) | – | – | -15...+10 % | | | | | |
| Input frequency (UL) | $f_{LN}$ | Hz | 50...60 | | | | | |
| Nominal current | $I_{L_cont}$ | A | 120 | 250 | 320 | 400 | 600 | 1000 |
| Calculation of leakage current | $I_{leak}$ | mA | 5 | 14 | 14 | 14 | 14 | 14 |
| Required wire size according to IEC 60364-5-52; at $I_{L_cont}$ | $A_{LN}$ | $mm^2$ | 35 | 70 | 120 | 240.0 / 120.0*2 | 95.0*4 | |

**Tab. 15-8:** 3P 380 VAC electric data

## 15.10 External Brake Resistor

### 15.10.1 Braking Ratio

Brake resistors with different power ratings are available to dissipate braking energy when the frequency converter is in generator mode.

The tables below list the optimal combination of frequency converter, brake resistor and the number of components required to operate one frequency converter with respect to a given moderating ratio OT.

$$OT = \frac{Tb}{Tc} * 100\%$$

**OT (On Time percentage)** Braking ratio
**Tb** Braking time
**Tc** Engineering cycle time in application

**Fig. 15-33:** Braking ratio

## 15.10.2 Brake Resistor Type for Braking Ratio of 10 %

The recommended brake chopper and brake resistor listed below are for default braking voltage, ED = 10 % and braking torque is 100%.

| Converter model | | Brake resistor | | | | | Brake chopper | |
|---|---|---|---|---|---|---|---|---|
| | | Type | Specification | Number | Max. braking ON time [s] | Max. braking energy [KWs] | Type | Number |
| 1P 200 VAC | 0K40 | FCAR01.1W0060-N400R0-B-03-NNNN | 400Ω /60W | 1 | 12 | 7.1424 | - | - |
| | 0K75 | FCAR01.1W0100-N190R0-B-03-NNNN | 190Ω/ 100W | 1 | 12 | 11.904 | - | - |
| | 1K50 | FCAR01.1W0200-N095R0-B-03-NNNN | 95Ω/ 200W | 1 | 12 | 23.808 | - | - |
| | 2K20 | FCAR01.1W0300-N065R0-B-03-NNNN | 65Ω/ 300W | 1 | 12 | 35.712 | - | - |

**Tab. 15-9:** Brake resistor type for braking ratio of 10 % for 1P 200 VAC

| Converter model | | Brake resistor | | | | | Brake chopper | |
|---|---|---|---|---|---|---|---|---|
| | | Type | Specification | Number | Max. braking ON time [s] | Max. braking energy [KWs] | Type | Number |
| 3P 380 VAC | 0K40 | FCAR01.1W0080-N750R0-B-05-NNNN | 750Ω /80W | 1 | 12 | 9.5232 | - | - |
| | 0K75 | FCAR01.1W0080-N750R0-B-05-NNNN | 750Ω /80W | 1 | 12 | 9.5232 | - | - |
| | 1K50 | FCAR01.1W0260-N400R0-B-05-NNNN | 400Ω/ 260W | 1 | 12 | 30.950 4 | - | - |
| | 2K20 | FCAR01.1W0260-N250R0-B-05-NNNN | 250Ω/ 260W | 1 | 12 | 30.950 4 | - | - |
| | 3K00 | FCAR01.1W0390-N150R0-B-05-NNNN | 150Ω/ 390W | 1 | 12 | 46.425 6 | - | - |
| | 4K00 | FCAR01.1W0390-N150R0-B-05-NNNN | 150Ω/ 390W | 1 | 12 | 46.425 6 | - | - |
| | 5K50 | FCAR01.1W0780-N075R0-A-05-NNNN | 75Ω/ 780W | 1 | 12 | 112.32 | - | - |
| | 7K50 | FCAR01.1W0780-N075R0-A-05-NNNN | 75Ω/ 780W | 1 | 12 | 112.32 | - | - |
| | 11K0 | FCAR01.1W0780-N075R0-A-05-NNNN | 75Ω/ 780W | 1 | 12 | 112.32 | - | - |
| | 15K0 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40Ω/ 1,560 W | 1 | 12 | 224.64 | - | - |
| | 18K5 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40Ω/ 1,560 W | 1 | 12 | 224.64 | - | - |
| | 22K0 | FCAR01.1W04K8-N032R0-A-05-NNNN | 32Ω/ 4,800 W | 1 | 12 | 506.88 | - | - |
| | 30K0 | FCAR01.1W3K50-N018R9-A-05-NNNN | 18.9Ω / 3,500 W | 1 | 12 | 369.6 | - | - |
| | 37K0 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16Ω/ 4,000 W | 1 | 10 | 352 | FEAE07.1-VA1-NNN | 1 |
| | 45K0 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16Ω/ 4,000 W | 1 | 10 | 352 | FEAE07.1-VA1-NNN | 1 |
| | 55K0 | FCAR01.1W6K50-N010R0-A-05-NNNN | 10Ω/ 6,500 W | 1 | 10 | 572 | FEAE07.1-VA1-NNN | 1 |

Tab. 15-10: Brake resistor type for braking ratio of 10 % for 3P 380 VAC (0K40-55K0)

| Converter model | | Brake resistor | | | | | Brake chopper | |
|---|---|---|---|---|---|---|---|---|
| | | Type | Specification | Number | Max. braking ON time [s] | Max. braking energy [KWs] | Type | Number |
| 3P 380 VAC | 75K0 | FCAR01.1W6K50-N010R0-A-05-NNNN | 10 Ω/ 6,500 W | 1 | 10 | 572 | FEAE07.1-VA1-NNN | 1 |
| | 90K0 | FCAR01.1W10K0-N006R0-A-05-NNNN | 6Ω/ 10,000W | 1 | 10 | 880 | FEAE07.1-VA2-NNN | 1 |
| | 110K | FCAR01.1W10K0-N006R0-A-05-NNNN | 6Ω/ 10,000W | 1 | 10 | 880 | FEAE07.1-VA2-NNN | 1 |
| | 132K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 2 | 10 | 2112 | FEAE07.1-VA1-NNN | 2 |
| | 160K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 2 | 10 | 2112 | FEAE07.1-VA2-NNN | 2 |
| | 185K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 2 | 10 | 2112 | FEAE07.1-VA2-NNN | 2 |
| | 200K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 3 | 10 | 2112 | FEAE07.1-VA2-NNN | 3 |
| | 220K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 3 | 10 | 2112 | FEAE07.1-VA2-NNN | 3 |
| | 250K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 3 | 10 | 2112 | FEAE07.1-VA2-NNN | 3 |
| | 280K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 3 | 10 | 2112 | FEAE07.1-VA2-NNN | 3 |
| | 315K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 4 | - | 2112 | FEAE07.1-VA2-NNN | 4 |
| | 355K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 4 | - | 2112 | FEAE07.1-VA2-NNN | 4 |
| | 400K | FCAR01.1W12K0-N008R0-A-05-NNNN | 8Ω/ 12,000W | 4 | - | 2112 | FEAE07.1-VA2-NNN | 4 |

**Tab. 15-11:** Brake resistor type for braking ratio of 10 % for 3P 380 VAC (75K0-400K)



Models 37K0 and up require an external brake chopper module, see documentation R912007235 for details.

### 15.10.3 Brake Resistor Type for Braking Ratio of 20 %

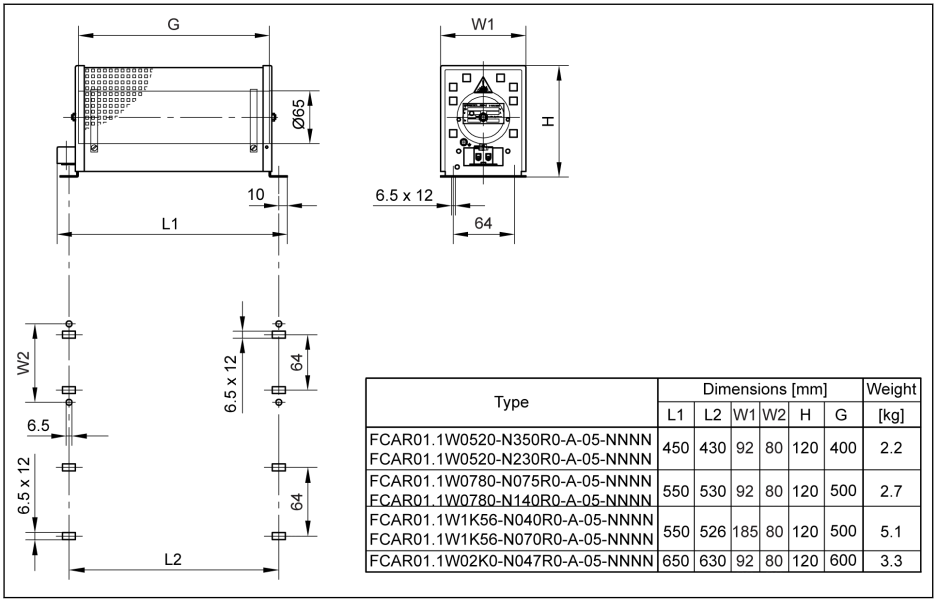
The recommended brake chopper and brake resistor listed below are for default braking voltage, ED = 20 % and braking torque is 100%.

| Converter model | | Brake resistor | | | | |
|---|---|---|---|---|---|---|
| | | Type | Specification | Number | Max. braking ON time [s] | Max. braking energy [KWs] |
| 1P 200 VAC | 0K40 | FCAR01.1W0100-N400R0-B-03-NNNN | 400 Ω / 100 W | 1 | 12 | 8.64 |
| | 0K75 | FCAR01.1W0200-N190R0-B-03-NNNN | 190 Ω / 200 W | 1 | 12 | 17.28 |
| | 1K50 | FCAR01.1W0400-N095R0-B-03-NNNN | 95 Ω / 400 W | 1 | 12 | 34.56 |
| | 2K20 | FCAR01.1W0500-N065R0-B-03-NNNN | 65 Ω / 500 W | 1 | 12 | 43.20 |

| Converter model | | Brake resistor | | | | |
|---|---|---|---|---|---|---|
| | | Type | Specification | Number | Max. braking ON time [s] | Max. braking energy [KWs] |
| 3P 380 VAC | 0K40 | FCAR01.1W0150-N750R0-B-05-NNNN | 750 Ω / 150 W | 1 | 12 | 12.96 |
| | 0K75 | FCAR01.1W0150-N750R0-B-05-NNNN | 750 Ω / 150 W | 1 | 12 | 12.96 |
| | 1K50 | FCAR01.1W0520-N350R0-A-05-NNNN | 350 Ω / 520 W | 1 | 12 | 51.92 |
| | 2K20 | FCAR01.1W0520-N230R0-A-05-NNNN | 230 Ω / 520 W | 1 | 12 | 51.92 |
| | 3K00 | FCAR01.1W0780-N140R0-A-05-NNNN | 140 Ω / 780 W | 1 | 12 | 77.88 |
| | 4K00 | FCAR01.1W0780-N140R0-A-05-NNNN | 140 Ω / 780 W | 1 | 12 | 77.88 |
| | 5K50 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 | 12 | 155.75 |
| | 7K50 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 | 12 | 155.75 |
| | 11K0 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 | 12 | 155.75 |
| | 15K0 | FCAR01.1W02K0-N047R0-A-05-NNNN | 47 Ω / 2,000 W | 1 | 12 | 199.68 |
| | 18K5 | FCAR01.1W03K0-N034R0-A-05-NNNN | 34 Ω / 3,000 W | 1 | 12 | 201.60 |
| | 22K0 | FCAR01.1W10K0-N028R0-A-05-NNNN | 28 Ω / 10,000 W | 1 | 12 | 672.00 |
| | 30K0 | FCAR01.1W10K0-N028R0-A-05-NNNN | 28 Ω / 10,000 W | 1 | 12 | 672.00 |

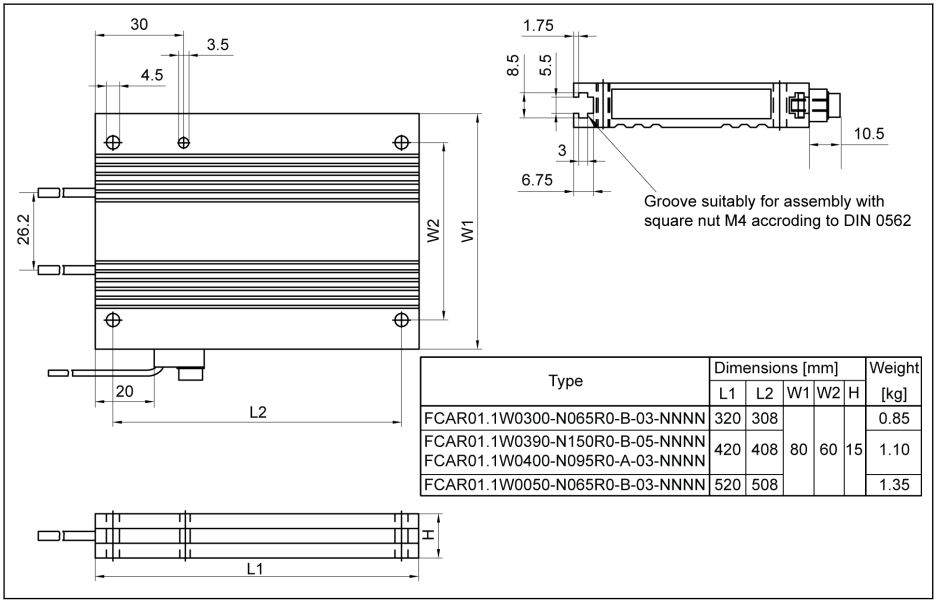
**Tab. 15-12:** Brake resistor type for braking ratio of 20 %

## 15.10.4 Brake Resistor Dimensions



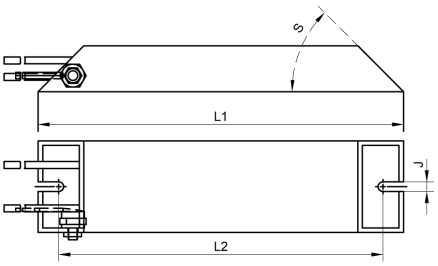

| Type | Dimensions [mm] | | | | | | Weight |
|---|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | G | [kg] |
| FCAR01.1W0520-N350R0-A-05-NNNN<br>FCAR01.1W0520-N230R0-A-05-NNNN | 450 | 430 | 92 | 80 | 120 | 400 | 2.2 |
| FCAR01.1W0780-N075R0-A-05-NNNN<br>FCAR01.1W0780-N140R0-A-05-NNNN | 550 | 530 | 92 | 80 | 120 | 500 | 2.7 |
| FCAR01.1W1K56-N040R0-A-05-NNNN<br>FCAR01.1W1K56-N070R0-A-05-NNNN | 550 | 526 | 185 | 80 | 120 | 500 | 5.1 |
| FCAR01.1W02K0-N047R0-A-05-NNNN | 650 | 630 | 92 | 80 | 120 | 600 | 3.3 |

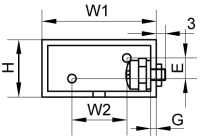
**Fig. 15-34:** Brake resistor dimensions_1




| Type | Dimensions [mm] | | | | | Weight |
|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | [kg] |
| FCAR01.1W0300-N065R0-B-03-NNNN | 320 | 308 | 80 | 60 | 15 | 0.85 |
| FCAR01.1W0390-N150R0-B-05-NNNN<br>FCAR01.1W0400-N095R0-A-03-NNNN | 420 | 408 | | | | 1.10 |
| FCAR01.1W0050-N065R0-B-03-NNNN | 520 | 508 | | | | 1.35 |

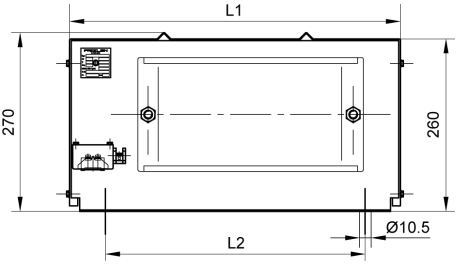
**Fig. 15-35:** Brake resistor dimensions_2

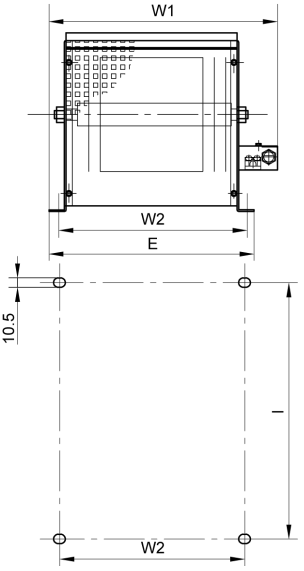



| Type | Dimensions [mm] | | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | E | G | J | S | [g] |
| FCAR01.1W0060-N400R0-B-03-NNNN | 150 | 132 | 40 | 18.2 | 20 | 6.2 | 2 | 4.3 | 45 | 215 |
| FCAR01.1W0080-N750R0-B-05-NNNN<br>FCAR01.1W0100-N190R0-B-03-NNNN<br>FCAR01.1W0100-N400R0-B-03-NNNN | 210 | 192 | | | | | | | | 300 |
| FCAR01.1W0150-N750R0-B-05-NNNN | 300 | 282 | | | | | | | | 430 |
| FCAR01.1W0200-N095R0-B-03-NNNN<br>FCAR01.1W0200-N190R0-B-03-NNNN<br>FCAR01.1W0200-N195R0-B-03-NNNN | 265 | 246 | 60 | 28.8 | 30 | 10.8 | 3 | 5.3 | 60 | 950 |
| FCAR01.1W0260-N400R0-B-05-NNNN<br>FCAR01.1W0260-N250R0-B-05-NNNN | 335 | 316 | | | | | | | | 1,200 |

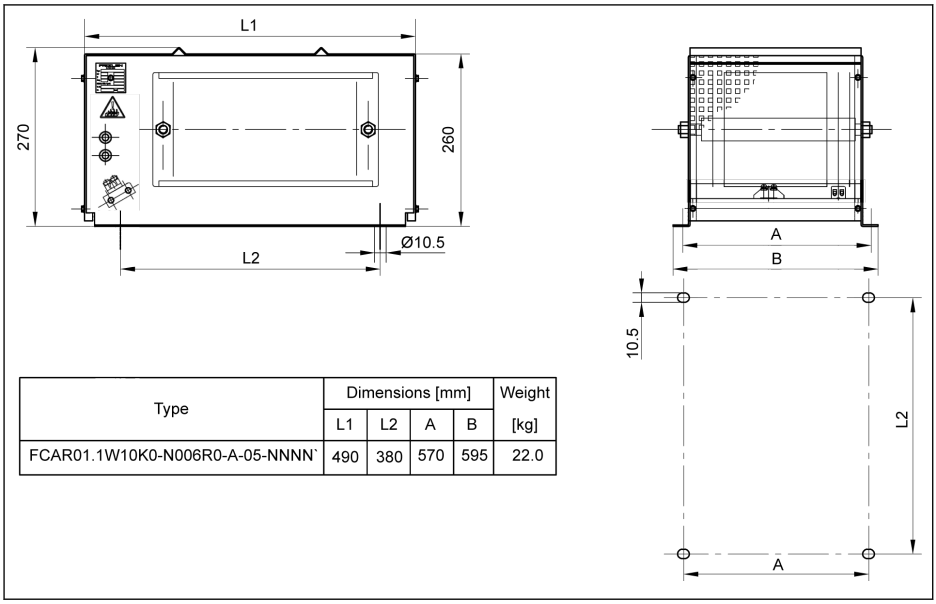
**Fig. 15-36:** Brake resistor dimensions_3




| Type | Dimensions [mm] | | | | | Weight |
|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | E | [kg] |
| FCAR01.1W03K0-N034R0-A-05-NNNN | 490 | 380 | 330 | 270 | 295 | 9.5 |
| FCAR01.1W04K8-N032R0-A-05-NNNN | | | 430 | 370 | 395 | 13.0 |
| FCAR01.1W10K0-N028R0-A-05-NNNN | | | 630 | 570 | 595 | 22.0 |
| FCAR01.1W3K50-N018R9-A-05-NNNN | | | 355 | 270 | 295 | 8.5 |
| FCAR01.1W4K00-N016R0-A-05-NNNN | | | 355 | 270 | 295 | 8.5 |
| FCAR01.1W6K50-N010R0-A-05-NNNN | | | 455 | 370 | 395 | 12.0 |

**Fig. 15-37:** Brake resistor dimensions_4




| Type | Dimensions [mm] | | | | Weight |
|---|---|---|---|---|---|
| | L1 | L2 | A | B | [kg] |
| FCAR01.1W10K0-N006R0-A-05-NNNN` | 490 | 380 | 570 | 595 | 22.0 |

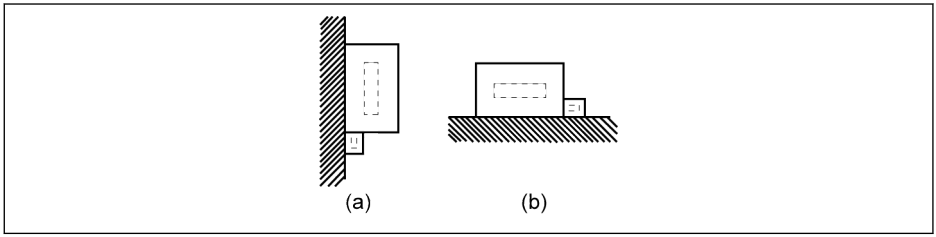
**Fig. 15-38:** Brake resistor dimensions_5

## 15.10.5 Installation of Brake Resistor

The given typical power values are valid for 100% duty cycle factor (DCF) (continuous dissipation) under the following conditions:

- Temperature rise of 200 K at the surface of fixed resistor enclosures (degree of protection > IP00)
- Temperature rise of 300 K at the surface of fixed resistor elements (degree of protection IP00)
- Unhindered access of cooling air
- Unhindered diverting of warmed up air (mind a minimum separation distance of approx. 200 mm to neighbouring components / walls and of approx. 300 mm to components above / ceiling)

The allowable mounting directions are shown as below:




**(a) On vertical surfaces, terminals at the bottom**
**(b) On horizontal surfaces**

**Fig. 15-39:** Mounting direction of brake resistor

## 15.11 Shielding Connector

The shielding layer of shielded cables must be reliably connected to the shielding terminals of the frequency converter. Accessories (connector and screws) for shielded cable connection are available for the connection convenience.

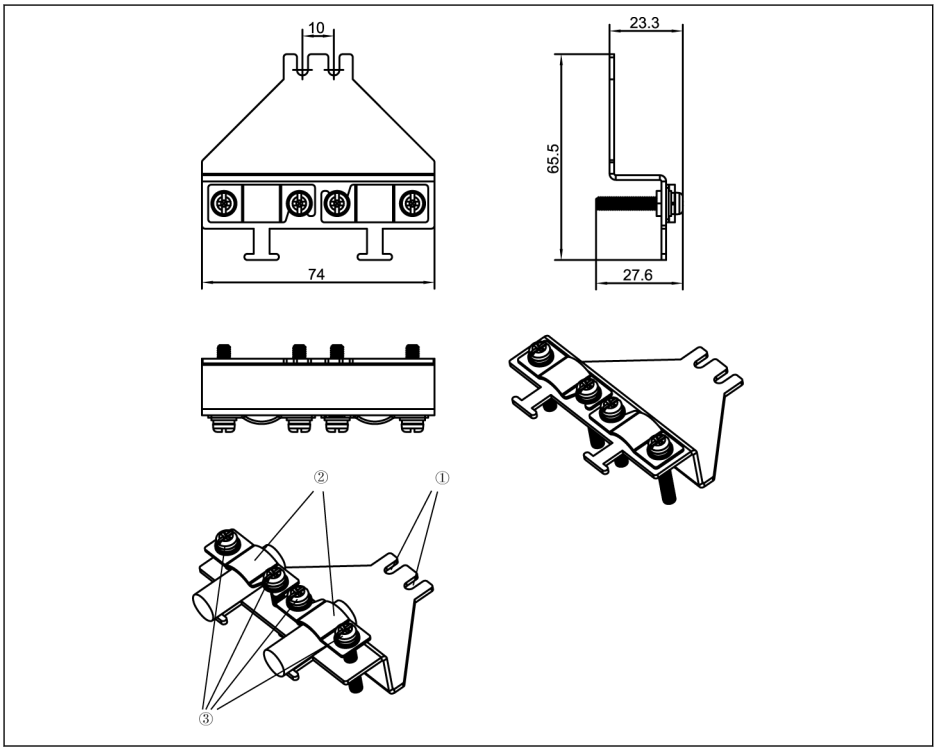



**Fig. 15-40:** Shielded cable connection with accessories for 0K40...4K00 (FEAM03.2-001-NNNNNN)

### Connection steps

Step 1: Place holes ① of the connector on the two screw holes inside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

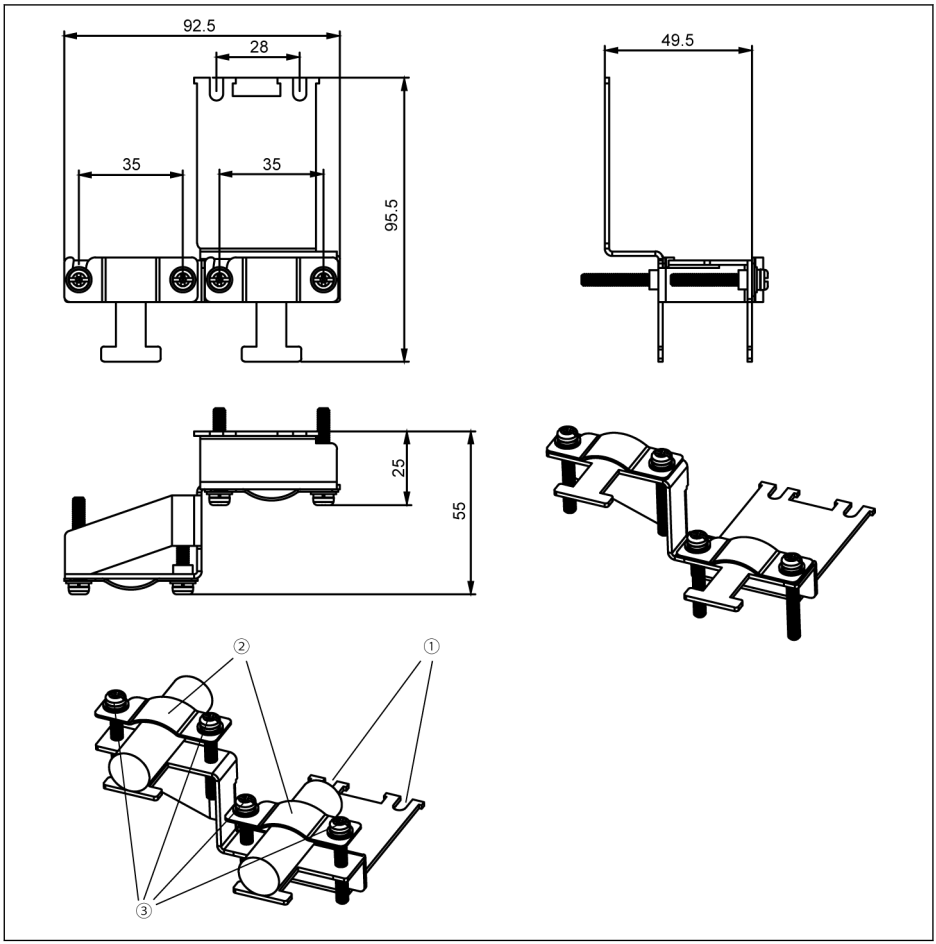



**Fig. 15-41:** Shielded cable connection with accessories for 5K50...30K0 (FEAM03.2-002-NNNNN)

### Connection steps

Step 1: Place holes ① of the connector on the two screw holes inside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

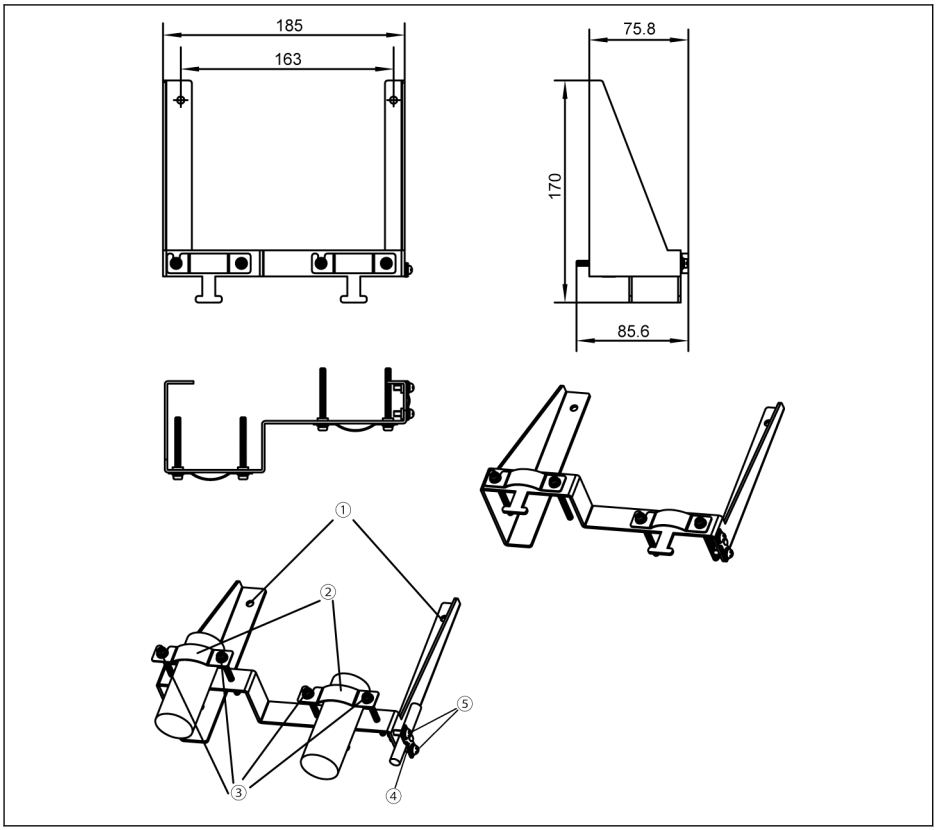



**Fig. 15-42:** Shielded cable connection with accessories for 37K0...45K0 (FEAM03.2-003-NNNNN)

### Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

Step 4 (Optional): Insert the STO shielded cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

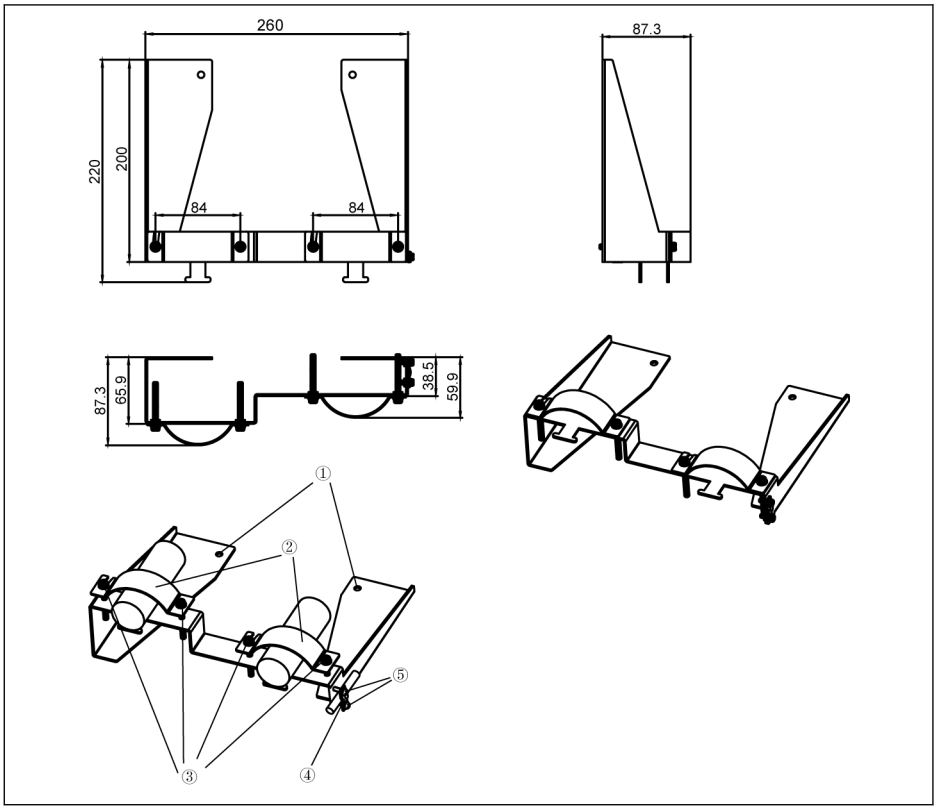



**Fig. 15-43:** Shielded cable connection with accessories for 55K0...110K (FEAM03.2-004-NN-NNNN)

### Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten four screws of the accessories.

Step 4 (Optional): Insert the STO shielded cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

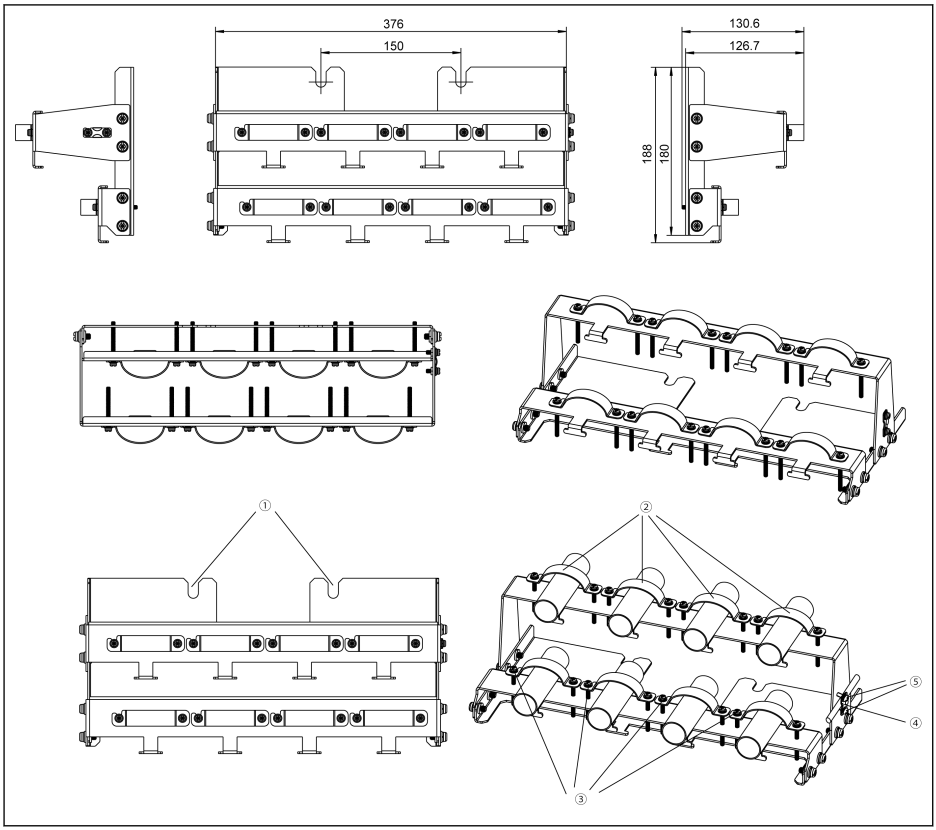



**Fig. 15-44:** Shielded cable connection with accessories for 132K...160K (FEAM03.2-005-NNNNNN)

### Connection steps

Step 1: Place holes ① of the connector on the two screw holes outside of symbols ⏚ and tighten two screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

☞ When double cables are used, put double cables in one clamp.

Step 3: Tighten sixteen screws of the accessories.

Step 4 (Optional): Insert the STO shielded cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

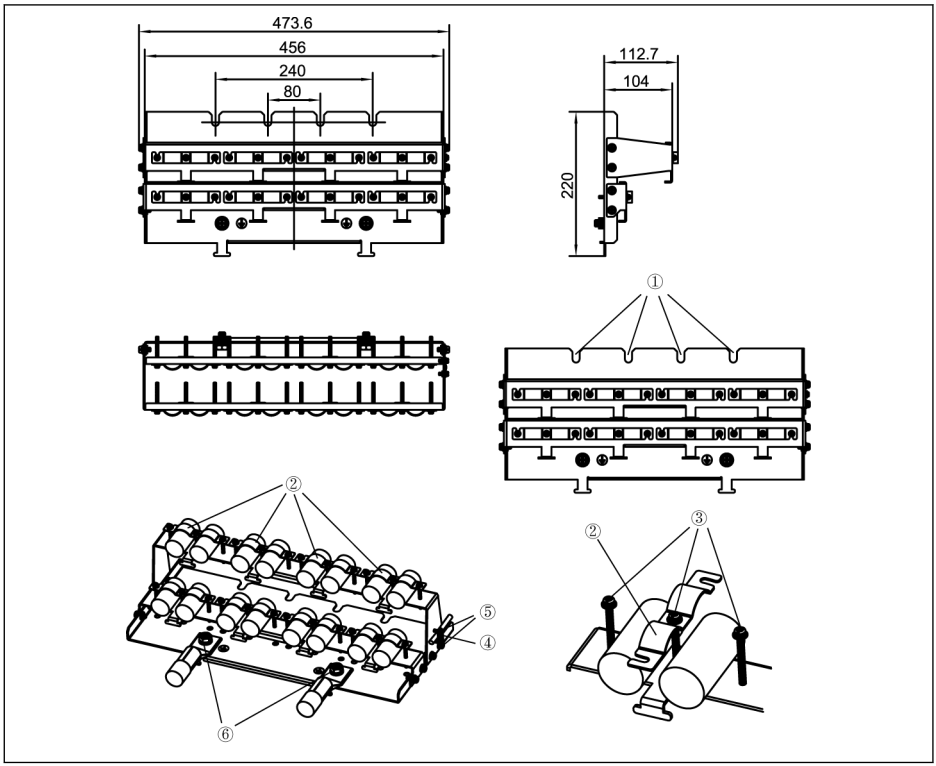



**Fig. 15-45:** Shielded cable connection with accessories for 185K...200K (FEAM03.2-006-NN-NNNN)

## Connection steps

Step 1: Place holes ① of the connector on the four screw holes at the bottom of frequency converter and tighten four screws.

Step 2: Insert the shielded cables through component ② of the connector with the shielding layer reliable contact with the metal.

Step 3: Tighten twenty-four screws of the accessories.

Step 4 (Optional): Insert the STO shielded cable through component ④ of the connector with the shielding layer reliable contact with the metal.

Step 5 (Optional): Tighten two screws of the accessories.

Step 6: Connect the grounding cable to component ⑥.

# 16 Maintenance

## 16.1 Safety Instructions

**⚠ WARNING** **High electric voltage! Risk of death or severe bodily injury by electric shock!**

- Only those trained and qualified to work with or on electric equipment are permitted to operate, maintain and repair this equipment.
- Do not operate electric equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electric parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage. Ensure that the mains voltage is not reconnected.
- In the frequency converters, capacitors are used in the DC-bus as energy stores. Energy stores maintain their energy even when the supply voltage has been cut off. Frequency converters have been dimensioned in such a way that after the supply voltage was cut off, the voltage value falls below 50 V within a discharging time of a maximum of 10 minutes.

## 16.2 Daily Inspection

Please conduct daily inspection as indicated in the table below in order to prolong the life cycle of frequency converters.

| Inspection category | Inspection item | Inspection criteria | Inspection result |
|---|---|---|---|
| Ambient conditions | Temperature | -10...55 ℃ (no frost or condensation) | |
| | Relative humidity | ≤ 90 % (no condensation) | |
| | Dust, water and leakage | No heavy dust or sign of leakage (visual inspection) | |
| | Gas | No harmful, flammable gas or strange smell | |
| | Sound | No strange sound | |
| | Panel display | No error code | |
| | Others | No direct sunlight, no oil or corrosive substances around | |
| Converter | Status | Running stably, the outlet temperature is normal | |
| | Fan | No blockage or contamination | |
| | Terminal, screw | Wiring is correct, screw fastening without loosening | |
| Motor | Sound, vibration | No strange sound, no abnormal vibration | |
| | Temperature, color | No abnormal temperature and discoloration | |

**Tab. 16-1:** Daily inspection list

## 16.3 Periodic Inspection

In addition to daily inspection, periodic inspection of frequency converters is also necessary. The inspection cycle should be less than 6 months. For operation details, please see table below:

| Inspection category | Inspection item | Inspection criteria | Solution |
|---|---|---|---|
| Power supply | Voltage | Specified in nameplate | 1P: 200...240 VAC (-10 % / +10 %) 3P: 380...480 VAC (-15 % / +10 %) |
| Power cable | Power cable | No color change or damage | Replace cable |
| Signal line | Signal line | | Replace signal line |
| Terminal connection | Crimp terminal and cable / line | No loose connection | Tighten crimp and terminal screw |
| | Crimp terminal and terminal block | | |
| Frequency converter | Visual appearance | No deformation | Contact with service |
| | Fan | No color change or deformation | Replace fan |
| | | No blockage or contamination | Eliminate blockage and clean fan |
| | Cooling system (radiator, inlet, outlet) | No blockage or foreign matters | Eliminate blockage and clear foreign matters |
| | Printed circuit board | No dust or oil contamination No discoloration or deformation | Clean printed circuit board |
| | Electrolytic capacitor | No leakage, color change, crack or expansion with safety valve shut down | Replace capacitor (must be operated by service engineers) |
| | IGBT module | no dust, cotton or oil around the module Module without discoloration, bulge or crack | Clear foreign matters or replace module |
| Accessories | Connection | No loose connection | Tighten terminal screw |
| | Cable | No color change or damage | Replace cable |

**Tab. 16-2:** Periodic inspection list

## 16.4 Expired replacement

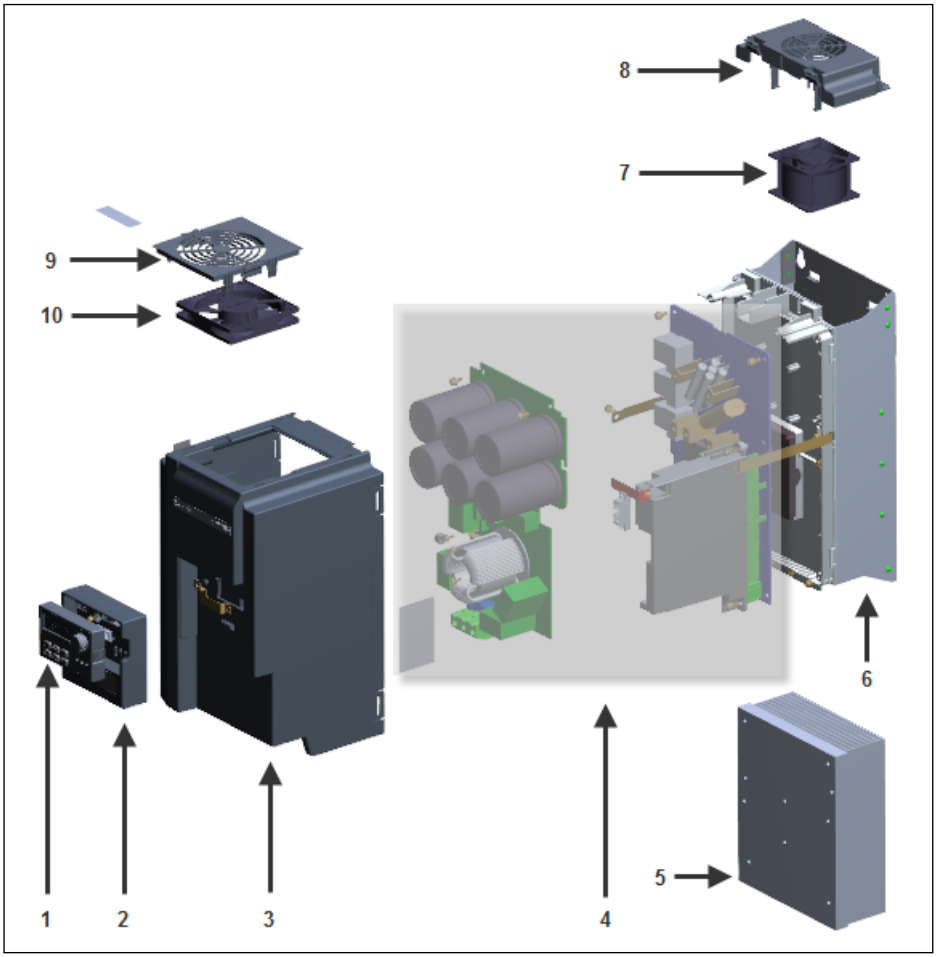
All electronic devices or equipment has certain service life, extended use will cause damage or change properties of devices, and even cause personal injury and property damage. Therefore, it is necessary to replace the device in time.

| Item | Replacement criteria |
|---|---|
| Fan | Replace the cooling fan that running time exceed thirty thousand hours |

**Tab. 16-3:** Device replacement

## 16.5 Removable Components Maintenance

### 16.5.1 Construction Overview




1 Operating panel
2 I/O interface adapter
3 Housing / Frame
4 Internal components
5 Heat sink / Radiator
6 Heat sink mounting plate
7 Back fan / Fan for heat sink
8 Back fan cover
9 Front fan cover
10 Front fan / Fan for internal components

**Fig. 16-1:** Construction overview

## 16.5.2 Disassembly of the Operating Panel

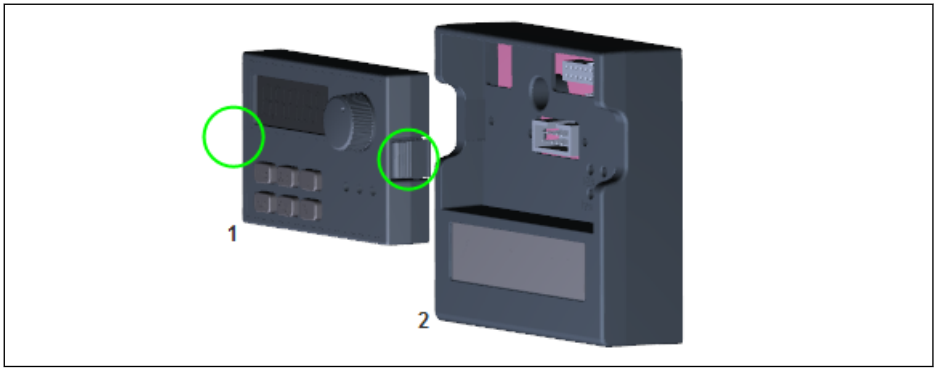



**Fig. 16-2:** Disassembly of operating panel

- Step 1: Press two buckles as circles indicating in the above figure
- Step 2: Hold component 1 and pull it out horizontally from component 2

### 16.5.3 Disassembly of Fans

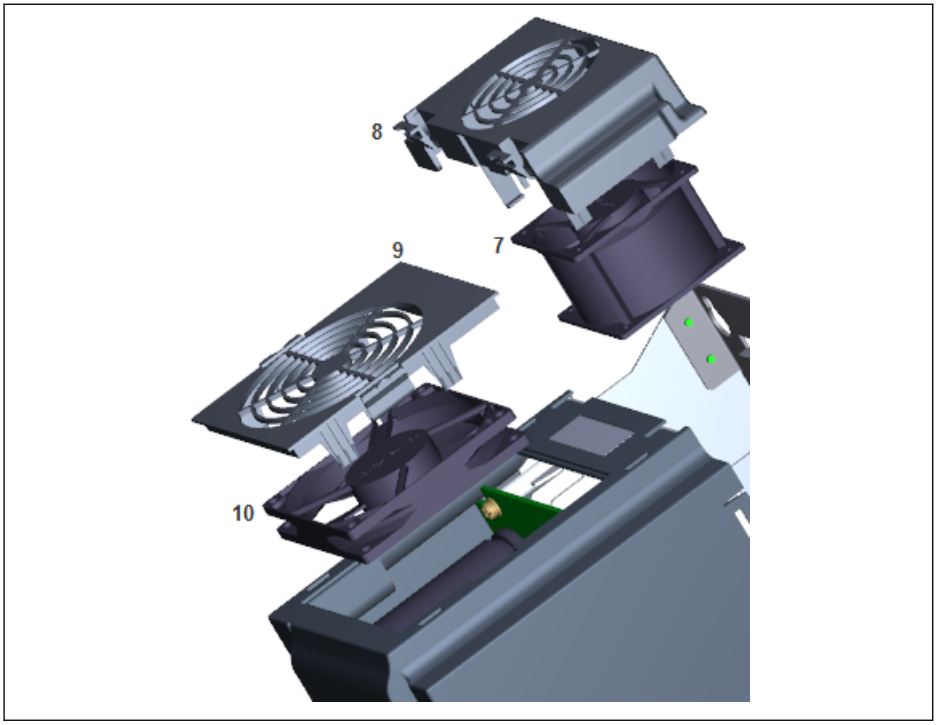



**Fig. 16-3:** Disassembly of fan

- Step 1: Press the buckle(s) on component 8 or 9 in the above figure
- Step 2: Hold component 8 or 9 and lift it up
- Step 3: Pull out component 7 or 10 slowly
- Step 4: Disconnect the cable connector of component 7 or 10

# 17 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

### Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

| | |
|---|---|
| Phone: | **+49 9352 40 5060** |
| Fax: | **+49 9352 18 4941** |
| E-mail: | service.svc@boschrexroth.de |
| Internet: | http://www.boschrexroth.com |

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

### Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

### Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

# 18 Environmental protection and disposal

## 18.1 Environmental protection

### Production processes

The products are manufactured in energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

### No release of hazardous substances

Our products do not contain any hazardous substances which may be released in case of appropriate use. Normally, our products will not have any negative influences on the environment.

### Significant components

Significant components of our products are:

**Electronic devices**
- Steel
- Aluminum
- Copper
- Plastics
- Electronic components

**Motors**
- Steel / Stainless steel
- Aluminum
- Copper
- Brass
- Magnetic materials
- Elektronic components

## 18.2 Disposal

### Return of products

Our products can be returned to us for disposal free of charge. However, this requires that the products be free from oil, grease or other dirt.

Furthermore, the products returned for disposal may not contain any undue foreign material or foreign components.

Deliver the products "free domicile" to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Straße 2
97816 Lohr am Main, Germany

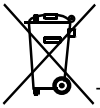
### Packaging

Packaging materials consist of cardboard, wood and polystyrene They can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

### Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.

 The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

End users in the EU are legally bound to return used batteries and accumulators. Outside the validity of the EU Directive 2006/66/EC, the particularly applicable regulations must be followed.

Batteries and accumulators can contain hazardous substances which can harm the environment or people's health when improperly stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products must be properly disposed of according to the country-specific collection systems.

### Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual assemblies.

Metals contained in electric and electronic assemblies can also be recycled by means of special separation processes.

Plastic parts of the products may contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the applicable legal provisions.

# 19 Appendix

## 19.1 Appendix I: Abbreviations

- VFC x615: Frequency Converter VFC 3615 or VFC 5615
- FPCC: Operating panel
- FEAM: Panel mounting plate
- FRKS: Communication cable for control cabinet
- FEAE: Accessories, electric
  - Extension card module
  - I/O module
  - Communication module
  - Plug-in connector for control section
  - Brake chopper module
- FCAF: External mains EMC filter
- FCAR: External brake resistor

- FEAM: Shielding connector

# 19.2 Appendix II: Type Coding

## 19.2.1 Frequency Converter Type Coding

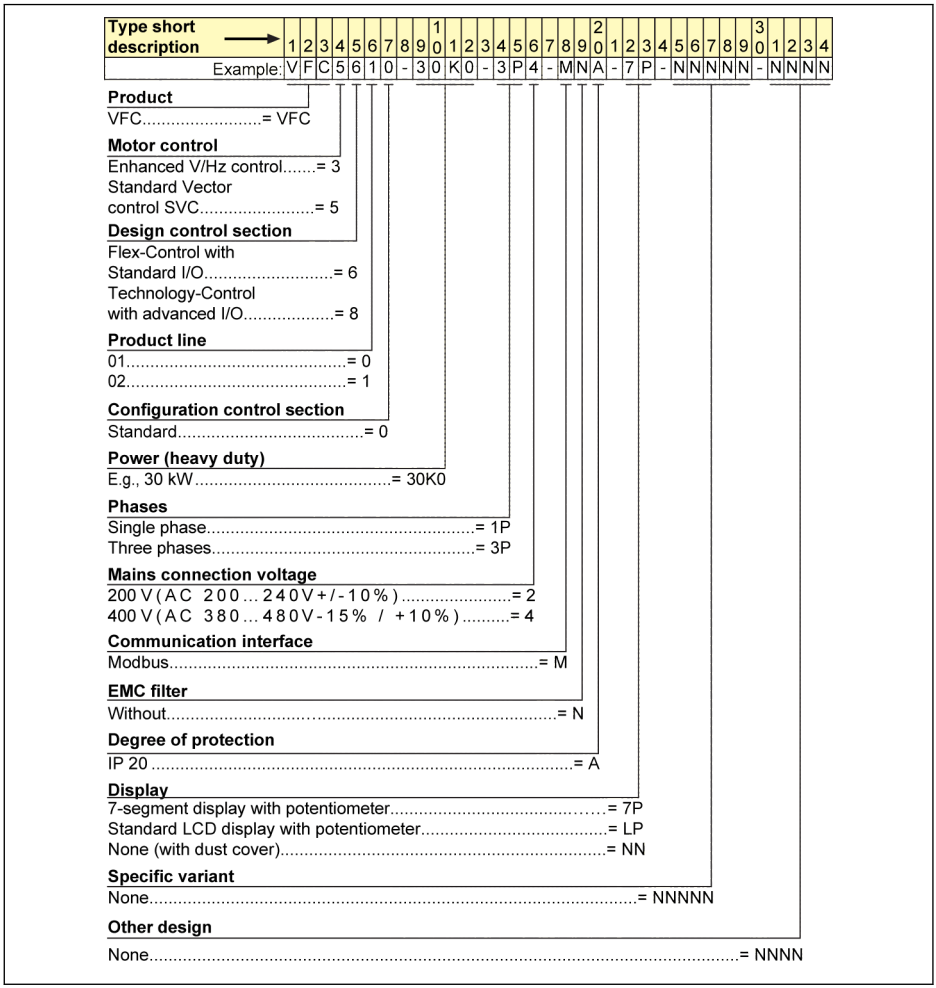



**Fig. 19-1:** Frequency converter type coding

## 19.2.2 Operating Panel Type Coding

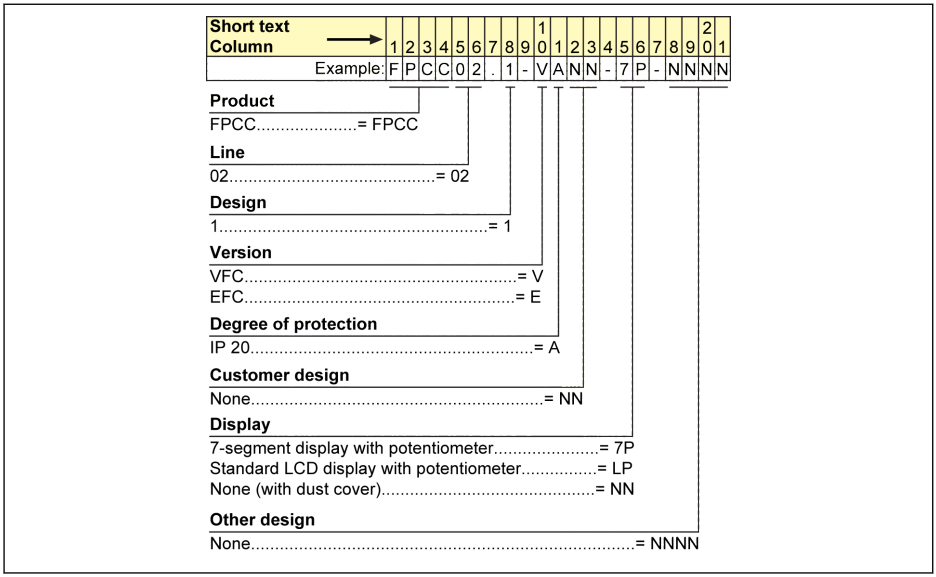



**Fig. 19-2:** Operating panel type coding

## 19.2.3 Panel Mounting Plate Type Coding

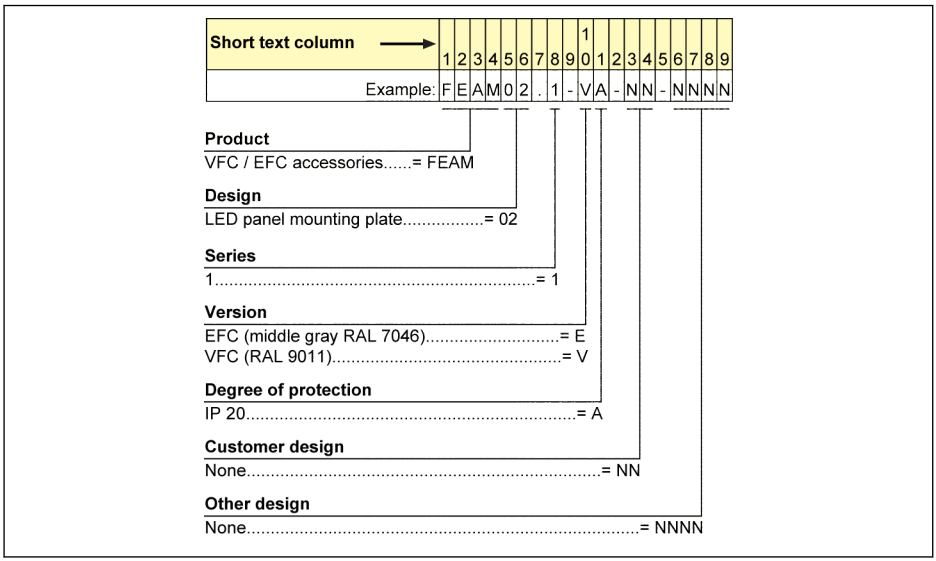



**Fig. 19-3:** Panel mounting plate type coding

## 19.2.4 Communication Cable for Control Cabinet Type Coding

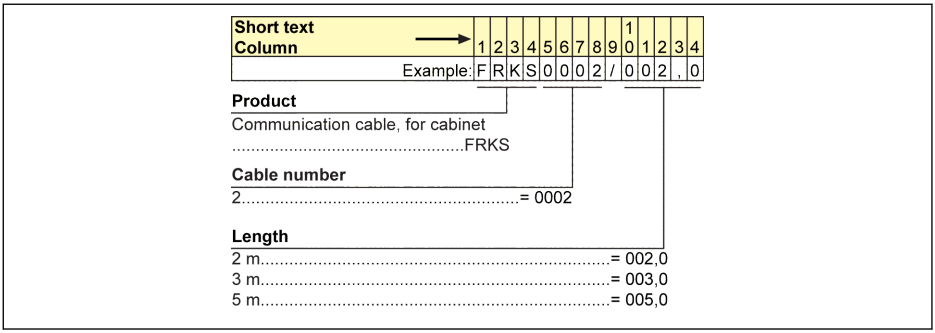
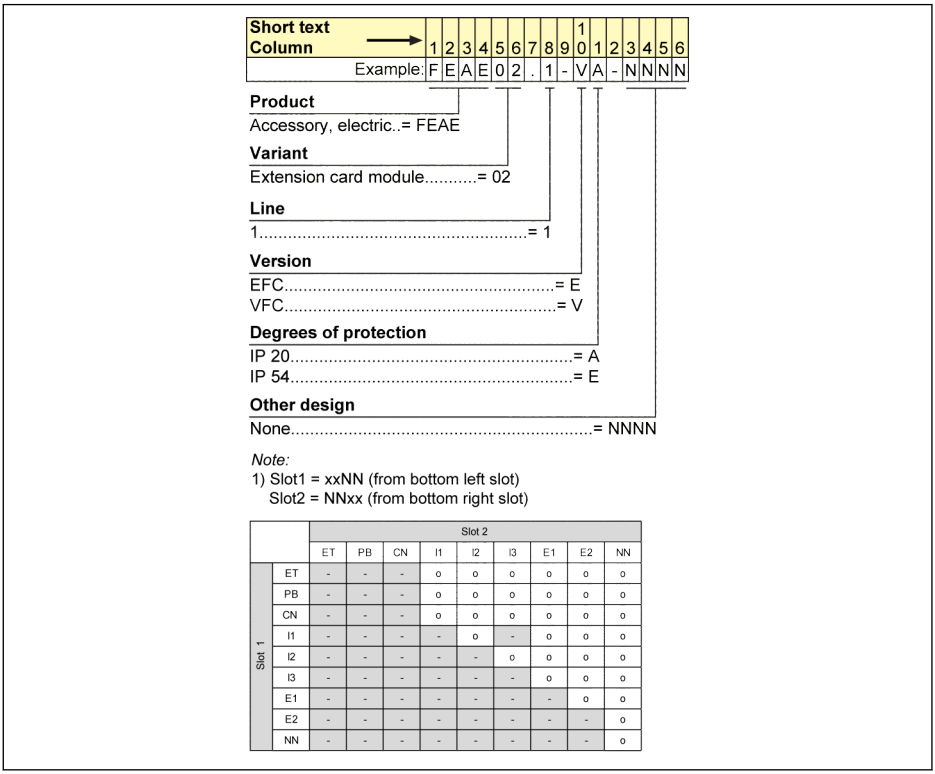



**Fig. 19-4:** Communication cable for control cabinet type coding

## 19.2.5 Extension Accessories Type Coding




| | | Slot 2 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ET | PB | CN | I1 | I2 | I3 | E1 | E2 | NN |
| Slot 1 | ET | - | - | - | o | o | o | o | o | o |
| | PB | - | - | - | o | o | o | o | o | o |
| | CN | - | - | - | o | o | o | o | o | o |
| | I1 | - | - | - | - | o | - | o | o | o |
| | I2 | - | - | - | - | - | o | o | o | o |
| | I3 | - | - | - | - | - | - | o | o | o |
| | E1 | - | - | - | - | - | - | - | o | o |
| | E2 | - | - | - | - | - | - | - | - | o |
| | NN | - | - | - | - | - | - | - | - | o |

**Fig. 19-5:** Extension card module type coding

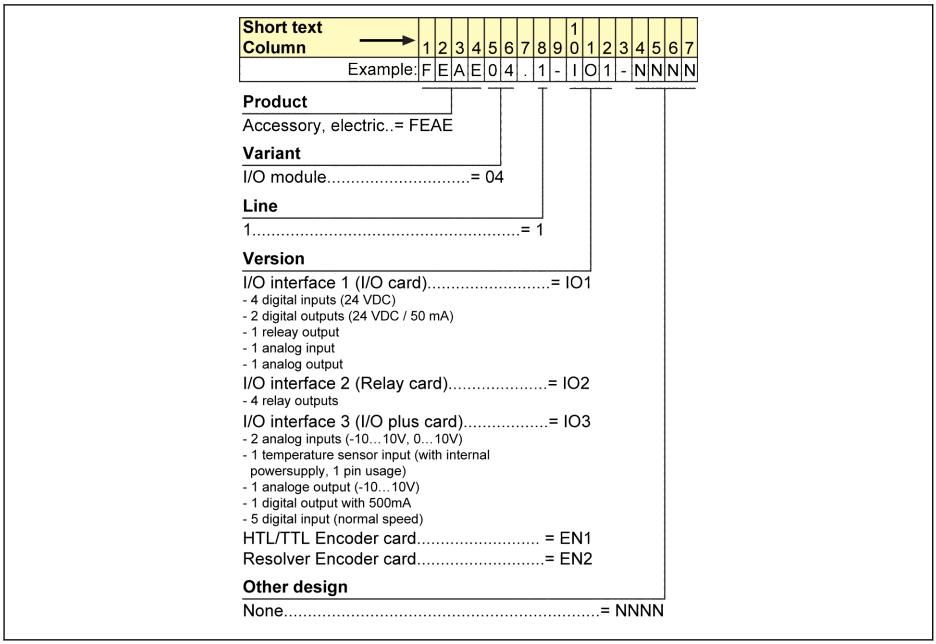



**Fig. 19-6:** I/O module type coding

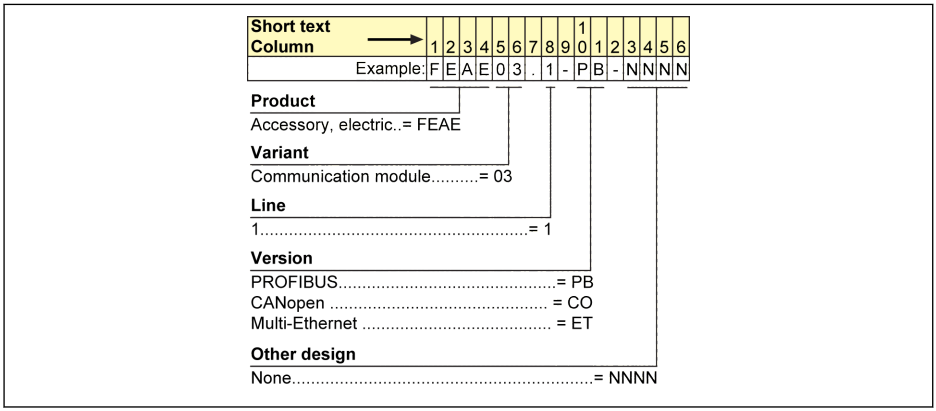



**Fig. 19-7:** Communication module type coding

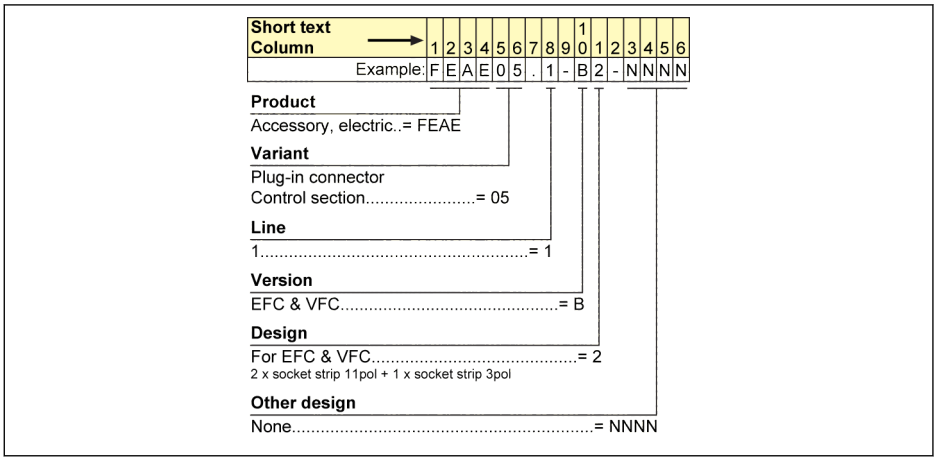



**Fig. 19-8:** Plug-in connector for control section type coding

## 19.2.6 External EMC Filter Type Coding

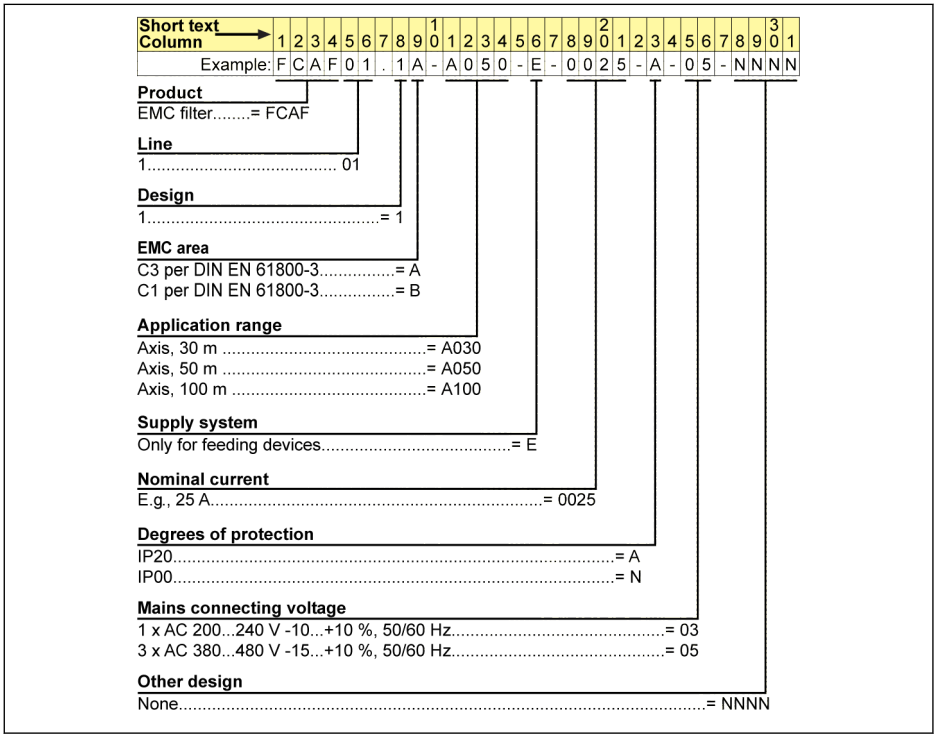



**Fig. 19-9:** External EMC filter type coding

## 19.2.7 External Brake Resistor Type Coding

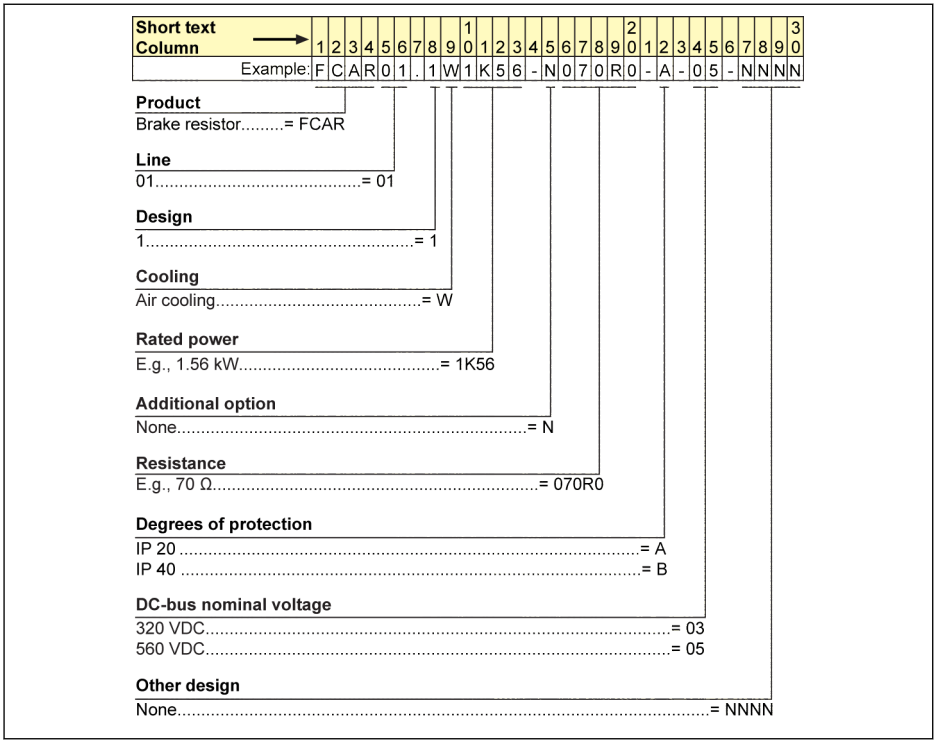



**Fig. 19-10:** External brake resistor type coding

## 19.2.8 Shielding Connector Type Coding

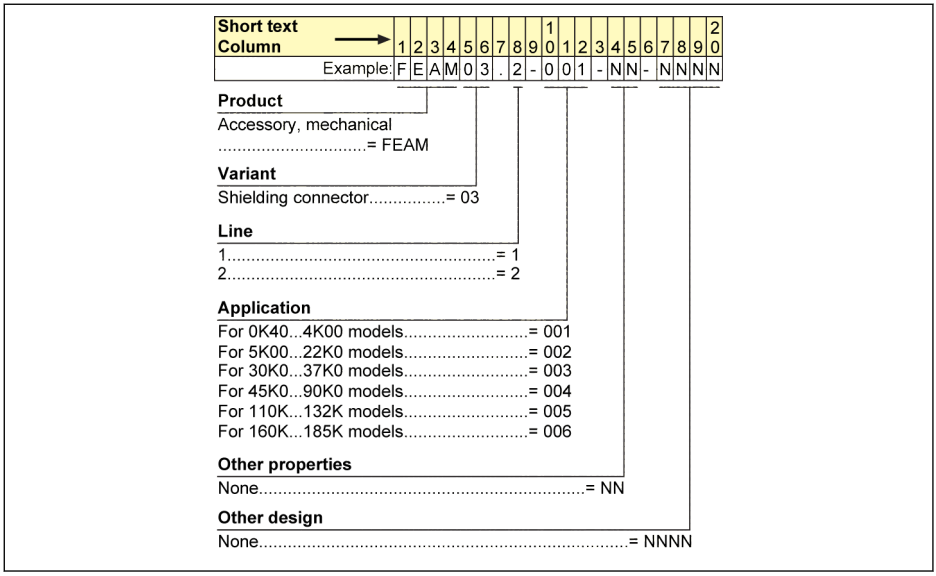



**Fig. 19-11:** Shielding connector type coding

## 19.3 Appendix III: Parameter List

### 19.3.1 Terminology and Abbreviation in Parameter List

- **Code:** Function / parameter code, written in bx.xx, Cx.xx, Ex.xx, Hx.xx, Ux.xx, dx.xx
- **Name:** Parameter name
- **Default:** Factory default
- **Min.:** Minimum setting step
- **Attri.:** Parameter attribute
  - **Run:** Parameter setting can be modified when the converter is in run or stop status.
  - **Stop:** Parameter setting can only be modified when the converter is in stop status.
  - **Read:** Parameter setting is read-only and cannot be modified.
- **DOM:** Depends on model
- **[bx.xx], [Cx.xx], [Ex.xx], [Hx.xx], [Ux.xx], [dx.xx]:** Function / parameter values

## 19.3.2 Group b: System Parameters

### b0: Basic system parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| b0.00 | Access authority setting | 0: Basic parameters<br>1: Standard parameters<br>2: Advanced parameters<br>3: Start-up parameters<br>4: Modified parameters | 0 | – | Run |
| b0.09 | Parameter initialization setting | 1: Base device and non fieldbus options<br>2: Fieldbus options<br>3: Base device, non fieldbus and fieldbus options | 1 | – | Stop |
| b0.10 | Parameter initialization | 0: Inactive<br>1: Restore to default settings<br>2: Clear error and warning record | 0 | – | Stop |
| b0.11 | Parameter copy | 0: Inactive<br>1: Backup parameters to panel<br>2: Restore parameters from panel | 0 | – | Stop |
| b0.12 | Parameter set selection | 0: Parameter set 1 active<br>1: Parameter set 2 active | 0 | – | Stop |
| b0.20 | User password | 0...65,535 | 0 | 1 | Run |
| b0.21 | Manufacturer password | 0...65,535 | 0 | 1 | Run |
| b0.22 | Device frequency mode① | 0: Low frequency mode<br>1: High frequency mode | 1 | – | Stop |



①: This parameter applies only to 2 KHz model.

## 19.3.3 Group C: Power Parameters

### C0: Power control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.00 | Control mode<br>(VFC 5615 only) | 0: V/f control<br>1: Sensorless vector control<br>1: Sensor vector control (VFC 5615 only) | 0 | – | Stop |
| C0.01 | Normal / Heavy duty setting① | 0: ND (Normal duty)<br>1: HD (Heavy duty) | 1 | – | Stop |
| C0.05 | Carrier frequency | 0K40...30K0 : 1...15 kHz<br>37K0...110K : 1...12 kHz<br>132K...400K: 1...6kHz | 0K40..110K : 4k<br>132K...400K : 2k | 1 | Run |
| C0.06 | Carrier frequency automatic adjustment | 0: Inactive<br>1: Active<br>2: Fixed carrier frequency | 1 | – | Stop |
| C0.07 | PWM mode | 0: SVPWM<br>1: SVPWM with overmodulation<br>2: DPWM<br>3: DPWM with overmodulation | DOM | – | Run |
| C0.08 | DPWM switchover frequency upper limit | 8.00...400.00 Hz | 12.00 | 0.01 | Run |
| C0.10 | Automatic voltage stabilization | 0: Always active<br>1: Always inactive<br>2: Inactive only during deceleration | 0 | 1 | Stop |
| C0.11 | Automatic voltage stabilization reference voltage | 1P 200 VAC: 180...264 V | 220 | 1 | Stop |
| | | 3P 380 VAC: 323...528 V | 380 | | |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.15 | Brake chopper start voltage② | 1P 200 VAC: 300...390 V | 385 | 1 | Stop |
| | | 3P 380 VAC: 600...785 V | 770 | | |
| C0.16 | Brake chopper duty cycle② | 1...100 % | 100 | 1 | Stop |
| C0.23 | Overvoltage suppression adjustment gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| C0.24 | Stall overvoltage hysteresis voltage | 0...100 V | 1P 200 VAC: 30 | 1 | Stop |
| | | | 3P 380 VAC: 50 | | |
| C0.25 | Overvoltage prevention mode | 0...4 | 3 | – | Stop |
| C0.26 | Stall overvoltage prevention level | 1P 200 VAC: 300...390 V | 385 | 1 | Stop |
| | | 3P 380 VAC: 600...785 V | 770 | | |
| C0.27 | Stall overcurrent prevention level③ | 20.0 %...[C2.42] | 150.0 | 0.1 | Stop |
| C0.28 | Phase loss protection mode | 0...3 | 3 | – | Run |
| C0.29 | Converter overload pre-warning level | 20.0...200.0 % | 110.0 | 0.1 | Stop |
| C0.30 | Converter overload pre-warning delay | 0.0...20.0 s | 2.0 | 0.1 | Stop |
| C0.40 | Power loss ride-through mode | 0: Inactive<br>1: Output disabled<br>2: Regain kinetic energy<br>3: Regain kinetic energy, decelerate to stop<br>4: Regain kinetic energy, decelerate no stop | 0 | – | Stop |
| C0.41 | Power loss ride-through recovery delay | 0.10...30.00 s | 0.50 | 0.01 | Stop |
| C0.42 | Power loss ride-through action voltage | 1P 200 VAC: 216...366 V | 240 | 1 | Stop |
| | | 3P 380 VAC: 406...739 V | 440 | | |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.43 | Power loss ride-through recovery voltage | 1P 200 VAC: 223...373 V | 250 | 1 | Stop |
| | | 3P 380 VAC: 413...746 V | 450 | | |
| C0.44 | Power loss ride-through deceleration to stop time | 0.1...6,000.0 s | 5.0 | 0.1 | Stop |
| C0.45 | Power loss ride-through control voltage | 1P 200VAC: 226...373 V | 250 | 1 | Stop |
| | | 3P 400VAC: 416...746 V | 450 | | |
| C0.46 | Power loss ride-through Limit voltage | 1P 200VAC: 233...373 V | 280 | 1 | Stop |
| | | 3P 400VAC: 423...746 V | 500 | | |
| C0.47 | Power loss ride-through switch frequency | 0.00...400.00 Hz | 5.00 | 0.01 | Stop |
| C0.48 | Power loss ride-through frequency deceleration rate | 0...100 Hz/s | 10 | 1 | Stop |
| C0.50 | Fan control | 0: Automatically controlled<br>1: Always on<br>2: On when converter run | 0 | – | Run |
| C0.51 | Fan total running time | 0...65,535 h | 0 | 1 | Read |
| C0.52 | Fan maintenance time | 0...65,535 h<br>(0: Inactive) | 0 | 1 | Stop |
| C0.53 | Fan total running time reset | 0: Inactive<br>1: Active<br>Reset to '0' after action is executed | 0 | – | Run |

①: this parameter is only available with 3P 380 VAC models of 5K50 and above.

②: the parameters are only available with models of 30K0 and below.

③: percentage of frequency converter rated current.

**Setting range of C0.25:**

0: Both disabled

1: Stall overvoltage protection enabled, resistor braking disabled

2: Stall overvoltage protection disabled, resistor braking enabled
3: Stall overvoltage protection enabled, resistor braking enabled
4: Reciprocating load mode

**Setting range of C0.28:**

0: Both input and output phase loss protection active
1: Only input phase loss protection active
2: Only output phase loss protection active
3: Both input and output phase loss protection inactive

## C1: Motor and system parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.00 | Motor type | 0: Asynchronous motor<br>1: Synchronous motor (only for VFC5615) | 0 | – | Stop |
| C1.01 | Motor parameter tuning | 0: Inactive<br>1: Static auto-tuning<br>2: Rotational auto-tuning① | 0 | – | Stop |
| C1.02 | Expert mode | 0: Standard mode<br>1: Expert mode | 0 | – | Stop |
| C1.03 | Synchronous machine type | 0 : SPM<br>1 : IPM | 0 | – | Stop |
| C1.05 | Motor rated power | 0.1...1,000.0 kW | DOM | 0.1 | Stop |
| C1.06 | Motor rated voltage | 0...480 V | DOM | 1 | Stop |
| C1.07 | Motor rated current | 0.01...655.00 A<br>(0.4...45 kW) | DOM | 0.01 | Stop |
| | | 0.1...6550.0 A<br>(55 kW and above) | | 0.1 | |
| C1.08 | Motor rated frequency | 5.00...400.00 Hz | 50.00 | 0.01 | Stop |
| C1.09 | Motor rated speed | 1...60,000 rpm | DOM | 1 | Stop |
| C1.10 | Motor rated power factor | 0.00...0.99② | 0.00 | 0.01 | Stop |
| C1.11 | Motor poles① | 2...256 | 4 | 1 | Stop |
| C1.12 | Motor rated slip frequency | 0.00...60.00 Hz | DOM | 0.01 | Stop |
| C1.13 | Motor inertia mantissa① | 1...5,000 | DOM | 1 | Stop |
| C1.14 | Motor inertia exponent① | 0...7 | DOM | 1 | Stop |
| C1.15 | Torque constant | 0.01...200.00 mH | DOM | 0.01 | Stop |
| C1.16 | Back emf voltage constant | 0.0...6550.0 V/1000 $min^{-1}$ | 0.0 | 0.1 | Read |
| C1.17 | Motor rated torque | 0.0...6553.5 N.m | DOM | 0.1 | Read |
| C1.20 | Motor no-load current | 0.00...[C1.07] A<br>(0.4...45 kW) | DOM | 0.01 | Stop |
| | | 0.0...[C1.07] A<br>(55 kW and above) | | 0.1 | |
| C1.21 | Stator resistance | 0.00...50.00 Ω<br>(0.4...45 kW) | DOM | 0.01 | Stop |
| | | 0.000...50.000 Ω<br>(55 kW and above) | | 0.001 | |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.22 | Rotor resistance | 0.00...50.00 Ω (0.4...45 kW) | DOM | 0.01 | Stop |
| | | 0.000...50.000 Ω (90 kW and above) | | 0.001 | |
| C1.23 | Leakage inductance | 0.00...600.00 mH | DOM | 0.01 | Stop |
| C1.24 | Mutual inductance | 0.0...6,000.0 mH | DOM | 0.1 | Stop |
| C1.25 | Rotor leakage inductance | 0.00...600.00 | DOM | 0.01 | Stop |
| C1.26 | d Axial inductance | 0.00...600.00 | 机型 | 0.01 | Stop |
| C1.27 | q Axial inductance | 0.00...600.00 | 机型 | 0.01 | Stop |
| C1.69 | Motor thermal model protection setting | 0: Inactive<br>1: Reserve<br>2: Current monitoring active | 0 | – | Stop |
| C1.70 | Motor overload pre-warning level | 100.0...250.0 % | 100.0 | 0.1 | Run |
| C1.71 | Motor overload pre-warning delay | 0.0...20.0 s | 2.0 | 0.1 | Run |
| C1.72 | Motor thermal sensor type | 0: KTY84/130;1 : PTC/ SNM-150; 2: PT100<br>3: PT1000; 4: TDK G1551_8320 (NTC) | 0 | – | Stop |
| C1.73 | Motor thermal sensor protection level | 0.0...10.0 V | 2.0 | 0.1 | Stop |
| C1.74 | Motor thermal model protection time constant | 0.0...400.0 min | DOM | 0.1 | Stop |
| C1.75 | Low speed derating frequency | 0.10...300.00 Hz | 25.00 | 0.01 | Run |
| C1.76 | Zero speed load | 25.0...100.0 % | 25.0 | 0.1 | Run |
| C1.77 | Motor Temperature Sensor Matching Resistor | 1...6000Ω | 150 | 1 | Stop |
| C1.78 | Motor temperature protection threshold | 50...170℃ | 150 | 1 | Run |

☞ ①: **ONLY** for VFC5615 , and motor load must be decoupled before rotational auto-tuning.

②: 0.00: Automatically identified; 0.01...0.99: Power factor setting.

## C2: V/f control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.00 | V/f curve mode | 0: Linear<br>1: Square<br>2: User-defined<br>3: V/f separation | 0 | – | Stop |
| C2.01 | V/f frequency 1 | 0.00...[C2.03] Hz | 0.00 | 0.01 | Stop |
| C2.02 | V/f voltage 1① | 0.0...120.0 % | 0.0 | 0.1 | Stop |
| C2.03 | V/f frequency 2 | [C2.01]...[C2.05] Hz | 0.00 | 0.01 | Stop |
| C2.04 | V/f voltage 2① | 0.0...120.0 % | 0.0 | 0.1 | Stop |
| C2.05 | V/f frequency 3 | [C2.03]...[E0.08] Hz | 50.00 | 0.01 | Stop |
| C2.06 | V/f voltage 3① | 0.0...120.0 % | 100.0 | 0.1 | Stop |
| C2.07 | Slip compensation factor | 0...200 % | 0 | 1 | Run |
| C2.08 | V/f separation output voltage source selection | 0: Panel potentiometer<br>1: Panel button setting<br>2: AI1 analog input<br>10: X5 pulse input<br>20: Communication (Modbus 0x7F0B/Fieldbus extension card H0.50)<br>22: Digital setting<br>23: Voltage PID control | 22 | – | Stop |
| C2.09 | V/f separation output voltage digital setting | 0.00...100.00 % | 0.00 | 0.01 | Run |
| C2.10 | V/f separation output voltage acceleration time | 0.0...6,000.0 s | 0.0 | 0.1 | Run |
| C2.11 | V/f separation output voltage deceleration time | 0.0...6,000.0 s | 0.0 | 0.1 | Run |
| C2.12 | V/f separation stop mode selection | 0: Voltage and frequency decelerates independently<br>1: Voltage decelerates to zero, then frequency decelerates to zero | 0 | – | Run |
| C2.13 | V/f separation boost factor | 0.00...100.00 | 0.00 | 0.01 | Run |
| C2.20 | 0 Hz output mode | 0: No output<br>1: Standard | 1 | 1 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.21 | Torque boost setting | 0.0 %: Automatic boost<br>0.1...20.0 %: Manual boost | DOM | 0.1 | Run |
| C2.22 | Automatic torque boost factor | 0...320 % | 50 | 1 | Run |
| C2.23 | Heavy load stabilization setting | 0: Inactive<br>1: Active | 1 | – | Run |
| C2.24 | Light load oscillation damping factor | 0...5,000 % | 0.4~110kW: 300<br>132kW and above: 100 | 1 | Run |
| C2.25 | Light load oscillation damping filter factor | 10...2,000 % | 0.4~110kW: 30<br>132kW and above: 50 | 1 | Run |
| C2.40 | Current limitation mode | 0: Always inactive<br>1: Inactive at constant speed<br>2: Active at constant speed | 2 | – | Stop |
| C2.42 | Current limitation level② | [C0.27]...250 % | 150 | 1 | Stop |
| C2.43 | Current limitation proportional gain | 0.000...10.000 | DOM | 0.001 | Stop |
| C2.44 | Current limitation integral time | 0.001...10.000 | DOM | 0.001 | Stop |

①: percentage of motor rated voltage [C1.06].

②: percentage of frequency converter rated current.

## C3: Vector control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C3.00 | Speed loop proportional gain 1 | 0.00...655.35 | DOM | 0.01 | Run |
| C3.01 | Speed loop integral time 1 | 0.01...655.35 ms | DOM | 0.01 | Run |
| C3.02 | Speed loop proportional gain 2 | 0.00...655.35 | DOM | – | Run |
| C3.03 | Speed loop integral time 2 | 0.00...655.35 ms | DOM | – | Run |
| C3.04 | Speed observer harmonics damping factor | 0.10...20.00 | 0.66 | 0.01 | Stop |
| C3.05 | Current loop proportional gain | 0.1...1,000.0 | DOM | 0.1 | Run |
| C3.06 | Current loop integral time | 0.01...655.35 ms | DOM | 0.01 | Run |
| C3.10 | Speed loop switching frequency 1 | 0.00...[C3.11] | 4.00 | 0.01 | Stop |
| C3.11 | Speed loop switching frequency 2 | [C3.10]...[C1.08] | 6.00 | 0.01 | Stop |
| C3.12 | Speed observer modFe | 0: mode 1<br>1: mode 2 | 0 | - | Stop |
| C3.13 | Speed observer mode 2 gain | 1...10 | 1 | 1 | Run |
| C3.15 | Weak magnetic region excitation current Id filtering | 1 ... 65535 | 6553 | 1 | Run |
| C3.16 | Weak magnetic area bus voltage Ddc utilization rate | 1 ... 1024 | 973 | 1 | Run |
| C3.20 | Low speed torque limitation | 1...200 % | 100 | 1 | Stop |
| C3.21 | Encoder speed filter time | 0...100.0 | 2.0 | 0.1 | Stop |
| C3.22 | Encoder commutation offset | 0.0...360.0 | 360.0 | 0.1 | Stop |
| C3.25 | Speed monitor timeout | 0.0...6553.5 s | 5.0 | 0.1 | Stop |
| C3.26 | Speed monitor max. speed difference | 0.00...655.35 Hz | 10.00 | 0.01 | Stop |
| C3.30 | Maximum fieldweakening current factor for SM | 1...95 % | 75 | 1 | Run |
| C3.38 | Forward frequency limitation at torque control mode | 0.00...[E0.09] | 50.00 | 0.01 | Run |
| C3.39 | Reverse frequency limitation at torque control mode | 0.00...[E0.09] | 50.00 | 0.01 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C3.40 | Torque control mode | 0: Activated by digital inputs<br>1: Always active<br>2: Communication<br>(Bit 8 of Modbus 0x7F00)<br>(Bit 9 of extension card H0.00) | 0 | – | Stop |
| C3.41 | Torque reference channel | 0: AI1 analog input<br>1: AI2 analog input<br>2: Panel potentiometer<br>3: EAI1 analog input<br>4: Pulse input via DI5<br>5: Parameter setting C3.46<br>6: Communication (Modbus 0x7F02/Fieldbus extension card H0.12)<br>7: EAI2 analog input | 0 | – | Stop |
| C3.42 | Torque reference minimum value① | 0.0 %...[C3.43] | 0.0 | 0.1 | Run |
| C3.43 | Torque reference maximum value① | [C3.42]...200.0 % | 150.0 | 0.1 | Run |
| C3.44 | Torque positive limit① | 0.0...200.0 % | 150.0 | 0.1 | Run |
| C3.45 | Torque negative limit① | 0.0...200.0 % | 150.0 | 0.1 | Run |
| C3.46 | Digital torque reference setting | 0.0...200.0 | 150.0 | 0.1 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C3.47 | Torque limitation reference selection at speed control mode | 0: Parameter C3.44 and C3.45<br>1: AI1 (0.0...200.0 %)<br>2: AI2 (0.0...200.0 %)<br>3: EAI1 analog input<br>4: Communication<br>(Torque FWD limitation register: Modbus 0x7F03/Fieldbus extension card H0.14)<br>(Torque REV limitation register: Modbus 0x7F04/Fieldbus extension card H0.15)<br>5: EAI2 analog input | 0 | - | Stop |
| C3.48 | Speed limitation reference selection at torque control mode | 0: Parameter C3.38 and C3.39<br>1: AI1<br>2: AI2<br>3: EAI1 analog input<br>4: Communication (Speed limitation register: Modbus 0x7F05/ Fieldbus extension card H0.16)<br>5: EAI2 analog input | 0 | - | Stop |
| C3.49 | Torque command ramp | 0.0...5.0 s | 0.0 | 0.1 | Stop |
| C3.50 | Initial angle detection current | 50...150 %② | 80 | 1 | Stop |
| C3.51 | Initial angle detection mode | 0: No detection<br>1: Detection when first power on<br>2: Detection at every running | 2 | – | Stop |
| C3.52 | SVC regulation area lower frequency | 0.00...600.00 Hz | DOM | 0.01 | Stop |
| C3.53 | SVC regulation area upper frequency | 0.00...600.00 Hz | DOM | 0.01 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C3.54 | SVC dampfactor enhance upper frequency | DOM | DOM | 0.01 | Stop |
| C3.55 | SVC dampfactor enhance coefficient | 1...20 | 1 | 1 | Stop |

①: percentage of motor rated torque.

②: percentage of motor rated current.



All parameters in Group C3 are **ONLY** for VFC5615.

## 19.3.4 Group E: Function Control Parameters

### E0: Set point and control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 0...21 | 0 | – | Stop |
| E0.01 | First run command source | 0...2 | 0 | – | Stop |
| E0.02 | Second frequency setting source | 0...21 | 2 | – | Stop |
| E0.03 | Second run command source | 0...2 | 1 | – | Stop |
| E0.04 | Frequency setting source combination | 0...6 | 0 | – | Stop |
| E0.06 | Digital setting frequency saving mode | 0...4 | 0 | – | Stop |
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | Run |
| E0.08 | Maximum output frequency | 50.00...400.00 Hz | 50.00 | 0.01 | Stop |
| E0.09 | Output frequency high limit | [E0.10]...[E0.08] Hz | 50.00 | 0.01 | Run |
| E0.10 | Output frequency low limit | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E0.11 | Reverse running frequency | 0.00...[E0.09] Hz | 0.00 | 0.01 | Stop |
| E0.15 | Low speed running setting | 0: Run with 0.00 Hz<br>1: Run with low limit frequency | 0 | – | Stop |
| E0.16 | Low speed frequency hysteresis | 0.00...[E0.10] Hz | 0.00 | 0.01 | Stop |
| E0.17 | Direction control | 0: Forward / Reverse<br>1: Forward only<br>2: Reverse only<br>3: Swap default direction | 0 | – | Stop |
| E0.18 | Direction change dead time | 0.0...60.0 s | 1.0 | 0.1 | Stop |
| E0.25 | Acceleration / deceleration curve mode | 0: Linear mode<br>1: S-curve | 0 | – | Stop |
| E0.26 | Acceleration time | 0.1...6,000.0 s | DOM | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6,000.0 s | DOM | 0.1 | Run |
| E0.28 | S-curve starting phase factor | 0.0...40.0 % | 20.0 | 0.1 | Stop |
| E0.29 | S-curve stopping phase factor | 0.0...40.0 % | 20.0 | 0.1 | Stop |
| E0.35 | Start mode | 0: Start directly<br>1: DC-braking before start<br>2: Start with speed tracing<br>3: Automatic start / stop according to setting frequency | 0 | – | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.36 | Start frequency | 0.00...50.00 Hz | 0.05 | 0.01 | Stop |
| E0.37 | Start frequency holding time | 0.0...20.0 s | 0.0 | 0.1 | Stop |
| E0.38 | Start DC-braking time | 0.0...20.0 s (0.0: Inactive) | 0.0 | 0.1 | Stop |
| E0.39 | Start DC-braking current① | 0.0...150.0 % | 0.0 | 0.1 | Stop |
| E0.41 | Automatic start / stop frequency threshold | 0.01...[E0.09] Hz | 16.00 | 0.01 | Stop |
| E0.42 | Speed tracing voltage recovery ratio | 0...20 | 10 | 1 | Stop |
| E0.43 | Speed tracing deceleration time | 0.5...20.0 s | 2.0 | 0.1 | Stop |
| E0.45 | Power loss restart mode | 0: Inactive<br>1: Active for panel control<br>2: Active for digital input control | 0 | – | Stop |
| E0.46 | Power loss restart delay | 0.0...10.0 s | 1.0 | 0.1 | Stop |
| E0.47 | Run command priority | 0: High priority<br>1: Low priority | 0 | – | Stop |
| E0.50 | Stop mode | 0: Decelerating stop<br>1: Freewheeling stop 1<br>2: Freewheeling stop 2 | 0 | – | Stop |
| E0.51 | Stop DC-braking waiting time | 0.00...100.00s | 0.00 | 0.01 | Stop |
| E0.52 | Stop DC-braking initial frequency | 0.00...50.00 Hz | 0.00 | 0.01 | Stop |
| E0.53 | Stop DC-braking time | 0.0...20.0 s (0.0: Inactive) | 0.0 | 0.1 | Stop |
| E0.54 | Stop DC-braking current① | 0.0...150.0 % | 0.0 | 0.1 | Stop |
| E0.55 | Overexcitation braking factor | 1.00...2.00 | 1.10 | 0.01 | Run |
| E0.56 | Emergency stop action | 0: Freewheeling stop<br>1: Decelerating stop | 0 | – | Stop |
| E0.57 | Emergency stop deceleration time | 0.1...6,000.0 s | 5.0 | 0.1 | Run |
| E0.60 | Jog frequency | 0.00...[E0.08] Hz | 5.00 | 0.01 | Run |
| E0.61 | Jog acceleration time | 0.1...6,000.0 s | 5.0 | 0.1 | Run |
| E0.62 | Jog deceleration time | 0.1...6,000.0 s | 5.0 | 0.1 | Run |
| E0.70 | Skip frequency 1 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Stop |
| E0.71 | Skip frequency 2 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Stop |
| E0.72 | Skip frequency 3 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.73 | Skip frequency range | 0.00...30.00 Hz | 0.00 | 0.01 | Stop |
| E0.74 | Skip window acceleration factor | 1...100 | 1 | 1 | Stop |

①: percentage of frequency converter rated current.

**Setting range of E0.00, E0.02:**

0: Panel potentiometer
1: Panel button setting
2: AI1 analog input
3: AI2 analog input
4: EAI1 analog input
5: EAI2 analog input
10: X5 pulse input
11: Digital input Up / Down command
20: Communication
21: Multi-speed settings

**Setting range of E0.01, E0.03:**

0: Panel
1: Multi-function digital input
2: Communication

**Setting range of E0.04:**

0: No combination
1: First frequency setting + second frequency setting
2: First frequency setting - second frequency setting
3: First frequency setting x second frequency setting
4: Bigger one of 2 sources
5: Smaller one of 2 sources
6: Valid which channel is non-zero

**Setting range of E0.06:**

0: Not saved when powered off or stopped
1: Not saved when powered off; saved when stopped
2: Saved when powered off; not saved when stopped
3: Saved when powered off or stopped
4: Not saved when powered off; memorized when stopped

## E1: Input terminal parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 0...52 | 35 | – | Stop |
| E1.01 | X2 input | | 36 | – | Stop |
| E1.02 | X3 input | | 0 | – | Stop |
| E1.03 | X4 input | | 0 | – | Stop |
| E1.04 | X5 input | 0...52 | 0 | – | Stop |
| E1.15 | 2-wire/3-wire control mode | 0...4 | 0 | – | Stop |
| E1.16 | Digital input Up / Down change rate | 0.10...100.00 Hz/s | 1.00 | 0.01 | Run |
| E1.17 | Digital input Up / Down initial frequency | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E1.25 | Pulse input maximum frequency | 0.0...50.0 kHz | 50.0 | 0.1 | Run |
| E1.26 | Pulse input filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |
| E1.35 | AI1 input mode | 0: 0...20 mA | 2 | – | Run |
| E1.40 | AI2 input mode | 1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V | 1 | – | Run |
| E1.38 | AI1 gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| E1.43 | AI2 gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| E1.60 | Motor temperature sensor channel | 0: Inactive<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: EAI2 analog input<br>5: TSI input (only for IO plus card) | 0 | – | Stop |
| E1.61 | Broken wire protection | 0: Inactive<br>1: Warning<br>2: Error | 0 | – | Stop |
| E1.62 | Broken threshold for motor temperature sensor | 0.0...10.0 | 2.0 | 0.1 | Stop |
| E1.68 | Analog input curve setting | 0...7 | 0 | – | Run |
| E1.69 | Analog input filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |
| E1.70 | Input curve 1 minimum | 0.0 %...[E1.72] | 0.0 | 0.1 | Run |
| E1.71 | Input curve 1 minimum frequency | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.72 | Input curve 1 maximum | [E1.70]...100.0 % | 100.0 | 0.1 | Run |
| E1.73 | Input curve 1 maximum frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | Run |
| E1.75 | Input curve 2 minimum | 0.0 %...[E1.77] | 0.0 | 0.1 | Run |
| E1.76 | Input curve 2 minimum frequency | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E1.77 | Input curve 2 maximum | [E1.75]...100.0 % | 100.0 | 0.1 | Run |
| E1.78 | Input curve 2 maximum frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | Run |

**Setting range of E1.00...E1.04:**

0: Inactive
1: Multi-speed control input 1
2: Multi-speed control input 2
3: Multi-speed control input 3
4: Multi-speed control input 4
10: Acceleration / deceleration time 1 activation
11: Acceleration / deceleration time 2 activation
12: Acceleration / deceleration time 3 activation
15: Freewheeling stop activation
16: Stop DC-braking activation
20: Frequency Up command
21: Frequency Down command
22: Up / Down command reset
23: Torque / speed control switch
25: 3-wire control
26: Simple PLC stop
27: Simple PLC pause
28: Simple PLC deactivation
30: Second frequency setting source activation
31: Second run command source activation
32: Error signal N.O. contact input
33: Error signal N.C. contact input
34: Error reset
35: Forward running (FWD)
36: Reverse running (REV)
37: Forward jog
38: Reverse jog

39: Counter input
40: Counter reset
41: PID deactivation
46: User parameter set selection
47: Pulse input mode activation
48: Motor overheating error N.O. contact input
49: Motor overheating error N.C. contact input
50: Motor overheating warning N.O. contact input
51: Motor overheating warning N.C. contact input
52: Jog with Run Command Direction

**Setting range of E1.15:**

0: 2-wire forward / stop, reverse / stop
1: 2-wire forward / reverse, run / stop
2: 3-wire control mode 1
3: 3-wire control mode 2
4: 1-wire control

**Setting range of E1.68:**

0: AI1: curve1, AI2: curve1, pulse input: curve1
1: AI1: curve2, AI2: curve1, pulse input: curve1
2: AI1: curve1, AI2: curve2, pulse input: curve1
3: AI1: curve2, AI2: curve2, pulse input: curve1
4: AI1: curve1, AI2: curve1, pulse input: curve2
5: AI1: curve2, AI2: curve1, pulse input: curve2
6: AI1: curve1, AI2: curve2, pulse input: curve2
7: AI1: curve2, AI2: curve2, pulse input: curve2

## E2: Output terminal parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 0...25 | 1 | – | Stop |
| E2.02 | DO1 pulse output setting | 0: Converter output frequency<br>1: Converter output voltage<br>2: Converter output current<br>3: Setting torque<br>4: Output torque | 0 | – | Stop |
| E2.03 | Pulse output maximum frequency | 0.1...32.0 kHz | 32.0 | 0.1 | Run |
| E2.15 | Relay 1 output selection | 0...25 | 1 | – | Stop |
| E2.20 | DO1/relay1 output values from extension card fieldbus communication | Bit0: 0 (open collector is opened); 1(open collector is closed)<br>Bit8: 0 (Tb_Ta is opened); 1(Tb_Ta is closed) | 0 | – | Run |
| E2.25 | AO1 output mode | 0: 0...10 V<br>1: 0...20 mA<br>3: 2...10 V<br>4: 4...20 mA | 0 | – | Run |
| E2.26 | AO1 output setting | 0: Output frequency<br>1: Setting frequency<br>2: Output current<br>4: Output voltage<br>5: Output power<br>6: AI1 analog input<br>7: AI2 analog input<br>8: EAI1 analog input<br>9: EAI2 analog input<br>11: Motor temperature sensor power supply<br>12: Parameter setting from communication ② <br>13: Setting torque<br>14: Output torque | 0 | – | Run |
| E2.27 | AO1 gain | 0.00...10.00 | 1.00 | 0.01 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.28 | AO1 value in percentage from extension card fieldbus communication | 0.00...100.00 % | 0.00 | 0.01 | Run |
| E2.40 | Rated voltage | 1P 200...240 VAC | 220 | 1 | Stop |
| | | 3P 380...480 VAC | 380 | | |
| E2.50 | Output curve 1 minimum | 0.0 %...[E2.52] | 0.0 | 0.1 | Run |
| E2.51 | Output curve 1 minimum value | 0.00...100.00 % | 0.00 | 0.01 | Run |
| E2.52 | Output curve 1 maximum | [E2.50]...100.0 % | 100.0 | 0.1 | Run |
| E2.53 | Output curve 1 maximum value | 0.00...100.00 % | 100.00 | 0.01 | Run |
| E2.70 | Frequency detection width | 0.00...400.00 Hz | 2.50 | 0.01 | Run |
| E2.71 | Frequency detection level FDT1 | 0.01...400.00 Hz | 50.00 | 0.01 | Run |
| E2.72 | Frequency detection level FDT1 width | 0.01...[E2.71] Hz | 1.00 | 0.01 | Run |
| E2.73 | Frequency detection level FDT2 | 0.01...400.00 Hz | 25.00 | 0.01 | Run |
| E2.74 | Frequency detection level FDT2 width | 0.01...[E2.73] Hz | 1.00 | 0.01 | Run |
| E2.80 | Counter middle value | 0...[E2.81] | 0 | 1 | Run |
| E2.81 | Counter target value | [E2.80]...9,999 | 0 | 1 | Run |

**Setting range of E2.01, E2.15:**

0: Converter ready
1: Converter running
2: Converter DC-braking
3: Converter running at zero speed
4: Speed arrival
5: Frequency level detection signal (FDT1)
6: Frequency level detection signal (FDT2)
7: Simple PLC stage complete
8: Simple PLC cycle complete
10: Converter undervoltage
11: Converter overload pre-warning
12: Motor overload pre-warning
13: Converter stop by external error
14: Converter error
15: Converter OK
16: Counter target value arrival
17: Counter middle value arrival

18: PID reference engineering value arrival

19: Pulse output mode enable (only available with DO1 output selection)

20: Torque control mode

21: Parameter setting from communication①

25: Converter error or warning

26 : Frequency inverter forward operation

27 : Frequency inverter reverse operation



①:

- For parameter E2.01, the relationship between the output of '21: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, when bit0 of register 0x7F08 is '0', open collector is opened; when bit0 is '1', open collector is closed.
  - For other fieldbus mode, the output is defined by bit0 of parameter E2.20.
- For parameter E2.15, the relationship between the output of '21: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, when bit8 of register 0x7F08 is '0', Tb_Ta is opened; when bit8 is '1', Tb_Ta is closed.
  - For other fieldbus mode, the output is defined by bit8 of parameter E2.20.

②:

- For parameter E2.26, the relationship between the output of '12: Parameter setting from communication' and the communication mode is as follow:
  - For modbus mode, the output is defined by register 0x7F06. The value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).
  - For other fieldbus mode, the output is defined by parameter E2.28.

## E3: Multi-speed and simple PLC parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E3.00 | Simple PLC running mode | 0: Inactive<br>1: Stop after selected cycle<br>2: Continuously cycling<br>3: Run last stage after selected cycle<br>4: Continuous cycling without decelerating to 0.00 Hz | 0 | – | Stop |
| E3.01 | Simple PLC time multiplier | 1...60 | 1 | 1 | Stop |
| E3.02 | Simple PLC cycle number | 1...1,000 | 1 | 1 | Stop |
| E3.10 | Acceleration time 2 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.11 | Deceleration time 2 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.12 | Acceleration time 3 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.13 | Deceleration time 3 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.14 | Acceleration time 4 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.15 | Deceleration time 4 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.16 | Acceleration time 5 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.17 | Deceleration time 5 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.18 | Acceleration time 6 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.19 | Deceleration time 6 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.20 | Acceleration time 7 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.21 | Deceleration time 7 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.22 | Acceleration time 8 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.23 | Deceleration time 8 | 0.1...6,000.0 s | 10.0 | 0.1 | Run |
| E3.40 | Multi-speed frequency 1 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.41 | Multi-speed frequency 2 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.42 | Multi-speed frequency 3 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.43 | Multi-speed frequency 4 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.44 | Multi-speed frequency 5 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.45 | Multi-speed frequency 6 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.46 | Multi-speed frequency 7 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.47 | Multi-speed frequency 8 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.48 | Multi-speed frequency 9 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.49 | Multi-speed frequency 10 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.50 | Multi-speed frequency 11 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.51 | Multi-speed frequency 12 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E3.52 | Multi-speed frequency 13 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.53 | Multi-speed frequency 14 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.54 | Multi-speed frequency 15 | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E3.59 | Stage 0 frequency source | 0: Digital setting frequency<br>1: AI1 analog input<br>2: AI2 analog input<br>3: EAI1 analog input<br>4: X5 pulse input<br>5: Communication<br>6: Panel potentiometer<br>7: Digital input up/down command<br>8: EAI2 analog input | 0 | – | Stop |
| E3.60 | Stage 0 action | 011, 012, 013, 014, 015, 016 ,017, 018, 021, 022, 023, 024, 025, 026, 027, 028, 031, 032, 033, 034, 035, 036, 037, 038, 041, 042, 043, 044, 045, 046, 047, 048, 051, 052, 053, 054, 055, 056, 057, 058, 061, 062, 063, 064, 065, 066, 067, 068, 071, 072, 073, 074, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 111, 112, 113, 114, 115, 116, 117, 118, 121, 122, 123, 124, 125, 126, 127, 128, 131, 132, 133, 134, 135, 136, 137, 138, 141, 142, 143, 144, 145, 146, 147, 148, 151, 152, 153, 154, 155, 156, 157, 158, 161, 162, 163, 164, 165, 166, 167, 168, 171, 172, 173, 174, 175, 176, 177, 178, 181, 182, 183, 184, 185, 186, 187, 188 | 011 | – | Stop |
| E3.62 | Stage 1 action | | 011 | – | Stop |
| E3.64 | Stage 2 action | | 011 | – | Stop |
| E3.66 | Stage 3 action | | 011 | – | Stop |
| E3.68 | Stage 4 action | | 011 | – | Stop |
| E3.70 | Stage 5 action | | 011 | – | Stop |
| E3.72 | Stage 6 action | | 011 | – | Stop |
| E3.74 | Stage 7 action | | 011 | – | Stop |
| E3.76 | Stage 8 action | | 011 | – | Stop |
| E3.78 | Stage 9 action | | 011 | – | Stop |
| E3.80 | Stage 10 action | | 011 | – | Stop |
| E3.82 | Stage 11 action | | 011 | – | Stop |
| E3.84 | Stage 12 action | | 011 | – | Stop |
| E3.86 | Stage 13 action | | 011 | – | Stop |
| E3.88 | Stage 14 action | | 011 | – | Stop |
| E3.90 | Stage 15 action | | 011 | – | Stop |
| E3.61 | Stage 0 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.63 | Stage 1 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.65 | Stage 2 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.67 | Stage 3 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.69 | Stage 4 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.71 | Stage 5 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.73 | Stage 6 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.75 | Stage 7 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E3.77 | Stage 8 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.79 | Stage 9 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.81 | Stage 10 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.83 | Stage 11 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.85 | Stage 12 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.87 | Stage 13 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.89 | Stage 14 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |
| E3.91 | Stage 15 running time | 0.0...6,000.0 s | 20.0 | 0.1 | Stop |

## E4: PID control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.00 | PID reference channel | 0...10 | 0 | – | Stop |
| E4.01 | PID feedback channel | 0: AI1 analog input<br>1: AI2 analog input<br>2: X5 pulse input<br>3: EAI1 analog input<br>4: Encoder card speed<br>5: EAI2 analog input | 0 | – | Stop |
| E4.02 | PID reference / feedback factor | 0.01...100.00 | 1.00 | 0.01 | Run |
| E4.03 | PID engineering analog reference | 0.00...10.00 | 0.00 | 0.01 | Run |
| E4.04 | PID engineering speed reference | 0...30,000 rpm | 0 | 1 | Run |
| E4.05 | PID feedback polarity | 0: Positive<br>1: Negative | 0 | – | Stop |
| E4.15 | Proportional gain - P | 0.000...60.000 | 1.500 | 0.001 | Run |
| E4.16 | Integral time - Ti | 0.00...100.00 s<br>(0.00: no integral) | 1.50 | 0.01 | Run |
| E4.17 | Derivative time - Td | 0.00...100.00 s<br>(0.00: no derivative) | 0.00 | 0.01 | Run |
| E4.18 | Sampling period - T | 0.01...100.00 s | 0.50 | 0.01 | Run |
| E4.19 | PID feed forward dynamic limit | 0.00...100.00 % | 10.00 | 0.01 | Run |
| E4.20 | PID feed forward limit offset | 0.00...100.00 % | 0.00 | 0.01 | Run |
| E4.30 | PID deadband | 0.0...20.0 % | 2.0 | 0.1 | Run |
| E4.31 | PID regulation mode | 0, 1 | 0 | – | Run |
| E4.32 | PID engineering value detection width | 0.01...100.00 | 1.00 | 0.01 | Run |
| E4.33 | PID feed forward settings | 0: Inactive<br>1: Active | 0 | – | Stop |

**Setting range of E4.00:**

0: Inactive
1: Panel potentiometer
2: Panel button
3: AI1 analog input
4: AI2 analog input
5: X5 pulse input
6: EAI1 analog input

7: Communication
8: Analog reference E4.03
9: Speed reference E4.04
10: EAI2 analog input

**Setting range of E4.31:**

0: Stop integral regulation when frequency arrives at upper / lower limit
1: Continue integral regulation when frequency arrives at upper / lower limit

## E5: Extended function parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E5.01 | High resolution output current filter time | 5...500 ms | 40 | 1 | Run |
| E5.02 | User-defined speed scaling factor | 0.01...100.00 | 1.00 | 0.01 | Run |
| E5.05 | Pump dry protection threshold | 0.0 %...[E5.08] | 30.0 | 0.1 | Run |
| E5.06 | Pump dry protection delay | 0.0...300.0 s (0.0: Inactive) | 0.0 | 0.1 | Run |
| E5.07 | Pump dry protection delay at start-up | 0.0...300.0 s | 30.0 | 0.1 | Run |
| E5.08 | Pump leakage protection threshold | 0.0...100.0 % | 50.0 | 0.1 | Run |
| E5.09 | Pump leakage protection delay | 0.0...600.0 s (0.0: Inactive) | 0.0 | 0.1 | Run |
| E5.10 | Pump leakage protection delay at start-up | 0.0...600.0 s | 60.0 | 0.1 | Run |
| E5.15 | Sleep level | 0.00...[E0.09] Hz | 0.00 | 0.01 | Run |
| E5.16 | Sleep delay | 0.0...3,600.0 s | 60.0 | 0.1 | Run |
| E5.17 | Sleep boost time | 0.0...3,600.0 s | 0.0 | 0.1 | Run |
| E5.18 | Sleep boost amplitude | 0.0...100.0 % | 0.0 | 0.1 | Run |
| E5.19 | Wake up level | 0.0...100.0 % | 0.0 | 0.1 | Run |
| E5.20 | Wake up delay | 0.0...60.0 s | 0.5 | 0.1 | Run |

## E8: Standard communication parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E8.00 | Communication protocol | 0: Modbus<br>1: Extension card | 0 | – | Stop |
| E8.01 | Communication error detection time | 0.0...60.0 s<br>(0.0: Inactive) | 0.0 | 0.1 | Stop |
| E8.02 | Communication error protection mode | 0: Freewheeling stop<br>1: Keep running<br>2: Emergency stop | 1 | – | Stop |
| E8.03 | Communication process data loss behavior | 0: Decelerating stop<br>1: Freewheeling stop<br>2: Keep running<br>3: Keep running without warning | 0 | – | Stop |
| E8.04 | Process data loss detection time | 0.000 - 10.000s | 0.000 | - | Stop |
| E8.10 | Modbus baud rate | 0: 1,200 bps; 1: 2,400 bps<br>2: 4,800 bps; 3: 9,600 bps<br>4: 19,200 bps; 5: 38,400 bps | 3 | – | Stop |
| E8.11 | Modbus data format | 0...3 | 0 | – | Stop |
| E8.12 | Modbus local address | 1...247 | 1 | 1 | Stop |
| E8.13 | Modbus level / edge sensitivity selection | 0: Level sensitive<br>1: Edge sensitive | 1 | – | Stop |

**Setting range of E8.11:**

0: N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no parity)

1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even parity)

2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd parity)

3: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, no parity)

## E9: Protection and error parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E9.00 | Automatic error reset attempts | 0...3<br>(0: Inactive) | 0 | – | Stop |
| E9.01 | Automatic error reset interval | 0.1...60.0 s | 10.0 | 0.1 | Stop |
| E9.02 | Automatic error reset attempts restart time | 0...65,535 | 0 | 1 | Stop |
| E9.04 | Diagnosis setting | 0...FFFF | 0 | 1 | Stop |
| E9.05 | Last error type | – | – | – | Read |
| E9.06 | Second last error type | – | – | – | Read |
| E9.07 | Third last error type | – | – | – | Read |
| E9.10 | Output frequency at last error | – | – | 0.01 | Read |
| E9.11 | Setting frequency at last error | – | – | 0.01 | Read |
| E9.12 | Output current at last error | – | – | 0.1 | Read |
| E9.13 | Output voltage at last error | – | – | 1 | Read |
| E9.14 | DC-bus voltage at last error | – | – | 1 | Read |
| E9.15 | Power module temperature at last error | – | – | 1 | Read |
| E9.50 | Last warning type | - | 0 | - | Read |
| E9.51 | Second last warning type | - | 0 | - | Read |
| E9.52 | Third last warning type | - | 0 | - | Read |
| E9.97 | Last error detail | 00000...FFFFF | 0 | – | Read |
| E9.98 | Second last error detail | 00000...FFFFF | 0 | – | Read |
| E9.99 | Third last error detail | 00000...FFFFF | 0 | – | Read |

*E9.04 Diagnosis setting:*

- 0000: UE-1 (by default)
- 0001: no error

**Value range of E9.05...E9.07:**

0: No error
1: OC-1, overcurrent at constant speed
2: OC-2, overcurrent during acceleration
3: OC-3, overcurrent during deceleration
4: OE-1, overvoltage at constant speed
5: OE-2, overvoltage during acceleration
6: OE-3, overvoltage during deceleration
7: OE-4, overvoltage during stop
8: UE-1, undervoltage during run

9: SC, surge current or short circuit
10: IPH.L, input phase loss
11: OPH.L, output phase loss
12: ESS-, soft start error
20: OL-1, converter overload
21: OH, converter over temperature
23: FF, fan failure
24: Pdr, pump dry
25: CoL-, command value lost
26: StO-r, STO request
27: StO-E, STO error
30: OL-2, motor overload
31: Ot, motor over temperature
32: t-Er, motor parameter tuning error
33: AdE-, motor angle detection error
35: SPE-, speed control loop error
38: AibE, analog input broken wire detection
39: EPS-, DC_IN power supply error
40: dir1, forward running lock error
41: dir2, reverse running lock error
42: E-St, terminal error signal
43: FFE-, firmware version mismatch
44: rS-, Modbus communication error
45: E.Par, parameter settings invalid
46: U.Par, unknown parameter restore error
48: idA-, internal communication error
49: idP-, internal parameter error
50: idE-, converter internal error
51: OCd-, extension card internal error
52: OCc, extension card PDOs configuration error
53: Fdi-, no valid process data
54: PcE-, remote control communication error
55: PbrE, parameter backup / restore error
56: PrEF, parameter restore error after firmware update
60: ASF-, application firmware error
61: APE1, application error 1

62: APE2, application error 2
63: APE3, application error 3
64: APE4, application error 4
65: APE5, application error 5
70: EIbE, Encoder input broken wire error
71:EPOE, Encoder phase order error
72:RDOS, Signal amplitude error
73:RLOT, Signal phase error
901:FCd-, Host communication timed out
902:FPC-, Fieldbus process data configuration erroneous
903:FtL-, RPDO Telegram Loss
904:FIn-, Communication platform initialization failed
905:FnC-, Fieldbus network configuration invalid
906:FCE-, Communication platform critical error
907:FnF-, Communication platform firmware corrupted
908:Fdi-, Fieldbus data Invalid

**Value range of E9.50...E9.52:**

0: No warning
6: PLE, pump leakage
7: OE-4, overvoltage during stop
31: Ot, motor over temperature
403: C-dr, communication disconnection
408: Aib-, analog input broken wire detection
409: FLE, fan maintenance period expired
410: OCi, communication data exceeds value range
411: UH-A, under Temperature warning
420: APF1, ASF customer warning 1
421: APF2, ASF customer warning 2
422: APF3, ASF customer warning 3
423: APF4, ASF customer warning 4
424: APF5, ASF customer warning 5
430: USdc, UnSupported Device Configuration
440: Sli-, speed limited by maximum Voltage
900: iSt, invalid State Transition
903: FtL, RPDO Telegram Loss

908: Fdi, option card process data invalid

### 19.3.5 Group F0: ASF Parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| F0.01 | ASF version | – | – | – | Read |
| F0.02 | ASF identifier | 0x0001 ... 0x0FFF | – | – | Read |
| F0.03 | ASF API required version | – | – | – | Read |
| F0.06 | ASF trial time left | 0...65,535 s | – | – | Read |
| F0.07 | ASF API version | – | – | – | Read |
| F0.10 | ASF status | 0x0000H...0xFFFFH | – | 1 | Read |
| F0.20 | ASF Command 1 | – | 0 | – | Read |
| F0.21 | ASF Command 2 | – | 0 | – | Read |
| F0.22 | ASF Command 3 | – | 0 | – | Read |
| F0.23 | ASF Command 4 | – | 0 | – | Read |
| F0.24 | ASF Command 5 | – | 0 | – | Read |
| F0.25 | ASF Command 6 | – | 0 | – | Read |
| F0.26 | ASF Command 7 | – | 0 | – | Read |
| F0.27 | ASF Command 8 | – | 0 | – | Read |

### 19.3.6 Group H: Extension Card Parameters

#### H0: Extension card general parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H0.00 | Control word | 0x00000...0x0FFFF | 0x00000 | 1 | Run |
| H0.01 | Status word | – | 0x00000 | 1 | Read |
| H0.02 | Extended status word | – | 0x00000 | 1 | Read |
| H0.10 | Frequency command | 0.00...655.35 | 0.00 | 0.01 | Run |
| H0.12 | Torque control reference from fieldbus | 0.0...6553.5 | 0.0 | 0.1 | Run |
| H0.14 | FWD torque limitation reference from fieldbus | 0.0...6553.5 | 0.0 | 0.1 | Run |
| H0.15 | REV torque limitation reference from fieldbus | 0.0...6553.5 | 0.0 | 0.1 | Run |
| H0.16 | Speed limitation at torque control mode from fieldbus | 0.00...655.35 | 0.00 | 0.01 | Run |
| H0.18 | Opt 1 active interface version | – | – | 0.01 | Read |
| H0.19 | Opt 2 active interface version | – | – | 0.01 | Read |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H0.20 | Extension card 1 type | 0: None | 0 | – | Read |
| H0.30 | Extension card 2 type | 1: PROFIBUS card<br>2: CANopen card<br>8: I/O card<br>9: Relay card<br>10: IO plus card | 0 | – | Read |
| H0.23 | Extension card 1 firmware version | – | – | 0.01 | Read |
| H0.33 | Extension card 2 firmware version | – | – | 0.01 | Read |
| H0.50 | Fieldbus voltage command | 0.00...100.00 % | 0.00 | 0.01 | Run |

## H1: PROFIBUS card parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H1.00 | PROFIBUS local address | 0...126 | 1 | 1 | Stop |
| H1.01 | Present baud rate | 0: None<br>1: 9.6 kbps<br>2: 19.2 kbps<br>3: 45.45 kbps<br>4: 93.75 kbps<br>5: 187.5 kbps<br>6: 500 kbps<br>7: 1,500 kbps<br>8: 3,000 kbps<br>9: 6,000 kbps<br>10: 12,000 kbps | – | – | Read |
| H1.02 | Present telegram type | 1: PPO1<br>2: PPO2<br>3: PPO3<br>4: PPO4<br>5: PPO5<br>6: PPO6<br>7: PPO7<br>8: PPO8 | – | – | Read |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H1.10 | Output PZD 1① | 0: Not used | 1 | – | Stop |
| H1.11 | Output PZD 2 | 1: Control word | 2 | – | Stop |
| H1.12 | Output PZD 3 | 2: Frequency command | 0 | – | Stop |
| H1.13 | Output PZD 4 | 3: Empty PZD | 0 | – | Stop |
| H1.14 | Output PZD 5 | 4: ASF command 1 | 0 | – | Stop |
| H1.15 | Output PZD 6 | 5: ASF command 2 | 0 | – | Stop |
| H1.16 | Output PZD 7 | 6: ASF command 3 | 0 | – | Stop |
| H1.17 | Output PZD 8 | 7: ASF command 4 | 0 | – | Stop |
| H1.18 | Output PZD 9 | 8: ASF command 5 | 0 | – | Stop |
| H1.19 | Output PZD 10 | 9: ASF command 6<br>10: ASF command 7<br>11: ASF command 8<br>12: Torque command<br>13: Forward torque limit<br>14: Reverse torque limit<br>15: Speed limit in torque mode<br>16: DO1/relay1 output values (see parameter E2.20)<br>17: AO1 value in percentage (see parameter E2.28)<br>18: EDO values (see parameter H8.23)<br>19: EAO value in percentage (see parameter H8.28)<br>20: Relay card output values (see parameter H9.10)<br>21: V/f separation voltage command in percentage (see parameter H0.50)<br>22: Acceleration time<br>23: Deceleration time | 0 | – | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H1.30 | Input PZD 1② | 0: Not used<br>1: Status word<br>2: Extended status word<br>3: Empty PZD<br>100: d0.00 (Output frequency)<br>101...199: d0.01...d0.99 (Monitoring values) | 1 | – | Stop |
| H1.31 | Input PZD 2 | | 100 | – | Stop |
| H1.32 | Input PZD 3 | | 0 | – | Stop |
| H1.33 | Input PZD 4 | | 0 | – | Stop |
| H1.34 | Input PZD 5 | | 0 | – | Stop |
| H1.35 | Input PZD 6 | | 0 | – | Stop |
| H1.36 | Input PZD 7 | | 0 | – | Stop |
| H1.37 | Input PZD 8 | | 0 | – | Stop |
| H1.38 | Input PZD 9 | | 0 | – | Stop |
| H1.39 | Input PZD 10 | | 0 | – | Stop |

①: Output PZD 1...Output PZD 10 are the process data containers for data transferring from PROFIBUS master to slave.

②: Input PZD 1...Input PZD 10 are the process data containers for data transferring from PROFIBUS slave to master.

### H2: CANopen card parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H2.00 | CANopen address | 1...127 | 1 | - | Stop |
| H2.01 | CAN baudrate | 0: 10 kbits/s<br>1: 20 kbits/s<br>2: 50 kbits/s<br>3: 125 kbits/s<br>4: 250 kbits/s<br>5: 500 kbits/s<br>6: 1 Mbit/s | 3 | - | Stop |
| H2.02 | CANopen device profile selection | 0...1 | 0-> Rexroth Drive Profile<br>1-> CiA-402 Drive Profile | - | Stop |
| H2.98 | CANopen termination resistor switch | 0: Disabled<br>1: Enabled | 0 | - | Stop |

**H2.00 'CANopen address'** is used to select the address for CANopen Node.

**H2.01 'CAN baudrate'** is used to set the speed of CANopen communication.

**H2.02 'CANopen device profile selection'** is used to switch between different drive profiles.

**H2.98 'CANopen termination resistor switch'** is used to select the state of the termination resistor.

## H8: I/O card parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H8.00 | EX1 input | 0...52 | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |
| H8.04 | EX5 input | | 0 | – | Stop |
| H8.05 | EAI input mode | 0: 0...20 mA<br>1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V<br>5: -10...10 V | 0 | – | Stop |
| H8.06 | EAI1 input polarity setting | 0...3 | 1 | – | Stop |
| H8.07 | EAI1 dead zone filter value | 0.0...30.0 % | 0.0 | 0.1 | Run |
| H8.09 | EAI1 filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |
| H8.10 | EAI1 gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| H8.15 | EAI1 curve minimum | -120.0 %...[H8.17] | 0.0 | 0.1 | Run |
| H8.16 | EAI1 curve minimum value | -[E0.09]...[E0.09] Hz | 0.00 | 0.01 | Run |
| H8.17 | EAI1 curve maximum | [H8.15]...120.0 % | 100.0 | 0.1 | Run |
| H8.18 | EAI1 curve maximum value | -[E0.09]...[E0.09] Hz | 50.00 | 0.01 | Run |
| H8.20 | EDO1 output selection | 0...25 | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H8.22 | EDO2 output selection | | 1 | – | Stop |
| H8.23 | Extended digital output value from extension card fieldbus communication | Bit0: EDO1 (IO / IO plus card)<br>Bit1: EDO2 (IO plus card)<br>Bit8: Erelay (IO card) | 0 | – | Stop |
| H8.25 | EAO output mode | 0: 0...10 V<br>1: 0...20 mA<br>3: 2....10V<br>4: 4.....20mA | 0 | – | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H8.26 | EAO output selection | 0: Output frequency<br>1: Set frequency<br>2: Output current<br>4: Output voltage<br>5: Output power<br>6: AI1 analog input<br>7: AI2 analog input<br>8: EAI1 analog input<br>9: EAI2 analog input<br>11: Motor temperature sensor power<br>12: Parameter setting from communication② <br>13: Setting torque<br>14: Output torque | 0 | – | Run |
| H8.27 | EAO gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| H8.28 | EAO value in percentage from extension card fieldbus communication | 0.00...100.00% | 0.00 | 0.01 | Stop |
| H8.30 | EAI2 input mode | 0: 0...20 mA<br>1: 4...20 mA<br>2: 0...10 V<br>3: 0...5 V<br>4: 2...10 V<br>5: -10...10 V | 0 | – | Stop |
| H8.31 | EAI2 input polarity setting | 0: Polarity inactive<br>1: Polarity active without direction control<br>2: Polarity active with direction control<br>3. Combination direction control | 1 | – | Stop |
| H8.32 | EAI2 filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |
| H8.33 | EAI2 gain | 0.00...10.00 | 1.00 | 0.01 | Run |
| H8.34 | EAI2 curve minimum | -120.0 %...[H8.36] | 0.0 | 0.1 | Run |
| H8.35 | EAI2 curve minimum value | -[E0.09]...[E0.09] | 0.00 | 0.01 | Run |
| H8.36 | EAI2 curve maximum | [H8.34]...120.0 % | 100.0 | 0.1 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H8.37 | EAI2 curve maximum value | -[E0.09]...[E0.09] | 50.00 | 0.01 | Run |
| H8.38 | EAI2 dead zone filter value | 0.0...30.0 % | 0.0 | 0.1 | Run |
| H8.39 | EAO curve minimum | -100.0 %...[H8.41] | 0.0 | 0.1 | Run |
| H8.40 | EAO curve minimum value | -100.0...100.0 % | 0.00 | 0.01 | Run |
| H8.41 | EAO curve maximum | [H8.39]...100.0 % | 100.0 | 0.1 | Run |
| H8.42 | EAO curve maximum value | -100.0...100.0 % | 100.0 | 0.1 | Run |
| H8.87 | I/O card output channel diagnosis | 0: Inactive<br>1: EAO diagnosis<br>2: EDO diagnosis<br>3: ERO diagnosis/EDO2 diagnosis<br>4: All output diagnosis | 1 | – | Stop |

**Setting range of H8.00...H8.04:**

0: No function assigned
1: Multi-speed control input 1
2: Multi-speed control input 2
3: Multi-speed control input 3
4: Multi-speed control input 4
10: Acceleration/deceleration time 1 activation
11: Acceleration/deceleration time 2 activation
12: Acceleration/deceleration time 3 activation
15: Freewheeling stop activation
16: Stop DC-braking activation
20: Frequency Up command
21: Frequency Down command
22: Up/Down command reset
23: Torque/Speed control switch
25: 3-wire control
26: Simple PLC stop
27: Simple PLC pause
30: Second frequency setting source activation
31: Second run command source activation
32: Error signal N.O. contact input
33: Error signal N.C. contact input
34: Error reset

35: Forward running (FWD)
36: Reverse running (REV)
37: Forward jog
38: Reverse jog
39: Counter input
40: Counter reset
41: PID deactivation
46: User parameter set selection
48: Motor overheating error N.O. contact input
49: Motor overheating error N.C. contact input
50: Motor overheating warning N.O. contact input
51: Motor overheating warning N.C. contact input
52: Jog with Run Command Direction

**Setting range of H8.06:**

0: Polarity inactive
1: Polarity active without direction control
2: Polarity active with direction control
3. Combination direction control

**Setting range of H8.20, H8.21:**

0: Converter ready
1: Converter running
2: Converter DC-braking
3: Converter running at zero speed
4: Speed arrival
5: Frequency level detection signal (FDT1)
6: Frequency level detection signal (FDT2)
7: Simple PLC stage complete
8: Simple PLC cycle complete
10: Converter undervoltage
11: Converter overload pre-warning
12: Motor overload pre-warning
13: Converter stop by external error
14: Converter error
15: Converter OK
16: Counter target value arrival
17: Counter middle value arrival

18: PID reference engineering value arrival

19: Pulse output mode enable (only available with DO1 output selection)

20: Torque control mode

21: Parameter setting from communication①

25: Converter error or warning



①:

The relationship between the output of '21: Parameter setting from communication' and communication mode is as follow:

- For modbus mode,
  - The output of parameter H8.20 is defined by bit0 of register 0x7F09. When bit0 is '0', open collector is opened; when bit0 is '1', open collector is closed.
  - The output of parameter H8.21 is defined by bit8 of register 0x7F09. When bit8 is '0', ETb_ETa is opened; when bit8 is '1', ETb_ETa is closed.
  - The output of parameter H8.22 is defined by bit1 of register 0x7F09. When bit1 is '0', open collector is opened; when bit1 is '1', open collector is closed.
- For other fieldbus mode, the output is defined by parameter H8.23.

②:

The relationship between the output of '12: Parameter setting from communication' and communication mode is as follow:

- For modbus mode, the output is defined by register 0x7F07, the value range of register is 0.00 %...100.00 % (It means percentage of maximum analog output value).
- For other fieldbus mode, the output is defined by parameter H8.28.

### H9: Relay card parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H9.00 | Extended relay 1 output selection | 0...25 | 0 | – | Stop |
| H9.01 | Extended relay 2 output selection | | 0 | – | Stop |
| H9.02 | Extended relay 3 output selection | | 0 | – | Stop |
| H9.03 | Extended relay 4 output selection | | 0 | – | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H9.10 | Relay output setting value | Relay1 is defined by bit0, when bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed<br>Relay2 is defined by bit1, when bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed<br>Relay3 is defined by bit2, when bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed<br>Relay4 is defined by bit3, when bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed | 0 | – | Run |
| H9.97 | Relay card output channel diagnosis | 0: Inactive<br>1: Relay1 diagnosis<br>2: Relay2 diagnosis<br>3: Relay3 diagnosis<br>4: Relay4 diagnosis<br>5: All output diagnosis | 0 | – | Stop |

**Setting range of H9.00...H9.03:**

0: Converter ready
1: Converter running
2: Converter DC-braking
3: Converter running at zero speed
4: Speed arrival
5: Frequency level detection signal (FDT1)
6: Frequency level detection signal (FDT2)
7: Simple PLC stage complete
8: Simple PLC cycle complete
10: Converter undervoltage
11: Converter overload pre-warning
12: Motor overload pre-warning
13: Converter stop by external error
14: Converter error
15: Converter OK

16: Counter target value arrival

17: Counter middle value arrival

18: PID reference engineering value arrival

20: Torque control mode

21: Parameter setting from communication①

25: Converter error or warning



①:

The relationship between output of '21: Parameter setting from communication' and communication mode is as follow:

- For modbus mode,
  - The output of parameter H9.00 is defined by bit0 of register 0x7F0A. When bit0 is '0', R1b_R1a is opened; when bit0 is '1', R1b_R1a is closed.
  - The output of parameter H9.01 is defined by bit1 of register 0x7F0A. When bit1 is '0', R2b_R2a is opened; when bit1 is '1', R2b_R2a is closed.
  - The output of parameter H9.02 is defined by bit2 of register 0x7F0A. When bit2 is '0', R3b_R3a is opened; when bit2 is '1', R3b_R3a is closed.
  - The output of parameter H9.03 is defined by bit3 of register 0x7F0A. When bit3 is '0', R4b_R4a is opened; when bit3 is '1', R4b_R4a is closed.
- For other fieldbus mode, the output is defined by parameter H9.10.

## 19.3.7 Group U: Panel Parameters

### U0: General panel parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| U0.00 | Direction control by panel | 0: Forward; 1: Reverse | 0 | – | Run |
| U0.01 | Stop button control | 0: Active only for panel control<br>1: Valid for all control methods | 1 | – | Run |
| U0.99 | Panel firmware version | 00.00...99.99 | – | 0.01 | Read |

### U1: LED panel parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| U1.00 | Run monitoring display | 0...99 | 0 | – | Run |
| U1.10 | Stop monitoring display | | 2 | – | Run |

0: Output frequency; 1: Actual speed
2: Setting frequency; 3: Setting speed
4: User-defined setting speed; 5: User-defined actual speed
6: Encoder frequency
7: Encoder speed
9: V/f separation setting voltage; 10: Output voltage; 11: Output current
12: Output power; 13: DC-bus voltage
14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
38: I/O plus card TSI input signal value
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04

85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08; 89: ASF Display09
98: High resolution output current; 99: Firmware version

### U2: LCD panel parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| U2.01 | Backlight mode setting | 0: Energy saving<br>1: Always on | 1 | – | Run |
| U2.02 | Panel lock setting | 0: Unlock<br>1: Lock | 0 | – | Run |
| U2.03 | Remote / Local setting | 0: Remote<br>1: Local | 0 | – | Stop |
| U2.04 | Language selection | 0: English<br>1: Chinese<br>2: Germany<br>3: French<br>4: Russian<br>5: Spanish<br>6: Portugal<br>7: Italian<br>8: Korean | 0 | – | Stop |
| U2.09 | Permanent monitoring | 0...99 | 0 | – | Run |
| U2.10 | Run monitoring items 1 | | 0 | – | Run |
| U2.20 | Stop monitoring items 1 | | 0 | – | Run |
| U2.11 | Run monitoring items 2 | 0...100 | 2 | – | Run |
| U2.12 | Run monitoring items 3 | | 11 | – | Run |
| U2.13 | Run monitoring items 4 | | 13 | – | Run |
| U2.14 | Run monitoring items 5 | | 16 | – | Run |
| U2.15 | Run monitoring items 6 | | 17 | – | Run |
| U2.21 | Stop monitoring items 2 | | 2 | – | Run |
| U2.22 | Stop monitoring items 3 | | 11 | – | Run |
| U2.23 | Stop monitoring items 4 | | 13 | – | Run |
| U2.24 | Stop monitoring items 5 | | 16 | – | Run |
| U2.25 | Stop monitoring items 6 | | 17 | – | Run |

Setting range of U2.09...U2.25:
0: Actual output frequency; 1: Actual speed
2: Setting frequency; 3: Setting speed

4: User-defined setting speed; 5: User-defined output speed
9: V/f separation setting voltage; 10: Output voltage; 11: Output current
12: Output power; 13: DC-bus voltage
14: Energy saving counter kWh; 15: Energy saving counter MWh
16: Output torque; 17: Setting torque
20: Power module temperature; 21: Actual carrier frequency
23: Power stage running time; 30: AI1 input
31: AI2 input; 33: I/O card EAI1 input; 34: I/O card EAI2 input
35: AO1 output; 37: I/O card EAO output
38: I/O plus card TSI input signal value
40: Digital input 1; 43: I/O card digital input
45: DO1 output; 47: I/O card EDO1 output; 48: I/O card EDO2 output
50: Pulse input frequency; 55: Pulse output frequency
60: Relay output; 62: I/O card relay output
63: Relay card output; 70: PID reference engineering value
71: PID feedback engineering value; 80: ASF Display00
81: ASF Display01; 82: ASF Display02
83: ASF Display03; 84: ASF Display04
85: ASF Display05; 86: ASF Display06
87: ASF Display07; 88: ASF Display08
89: ASF Display09; 98: High resolution output current
99: Firmware version; 100: Inactive

## 19.3.8 Group d0: Monitoring Parameters

| Code | Name | Minimum unit |
|---|---|---|
| d0.00 | Output frequency | 0.01 Hz |
| d0.01 | Actual speed | 1 rpm |
| d0.02 | Setting frequency | 0.01 Hz |
| d0.03 | Setting speed | 1 rpm |
| d0.04 | User-defined setting speed | 0.1 |
| d0.05 | User-defined output speed | 0.1 |
| d0.06 | Encoder frequency | 0.01 |
| d0.07 | Encoder speed | 1 |
| d0.09 | V/f separation setting voltage | 0.01 V |
| d0.10 | Output voltage | 1 V |
| d0.11 | Output current | 0.1 A |
| d0.12 | Output power | 0.1 kW |
| d0.13 | DC-bus voltage | 1 V |
| d0.14 | Energy saving counter kWh | 0.1 kWh |
| d0.15 | Energy saving counter MWh | 1 MWh |
| d0.16 | Output torque | 0.1 % |
| d0.17 | Setting torque | 0.1 % |
| d0.18 | FWD speed limitation setting | 0.01 rpm |
| d0.19 | REV speed limitation setting | 0.01 rpm |
| d0.20 | Power module temperature | 1 °C |
| d0.21 | Actual carrier frequency | 1 kHz |
| d0.23 | Power stage running time | 1 h |
| d0.30 | AI1 input | 0.01 V / 0.01 mA |
| d0.31 | AI2 input | 0.01 V / 0.01 mA |
| d0.33 | I/O card EAI1 input | 0.01 V / 0.01 mA |
| d0.34 | I/O card EAI2 input | 0.01 V / 0.01 mA |
| d0.35 | AO1 output | 0.01 V / 0.01 mA |
| d0.37 | I/O card EAO output | 0.01 V / 0.01 mA |
| d0.38 | I/O plus card TSI input signal value | 0.001 V |
| d0.40 | Digital input 1 | – |
| d0.43 | I/O card digital input | – |
| d0.45 | DO1 output | – |
| d0.47 | I/O card EDO1 output | – |
| d0.48 | I/O card EDO2 output | – |
| d0.50 | Pulse input frequency | 0.01 kHz |
| d0.55 | Pulse output frequency | 0.1 kHz |

| Code | Name | Minimum unit |
|---|---|---|
| d0.60 | Relay output | – |
| d0.62 | I/O card relay output | – |
| d0.63 | Relay card output | – |
| d0.64 | Motor thermal sensor temperature | – |
| d0.70 | PID reference engineering value | 0.1 |
| d0.71 | PID feedback engineering value | 0.1 |
| d0.80 | ASF Display00 | – |
| d0.81 | ASF Display01 | – |
| d0.82 | ASF display02 | – |
| d0.83 | ASF display03 | – |
| d0.84 | ASF display04 | – |
| d0.85 | ASF display05 | – |
| d0.86 | ASF display06 | – |
| d0.87 | ASF display07 | – |
| d0.88 | ASF display08 | – |
| d0.89 | ASF display09 | – |
| d0.98 | High resolution output current | 0.01 A |
| d0.99 | Firmware version | 0.01 |



Parameters d0.16...d0.19 are only applicable to Vector Control mode.

### 19.3.9 Group d1: Enhanced Monitoring

This part is about enhanced monitoring parameters, which are not visible via Panel, but can be scoped in IndraWorks.

| Code | Name | Minimum Unit | Attri. |
|---|---|---|---|
| d1.00 | Phase current U [A] | 0.1A | Read |
| d1.01 | Phase current V [A] | 0.1A | Read |
| d1.02 | Phase current W [A] | 0.1A | Read |
| d1.05 | Current Id filtered Display | 0.01A | Read |
| d1.06 | Current Iq filtered Display | 0.01A | Read |
| d1.10 | Signed rotor frequency | 0.1Hz | Read |
| d1.11 | Rotor speed | 1rpm | Read |
| d1.12 | Signed encoder frequency | 0.1Hz | Read |
| d1.15 | High resolution output power | 0.01kW | Read |
| d1.20 | Encoder angle | 0.01° | Read |

# 19.4 Appendix IV: Certification

## 19.4.1 CE

### Declaration of conformity

For Frequency Converters VFC x615 (0K40~400K), there are declarations of conformity which confirm that the devices comply with the applicable EN Standards and EC Directives. If required, you may ask our sales representative for the declarations of conformity.

| EU directives | Standard |
|---|---|
| Low-Voltage Directive 2014/35/EU | EN 61800-5-1 (IEC 61800-5-1: 2007) |
| EMC Directive 2014/30/EU | EN 61800-3 (IEC 61800-3: 2004+A1: 2012) |

**Tab. 19-1:** EU directives and standards

### CE label



**Fig. 19-12:** CE label

### High-voltage test

According to standard EN 61800-5-1, VFC x615 (0K40~400K) components are tested with high voltage.

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