The Drive & Control Company

Rexroth
Bosch Group

# Frequency Converter

## EFC 3610 / EFC 5610 Series

**Operating Instructions**
**R912005854**

Edition 08

## Record of Revision

| Edition | Release Date | Notes |
|---|---|---|
| DOK-RCON03-EFC-X610***-IT01-EN-P | 2014.10 | First release |
| DOK-RCON03-EFC-X610***-IT02-EN-P | 2014.12 | New functions |
| DOK-RCON03-EFC-X610***-IT03-EN-P | 2015.05 | New functions |
| DOK-RCON03-EFC-X610***-IT04-EN-P | 2015.11 | New functions |
| DOK-RCON03-EFC-X610***-IT05-EN-P | 2016.04 | New functions |
| DOK-RCON03-EFC-X610***-IT06-EN-P | 2017.02 | New functions |
| DOK-RCON03-EFC-X610***-IT07-EN-P | 2017.08 | New functions |
| DOK-RCON03-EFC-X610***-IT08-EN-P | 2018.04 | New functions |

## Version Matching Table

| Firmware | Operating Instructions | Quick Start Guide |
|---|---|---|
| 01V20 | Edition 02 | Edition 02 |
| 03V02 | Edition 03 | Edition 04 |
| 03V08 | Edition 04 | Edition 06 |
| 03V12 | Edition 05 | Edition 07 |
| 03V20 | Edition 06 | Edition 09 |
| 03V24 | Edition 07 | Edition 11 |
| 03V26 | Edition 08 | Edition 12 |

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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 |
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| **⚠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 Karšti paviršiai (> 60 °C)! Nudegimo pavojus!**<br>Venkite liesti metalinius paviršius (pvz., radiatorių). Išlaikykite pavaros komponentų atvėsimo trukmę (bent 15 minučių). | **⚠ ETTEVAATUST Kuumad välispinnad (> 60 °C)! Põletusoht!**<br>Vältige metalsete välispindade (nt radiaatorid) puudutamist. Pidage kinni ajamikomponentide mahajahtumisajast (vähemalt 15 minutit). | **⚠ ΠΡΟΣΟΧΗ 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 Netinkamas darbas transportuojant ir montuojant! Susižalojimo pavojus!**<br>Naudokite tinkamus montavimo ir transportavimo įrenginius.<br>Naudokite tinkamus įrankius ir asmens saugos priemones. | **⚠ ETTEVAATUST Asjatundmatu käsitsemine transportimisel ja montaažil! Vigastusoht!**<br>Kasutage sobivaid montaaži- ja transpordiseadiseid.<br>Kasutage sobivaid tööriistu ja isiklikku kaitsevarustust. | **⚠ ΠΡΟΣΟΧΗ 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 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 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 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.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.

- 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 **5 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.

- ConverterWorks

  Click www.boschrexroth.com, choose "Products > Electric Drives and Controls > Frequency Converters > EFC3610 (EFC5610) > 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/various/utilities/mediadirectory/

| Documentation type | Short text / Type code | Material number |
|---|---|---|
| Operating Instructions | DOK-RCON03-EFC-x610***-ITRS-EN-P | R912005854 |
| Quick Start Guide | DOK-RCON03-EFC-x610***-QURS-EN-P | R912005856 |
| 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-RCON03-EFC*BRAKE**-ITRS-EN-P | R912007235 |
| Product Insert (Encoder Card) | DOK-RCON0*-ABZ*ENCODER-ISRS-EN-P | R912004809 |
| Product Insert (Resolver Card) | DOK-RCON0*-RESOL**CARD-ISRS-EN-P | R912007839 |

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

# 4 Delivery and Storage

## 4.1 Product Identification

### 4.1.1 Packing Nameplate

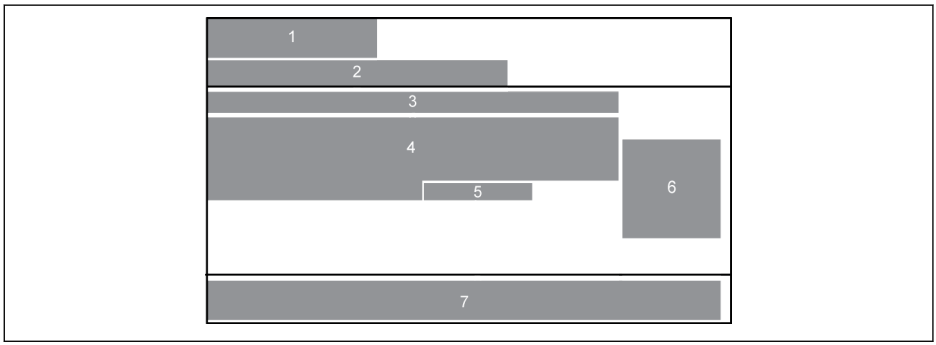
Check if the model information on the packing nameplate is the same as you ordered **immediately** after receipt. If the model is wrong, please contact Bosch Rexroth distributor.

**1** Product series
**2** Short text / Type code
**3** Volume
**4** Net weight
**5** Material number
**6** Product version index
**7** Mass weight
**8** Production week: e.g., 14W20 means week 20 in 2014
**9** Product QR code
**10** Serial number
**11** Manufacturer
**12** QR code (Internal use)
**13** Certification

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

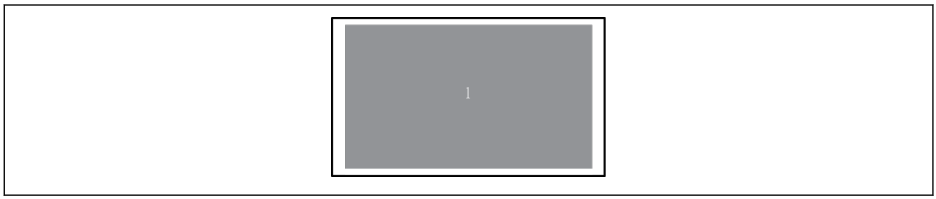
### 4.1.2 Product Nameplate

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** Brand logo
**2** Product series
**3** Short text / Type code
**4** Technical data
**5** Production week: e.g., 14W20 means week 20 in 2014
**6** Product QR code
**7** Manufacturer

**Fig. 4-2:** Product nameplate1




**1** Certification

**Fig. 4-3:** Product nameplate2

## 4.2 Remove from Packing Box

For models of 30K0 and above, there are four eyebolts on the side of the device for user to remove (or lift) the device from packing box.

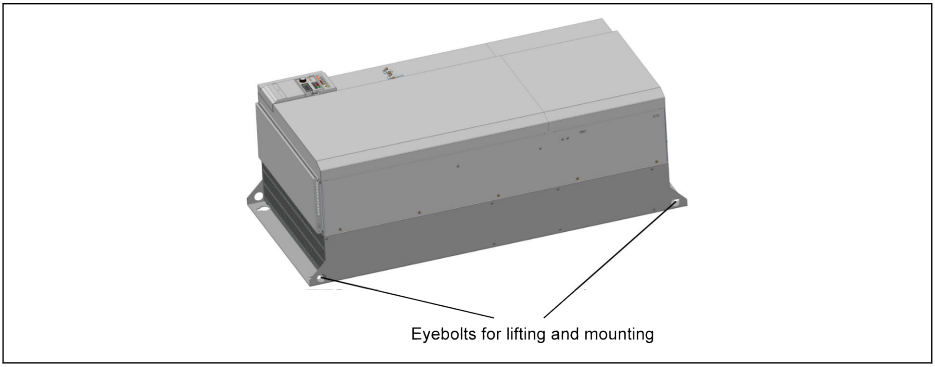



**Fig. 4-4:** Eyebolts for lifting and mounting

## 4.3 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.

## 4.4 Scope of Supply

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

- Frequency Converter EFC x610 (According to type code)
- Safety Instructions (Multi-lingual)
- Quick Start Guide
- Instruction Manual (UL)

## 4.5 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

## 4.6 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:

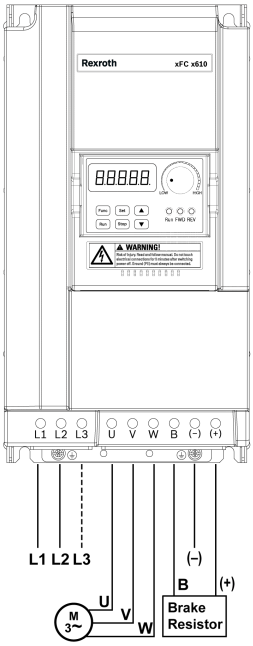
- Run Frequency Converter EFC x610 under power $U_{LN}$ for at least 1 hour.
- For more information of electrolytic capacitors, please contact service.

| 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 200 VAC 380 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 | | | **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 | | | **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 57.

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)<br>3P 200...240 VAC (-10 % / +10 %) (IT-Net, TN-Net)<br>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)<br>0.4...11 kW (3P 200 VAC)<br>0.4...160 kW (3P 380 VAC) |
| Rated frequency | 0.00...400.00 Hz |
| Default carrier frequency | 0K40...4K00: 6k<br>5K50...22K0 (Heavy Duty): 6k<br>5K50...22K0 (Normal Duty): 4k<br>30K0...90K0: 4k<br>110K...160K: 2k |
| Carrier frequency range | 0.4...22 kW: 1...15 kHz<br>30...160 kW: 1...12 kHz |
| Efficiency | > 95 % |
| Overload capability | Heavy Duty*: 200 % of rated current for 1 s [1)]<br>Heavy Duty: 150 % of rated current for 60 s [2)]<br>Normal Duty*: 120 % of rated current for 60 s [3)] |
| dv / dt (Without filter) | < 5kV / us |

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

1): 200 % of HD rated current for 1 s, and then 19 s with rated current for recovery from the overload influence, after this comes next overload period.

2): 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.

3): 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, 2-wire / 3-wire control, quick start parameters, parameter replication, output current limitation, power fault ride-through, safe torque off (STO), 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 extension 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...45 °C |
| Derating / ambient temperature | 1.5 % / 1 °C (45...55 °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<br>DIN rail mounting |
| Cooling type | • Natural cooling:<br>1P 200 / 3P 380 VAC: ≤ 0K75<br>3P 200 VAC: 0K40<br>• Enforced air cooling:<br>1P 200 / 3P 380 VAC: ≥ 1K50<br>3P 200 VAC: 0K75...11K0 |
| Certification | CE (applicable to 0K40...160K)<br>cUL (applicable to 0K40...160K)<br>EAC (applicable to 0K40...160K)<br>RCM (applicable to 0K40...90K0) |

## 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] | 200 V / 240 V Input current [A] | 200 V / 240 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 0K40 | 0.4 | 3.6 / 3.0 | 2.4 / 2.0 | 0.8 |
| 0K75 | 0.75 | 5.8 / 4.9 | 4.1 / 3.4 | 1.4 |
| 1K50 | 1.5 | 9.4 / 7.8 | 7.3 / 6.1 | 2.5 |
| 2K20 | 2.2 | 12.9 / 10.7 | 10.1 / 8.4 | 3.5 |
| 3K00 | 3.0 | 16.5 / 13.8 | 13.4 / 11.2 | 4.7 |
| 4K00 | 4.0 | 21.6 / 18.0 | 17.5 / 14.6 | 6.1 |
| 5K50 | 5.5 | 28.9 / 24.1 | 23.4 /19.5 | 8.1 |
| 7K50 | 7.5 | 38.8 / 32.4 | 31.1 / 25.9 | 10.8 |
| 11K0 | 11.0 | 51.8 / 43.2 | 44.9 / 37.4 | 15.5 |

**Tab. 6-2:** 3P 200 VAC 0K40...11K0 electric data

3P 200 VAC: available with ONLY EFC 5610.

| 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. 6-3:** 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 | 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 | 56.8 / 44.9 | 60.8 / 48.1 | 40.0 |
| 37K0 | 37.0 | 69.6 / 55.1 | 73.7 / 58.3 | 48.5 |
| 45K0 | 45.0 | 86.0 / 68.0 | 89.0 / 71.0 | 58.6 |
| 55K0 | 55.0 | 105.0 / 83.0 | 108.0 / 86.0 | 71.3 |
| 75K0 | 75.0 | 140.0 / 111.0 | 147.0 / 116.0 | 96.6 |
| 90K0 | 90.0 | 167.0 / 133.0 | 176.0 / 139.0 | 115.7 |
| 110K | 110.0 | 205.0 / 162.0 | 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 |

**Tab. 6-4:** 3P 380 VAC 5K50...160K, electric data, Heavy Duty

30K0...160K: available with ONLY EFC 5610.

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 | 11.0 | 28.0 / 22.2 | 24.3 / 19.2 | 16.0 |
| 11K0 | 15.0 | 37.8 / 29.9 | 32.4 / 25.6 | 21.3 |
| 15K0 | 18.5 | 45.8 / 36.3 | 39.2 / 31.0 | 25.8 |
| 18K5 | 22.0 | 52.7 / 41.7 | 45.0 / 36.0 | 29.7 |
| 22K0 | 30.0 | 71.2 / 56.3 | 60.8 / 48.0 | 40.0 |
| 30K0 | 37.0 | 69.6 / 55.1 | 73.7 / 58.3 | 48.5 |
| 37K0 | 45.0 | 84.2 / 66.6 | 89.1 / 70.5 | 58.7 |
| 45K0 | 55.0 | 105.0 / 83.0 | 108.0 / 86.0 | 71.3 |
| 55K0 | 75.0 | 140.0 / 111.0 | 147.0 / 116.0 | 96.6 |
| 75K0 | 90.0 | 167.0 / 133.0 | 176.0 / 139.0 | 115.7 |
| 90K0 | 110.0 | 205.0 / 162.0 | 212.0 / 168.0 | 139.6 |
| 110K | 132.0 | 252.0 / 200.0 | 253.0 / 200.0 | 166.0 |

| Model | Motor power Normal Duty [kW] | 380 V / 480 V Input current [A] | 380 V / 480 V Output current [A] | Output capacity [kVA] |
|---|---|---|---|---|
| 132K | 160.0 | 305.0 / 242.0 | 303.0 / 240.0 | 199.0 |
| 160K | 200.0 | 383.0 / 303.0 | 380.0 / 300.0 | 250.0 |

**Tab. 6-5:** 3P 380 VAC 5K50...160K, electric data, Normal Duty

30K0...160K: available with ONLY EFC 5610.

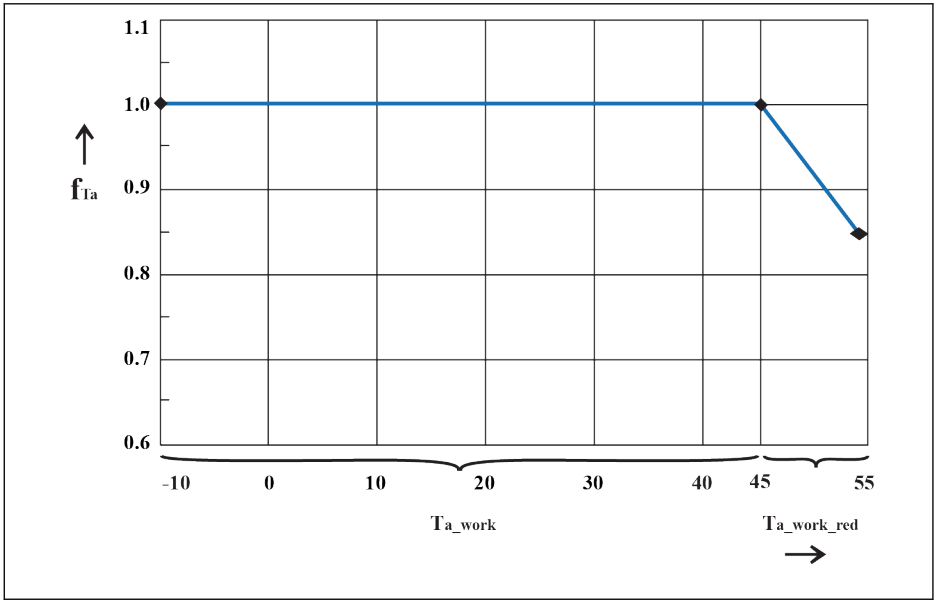
Please select the current rating of frequency converter according to the motor rated current on the nameplate.

## 6.2.2 Derating of Electric Data

### Derating and ambient temperature

The ambient temperature for Frequency Converter EFC x610 is -10...55 ℃. 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...45 ℃, there will be no need for derating.
- If the ambient temperature is 45...55 ℃, 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 EFC x610 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.

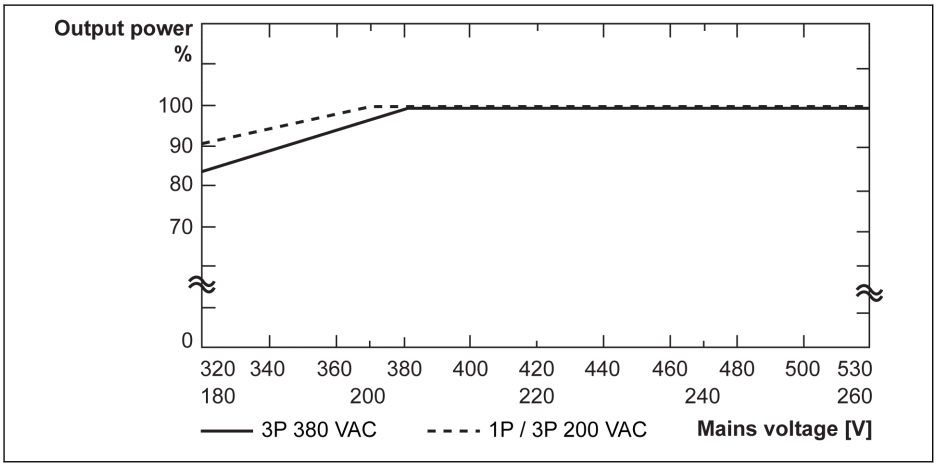
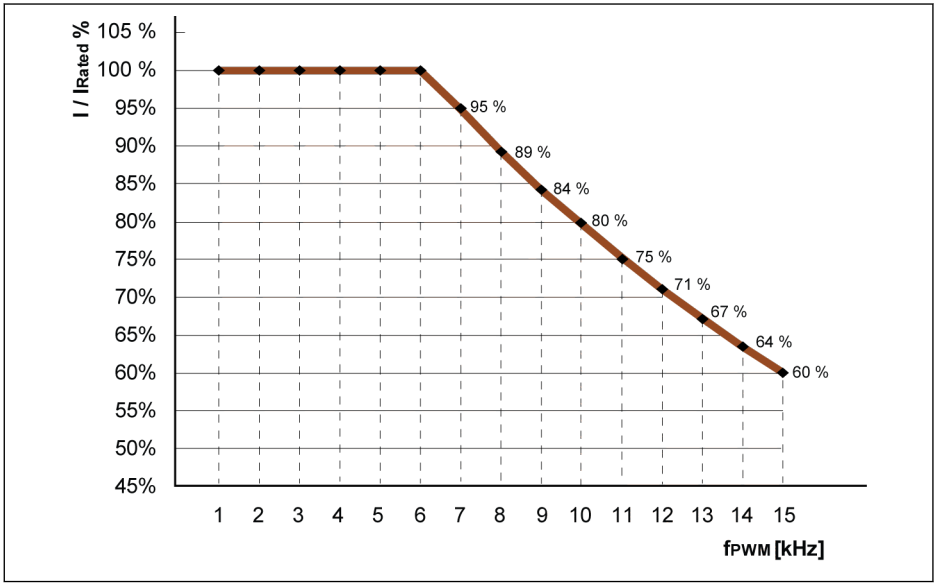



**Fig. 6-2:** Derating and mains voltage

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

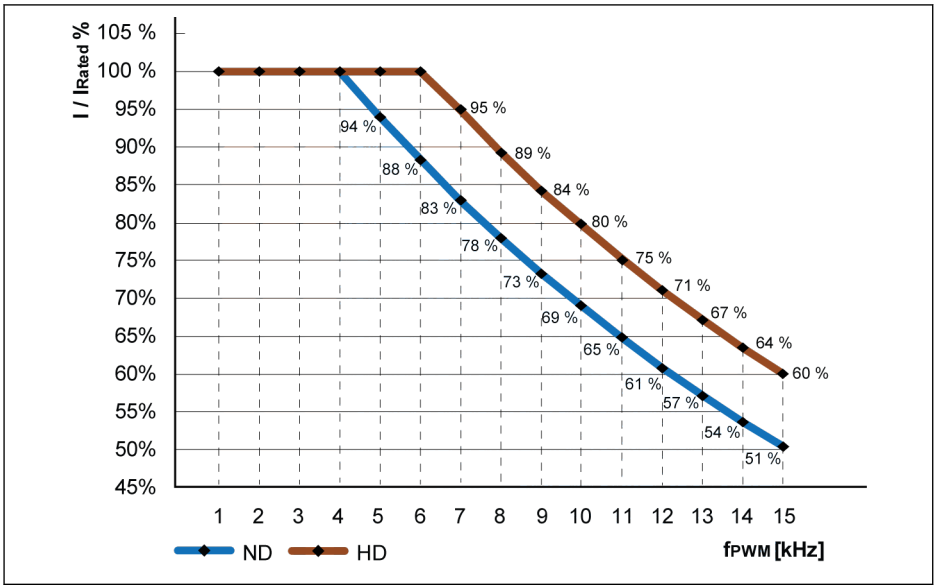
## Derating and carrier frequency

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:



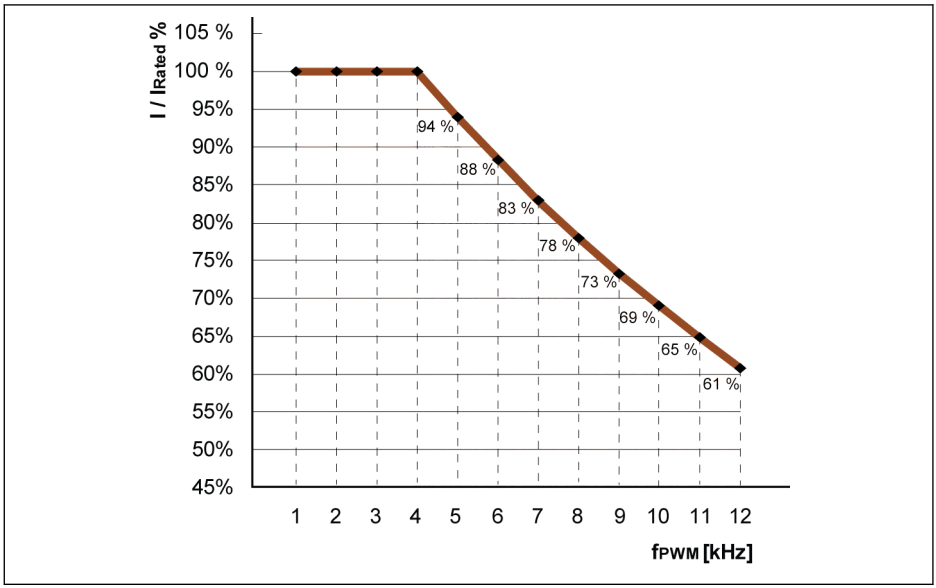

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency

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



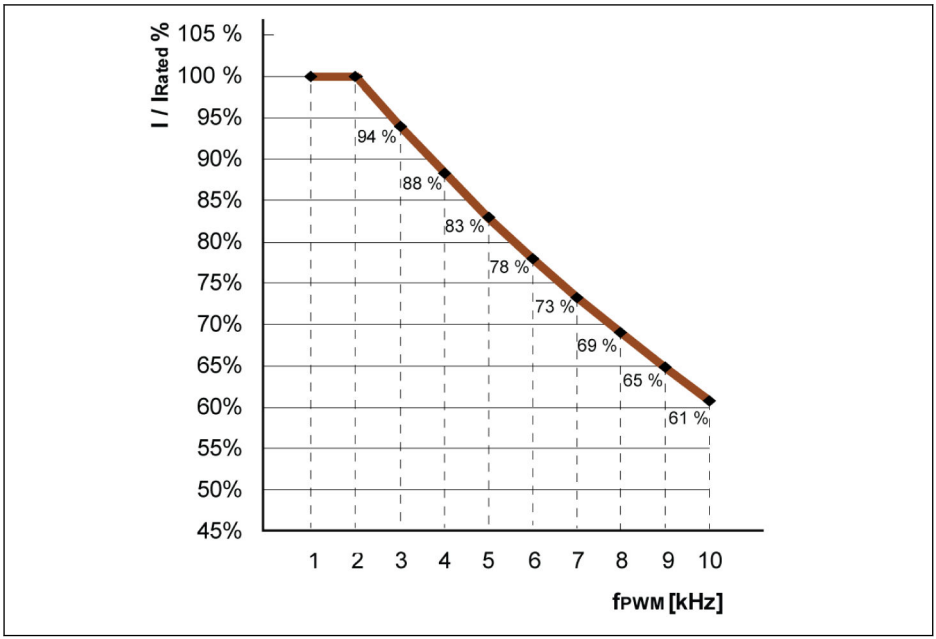

**I / $I_{rated}$ %** Percentage of rated output current
**$f_{PWM}$** PWM or carrier frequency
**ND** Normal Duty
**HD** Heavy Duty

**Fig. 6-4:** Derating and carrier frequency for 5K50...22K0 models




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

**Fig. 6-5:** Derating and carrier frequency for 30K0...90K0 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 110K...160K models (Normal Duty and Heavy Duty)

### 6.2.3 Maximum Length of Motor Cables

| Model | Configuration | Maximum length of motor cables | |
|---|---|---|---|
| | | C3 [m] | C1 [m] |
| 0K40...4K00 | EFC x610 (internal EMC filter) | 15 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 50 | 15 |
| 5K50...18K5 | EFC x610 (internal EMC filter) | 30 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 50 | 15 |
| 22K0 | EFC x610 (internal EMC filter) | 30 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 50 | – |
| 30K0...37K0 | EFC x610 (internal EMC filter) | 50 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 100 | – |
| 45K0...90K0 | EFC x610 (internal EMC filter) | 50 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 100 | – |
| 110K...160K | EFC x610 (internal EMC filter) | 75 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 150 | – |

**Tab. 6-6:** 1P 200 VAC / 3P 380 VAC maximum length of motor cables

| Model | Configuration | Maximum length of motor cables | |
|---|---|---|---|
| | | C3 [m] | C1 [m] |
| 0K40...2K20 | EFC x610 (internal EMC filter) | 15 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 50 | 15 |
| 4K00...11K0 | EFC x610 (internal EMC filter) | 30 | – |
| | EFC x610 (internal EMC filter) + External mains EMC filter | 50 | 15 |

**Tab. 6-7:** 3P 200 VAC maximum length of motor cables

1. **ONLY CONDUCTED EMISSION** can be guaranteed for C1.
2. **SHIELDED MOTOR CABLES** are used in test.
3. Longer motor cable length is possible with an additional output choke on request.

### 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 chapter 6.1.9 "Conditions" on page 24). 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.

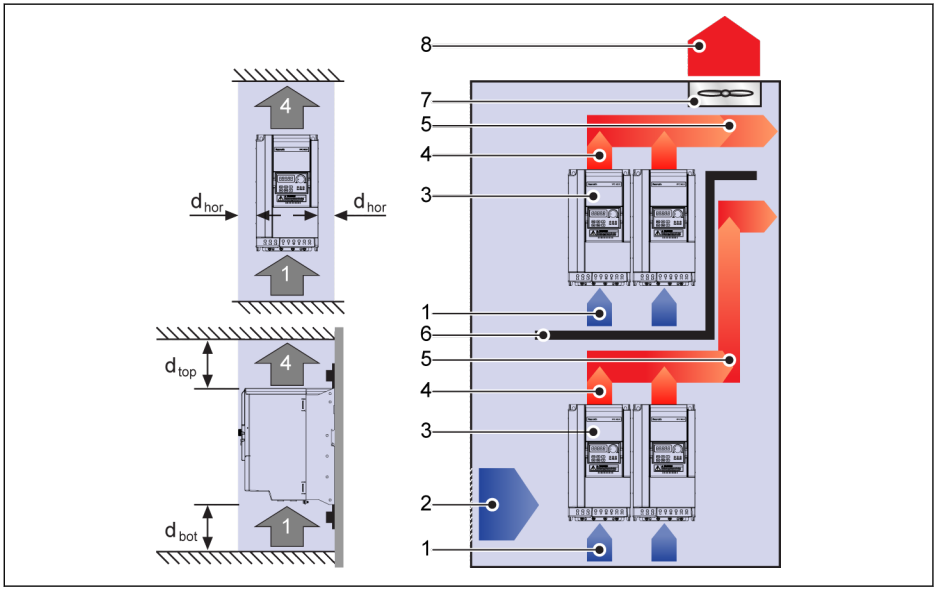



**Fig. 7-1:** Mounting distance and arrangement

$d_{hor}$ (Distance horizontal):

$d_{hor}$ = 0 mm (0K40...22K0); $d_{hor}$ = 10 mm (30K0...160K)

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

$d_{top}$ = 125 mm (0K40...90K0); $d_{top}$ = 400 mm (110K...160K)

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

$d_{bot}$ = 125 mm (0K40...90K0); $d_{bot}$ = 400 mm (110K...160K)

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 200 VAC

| Frame | Model | Heat dissipation | |
|---|---|---|---|
| | | [W] | [BTU/h] |
| B | 0K40 | 37 | 126 |
| C | 0K75 | 75 | 256 |
| D | 1K50 | 135 | 461 |
| D | 2K20 | 180 | 614 |
| E | 3K00 | 210 | 714 |
| E | 4K00 | 255 | 867 |
| F | 5K50 | 320 | 1,088 |
| F | 7K50 | 435 | 1,479 |
| G | 11K0 | 640 | 2,176 |

**Tab. 7-2:** 3P 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 | 255 | 867 |

| Frame | Model | Heat dissipation | |
|---|---|---|---|
| | | [W] | [BTU/h] |
| F | 11K0 | 320 | 1,088 |
| F | 15K0 | 435 | 1,479 |
| G | 18K5 | 530 | 1,802 |
| G | 22K0 | 640 | 2,176 |
| H | 30K0 | 745 | 2,533 |
| H | 37K0 | 874 | 2,972 |
| I | 45K0 | 1,405 | 4,794 |
| I | 55K0 | 1,951 | 6,658 |
| J | 75K0 | 2,074 | 7,076 |
| J | 90K0 | 2,653 | 9,051 |
| K | 110K | 2,530 | 8,602 |
| K | 132K | 2,772 | 9,425 |
| L | 160K | 3,813 | 13,002 |

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

## 7.3 Air Flow of Fans

### 1P 200 VAC

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

**Tab. 7-4:** 1P 200 VAC air flow of fans

1P 200 VAC: Models 1K50...2K20 have only one fan for heat sink.

### 3P 200 VAC

| Frame | Model | Fan for heat sink | | Fan for internal components | |
|---|---|---|---|---|---|
| | | [CFM] | [m³/min] | [CFM] | [m³/min] |
| B | 0K40 | – | – | – | – |
| C | 0K75 | 19.20 | 0.54 | – | – |
| D | 1K50 | 19.20 | 0.54 | – | – |
| D | 2K20 | 19.20 | 0.54 | – | – |
| E | 3K00 | 40.00 | 1.13 | 32.17 | 0.91 |
| E | 4K00 | 40.00 | 1.13 | 32.17 | 0.91 |
| F | 5K50 | 56.50 | 1.60 | 34.90 | 0.99 |
| F | 7K50 | 56.50 | 1.60 | 34.90 | 0.99 |
| G | 11K0 | 49.20 | 1.39 | 47.60 | 1.35 |

**Tab. 7-5:** 3P 200 VAC air flow of fans

3P 200 VAC:

- Models 3K00 and above have only one fan for internal components.
- Models 0K75...4K00 have only one fan for heat sink.
- Models 5K50 and above have **TWO** fans for heat sink.

### 3P 380 VAC

| Frame | Model | Fan for heat sink | | Fan for internal components | |
|---|---|---|---|---|---|
| | | [CFM] | [m³/min] | [CFM] | [m³/min] |
| B | 0K40 | – | – | – | – |
| B | 0K75 | – | – | – | – |
| C | 1K50 | 19.20 | 0.54 | – | – |
| C | 2K20 | 19.20 | 0.54 | – | – |
| D | 3K00 | 19.20 | 0.54 | – | – |
| D | 4K00 | 19.20 | 0.54 | – | – |
| E | 5K50 | 40.00 | 1.13 | 32.17 | 0.91 |
| E | 7K50 | 40.00 | 1.13 | 32.17 | 0.91 |
| F | 11K0 | 56.50 | 1.60 | 34.90 | 0.99 |
| F | 15K0 | 56.50 | 1.60 | 34.90 | 0.99 |
| G | 18K5 | 40.00 | 1.13 | 34.90 | 0.99 |
| G | 22K0 | 49.20 | 1.39 | 47.60 | 1.35 |
| H | 30K0 | 120.20 | 3.40 | – | – |
| H | 37K0 | 120.20 | 3.40 | – | – |
| I | 45K0 | 215.74 | 6.11 | – | – |
| I | 55K0 | 215.74 | 6.11 | – | – |
| J | 75K0 | 215.74 | 6.11 | – | – |
| J | 90K0 | 215.74 | 6.11 | – | – |
| K | 110K | 243.64 | 6.90 | – | – |
| K | 132K | 243.64 | 6.90 | – | – |
| L | 160K | 243.64 | 6.90 | – | – |

**Tab. 7-6:** 3P 380 VAC air flow of fans

3P 380 VAC:

- Models 5K50...22K0 have only one fan for internal components.
- Models 30K0 and above have no fan for internal components.
- Models 1K50...7K50 have only one fan for heat sink.
- Models 11K0 and above have TWO fans for heat sink.

# 7.4 Figures and Dimensions

## 7.4.1 Figures

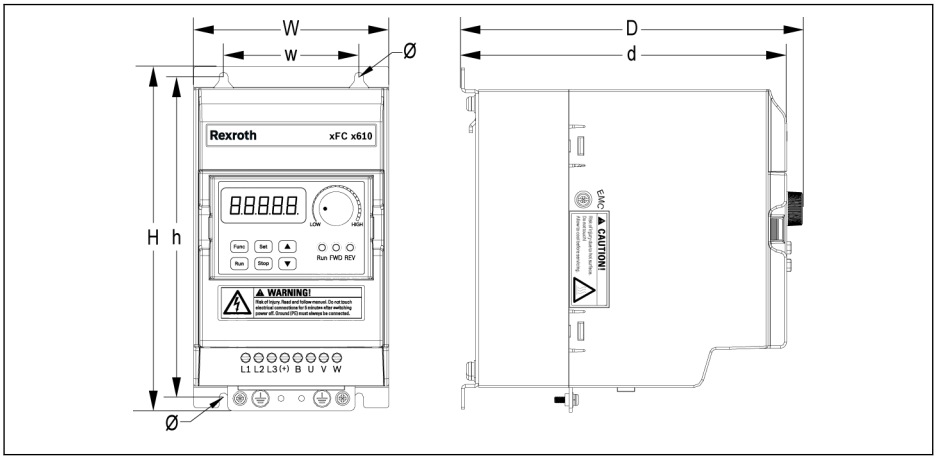



**Fig. 7-2:** EFC x610 0K40...4K00 dimensions figure (1P 200 VAC / 3P 380 VAC)

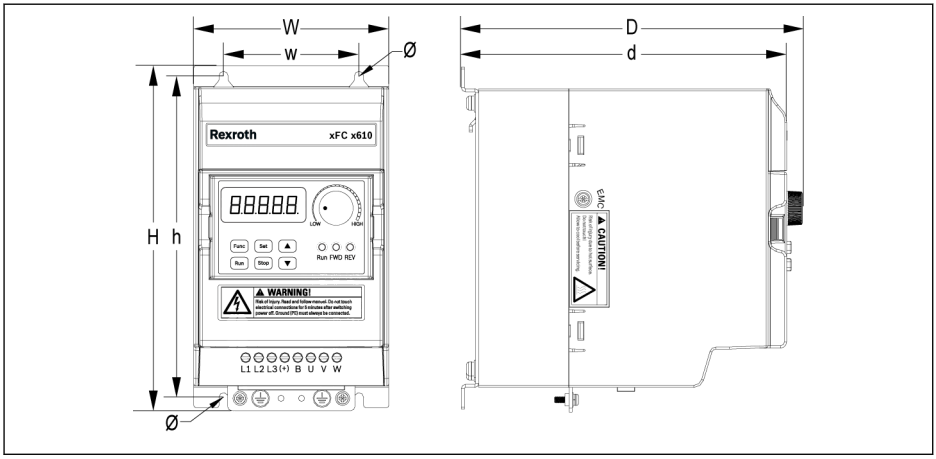



**Fig. 7-3:** EFC x610 0K40...2K20 dimensions figure (3P 200 VAC)

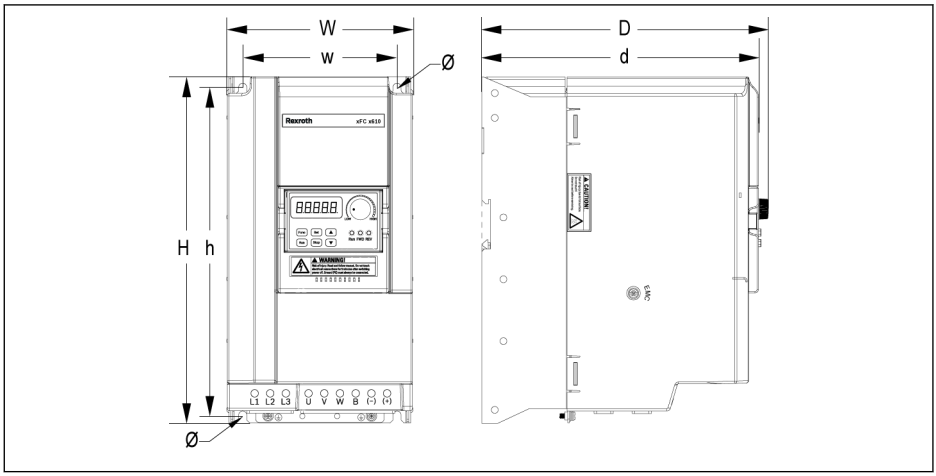



**Fig. 7-4:** EFC x610 3K00...11K0 dimensions figure (3P 200 VAC)

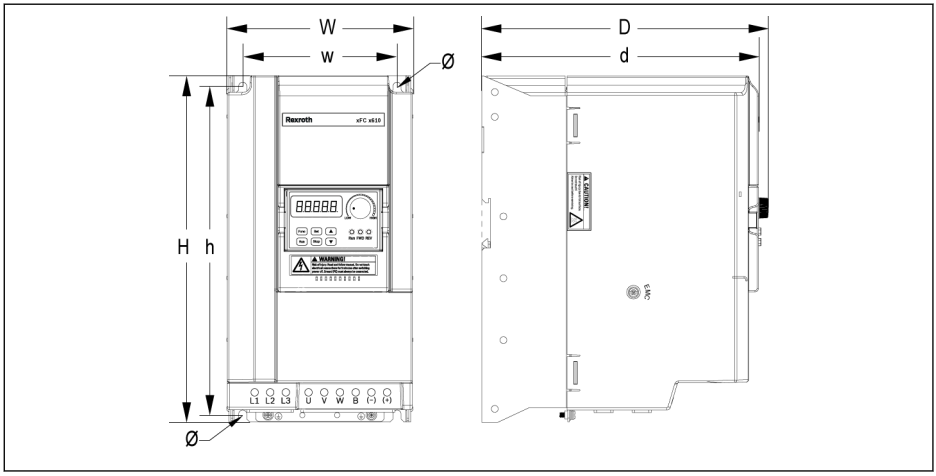



**Fig. 7-5:** EFC x610 5K50...22K0 dimensions figure (3P 380 VAC)

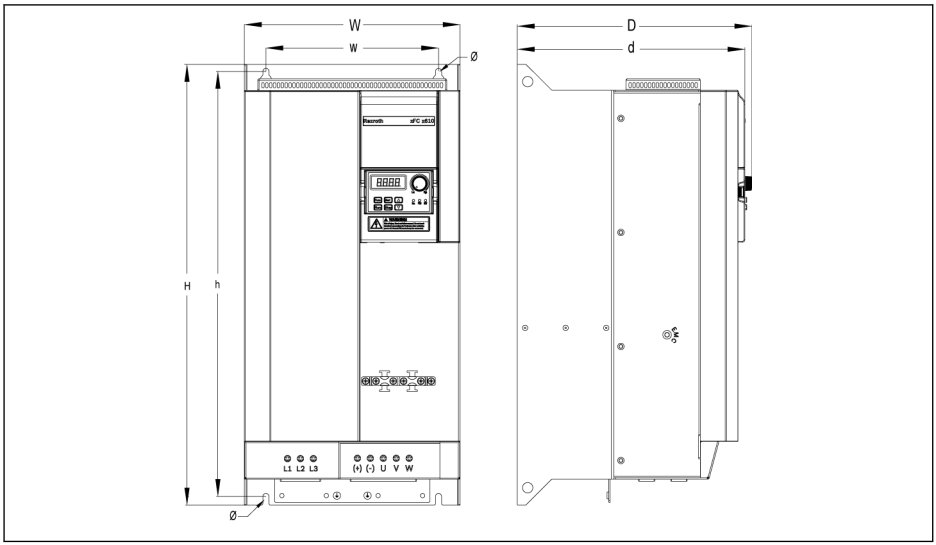



**Fig. 7-6:** EFC 5610 30K0...37K0 dimensions figure (3P 380 VAC)

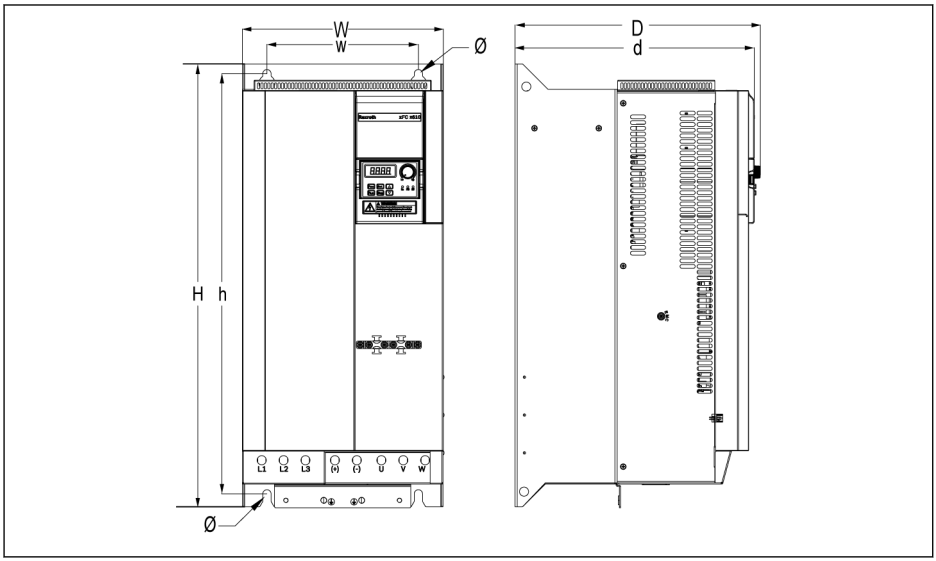



**Fig. 7-7:** EFC 5610 45K0...55K0 dimensions figure (3P 380 VAC)

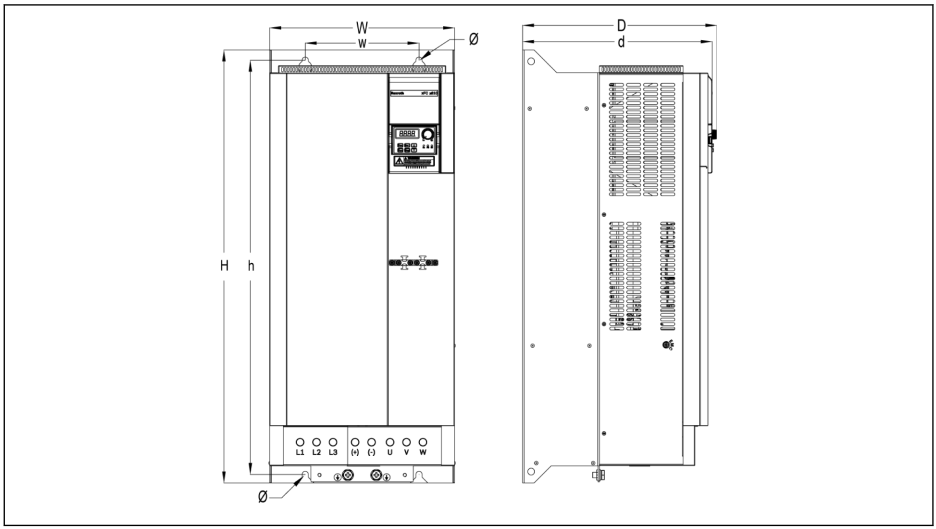



**Fig. 7-8:** EFC 5610 75K0...90K0 dimensions figure (3P 380 VAC)

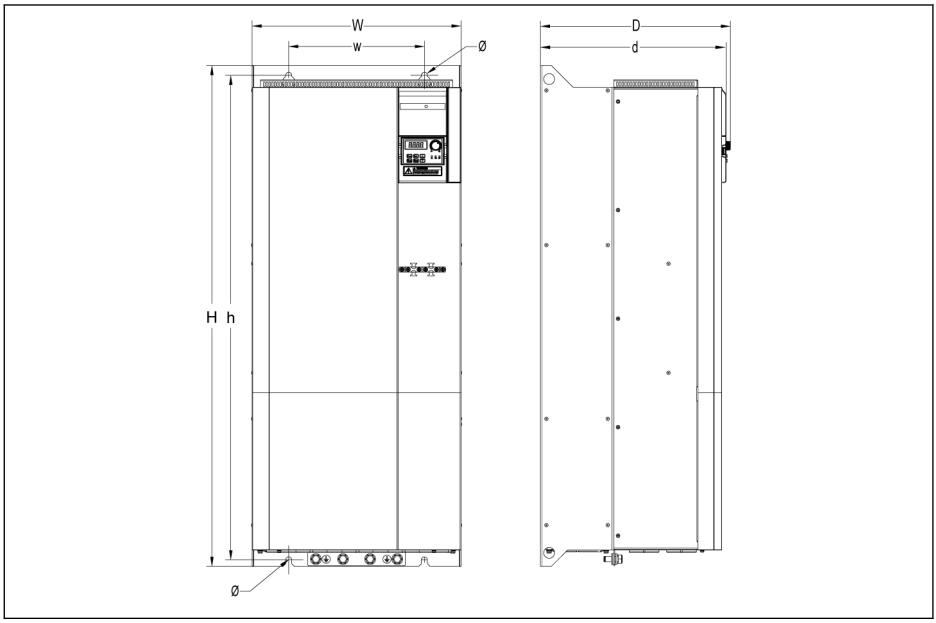



**Fig. 7-9:** EFC 5610 110K...132K dimensions figure (3P 380 VAC)

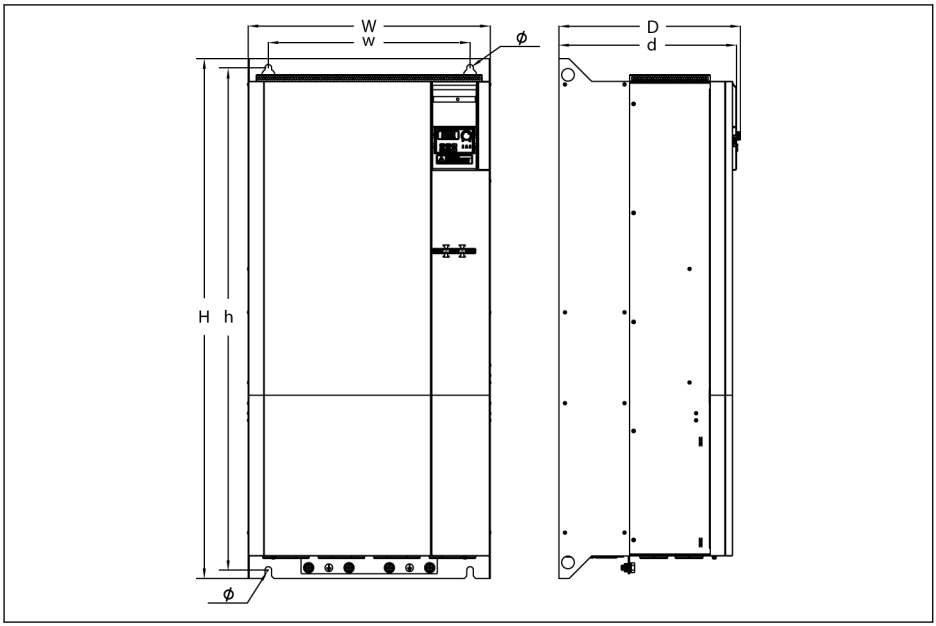



**Fig. 7-10:** EFC 5610 160K dimensions figure (3P 380 VAC)

## 7.4.2 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 | 1.9 |
| D | 2K20 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |

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

| Frame | Model① | Dimensions [mm] | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D④ | w | h | d④ | Ø | | |
| B③ | 0K40 | 95 | 166 | 167 | 66 | 156 | 159 | 4.5 | M4 | 1.5 |
| C③ | 0K75 | 95 | 206 | 170 | 66 | 196 | 162 | 4.5 | M4 | 1.9 |
| D③ | 1K50 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |
| D③ | 2K20 | 120 | 231 | 175 | 80 | 221 | 167 | 4.5 | M4 | 2.6 |
| E③ | 3K00 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 3.9 |
| E③ | 4K00 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 4.3 |
| F③ | 5K50 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 5.7 |
| F③ | 7K50 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 6.4 |
| G③ | 11K0 | 165 | 315 | 241 | 140 | 300 | 233 | 6.5 | M6 | 8.5 |

**Tab. 7-8:** EFC x610 3P 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 | 1.9 |
| C | 2K20 | 95 | 206 | 170 | 66 | 196 | 162 | 4.5 | M4 | 1.9 |
| 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 | 3.9 |
| E | 7K50 | 130 | 243 | 233 | 106 | 228 | 225 | 6.5 | M6 | 4.3 |
| F | 11K0 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 5.7 |
| F | 15K0 | 150 | 283 | 233 | 125 | 265 | 225 | 6.5 | M6 | 6.4 |
| G | 18K5 | 165 | 315 | 241 | 140 | 300 | 233 | 6.5 | M6 | 8.0 |

| Frame | Model① | Dimensions [mm] | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D④ | w | h | d④ | Ø | | |
| G | 22K0 | 165 | 315 | 241 | 140 | 300 | 233 | 6.5 | M6 | 8.5 |
| H③ | 30K0 | 250 | 510 | 272 | 200 | 492 | 264 | 7.0 | M6 | 27.5 |
| H③ | 37K0 | 250 | 510 | 272 | 200 | 492 | 264 | 7.0 | M6 | 29.5 |
| I③ | 45K0 | 265 | 585 | 325 | 200 | 555 | 317 | 11.0 | M10 | 39.0 |
| I③ | 55K0 | 265 | 585 | 325 | 200 | 555 | 317 | 11.0 | M10 | 42.0 |
| J③ | 75K0 | 325 | 760 | 342 | 200 | 727 | 334 | 11.0 | M10 | 54.0 |
| J③ | 90K0 | 325 | 760 | 342 | 200 | 727 | 334 | 11.0 | M10 | 61.0 |
| K③ | 110K | 385 | 923 | 350 | 250 | 893 | 342 | 11.0 | M10 | 71.7 |
| K③ | 132K | 385 | 923 | 350 | 250 | 893 | 342 | 11.0 | M10 | 76.6 |
| L③ | 160K | 480 | 1030 | 360 | 400 | 995 | 352 | 13.0 | M12 | 108.0 |

**Tab. 7-9:** EFC x610 3P 380 VAC dimensions

- ①: For complete type code for frequency converter, see chapter 20.2 "Appendix II: Type Coding" on page 395.

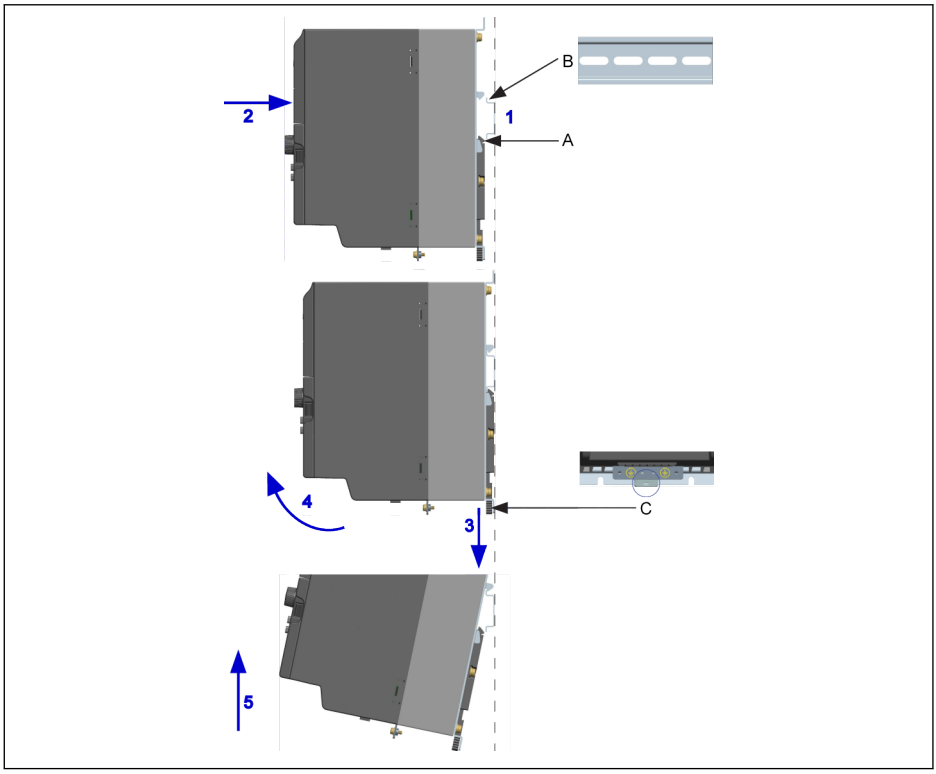
  E.g., type code for EFC 5610 5K50 (3P 380 VAC model) is:

  EFC5610-5K50-3P4-MDA-7P-NNNNN-NNNN.
- ②: 4 screws are needed for mounting of EFC x610.
- ③: **ONLY** available with EFC 5610.
- ④: Add **35 mm** to dimension **D** and **d** when extension module is used and installed.

### 7.4.3 DIN Rail Mounting

Besides wall mounting with screws, below models (does not include cold plate models) also provide DIN rail mounting.

- 1P 200 VAC: 0K40...2K20
- 3P 200 VAC: 0K40...4K00
- 3P 380 VAC: 0K40...7K50




**A** Mounting buckle
**B** Mounting rail
**C** Disassembly handle

**Fig. 7-11:** DIN rail mounting and disassembly

**Mounting steps:**

1: Hold the frequency converter and keep component A and the lower edge of component B at the same position level.

2: Push the frequency converter horizontally till a buckle sound indicates a successful mounting.

**Disassembly steps:**

3: Pull down component C and hold it.

4: Rotate the frequency converter to an appropriate angle as the arrow indicates.

5: Lift the frequency converter upwards.

## 7.5 Installation of Cold Plate Models

### 7.5.1 Installation Conditions

See chapter 7.1 "Installation Conditions" on page 36.

### 7.5.2 Heat Dissipation

| Frame | Model | Cold plate loss [W] | Heat dissipation | |
|---|---|---|---|---|
| | | | [W] | [BTU/h] |
| B | 0K40 | 20 | 40 | 136 |
| B | 0K75 | 35 | 70 | 256 |
| C | 1K50 | 52 | 120 | 409 |
| D | 2K20 | 94 | 165 | 563 |

**Tab. 7-10:** Heat dissipation of EFC 5610 1P 200 VAC (cold plate models)

| Frame | Model | Cold plate loss [W] | Heat dissipation | |
|---|---|---|---|---|
| | | | [W] | [BTU/h] |
| B | 0K40 | 15 | 20 | 68 |
| B | 0K75 | 24 | 37 | 126 |
| C | 1K50 | 45 | 75 | 256 |
| C | 2K20 | 54 | 99 | 338 |
| D | 3K00 | 86 | 135 | 461 |
| D | 4K00 | 106 | 180 | 614 |

**Tab. 7-11:** Heat dissipation of EFC 5610 3P 380 VAC (cold plate models)

## 7.5.3 Figures and Dimensions

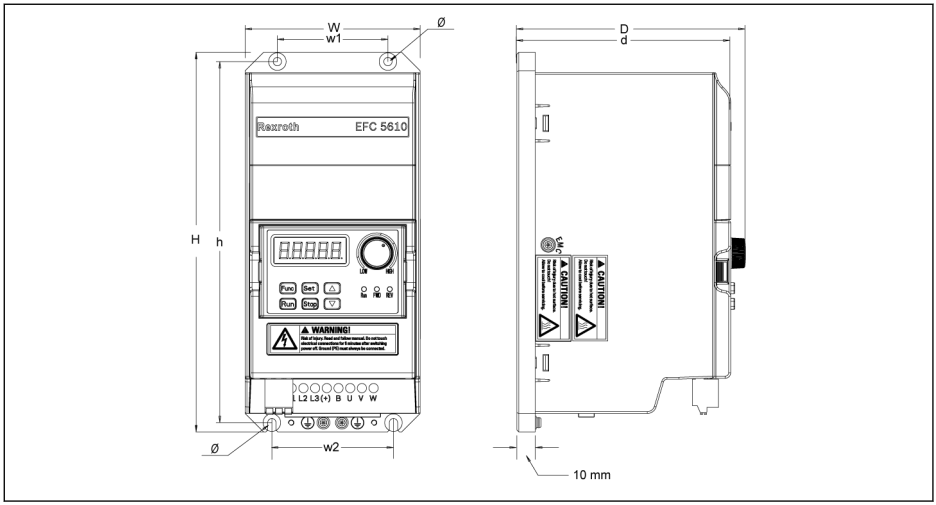



**Fig. 7-12:** EFC 5610 0K40...4K00 dimensions figure (cold plate models)

Cold plate models do not contain fan units.

| Frame | Model① | Dimensions [mm] | | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D③ | w1 | w2 | h | d③ | Ø | | |
| B | 0K40 | 95 | 166 | 124 | 60 | 66 | 156 | 116 | 4.5 | M4 | 1.0 |
| B | 0K75 | 95 | 166 | 124 | 60 | 66 | 156 | 116 | 4.5 | M4 | 1.0 |
| C | 1K50 | 95 | 206 | 124 | 60 | 66 | 196 | 116 | 4.5 | M4 | 1.2 |
| D | 2K20 | 120 | 231 | 124 | 60 | 66 | 221 | 116 | 4.5 | M4 | 1.5 |

**Tab. 7-12:** EFC 5610 1P 200 VAC dimensions (cold plate models)

| Frame | Model① | Dimensions [mm] | | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D③ | w1 | w2 | h | d③ | Ø | | |
| B | 0K40 | 95 | 166 | 124 | 60 | 66 | 156 | 116 | 4.5 | M4 | 1.1 |
| B | 0K75 | 95 | 166 | 124 | 60 | 66 | 156 | 116 | 4.5 | M4 | 1.1 |
| C | 1K50 | 95 | 206 | 124 | 60 | 66 | 196 | 116 | 4.5 | M4 | 1.4 |
| C | 2K20 | 95 | 206 | 124 | 60 | 66 | 196 | 116 | 4.5 | M4 | 1.4 |

| Frame | Model① | Dimensions [mm] | | | | | | | | Screw size② | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D③ | w1 | w2 | h | d③ | Ø | | |
| D | 3K00 | 120 | 231 | 124 | 60 | 66 | 221 | 116 | 4.5 | M4 | 1.8 |
| D | 4K00 | 120 | 231 | 124 | 60 | 66 | 221 | 116 | 4.5 | M4 | 1.8 |

**Tab. 7-13:** EFC 5610 3P 380 VAC dimensions (cold plate models)

- ①: For complete type code of frequency converter, see chapter 20.2 "Appendix II: Type Coding" on page 395.
- ②: 4 screws (M4) are needed for mounting.
- ③: Add **35 mm** to dimension **D** and **d** when extension module is used and installed.

### 7.5.4 Use of Thermal Compound Paste (Only for Cold Plate Models)

To use the thermal compound paste, the surface of heatsink and cold plate must be free from dust, dirt, oil and particles.

In addition, the heatsink surface must meet the following three conditions:

- Minimum surface flatness: 50 µm (DIN EN ISO 1101)
- Maximum surface roughness: 6 µm (DIN EN ISO 4287)
- Maximum peak-valley height of the surface: 10 µm (DIN EN ISO 4287)

It is recommended to use P12 thermal compound paste from Wacker Chemie. It should be applied evenly. The maximum thickness is 100 µm.

After the use of thermal paste, tighten four M4 fastening screws by following procedure.

1. Fix the screws with 0.5 Nm (hand tight, crosswise) in the sequence:
   1 -> 2 -> 3 -> 4

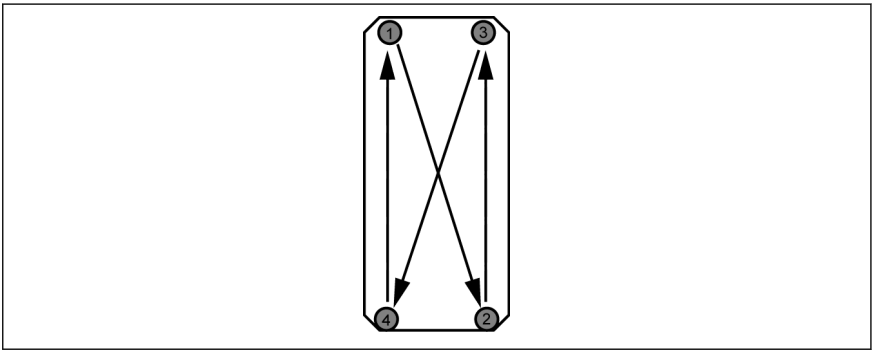



**Fig. 7-13:** Tightening sequence to mount the module to the heatsink

2. Tighten the screws with 2.0...2.5 Nm in the same sequence (crosswise):
   1 -> 2 -> 3 -> 4

Tighten the screws with specified torques. Failure to do so, may inhibit drive cooling and cause possible damage to the drive.

### 7.5.5 Selecting an External Heat Sink

The heat transfer principle from the cold plate to the heat sink ambient air is shown as below:

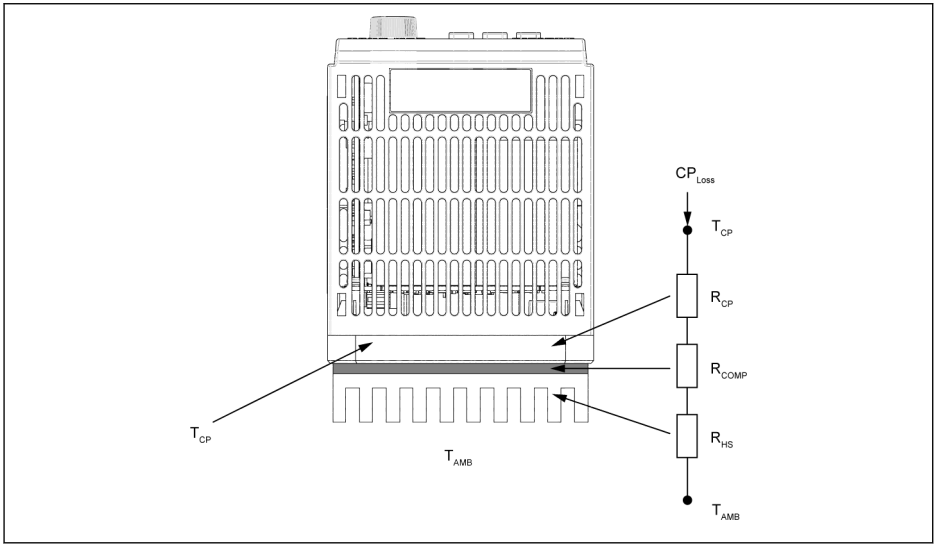



**Fig. 7-14:** Thermal equivalent circuit

- Temperature around the cold plate must be not more than 45 °C.
- Temperature of the cold plate must be not more than 70 °C.

The formula to calculate the maximum thermal resistance of the heat sink is as follows:

$$R_{HSmax} = \frac{T_{CPmax} - T_{AMB}}{CP_{Loss}} - R_{CP} - R_{COMP}$$

**Fig. 7-15:** Calculation formula of thermal resistance

$CP_{Loss}$: Cold plate loss [W]

$T_{CPmax}$: Maximum cold plate temperature [°C]

$R_{CP}$: Equivalent thermal resistance of cold plate [°C/W]

$R_{HSmax}$: Thermal resistance of external heat sink [°C/W]

$T_{AMB}$: External heat sink ambient temperature [°C]

$R_{COMP}$: Thermal resistance between cold plate and external heat sink [°C/W]

The thermal resistance between the cold plate and the external heat sink can be calculated by:

$$R_{COMP} = \frac{t_{com}}{k_{com} A_{com}}$$

**Fig. 7-16:** Calculation formula of $R_{COMP}$

$t_{com}$: The thickness of thermal compound paste [μm]

$k_{com}$: Thermal conductivity of thermal compound paste [W/m·°C]

$A_{com}$: Heat transfer area between cold plate and external heat sink [$m^2$]

- Use the formulas above to calculate the maximum thermal resistance of external heat sink $R_{HSmax}$. Select a heat sink with a smaller thermal resistance than $R_{HSmax}$. The heat sink dimensions should be closed to the cold plate dimensions.
- Due to uneven heat transfer across the cold plate (by arrangement of internal components), the effective area for heat transfer is about 70 % of cold plate area. This must be considered when calculating the thermal resistance.
- For a given ambient temperature $T_{AMB}$, the maximum cold plate temperature $T_{CPmax}$ must not exceed 70 °C. As $R_{CP}$ and $R_{COMP}$ is essentially fixed, this condition must be satisfied with a proper heat sink selection.

The table below shows the typical values of thermal resistance of cold plate.

| Model | $R_{CP}$ [°C/W] |
|---|---|
| 0K40 | 0.107 |
| 0K75 | |
| 1K50 | 0.114 |
| 2K20 | |
| 3K00 | 0.098 |
| 4K00 | |

**Tab. 7-14:** Typical values of thermal resistance of cold plate

- If the dimensions of heat sink are much larger than the cold plate, or if multiple drives are installed on one heat sink, it may be necessary to apply correction factors to calculate the thermal resistance value. Contact the heat sink manufacturer.
- It is recommended that the calculated $R_{HS}$ is multiplied by 0.7 to obtain a resistance value with a reasonable safety margin in order to ensure tripless drive operation.

# 8 Frequency Converter Wiring

## 8.1 Wiring Diagram

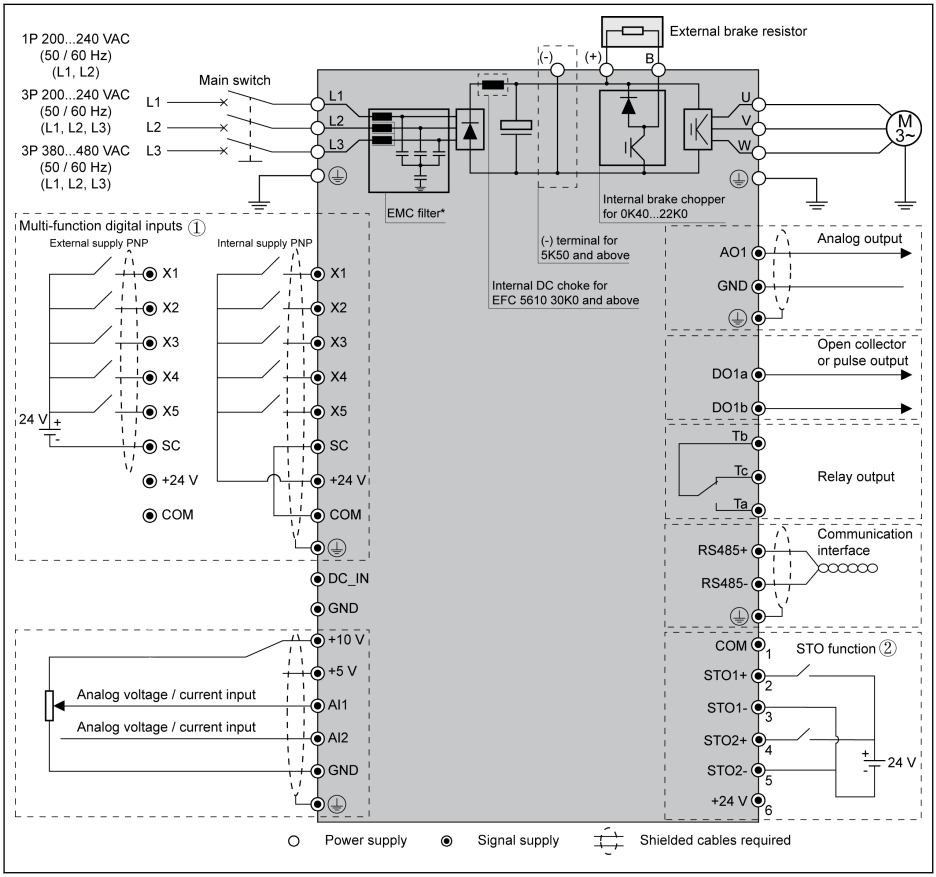



**Fig. 8-1:** Wiring diagram

- For cable size, fuse, screw torque, see chapter 8.2 "Cable Specifications" on page 57.
- For terminals, see chapter 8.3 "Terminals" on page 65.
- ①: NPN modes, see fig. 8-10 "Digital input NPN / PNP wiring" on page 74.
- ②: STO (Safe Torque Off) function is only available on EFC 5610 models.
- *: Can be disconnected by disassembly of a screw.
- 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...7K50, please refer to the torque data on labels.

| EFC x610 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.

| EFC x610 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 | 10.0 | 2.5 | 2.5 | 2.5 | 10.0<br>2.5*2 | 1.00* / 9.0 (M3) |
| 1K50 | 20.0 | 4.0 | 4.0 | 2.5 | 10.0<br>4.0*2 | 1.00* / 9.0 (M3) |

| EFC x610 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | | B1 | B2 | E | | |
| | [A] | [mm²] | | | [mm²] | [N·m / lbf·in] (Mx) |
| 2K20 | 20.0 | 4.0 | 4.0 | 2.5 | 10.0<br>4.0*2 | 1.00* / 9.0 (M3) |
| 3K00 | 32.0 | 6.0 | 6.0 | 4.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 4K00 | 40.0 | 6.0 | 10.0 | 6.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 5K50 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 7K50 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 11K0 | 100.0 | 25.0 | 35.0 | 25.0 | 25.0 | 3.73 / 33.0 (M5) |

**Tab. 8-2:** 3P 200 VAC fuse and cable dimensions for international without USA / Canada

| EFC x610 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | | B1 | B2 | E | | |
| | [A] | [mm²] | | | [mm²] | [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) |
| 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 | 40.0 | 6.0 | 10.0 | 6.0 | 10.0<br>6.0*2 | 1.20* / 10.5 (M4) |
| 11K0 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 15K0 | 50.0 | 10.0 | 10.0 | 10.0 | 10.0 | 1.76 / 15.6 (M4) |
| 18K5 | 80.0 | 25.0 | 25.0 | 16.0 | 16.0 | 3.73 / 33.0 (M5) |
| 22K0 | 100.0 | 25.0 | 35.0 | 25.0 | 25.0 | 3.73 / 33.0 (M5) |

| EFC x610 Model | Fuse (gG) | Power cables installation mode | | | PE Cable | Torque / Screw |
|---|---|---|---|---|---|---|
| | | B1 | B2 | E | | |
| | [A] | [mm²] | | | [mm²] | [N·m / lbf·in] (Mx) |
| 30K0 | 125.0 | 35.0 | 50.0 | 35.0 | 25.0 | 3.80 / 33.6 (M6) |
| 37K0 | 125.0 | 35.0 | 50.0 | 35.0 | 35.0 | 3.80 / 33.6 (M6) |
| 45K0 | 160.0 | 50.0 | 70.0 | 50.0 | 35.0 | 31.1 / 275.0 (5/16 in) |
| 55K0 | 200.0 | 70.0 | 95.0 | 70.0 | 50.0 | 31.1 / 275.0 (5/16 in) |
| 75K0 | 250.0 | 120.0 | 150.0 | 95.0 | 95.0 | 31.1 / 275.0 (5/16 in) |
| 90K0 | 250.0 | 120.0 | 150.0 | 95.0 | 95.0 | 31.1 / 275.0 (5/16 in) |
| 110K | 315.0 | 120.0 | 150.0 | 120.0 | 95.0 | 15.0 / 132.7 (M10)① |
| | | 95.0*2 | 95.0*2 | 95.0*2 | | 8.0 / 70.8 (M8)② |
| 132K | 315.0 | 185.0 | 240.0 | 185.0 | 120.0 | 15.0 / 132.7 (M10)① |
| | | 95.0*2 | 95.0*2 | 95.0*2 | | 8.0 / 70.8 (M8)② |
| 160K | 400.0 | 120*2 | 150*2 | 120*2 | 150.0 | 15.0 / 132.7 (M10)② |

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

① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 110K 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 508C.
- It is recommended to use shielded cables to connect the motor.
- *: If additional labels available with the terminals of 0K40...7K50, please refer to the torque data on labels.

| EFC x610 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

| EFC x610 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lbf·in] (Mx) |
|---|---|---|---|---|
| 0K40 | 10.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 0K75 | 10.0 | 14 | 8 | 1.00* / 9.0 (M3) |
| 1K50 | 20.0 | 12 | 8 | 1.00* / 9.0 (M3) |
| 2K20 | 20.0 | 12 | 8 | 1.00* / 9.0 (M3) |
| 3K00 | 30.0 | 10 | 8 | 1.2* / 10.5 (M4) |
| 4K00 | 40.0 | 8 | 8 | 1.2* / 10.5 (M4) |
| 5K50 | 50.0 | 8 | 8 | 1.76 / 15.6 (M4) |
| 7K50 | 60.0 | 6 | 6 | 1.76 / 15.6 (M4) |
| 11K0 | 100.0 | 2 | 4 | 3.73 / 33.0 (M5) |

**Tab. 8-5:** 3P 200 VAC fuse and cable dimensions for USA / Canada

| EFC x610 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lb·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) |

| EFC x610 Model | Fuse (Class J) [A] | Power cables [AWG] | PE Cable [AWG] | Torque / Screw [N·m / lb·in] (Mx) |
|---|---|---|---|---|
| 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 | 40.0 | 8 | 8 | 1.20* / 10.5 (M4) |
| 11K0 | 50.0 | 8 | 8 | 1.76 / 15.6 (M4) |
| 15K0 | 60.0 | 6 | 6 | 1.76 / 15.6 (M4) |
| 18K5 | 80.0 | 4 | 6 | 3.73 / 33.0 (M5) |
| 22K0 | 100.0 | 2 | 4 | 3.73 / 33.0 (M5) |
| 30K0 | 100.0 | 2 | 4 | 3.80 / 33.6 (M6) |
| 37K0 | 125.0 | 1 | 3 | 3.80 / 33.6 (M6) |
| 45K0 | 150.0 | 1 / 0 | 1 | 31.1 / 275.0 (5/16 in) |
| 55K0 | 175.0 | 2 / 0 | 1 / 0 | 31.1 / 275.0 (5/16 in) |
| 75K0 | 225.0 | 4 / 0 | 3 / 0 | 31.1 / 275.0 (5/16 in) |
| 90K0 | 250.0 | 250 kcmil | 3 / 0 | 31.1 / 275.0 (5/16 in) |
| 110K | 300.0 | 400 kcmil | 3 / 0 | 15.0 / 132.7 (M10)① |
| | | 3 / 0 * 2 | | 8.0 / 70.8 (M8)② |
| 132K | 350.0 | 500 kcmil | 250 kcmil | 15.0 / 132.7 (M10)① |
| | | 250 kcmil * 2 | | 8.0 / 70.8 (M8)② |
| 160K | 450.0 | 350 kcmil * 2 | 350 kcmil | 15.0 / 132.7 (M10)② |

**Tab. 8-6:** 3P 380 VAC fuse and cable dimensions for USA / Canada

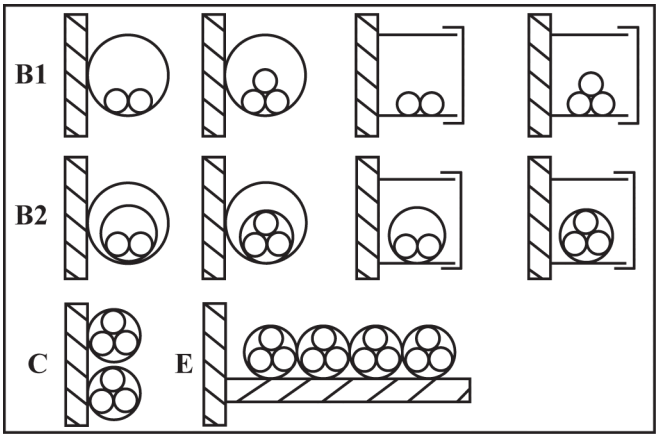
☞ ① and ②: According to the actual situation, single cable or double cable can be selected as the power cable of model 110K and above. ① is the torque and screw of single cable and ② is the torque and screw of double cable.

### 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 EN 60204-1, e.g. multi-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** 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

### 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.
- For STO wiring specification, see chapter 15.2.2 "Cable Definition" on page 335.

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.

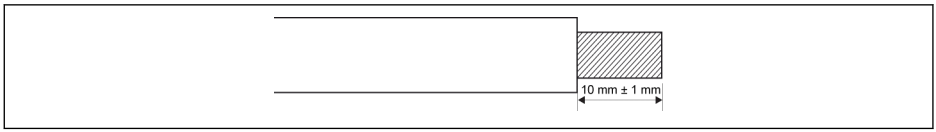



**Fig. 8-3:** Cable insulation stripping length

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.

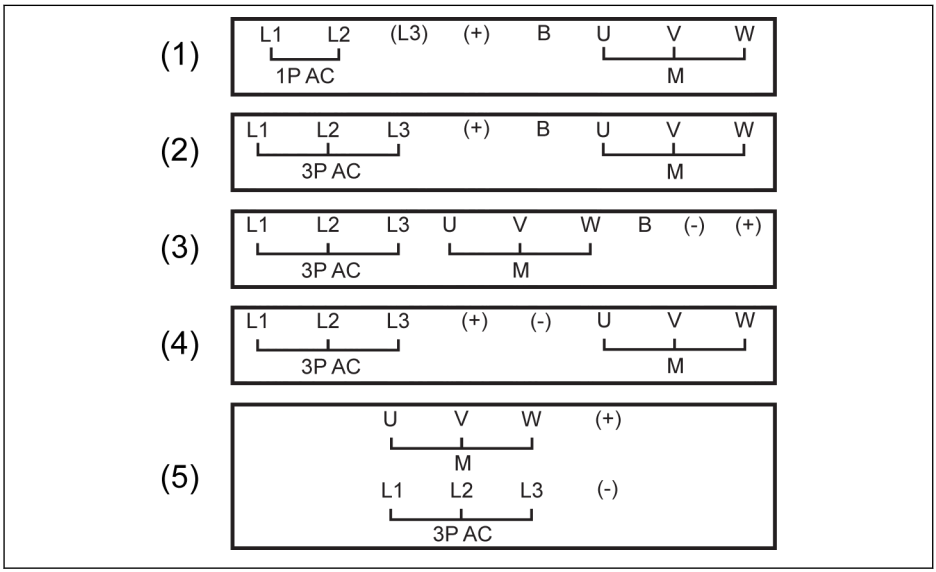
Step 4: Set respective parameters.

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 200 VAC 0K40...2K20 / 3P 380 VAC 0K40...4K00
**(3)** 3P 200 VAC 3K00...11K0 / 3P 380 VAC 5K50...22K0
**(4)** 3P 380 VAC 30K0...90K0
**(5)** 3P 380 VAC 110K...160K
**1P AC:** Single phase AC power supply
**3P AC:** Three phases AC power supply
**M:** For three phases motor connection

**Fig. 8-4:** 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. 8-7:** 1P 200 VAC power terminals description

| Terminal | Description |
|---|---|
| L1, L2, L3 | Mains supply input terminals |
| U, V, W | Converter output terminals |

| Terminal | Description |
|---|---|
| B | External brake resistor terminal |
| (-) | DC negative bus terminal (only available with models of 5K50 and above) |
| (+) | DC positive bus terminal |

**Tab. 8-8:** 3P 200 / 380 VAC power terminals description

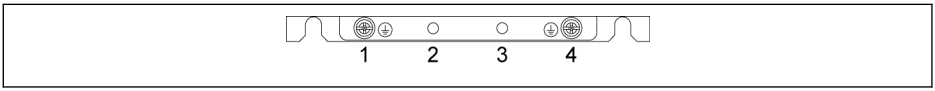



**Fig. 8-5:** Grounding and PE terminals

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

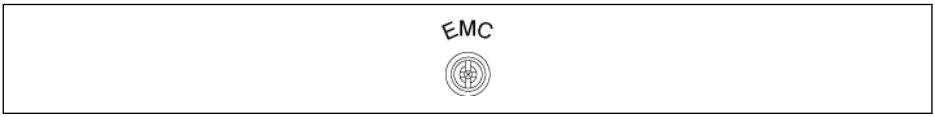


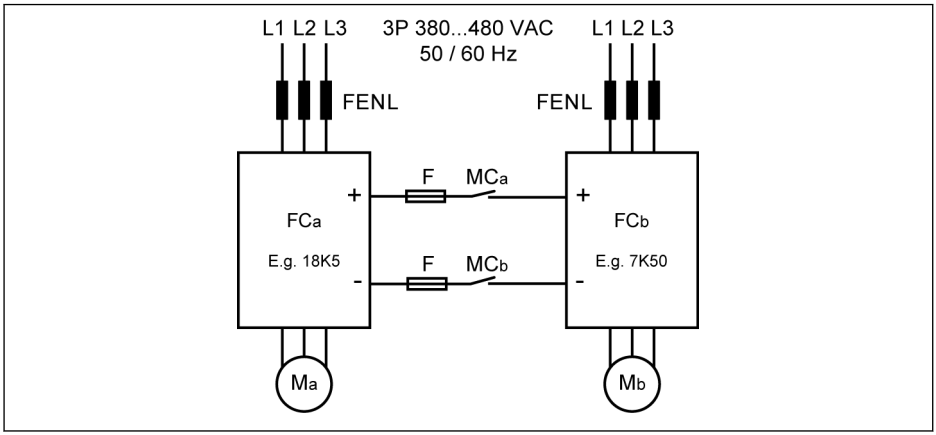

**Fig. 8-6:** Connection screw for internal EMC filter

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. 8-7:** Wiring of DC-bus in parallel

### Conditions for DC-bus in parallel

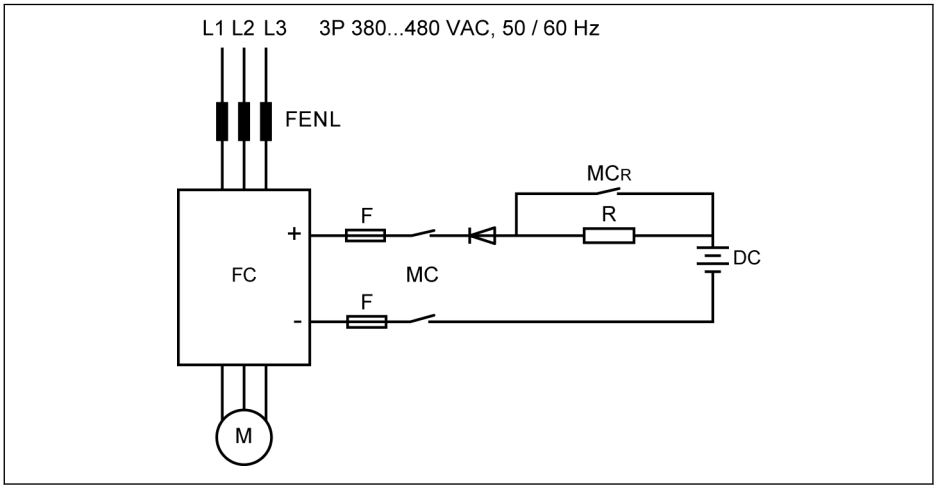
- In the above typical application, $FC_b$ runs in generation mode and $FC_a$ runs in motor mode. The power rating of $FC_a$ needs to be 3 levels higher than that of $FC_b$.

  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 70.
- 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 70.
- 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. 8-8:** 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 70.
- 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 | 35 |
| 11K0 | 50 |
| 15K0 | 75 |
| 18K5 | 100 |
| 22K0...90K0 | –① |
| 110K | 300 |
| 132K | 350 |
| 160K | 450 |

**Tab. 8-9:** Allowed maximum charging current

①: 22K0...90K0 models do not need external softstart resistor.

- 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.

### 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 | 7.5 | 87.1 % | 16.8 | 25 |
| 11K0 | 11.0 | 88.5 % | 24.2 | 35 |
| 15K0 | 15.0 | 89.5 % | 32.7 | 50 |
| 18K5 | 18.5 | 90.1 % | 40.0 | 50 |
| 22K0 | 22.0 | 90.6 % | 52.7 | 63 |
| 30K0 | 30.0 | 91.5 % | 71.1 | 80 |
| 37K0 | 37.0 | 92.1 % | 87.1 | 100 |
| 45K0 | 45.0 | 92.6% | 94.7 | 125 |
| 55K0 | 55.0 | 93.1% | 115.2 | 125 |
| 75K0 | 75.0 | 93.7% | 156.0 | 200 |
| 90K0 | 90.0 | 94.0% | 186.6 | 200 |
| 110K | 110.0 | 94.6% | 226.7 | 250 |
| 132K | 132.0 | 94.8% | 271.4 | 300 |
| 160K | 160.0 | 94.8% | 353.0 | 400 |

**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

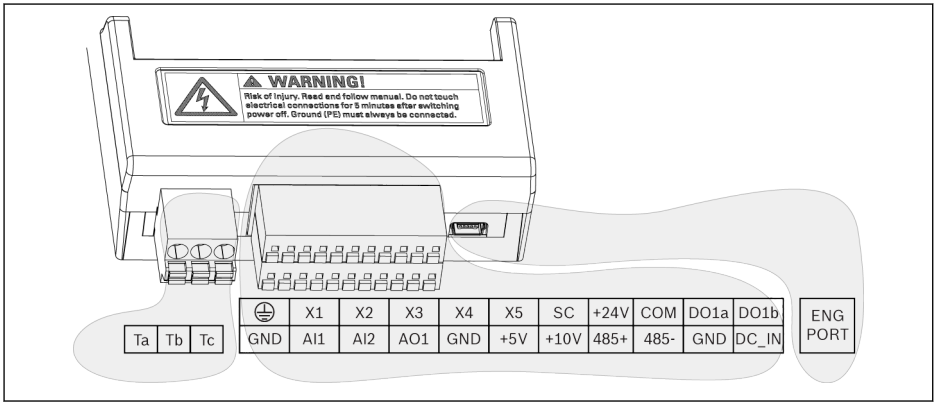



**Fig. 8-9:** Control circuit terminals

**⚠ 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 chapter "E1: Input terminal parameters" on page 418 | Inputs via opto-electric couplers: 24 VDC, 8 mA / 12 VDC, 4 mA<br>Pulse input: Max. 50.0 kHz |
| X5 (multiplex) | Pulse input | | |
| SC | Shared connection of digital inputs | 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 input 1 (Voltage or current sensitive, configurable) | 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 chapter "E1: Input terminal parameters" on page 418 | 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 input 2 (Voltage or current sensitive, configurable) | | |
| GND | Shared connection of analog inputs | 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 chapter "E2: Output terminal parameters" on page 421<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 chapter "E2: Output terminal parameters" on page 421 | 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 chapter "E2: Output terminal parameters" on page 421 | 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

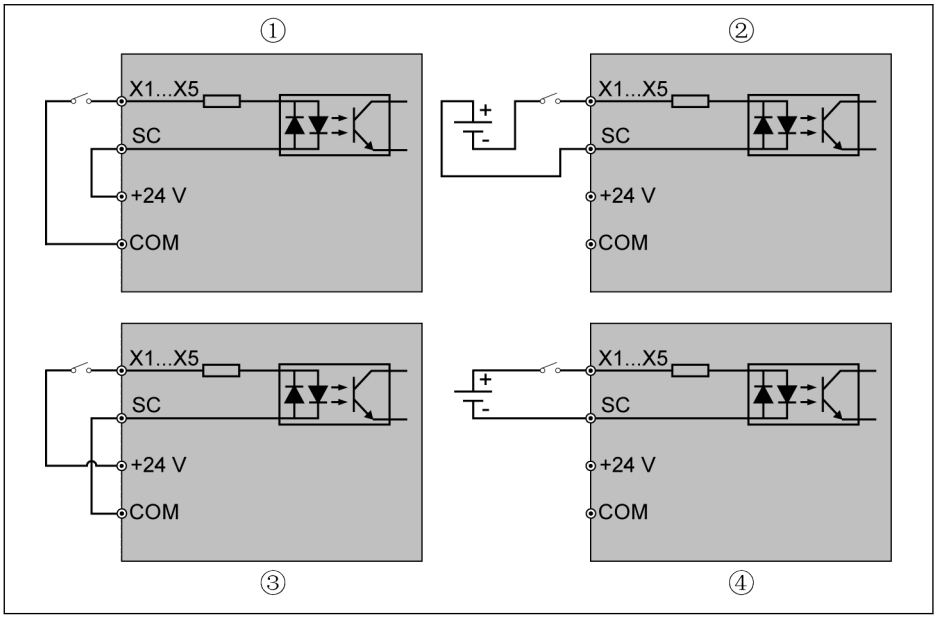
| Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|
| 485+ | Positive differential signal | GND is reference | – |
| 485- | Negative differential signal | | |

### 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 | – |

DC_IN power is used for keeping the control section, display and extension cards powered. If applied with Multi-ethernet card keep the communication up. For commissioning and parameterization, AC line voltage is required.

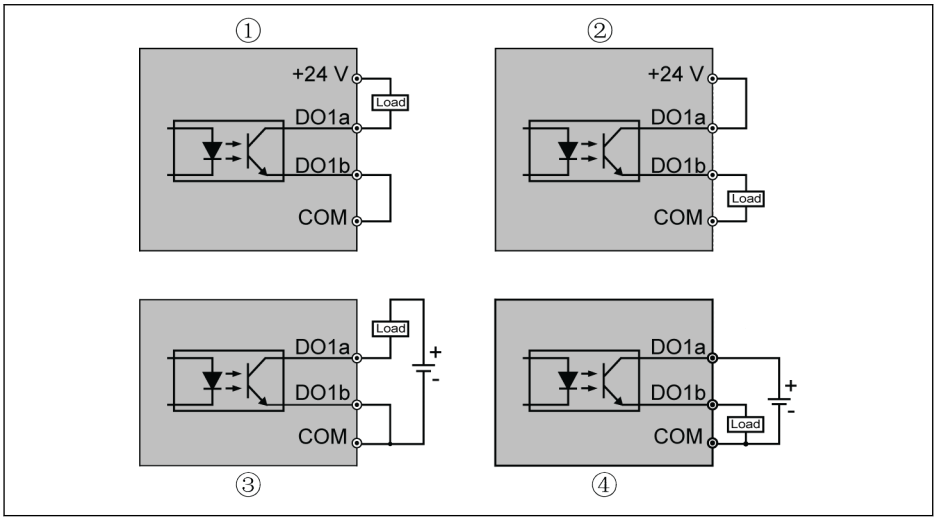
## Digital input NPN / PNP wiring




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

**Fig. 8-10:** Digital input NPN / PNP wiring

## 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

**Fig. 8-11:** 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!

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

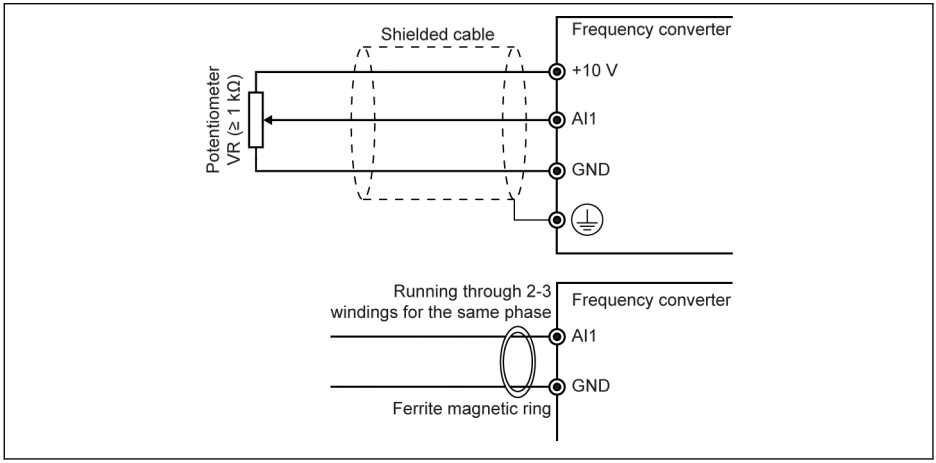
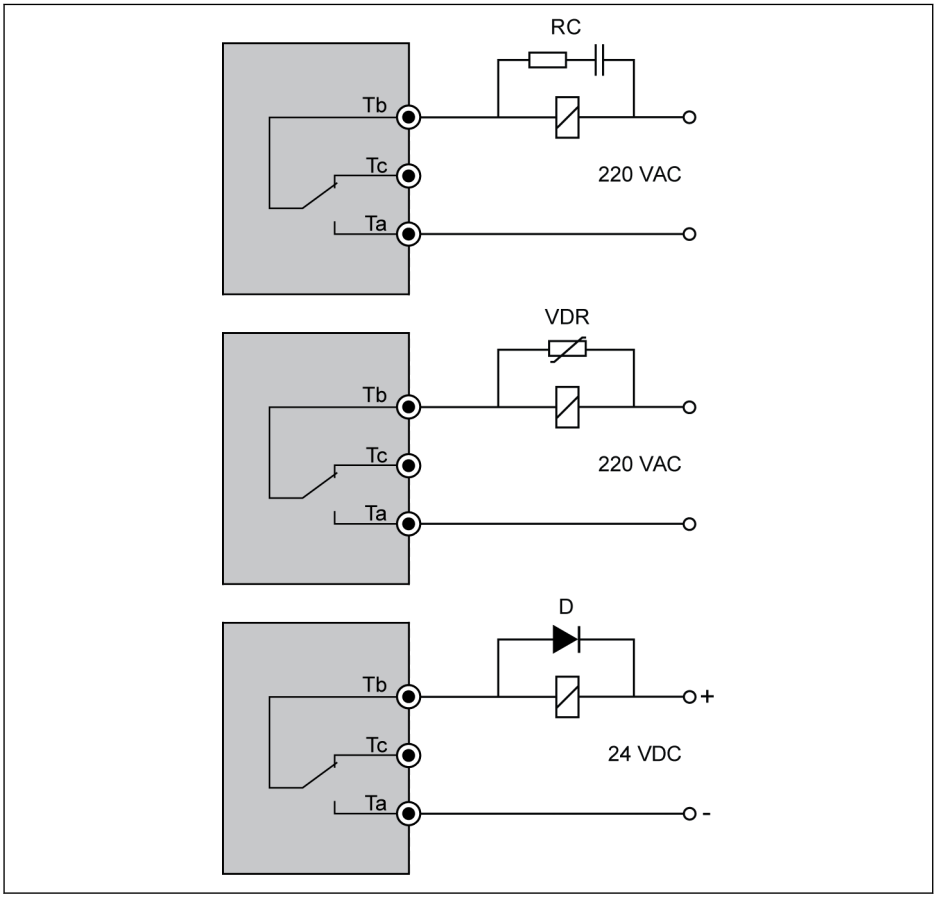



**Fig. 8-12:** Analog input terminals

- 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. 8-13:** 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' 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' 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

DC_IN power is used for keeping the control section, display and extension cards powered. If applied with Multi-ethernet card keep the communication up. For commissioning and parameterization, AC line voltage is required.

### 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.

## 8.3.3 Safe Torque Off (STO) Terminals

### Terminal Definition

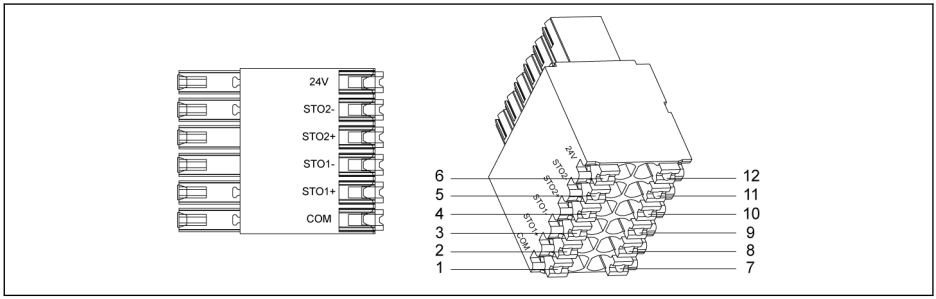



**Fig. 8-14:** STO terminals

| Connection | Signal name | Function |
|---|---|---|
| 1 / 7 | COM | COM is the reference of +24 V |
| 2 / 8 | STO1+ | Input channel 1 |
| 3 / 9 | STO1- | The reference of Input channel 1 |
| 4 / 10 | STO2+ | Input channel 2 |
| 5 / 11 | STO2- | The reference of Input channel 2 |
| 6 / 12 | +24 V | Power supply |

**Tab. 8-14:** Terminal definition

The 12-pin socket has two rows of connectors which are bridged for easy wiring.

# 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.

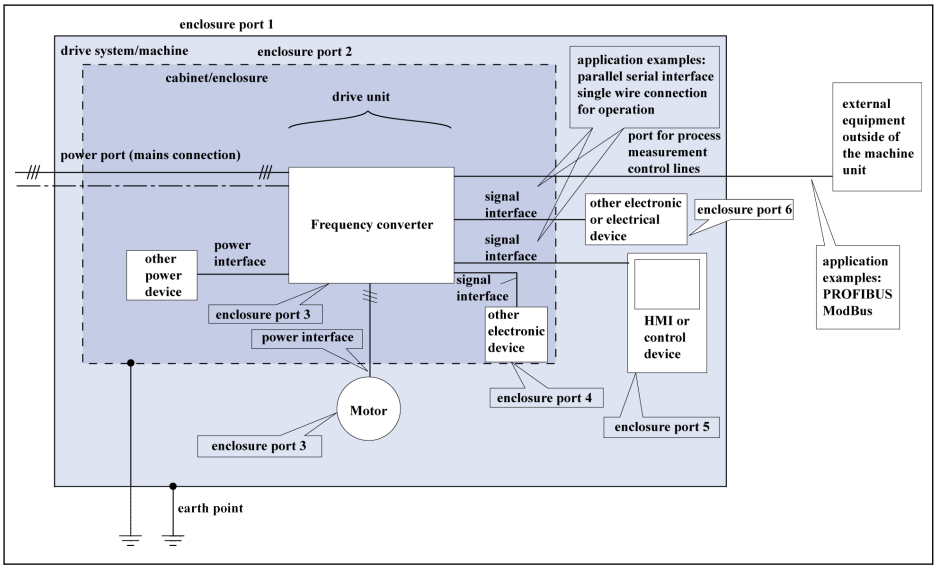



**Fig. 9-1:** Noise immunity in the drive system

### 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

### Minimum immunity requirements for PDSs intended for use in the first 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 3 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 | 1 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 3 V<br>80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz<br>Capacitive clamp | B |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 0.5 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 3 V<br>80 % AM (1 kHz) | A |

**CD: Contact discharge**
**AD: Air discharge**
**AM: Amplitude modulation**

**[a]: Coupling line to line**
**[b]: Coupling line to earth**

**Tab. 9-2:** Minimum immunity requirements for PDSs intended for use in the first environment

Category C1 is only for conducted emission, radiated emission needs checking with metallic cabinet. For installation, see chapter 9.3 "EMC Measures for Design and Installation" on page 91.

### 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. 9-3:** 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

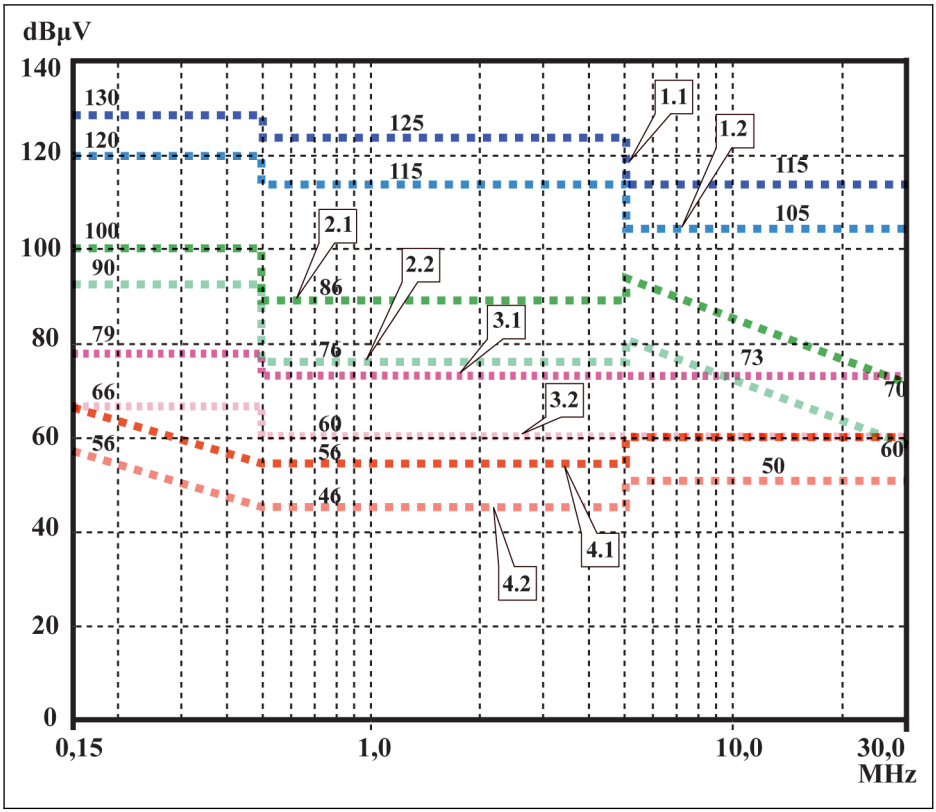
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

#### 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. 9-4:** 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 standard EN 61800-3:

The drive system of standard EFC x610 with internal EMC filter, is product of category C3 and applicable to industrial environment.

**⚠ WARNING**

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

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 EFC x610.

## 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 EFC x610.
- Minimum immunity requirements in the second environment according to product standard EN 61800-3 have been complied with for EFC x610.

### 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, EFC x610 drive system is complied with product standard EN 61800-3 C3. 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.

#### 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 6.2.3 "Maximum Length of Motor Cables" on page 34.
- 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 95.

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

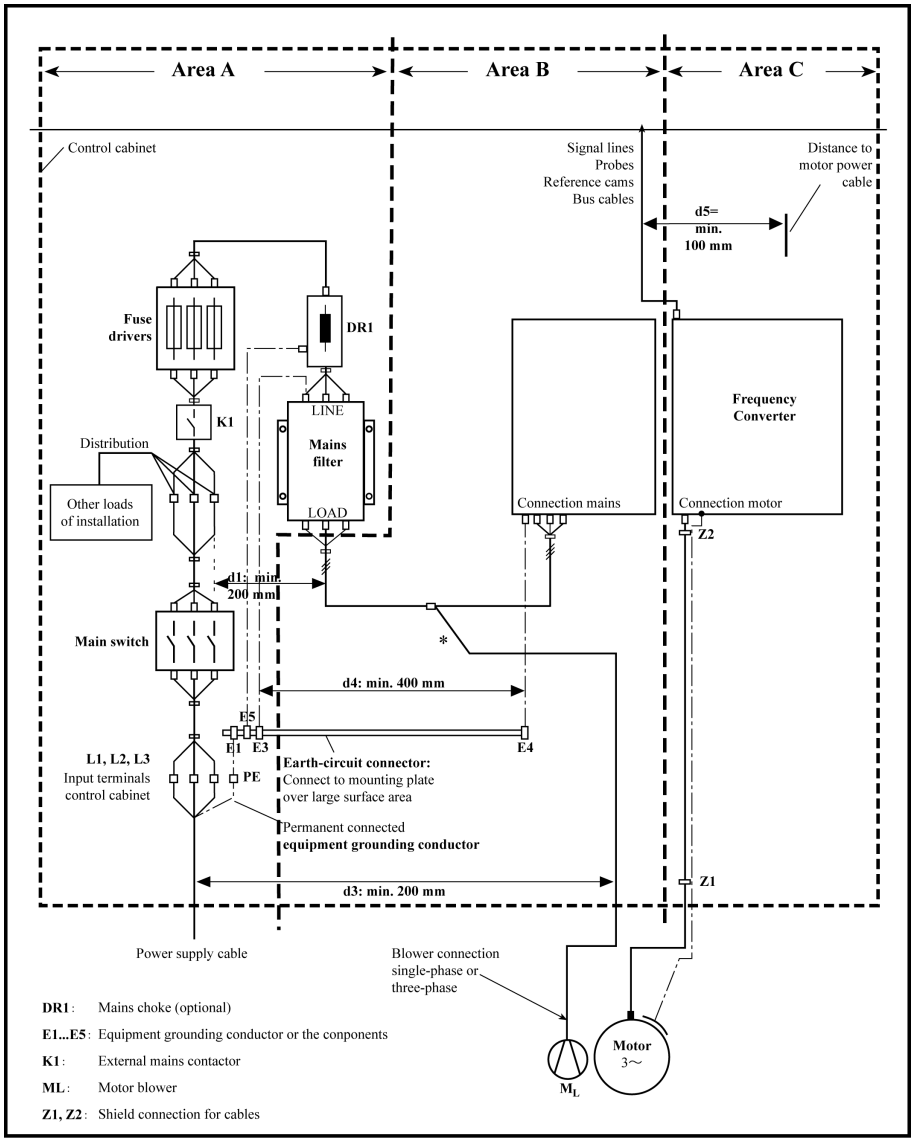



**Fig. 9-3:** Control cabinet mounting according to interference areas – exemplary arrangements

### 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 93.

### 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 93.

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 93) 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.

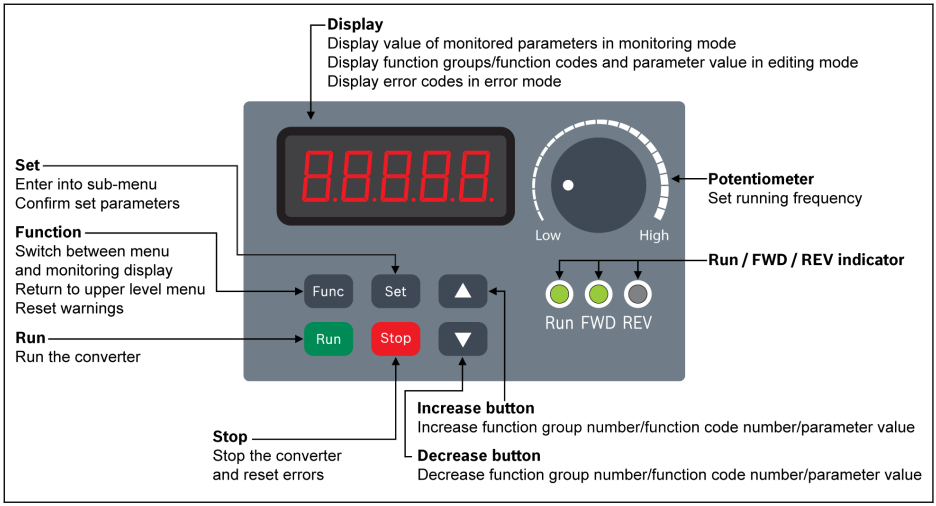



**Fig. 10-1:** LED panel

## 10.2 LED Display

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

## 10.3 Dust Cover

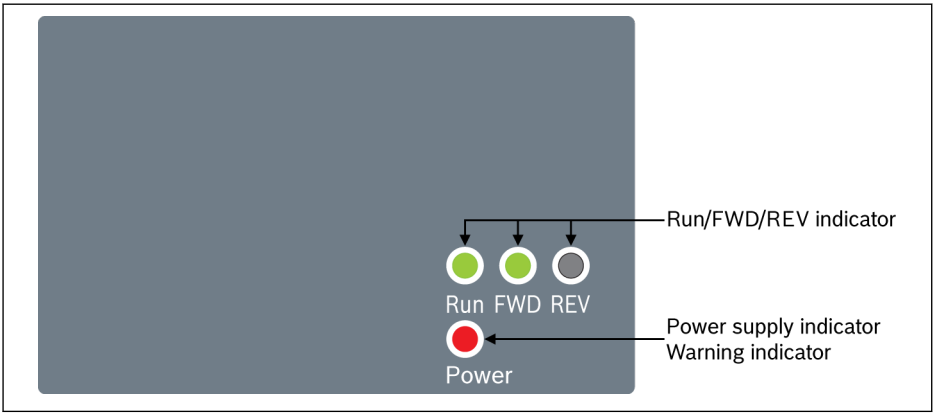



**Fig. 10-3:** Dust cover

Frequency Converter EFC x610 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 Replication" on page 120.

## 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

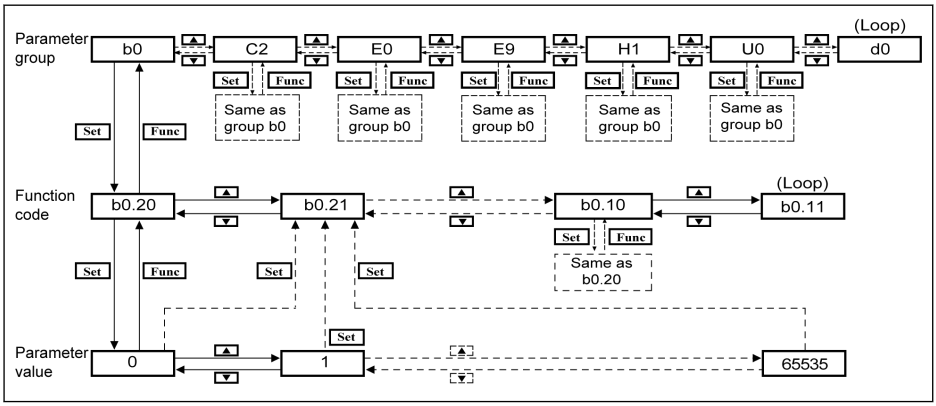



**Fig. 10-4:** Operating mode

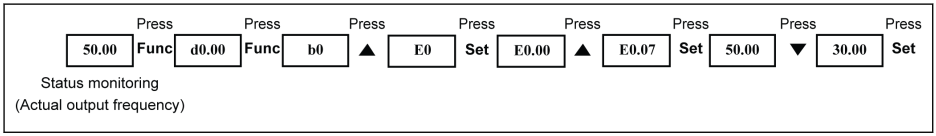



**Fig. 10-5:** Operating example

## 10.6 Fast Access to Parameters with Button Combinations

EFC x610 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

EFC x610 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

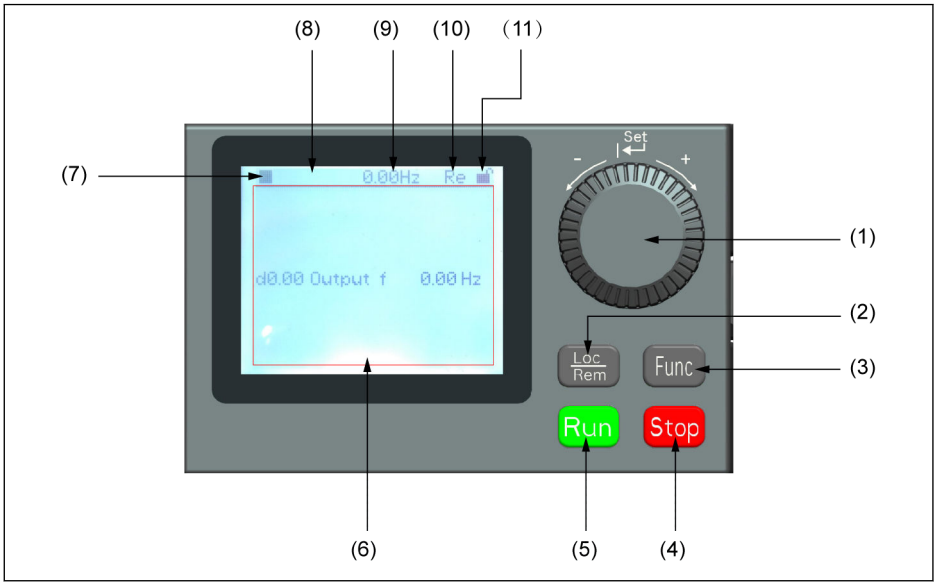



**Fig. 10-6:** LCD panel appearance

**(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 277 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...45 °C |
| Derating / ambient temperature | 1.5 % / 1 °C (45...55 °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, DIN rail 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 36.

### 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 8.2.1 "Power Cables" on page 57 |
| Control terminals connection | Must be securely connected |
| Control cables | Must observe chapter 8.2.2 "Control Cables" on page 64 |
| EMC | Must observe chapter 9 "Electromagnetic Compatibility (EMC)" on page 81 |
| 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 **5 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

- With AC mains voltage, EFC x610 will generate output if pressing down the **<Run>** button (or 'Control by terminals' is activated).
- By default, EFC x610 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.
- With AC mains voltage, 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 used **mainly** for SVC control. For details, see chapter "Motor parameter auto-tuning" on page 240 or chapter "Auto-tuning of Motor Parameters" on page 266.

## 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. 11-6:** 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. 11-7:** Parameter settings by factory defaults

# 12 Functions and Parameters

## 12.1 Basic Settings

### 12.1.1 Parameter Group Access Control

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

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

For terminologies and abbreviations, see chapter 20.3.1 "Terminology and Abbreviation in Parameter List" on page 403.

- 0: Basic parameters

  **ONLY** parameters in group b0, d0, C0, E0, U0, U1, U2, -EP- are visible.

- 1: Standard parameters

  Parameters in group b0, d0, C0, C1, C2, C3, E0, E5, E8, U0, U1, U2, -EP- are visible.

- 2: Advanced parameters

  Parameters in group b0, d0, C0, C1, C2, C3, E0, E1, E2, E3, E4, E5, E8, E9, H0, H1, H2, H3, H4, H8, H9, U0, U1, U2, F0, -EP- are visible.

- 3: Start-up parameters

  Parameters in group b0, d0 and chapter 11.2 "Quick Start Parameters" on page 113 are visible.

chapter 20.3.8 "Group d0: Monitoring Parameters" on page 448 are always visible.

- 4: Modified parameters

  This option provides the possibility for users to view or modify the parameter settings which have been modified and different than default settings.

  When [b0.00] = 4:

  – Parameters in group b0, group d0 and an additional group '-PF-' are visible.

  – Parameter settings can be modified directly once group '-PF-' has been accessed to.

- If a parameter in group '-PF-' is changed back to its default setting, that parameter is still visible in group '-PF-'. It is invisible after exit from and re-access to group '-PF-'.
- Parameters b0.10, b0.11, b0.20, b0.21, C1.01, C0.53, E9.05... E9.07, E9.10...E9.15, H8.87, H9.97 are excluded for this function.
- Accessing to group '-PF-' if no parameter has been changed, the warning message 'noCP' will be displayed for 1.5 s, and then '-PF-' will be displayed again.
- Parameters which are linked to an optional extension are only shown if the corresponding extension is installed.

  Example: 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.
- Related ASF parameter (Fx group) will be shown if ASF is loaded while b0.00 = 2.
- 'EP' group is only visible if there are erroneous (E.PAr) parameters during parameter restore.

### 12.1.2 Parameter Initialization

This function is used to restore parameter settings to factory defaults when a frequency converter fails to drive the motor due to wrong parameter settings.

Be sure that the parameter settings match with the motor data and the actual applications after factory defaults restore. Adjust the parameter default settings if necessary.

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

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, ASF related parameters
- b0.09 = 2: H1, H2, H3
- b0.09 = 3: All parameters are restored to factory default

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| b0.10 | Parameter initialization | 0...2 | 0 | – | Stop |

- 0: Inactive

  This parameter will be reset to '0: Inactive' automatically after parameter initialization.
- 1: Restore to default settings

  All parameters are restored to factory default settings except for:
  - 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 record

  Parameter E9.05... E9.07, E9.10...E9.15, E9.97...E9.99 (Error records) will be cleared.

- b0.09 is available from firmware version 03V08.
- E9.97...E9.99 are available from firmware version 03V10.

### 12.1.3 Parameter Replication

This function is used for setting multiple frequency converters with the same settings via the operating panel.

With this function, users only need set parameters of one frequency converter (source converter), and then replicate its settings for all the other frequency converters (target converters).

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

- 0: Inactive

  This parameter will be reset to '0: Inactive' automatically after parameter replication.

- 1: Backup parameters to panel (from source converter to panel)

  All parameter settings are copied from the source frequency converter to the operating panel **EXCEPT** that of

  – Read-only parameters
  – C0.51, C0.53 (Fan total running time)
  – E9.05...E9.07, E9.10...E9.15, E9.97...E9.99 (Error records)
  – d0.23 (Power stage running time)
  – b0.10, b0.11, b0.20, b0.21
  – C1.01
  – U0.99

- 2: Restore parameters from panel (from panel to target converters)

  All parameter settings are replicated from the operating panel to the target frequency converters **EXCEPT** that of

  – Read-only parameters
  – C0.51, C0.53 (Fan total running time)
  – E9.05...E9.07, E9.10...E9.15, E9.97...E9.99 (Error records)
  – d0.23 (Power stage running time)
  – b0.10, b0.11, b0.20, b0.21
  – C1.01
  – U0.99

- Read-only parameters are marked with **Read** in parameter list, see chapter 20.3.1 "Terminology and Abbreviation in Parameter List" on page 403
- Any of other operations is inactive in parameter replication
- U0.99 is available from firmware version 03V02
- E9.97...E9.99 are available from firmware version 03V10

### 12.1.4 Parameter Set Selection

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

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. During 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.

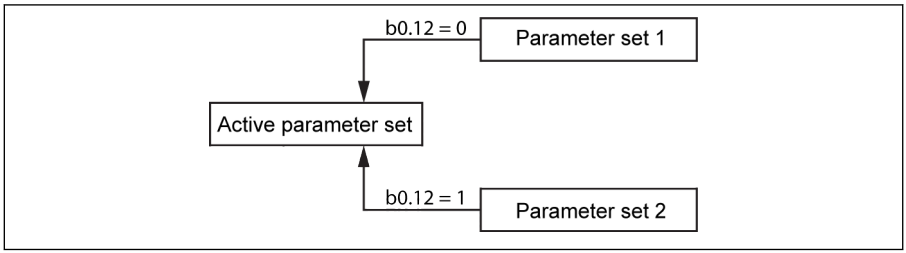



**Fig. 12-1:** Parameter set selection by b0.12

- 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 try to change the value of [b0.12] while digital input is active, 'S.Err' will be shown.

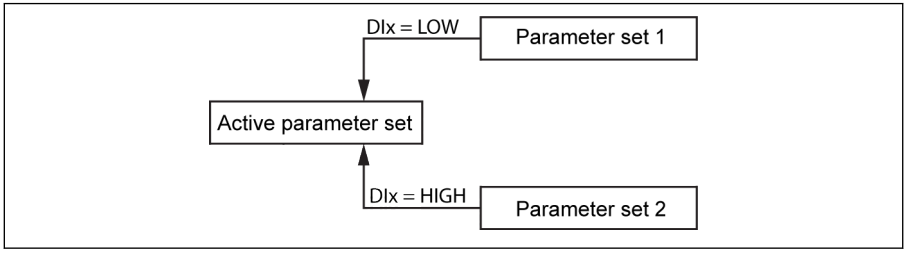



**Fig. 12-2:** Parameter set selection by digital input

Terminal value is considered for active parameter set selection only during STOP mode.

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.

1. During parameter backup both sets will be copied and during restore both sets will be restored.
2. This function is available from firmware version 03V08.

### 12.1.5 Password Protection

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

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

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

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 first, and then modify the value with entering another integer number between 1 and 65,535.

- Clear user password

  Enter the existing user password or super user password, then user password will be cleared.

- Without entering or entering a wrong password, all parameters except for b0.00 'Access authority setting', can only be read, while parameter modification or replication is impossible.
- Contact with service if you forget the user password.
- User password protection does not affect frequency adjustment with **<▲>** and **<▼>** buttons in running status or frequency saving.

### 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 | Min. | Attri. |
|---|---|---|---|---|---|
| b0.22 | Device frequency mode① | 0: Low frequency mode<br>1: High frequency mode | 1 | - | Stop |

☞ ①: This parameter applies only to 1 KHz model.

Low frequency mode: In this mode, device can reach up to 400.00 Hz. Resolution of frequency parameters is 2 decimals; Range of E0.08 is 50.00...400.00 Hz.

High frequency mode: In this mode, device can reach up to 1,000.0 Hz. Resolution of frequency parameters is 1 decimal; Range of E0.08 is 50.0...1,000.0 Hz.

When changing the frequency mode, only resolution of parameter will be changed, value is not updated as per new resolution. i.e if in low frequency mode E0.08 was 50.00 Hz, when switched to high frequency mode E0.08 will be 500.0 Hz. Only in case if E0.08 is out of range then value is saturated to maximum value.

☞ b0.22 will not be reset to default when factory reset is done (b0.10 = 1).

## 12.2 Input and Output Terminals Configuration

### 12.2.1 Digital Input Configuration

5 multi-function digital inputs are available with PNP and NPN wiring.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 0...51 | 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...51 | 0 | – | Stop |

- 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

16 multi-speeds are available by combination of 4 terminals, see chapter "Adjust the setting frequency by multi-speed function" on page 164.

- 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, see chapter 12.4.3 "Acceleration and Deceleration Configuration" on page 170.

- 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'.

See chapter 12.5.5 "Stop Behavior Setting" on page 186

- 20: Frequency Up command
- 21: Frequency Down command
- 22: Up / Down command reset

Used to change the output frequency, see chapter "Adjust the setting frequency by digital input Up / Down command" on page 162.

- 23: Torque / speed control switch
- 25: 3-wire control

Used for the 3-wire control mode, see chapter 12.6.3 "2-wire / 3-wire Control (Forward / stop, reverse / stop)" on page 196.

- 26: Simple PLC stop
- 27: Simple PLC pause

Used for the simple PLC to stop and pause a PLC cycle, see chapter 12.8.4 "Stop and Pause Simple PLC Control" on page 210.

- 30: Second frequency setting source activation

  Used for switching to the second frequency setting source, see chapter "Frequency setting source switching" on page 157.
- 31: Second run command source activation

  Used for switching to the second run command source, see chapter "Switch between first and second run command source" on page 177.
- 32: Error signal N.O. contact input
- 33: Error signal N.C. contact input

Used for receive error signal from external sources, see chapter "Reaction to External Error Signals" on page 231.

- 34: Error reset

  Used for error reset operation, see chapter 13.5 "Error Handling" on page 289.
- 35: Forward running (FWD)
- 36: Reverse running (REV)

Used for Run / Stop command control, see chapter 12.5 "Run- / Stop- / Direction Command Source" on page 176.

- 37: Forward jog
- 38: Reverse jog

See chapter 12.6.2 "Jog Function" on page 194.

- 39: Counter input
- 40: Counter reset

See chapter 12.7.1 "Counter Function" on page 200.

- 41: PID deactivation

  See chapter 12.9 "PID Control" on page 213.
- 46: User parameter set selection
- 47: Pulse input mode activation (**ONLY** for X5 input)

  See chapter 12.2.2 " X5 Pulse Input Configuration" on page 129.
- 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

Digital input status is monitored by parameter d0.40 'Digital input 1'.

### 12.2.2 X5 Pulse Input Configuration

X5 digital input can also be used to receive pulse signal with a 30...70 % duty ratio. This pulse input can be used in 3 purposes:

- Frequency setting source
  See chapter 12.4.2 "Select the Frequency Setting Source" on page 156.
- PID reference
- PID feedback

See chapter 12.9.2 "Selecting the Reference and Feedback" on page 214.

To use 'X5 pulse input' as the frequency source, take following steps:

**Step 1: Activate terminal 'X5 input' with pulse input function**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.04 | X5 input | 47: Pulse input mode activation | 0 | – | Stop |

**Step 2: Set the maximum input frequency and filter time**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

**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. 12-1:** Curve configuration

[E1.70]...[E1.73] are used to define characteristics of curve 1:

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.68 | Analog input curve setting | 0...7 | 0 | – | 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 |
| 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 |

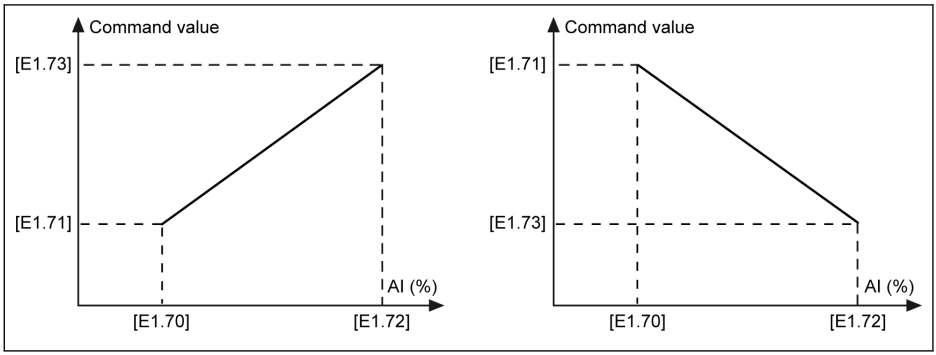



**Fig. 12-3:** Curve 1

[E1.75]...[E1.78] are used to define characteristics of curve 2:

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.68 | Analog input curve setting | 0...7 | 0 | – | 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 |

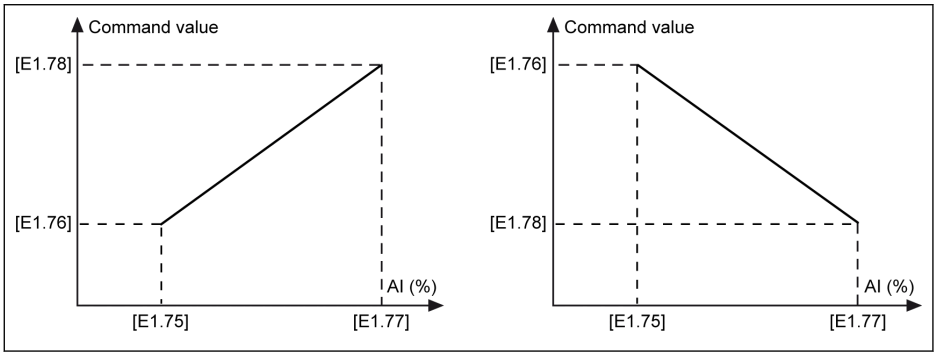



**Fig. 12-4:** Curve 2

Pulse input frequency is monitored by parameter d0.50 'Pulse input frequency'.

### 12.2.3 Analog Input Configuration

Please read through the information on 'Wiring diagram' and 'Terminals' before configuration of 'Analog inputs AI1, AI2', see chapter 8 "Frequency Converter Wiring" on page 55 and chapter "Analog inputs" on page 72 respectively. To configure these two inputs, take the following steps:

**Step 1: Select the input mode**

| Code | Name | Setting range | Default | Min. | 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 |

When AI1 or AI2 is set to 4...20 mA, or 2...10 V, the broken wire detection for analog input can be configured, see chapter "Analog Input Broken Wire Detection" on page 230.

**Step 2: Set the channel gain and filter time**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| E1.69 | Analog input filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |

When AI1 or AI2 input is used as the reference frequency input channel, see chapter "Adjust the setting frequency by analog inputs" on page 161.

**Step 3: Select input curve**

AI1 and AI2 inputs can use both curve 1 and curve 2. For details about curve 1 and curve 2, see step 3 of chapter 12.2.2.

Analog input status is monitored by parameter d0.30 'AI1 input' / d0.31 'AI2 input'.

### 12.2.4 Digital Output Configuration

Please read through the information on 'Wiring diagram' and 'Terminals' before configuration of 'Digital output', see chapter 8 "Frequency Converter Wiring" on page 55 and chapter "Digital outputs" on page 73 respectively. To configure this output DO1, take the following steps:

**Step 1: Select the output signal**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 0...25 | 1 | – | Stop |
| 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 |

- 0: Converter ready

  After powering on, if no error occurs and there is no run command or output active indication, the frequency 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 frequency converter is in Start- or Stop- DC braking, see chapter "DC-braking before start" on page 182 and chapter "DC-braking during deceleration to stop" on page 187.

- 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

  See chapter 12.7.2 "Frequency Arrival" on page 203.

- 5: Frequency level detection signal (FDT1)
- 6: Frequency level detection signal (FDT2)

See chapter 12.7.3 "Frequency Level Detection" on page 204.

- 7: Simple PLC stage complete; 8: Simple PLC cycle complete

See chapter 12.8.4 "Stop and Pause Simple PLC Control" on page 210.

- 10: Converter undervoltage

  The output is active when DC-bus voltage is lower than 190 VDC (1P 200 VAC / 3P 200 VAC models) / 380 VDC (3P 380 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 "Overload pre-warning" on page 226.

- 12: Motor overload pre-warning

  See chapter "Motor overload pre-warning" on page 235.

- 13: Converter stop by external error

  See chapter "Reaction to External Error Signals" on page 231.

- 14: Converter error

  The output is active when an error occurs, inactive when the error is reset, see chapter 13.4 "Error Code" on page 279.

- 15: Converter OK

  The output is inactive when the frequency converter is powered off or encounters error / warning during running. 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

Used for the counter function, see chapter 12.7.1 "Counter Function" on page 200.

- 18: PID reference engineering value arrival

  Used for PID function, see chapter 12.9 "PID Control" on page 213.

- 19: Pulse output mode enable (only available with DO1 output selection)

  See '**Step 2: Use DO1 in pulse output mode**'.

- 20: Torque control mode

  See chapter "Torque control mode" on page 259.

- 21: Parameter setting from communication

- 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.

- 25: Converter error or warning

**Step 2: Use DO1 in pulse output mode**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 19: Pulse output mode | 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 |

Digital output status is monitored by parameter d0.45 'DO1 output'.

## 12.2.5 Analog Output Configuration

### Step 1: Set AO1 output mode

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.25 | AO1 output mode | 0: 0...10 V<br>1: 0...20 mA | 0 | – | Run |

### Step 2: Select AO1 output signal

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.26 | AO1 output setting | 0...14 | 0 | – | 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 VAC: 200...240 V | 220 | 1 | Stop |
| | | 3P 200 VAC: 200...240 V | | | |
| | | 3P 380 VAC: 380...480 V | 380 | | |

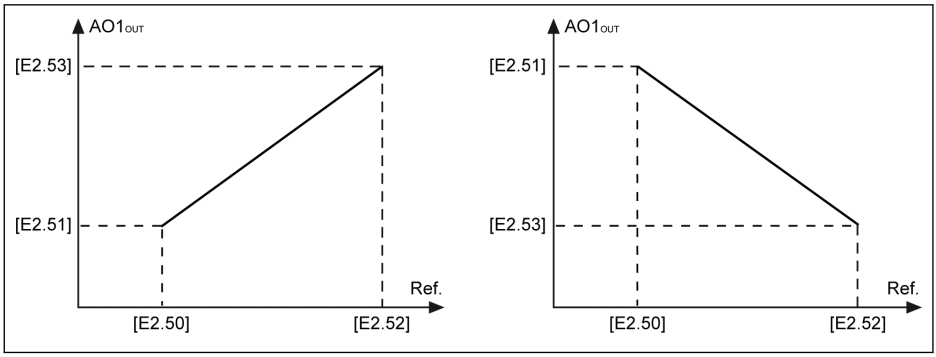
- 0: Output frequency
  Represents the actual output frequency between 0.00...[E0.08] Hz.
- 1: Setting frequency
  Represents the setting frequency between 0.00...[E0.08] Hz.
- 2: Output current
  Represents the 0...2 x [rated current].
- 4: Output voltage
  Represents 0...1.2 x [rated voltage], which is defined by parameter E2.40.
- 5: Output power, represents 0...1.2 x [rated power]
- 6: Analog input, represents AI1 input value
- 7: Analog input, represents AI2 input value
- 8: EAI1 analog input, represents the analog input value 1 from I/O plus card
- 9: EAI2 analog input, represents the analog input value 2 from I/O plus card
- 11: Motor temperature sensor power supply
  Provides current source for motor temperature sensor, see chapter "Motor thermal protection with temperature sensor" on page 236.
- 12: Parameter setting from communication
  – 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.

- 13: Setting torque
- 14: Output torque

**Step 3: Set AO1 filter time and output curve**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.27 | AO1 gain | 0.0...10.00 | 1.00 | 0.01 | Run |
| 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 |




**$AO1_{OUT}$** AO1 output
**Ref.** Reference

**Fig. 12-5:** AO1 output curve

Analog output status is monitored by parameter d0.35 'AO1 output'.

## 12.2.6 I/O Card Terminal Configuration

### Set digital input terminals

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H8.00 | EX1 input | 0...51 | 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: 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: Fault signal N.O. contact input
33: Fault 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

I/O card digital input status is monitored by parameter d0.43 'I/O card digital input'.

## Set analog input terminals

| Code | Name | Setting range | Default | Min. | 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 | 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 | 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 |
| H8.30 | 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 | 1 | – | Stop |
| H8.32 | EAI2 filter time | 0.000...2.000 | 0.100 | 0.001 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |

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

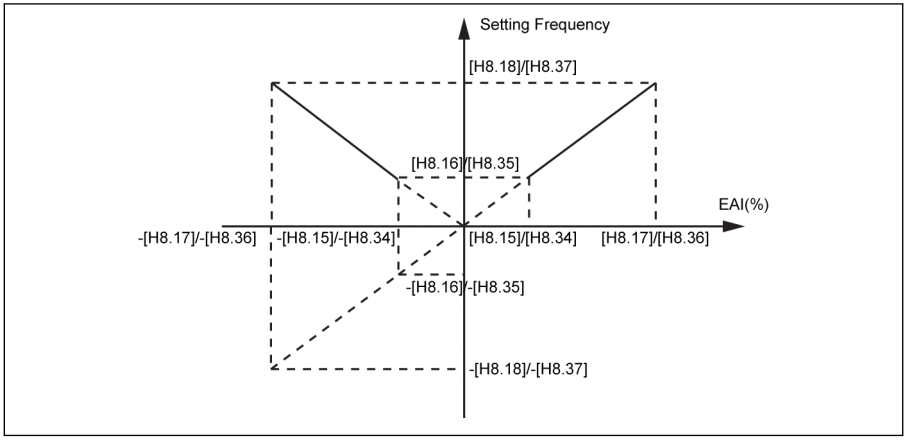



**Fig. 12-6:** Polarity inactive

  - 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

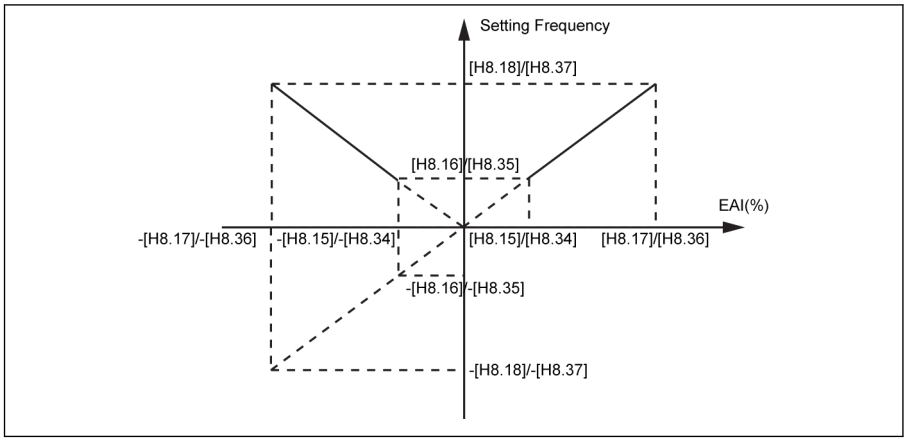



**Fig. 12-7:** Polarity active without direction control

– 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

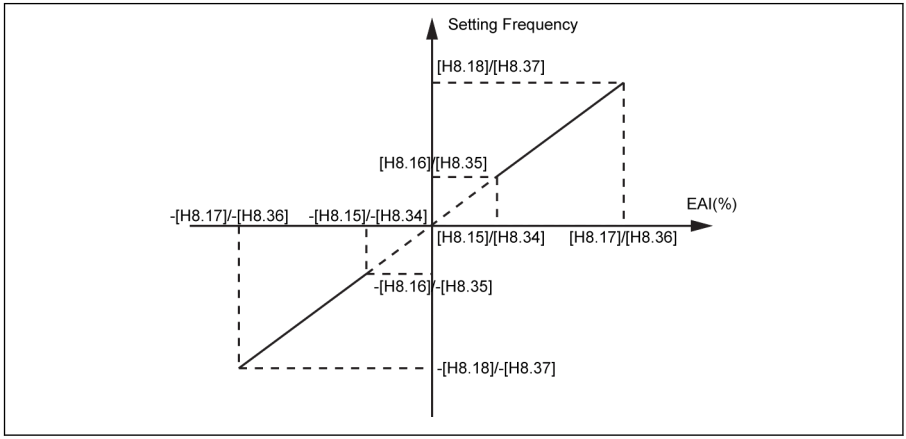



**Fig. 12-8:** Polarity active with direction control

– 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.

**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.

**Example**

When H8.05 = 5:

1. H8.06 = 0

   H8.15 = -100.0, H8.16 = 0.0, H8.17 = 100.0, H8.18 = 50.0

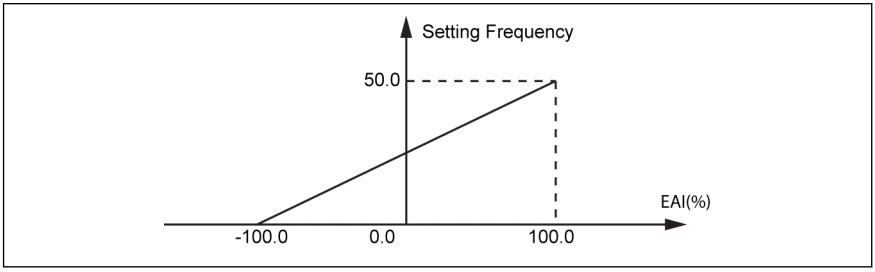



**Fig. 12-9:** EAI1 example 1

2. H8.06 = 1

   H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

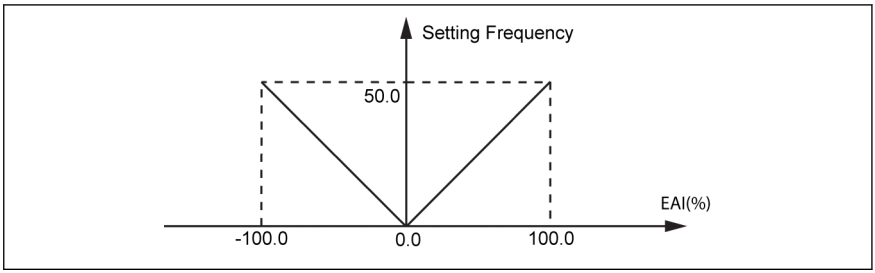



**Fig. 12-10:** EAI1 example 2

3. H8.06 = 2

   H8.15 = -100.0, H8.16 = -50.0, H8.17 = 100.0, H8.18 = 50.0

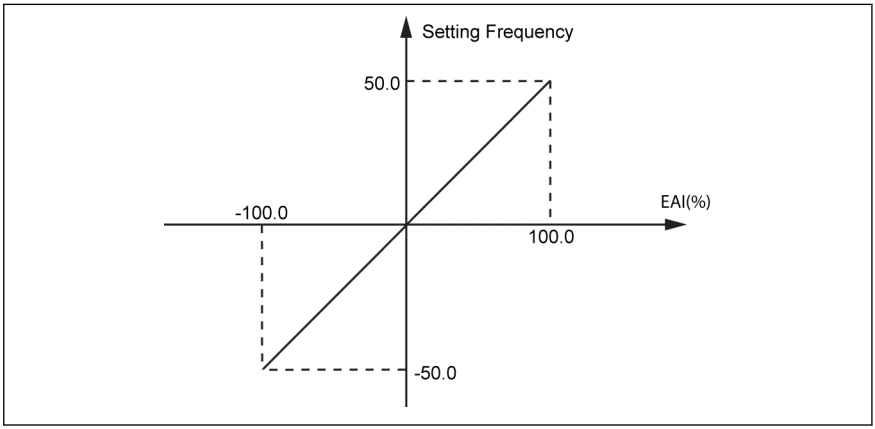



**Fig. 12-11:** EAI1 example 3

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

I/O card analog input status is monitored by parameter d0.33 'I/O card EAI1 input' or d0.34 'I/O card EAI2 input'.

## Dead zone filter for external analog input -10 ...+10 V

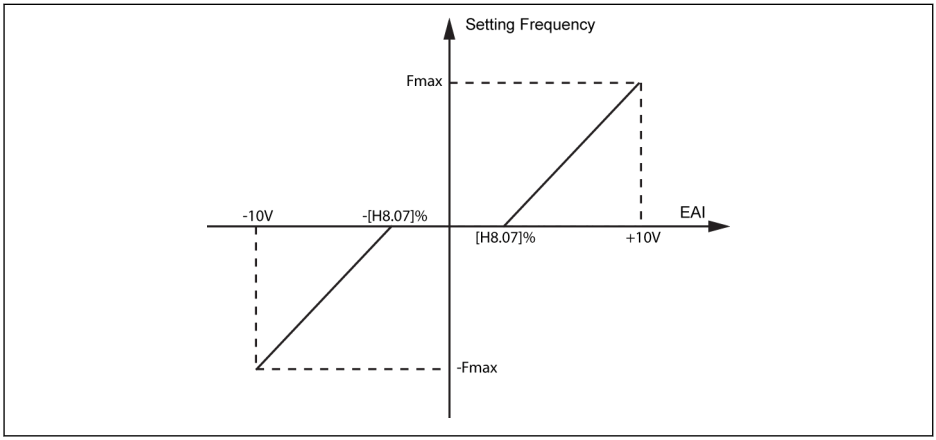



**Fig. 12-12:** Dead zone filter for external analog input

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.

## Set digital / analog output terminals

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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>2: -10...10 V (only for IO plus card) | 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 |
| H8.39 | 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 |

**Setting range of H8.20, H8.21, H8.22:**

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 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.

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

Since mode 2 for H8.25 is valid only for IO plus card, when backup 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.

### Perform the self-test function

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 | 0 | – | Stop |

- 0: Inactive

  The test is complete. All outputs are restored to default settings.
- 1: EAO diagnosis. The analog output of I/O card outputs 10 V.
- 2: EDO diagnosis. The open collector output of I/O card outputs 10 V.
- 3: ERO diagnosis/EDO2 diagnosis. The relay output of I/O card is closed.
- 4: All output diagnosis. EAO, ERO, EDO are all tested with the above methods.

- Broken wire detection function is also active for I/O card when [H8.05] = ‘1: 4...20 mA’ or ‘4: 2...10 V’, see chapter "Analog Input Broken Wire Detection" on page 230.
- I/O card digital output status is monitored by parameters d0.47 'I/O card EDO1 output' and d0.48 'I/O card EDO2 output'.
- I/O card analog output status is monitored by parameter d0.37 'I/O card EAO output'.

## 12.2.7 Relay Card Terminal Configuration

### Set the relay terminals

| 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 |
| 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 |

**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.

### Perform the self-test function

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

- 0: Inactive
  All relays are restored to default settings.
- 1: Relay1 diagnosis
  Relay1 is closed.
- 2: Relay2 diagnosis
  Relay2 is closed.
- 3: Relay3 diagnosis
  Relay3 is closed.
- 4: Relay4 diagnosis
  Relay4 is closed.
- 5: All output diagnosis
  All relays are closed.

Relay card output status is monitored by parameter d0.63 'Relay card output'.

## 12.3 Power Stage Configuration

### 12.3.1 Set the Control Mode

This function is **ONLY** available with Frequency Converter EFC 5610. For Frequency Converter EFC 3610, **ONLY** 'V/f control' is available.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.00 | Control mode (EFC 5610 only) | 0, 1, 2 | 0 | – | Stop |

- 0: V/f control. This mode is active by default.
- 1: Sensorless vector control (SVC control)

  As for permanent magnetized synchronous motor, Only option 1 is applicable.

  In case of both asynchronous motor and permanent magnetized synchronous motor, the parameters concerning Motor parameterization and SVC control need to be set properly. For asynchronous motor, see chapter 12.11.1 "Motor Parameterization" on page 239 and chapter 12.11.3 "SVC Control (EFC 5610 ONLY)" on page 255 respectively. For permanent magnetized synchronous motor, See chapter 12.12.1 "The Setting of Motor Type" on page 265 and chapter 12.12.3 "PMSM SVC control" on page 270 respectively.
- 2: Vector control with encoder

Detailed information about encoder card, please refer to "Frequency Converter ABZ (HTL / TTL) Encoder Card Product Insert (R912004809)".

### 12.3.2 Normal / Heavy Duty Setting

This function is used for switching the duty mode of a frequency converter according to the load type of the actual application.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.01 | Normal / Heavy duty setting | 0, 1 | 1 | – | Stop |

- 0: ND (Normal duty)

  Change the duty mode to 'Normal duty' by modifying the parameter setting from '1' to '0' according to the actual application.

  **Example:**

  A motor of 7.5 kW is used to drive a light load, e.g. a fan:

  – Select a Frequency Converter EFC 3610 of 5.5 kW (5K50).

  – Modify the duty mode of the frequency converter from 'Heavy duty' to 'Normal duty'.

- 1: HD (Heavy duty). This mode is set by default.

  **Example:**

  A motor of 7.5 kW is used to drive a heavy load, e.g. a compressor:

  – Select a Frequency Converter EFC 3610 of 7.5 kW (7K50).

For overload capability and output current in ND and HD modes, see chapter 6.1.2 "Output" on page 20.

### 12.3.3 Carrier Frequency Setting

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.05 | Carrier frequency | 0K40...22K0: 1...15 kHz<br>30K0...160K: 1...12 kHz | 0K40...4K00: 6k<br>5K50...22K0 (HD): 6k<br>5K50...22K0 (ND): 4k<br>30K0...90K0: 4k<br>110K...160K: 2k | 1 | Run |
| C0.06 | Carrier frequency automatic adjustment | 0: Inactive<br>1: Active<br>2: Fixed carrier frequency | 1 | – | Stop |

When output frequency is less than 5 Hz, the carrier frequency is 2 kHz; When output frequency is 5...10 Hz, the carrier frequency is 4 kHz; When output frequency is more than 10 Hz, the carrier frequency is the same as customer's setting.

The relationship between the carrier frequency, 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. 12-2:** Influence of carrier frequency

For derating figures related to carrier frequency, see chapter 6.2.2 "Derating of Electric Data" on page 28.

To achieve optimized performance, the carrier frequency setting should follow the equation: [C0.05] ≥ 10 x [E0.08].

With [C0.06] = 1, the carrier frequency can also be changed automatically to keep the power module temperature within the normal range.

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

### 12.3.4 Fan Control

This function is used to set the running mode of the fan for the heat sink and fan for electrolytic capacitor.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.50 | Fan control | 0: Automatically controlled<br>1: Always on<br>2: On when converter run | 0 | – | Run |

- 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.

- 1: Always on

  The fan for the heat sink and 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.

- 2: On when converter run.

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

When C0.50 = "0: Automatically controlled", the electrolytic capacitor fan starts running when the frequency converter is running and stops running when the frequency converter stops.

### 12.3.5 Fan Maintenance Reminder

This function is used to remind users maintaining the cooling fan in time. The maintenance time can be set according to the actual application conditions.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.51 | Fan total running time | 0...65,535 h | 0 | 1 | Read |
| C0.52 | Fan maintenance time | 0...65,535 h | 0 | 1 | Stop |
| C0.53 | Fan total running time reset | 0: Inactive<br>1: Active | 0 | – | Run |

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

- 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'

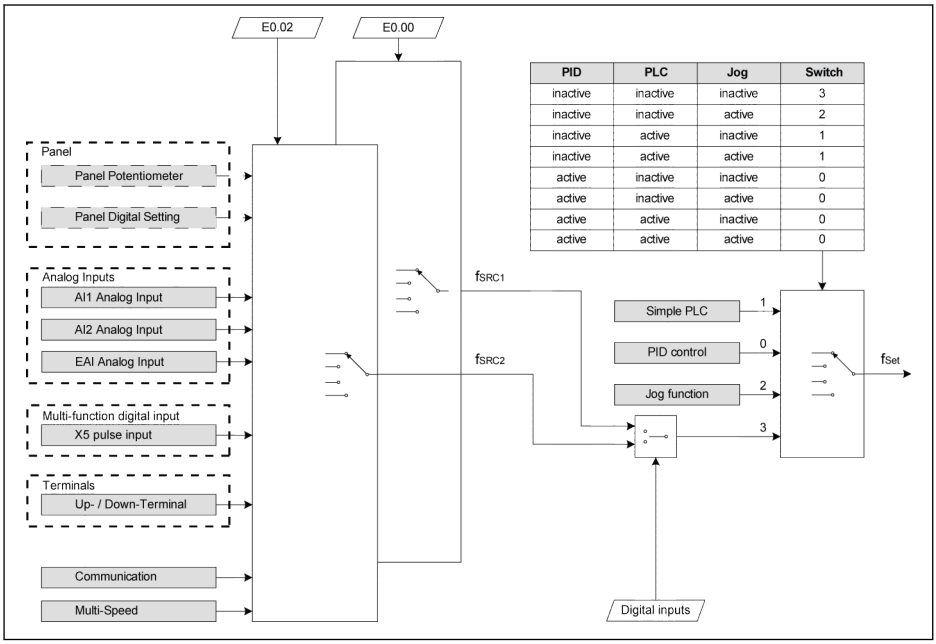
  After the execution, [C0.53] and [C0.51] will be reset to '0' automatically. By now, the warning code 'FLE' is cleared completely.
- Adjust the value of C0.52 'Fan maintenance time' if necessary

## 12.4 Basic Frequency Setting Sources

### 12.4.1 Function Description

Four means of frequency setting sources are available with priority (0, 1, 2, 3) as shown in the figure below.

Only frequency setting source of the fourth priority '3: Basic frequency setting sources' is introduced in this chapter. Other frequency setting sources of '0: PID control', '1: Simple PLC' and '2: Jog function' will be introduced later in separate chapters.




$f_{SRC1}$ First frequency setting source
$f_{SRC2}$ Second frequency setting source
0 First priority (PID control)
1 Second priority (Simple PLC)
2 Third priority (Jog function)
3 Fourth priority (Basic frequency setting sources)
$f_{Set}$ Setting frequency

**Fig. 12-13:** Frequency setting sources

The frequency setting source switching and combination cannot be active at the same time.

## 12.4.2 Select the Frequency Setting Source

### General setting

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 | Min. | Attri. |
|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 0...21 | 0 | – | Stop |
| E0.02 | Second frequency setting source | 0...21 | 2 | – | Stop |

- 0: Panel potentiometer

  The setting frequency is set by adjusting the potentiometer on the operating panel.
- 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 AI1 input.
- 3: AI2 analog input

  The setting frequency is set by AI2 input.
- 4: EAI1 analog input

  The setting frequency is set by EAI1 analog input.
- 5: EAI2 analog input

  The setting frequency is set by EAI2 analog input.
- 10: X5 pulse input

  The setting frequency is set by pulse input via X5 input.
- 11: Digital input Up / Down command

  The setting frequency is set by command of Up / Down / Reset via digital inputs.
- 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.

### 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 digital input.

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.

The active / inactive of the selected digital input is triggered by voltage level, instead of the edge.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 30: Second frequency setting source activation | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

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.

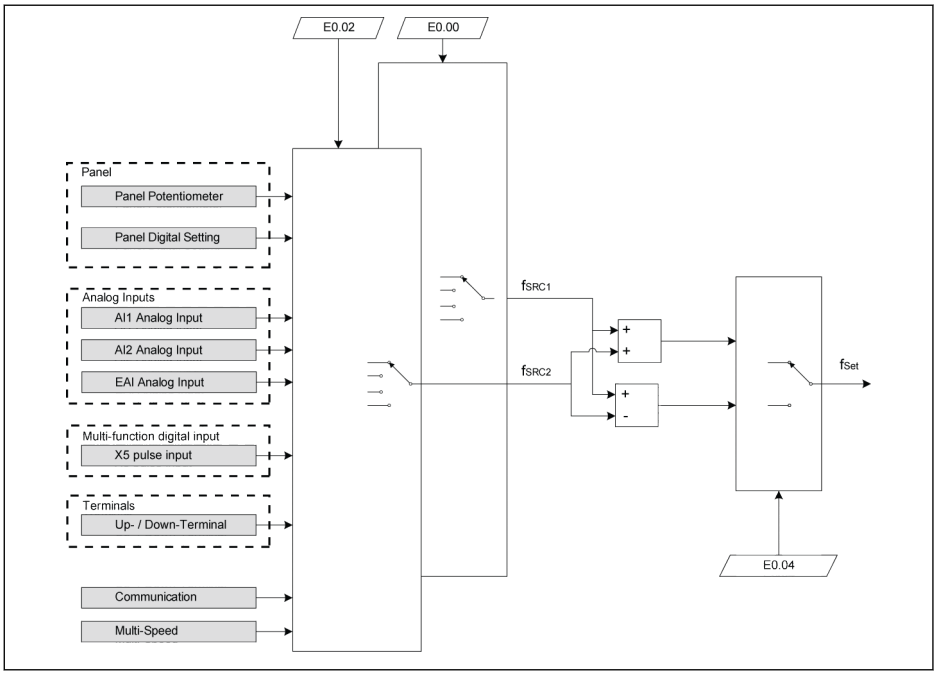
[E0.02] = '3: AI2 analog input', the setting frequency of the second frequency setting source is 50.00 Hz.

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 ste by AI2 analog 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. 12-14:** Combination of frequency sources

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.04 | Frequency setting source combination | 0...6 | 0 | – | Stop |

- 0: No combination

  By default, actual setting frequency is set by 'First frequency setting source'. 'Second frequency setting source' can be activated by one of digital inputs, see chapter "Frequency setting source switching" on page 157.

- 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 0 Hz.

To use the frequency setting source combination function, take the following steps:

**Step 1:** Be sure that [E1.00] ≠ '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] = 1 or 2 according to the actual application

The result of the combination is always limited within the range of 0.00...[E0.09] Hz.

### Adjust the setting frequency by panel potentiometer

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.

### Adjust the setting frequency by panel button

The setting frequency of the first and second frequency setting sources can be adjusted by pressing the <▲> / <▼> button on the operating panel.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 1: Panel button setting | 0 | – | Stop |
| E0.02 | Second frequency setting source | | 2 | – | Stop |
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | Run |

### Adjust the setting frequency by analog inputs

When analog input AI1, AI2 or EAI is used as the frequency setting source, the relationship between AI1, AI2, EAI and the setting frequency is shown as the figure below:

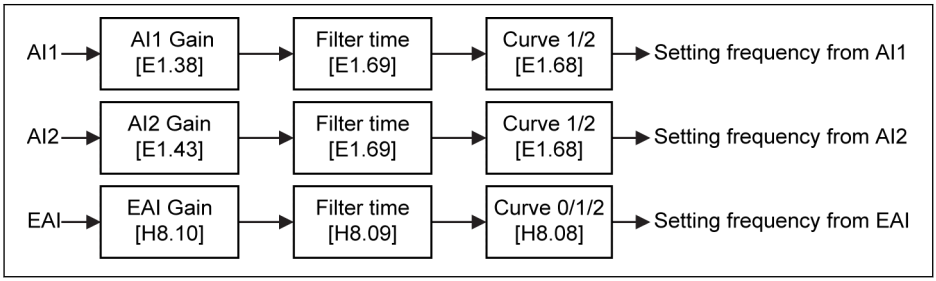



**Fig. 12-15:** AI1, AI2, EAI and setting frequency

- To set analog input AI1, AI2 and EAI properly, see chapter 12.2.3 "Analog Input Configuration" on page 131 and chapter 12.2.6 "I/O Card Terminal Configuration" on page 137.
- When [H8.05] = '5: -10...10 V', set [H8.08] = '0: Curve 0'.

### Adjust the setting frequency by X5 pulse input

When X5 pulse input is used as the frequency setting source, the setting frequency can be changed by changing the pulse frequency.

By default, 'Pulse input maximum frequency' [E1.25] = 50.0 kHz, which can be adjusted according to the actual application.

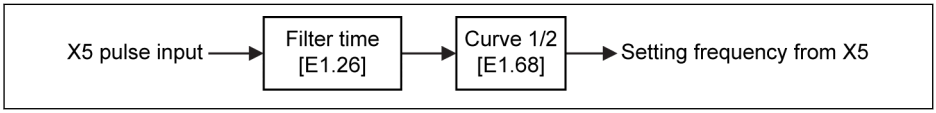



**Fig. 12-16:** X5 pulse input and setting frequency

To set X5 pulse input properly, see chapter 12.2.2 " X5 Pulse Input Configuration" on page 129.

### Adjust the setting frequency by digital input Up / Down command

The setting frequency can also 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 the first or the second frequency setting source to '11: Digital input Up / Down command'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 11: Digital input Up / Down command | 0 | – | Stop |
| E0.02 | Second frequency setting source | | 2 | – | Stop |

#### Step 2: Select any 3 digital inputs and define functions accordingly

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 20: Frequency Up command<br>21: Frequency Down command<br>22: Up / Down command reset | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

#### Step 3: Set the change rate and initial frequency for Up / Down operation

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

**Example:** [E1.00] = 20, [E1.01] = 21, [E1.02] = 22

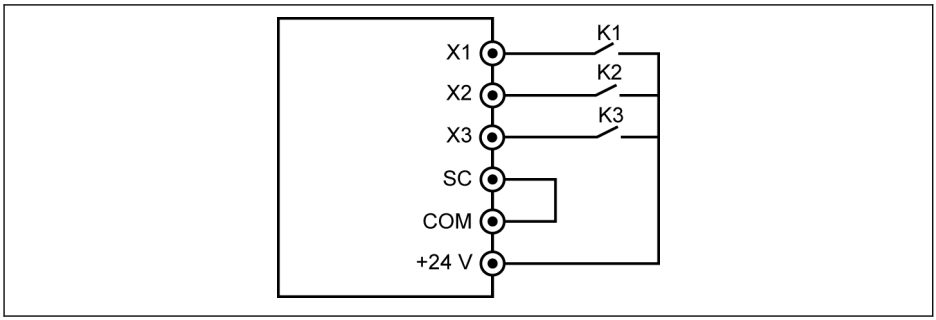



**Fig. 12-17:** External control terminals

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'.

| K1 | K2 | K3 | Response of setting frequency |
|---|---|---|---|
| Closed / Open | Closed / Open | Closed | Is reset to 0.00 Hz |
| Closed | Open | Open | Increases from [E1.17] with the change rate defined by [E1.16] |
| Open | Closed | Open | Decreases from [E1.17] with the change rate defined by [E1.16] |
| Open | Open | Open | No change |
| Closed | Closed | Open | No change |

**Tab. 12-3:** 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 12.4.5 "Frequency Setting Saving" on page 175.

### Adjust the setting frequency by multi-speed function

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. 12-4:** Setting frequency and multi-speed settings

To configure the multi-speed settings, take the following steps:

### Step 1: Activate multi-speed function

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.00 | First frequency setting source | 21: Multi-speed settings | 0 | – | Stop |
| E0.02 | Second frequency setting source | | 2 | – | Stop |

### Step 2: Select any 3 digital inputs and define functions accordingly

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.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 1: Multi-speed control input 1<br>2: Multi-speed control input 2<br>3: Multi-speed control input 3<br>4: Multi-speed control input 4 | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

### 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 | Min. | Attri. |
|---|---|---|---|---|---|
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | 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 |
| 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 |

**Step 4: Set the acceleration time / deceleration time, rotation direction for each stage**

| Code | Name | Setting range | Default | Min. | 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 | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6,000.0 s | DOM | 0.1 | Run |
| 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 |

The digit definition for each stage action is as the figure below:

| Digit: | Hundreds | Tens | Unit |
|---|---|---|---|
| Example: | 0 | 1 | 1 |

**Rotation direction**
Forward (FWD).....= 0
Reverse (REV).....= 1

**Acceleration time**
[E0.26] Acceleration time ..... = 1
[E3.10] Acceleration time 2..... = 2
[E3.12] Acceleration time 3..... = 3
[E3.14] Acceleration time 4..... = 4
[E3.16] Acceleration time 5..... = 5
[E3.18] Acceleration time 6..... = 6
[E3.20] Acceleration time 7..... = 7
[E3.22] Acceleration time 8..... = 8

**Deceleration time**
[E0.27] Deceleration time..... = 1
[E3.11] Deceleration time 2..... = 2
[E3.13] Deceleration time 3..... = 3
[E3.15] Deceleration time 4..... = 4
[E3.17] Deceleration time 5..... = 5
[E3.19] Deceleration time 6..... = 6
[E3.21] Deceleration time 7..... = 7
[E3.23] Deceleration time 8..... = 8

**Fig. 12-18:** Bit definition of rotation direction, acceleration and deceleration time

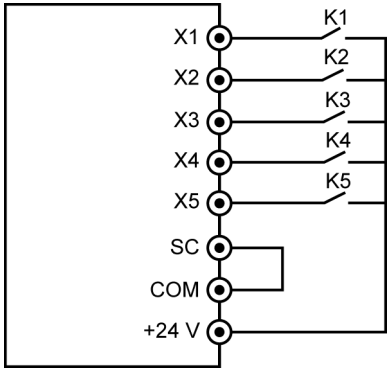



**Fig. 12-19:** Multi-speed control via digital inputs

## 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)'.

| K5 | K4 | K3 | K2 | K1 | Setting frequency | Acc. / Dec. time |
|---|---|---|---|---|---|---|
| See chapter "2-wire control mode 1" on page 196 and chapter "2-wire control mode 2 (Forward / reverse, run / stop)" on page 197 | | 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. 12-5:** Multi-speed settings for 8 or less stages

### 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] |

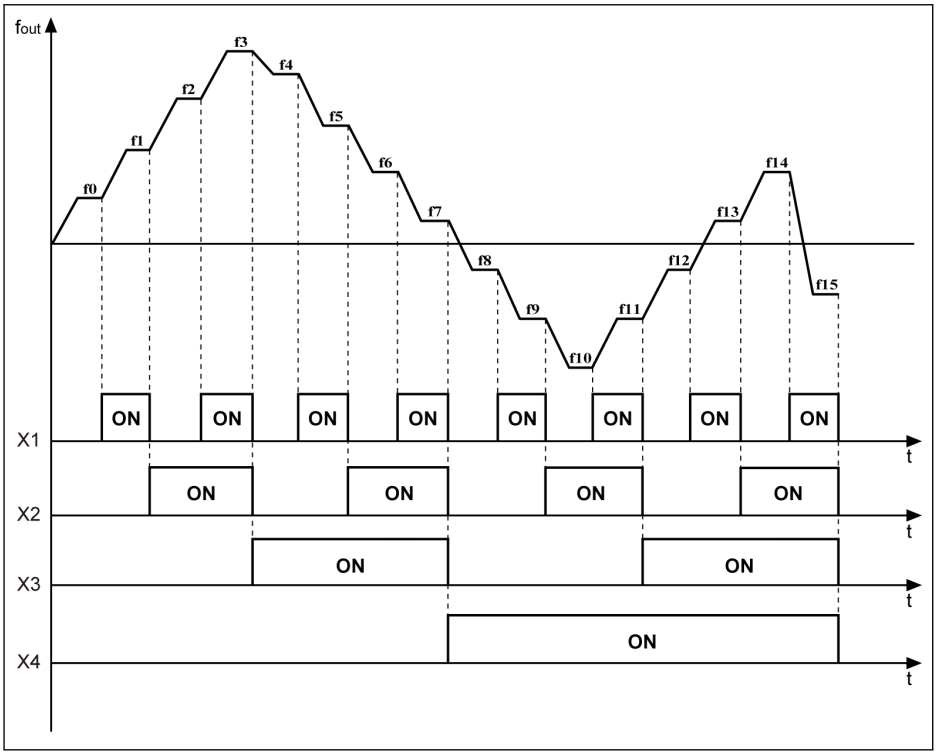
| K4 | K3 | K2 | K1 | Setting frequency | Acc. / Dec. time |
|---|---|---|---|---|---|
| Closed | Closed | Closed | Open | [E3.53] | [E3.20] / [E3.21] |
| Closed | Closed | Closed | Closed | [E3.54] | [E3.22] / [E3.23] |

**Tab. 12-6:** Multi-speed settings for 9 or more stages

| K5 | Status |
|---|---|
| Inactive | Stop |
| Active | Run |

**Tab. 12-7:** Run / Stop control via K5

Direction is controlled by parameters, see fig. 12-18 "Bit definition of rotation direction, acceleration and deceleration time" on page 167.




**$f_{out}$** Output frequency
**t** Time
**ON** Digital input switched on

**Fig. 12-20:** Multi-speed stage transition

## 12.4.3 Acceleration and Deceleration Configuration

### Acceleration and deceleration time configuration

Acceleration / deceleration time setting is the time for frequency increase from 0.00 Hz to [E0.08] 'Maximum output frequency' / the time for frequency decrease from [E0.08] to 0.00 Hz respectively.

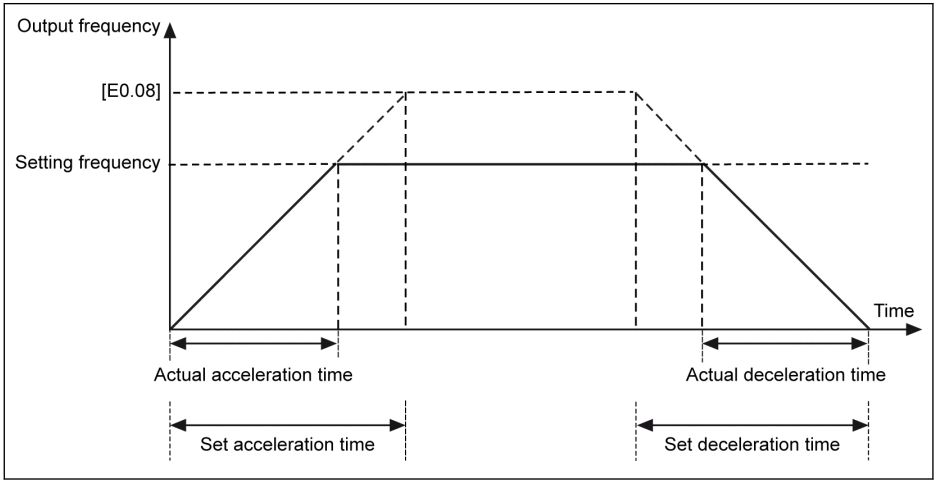



**Fig. 12-21:** Acceleration and deceleration time

8 groups of acceleration / deceleration time are available, which can be selected by setting digital inputs.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| E1.00 | X1 input | 10: Acceleration / deceleration time 1 activation<br>11: Acceleration / deceleration time 2 activation<br>12: Acceleration / deceleration time 3 activation | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

**Example:**

- Set [E1.00] 'X1 input' = '10: Acceleration / deceleration time 1 activation'.
- Set [E1.01] 'X2 input' = '11: Acceleration / deceleration time 2 activation'.
- Set [E1.02] 'X3 input' = '12: Acceleration / deceleration time 3 activation'.

The 'Acceleration / Deceleration time' configuration is shown as below:

| X1 | X2 | X3 | Acceleration time | Deceleration time |
|---|---|---|---|---|
| Inactive | Inactive | Inactive | [E0.26] | [E0.27] |
| Active | Inactive | Inactive | [E3.10] | [E3.11] |
| Inactive | Active | Inactive | [E3.12] | [E3.13] |
| Active | Active | Inactive | [E3.14] | [E3.15] |
| Inactive | Inactive | Active | [E3.16] | [E3.17] |
| Active | Inactive | Active | [E3.18] | [E3.19] |
| Inactive | Active | Active | [E3.20] | [E3.21] |
| Active | Active | Active | [E3.22] | [E3.23] |

**Tab. 12-8:** Acceleration / deceleration time configuration

### Acceleration and deceleration curve mode configuration

Two curve modes are available for acceleration / deceleration: 'linear curve' and 'S-curve'. The S-curve mode is used to achieve a smooth starting or stopping.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.25 | Acceleration / deceleration curve mode | 0: Linear mode<br>1: S-curve | 0 | – | Stop |
| 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 |

[E0.25] = 0: Linear mode

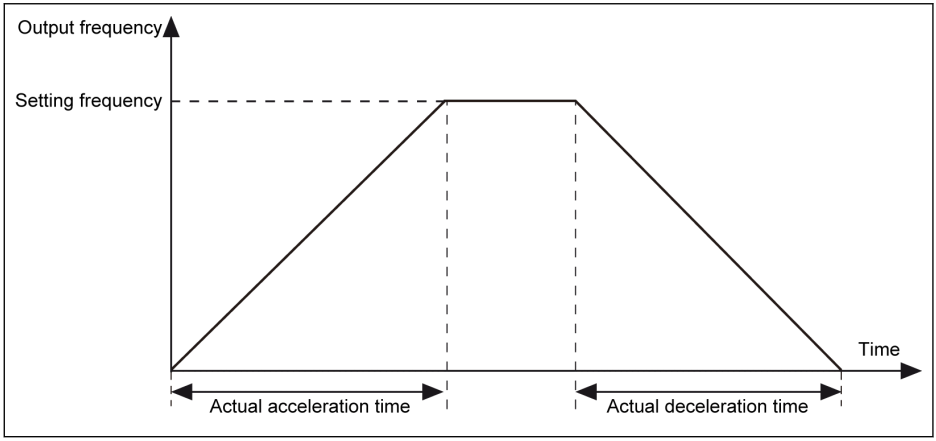
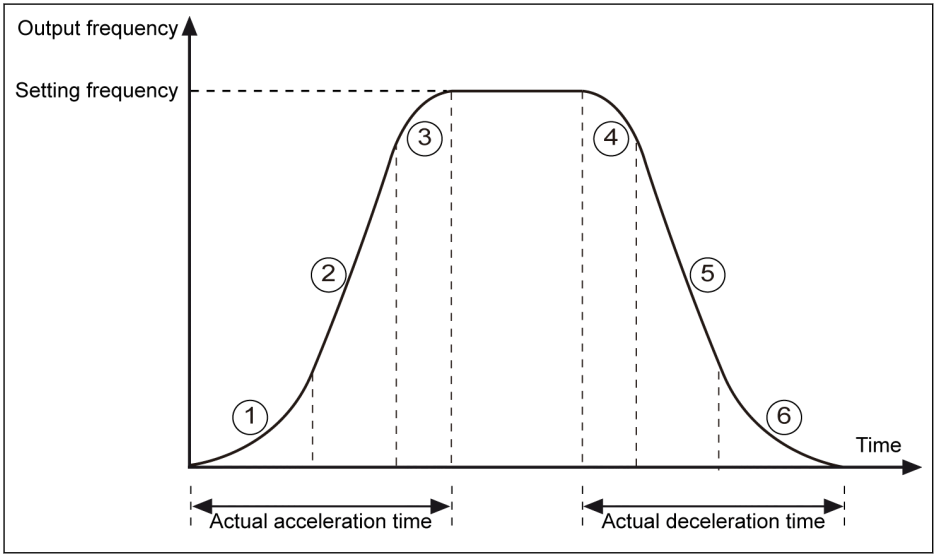



**Fig. 12-22:** Linear mode acceleration and deceleration

[E0.25] = 1: S-curve




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. 12-23:** S-curve acceleration and deceleration

Stage ①, ③: a percentage of setting acceleration time.

Stage ④, ⑥: a percentage of setting deceleration time.

## 12.4.4 Output Frequency Limitation

### Direct output frequency limitation

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

- Maximum output frequency

  The allowed maximum output frequency of the frequency converter.
- Output frequency high limit

  The allowed maximum output frequency according to the requirements in actual applications.
- Output frequency low limit

  The allowed minimum output frequency according to the requirements in actual applications.

### Behavior at low speed running

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.15 | Low speed running setting | 0: Running at 0.00Hz<br>1: Running with low limit frequency | 0 | – | Stop |
| E0.16 | Low speed frequency hysteresis | 0.00...[E0.10] Hz | 0.00 | 0.01 | Stop |

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

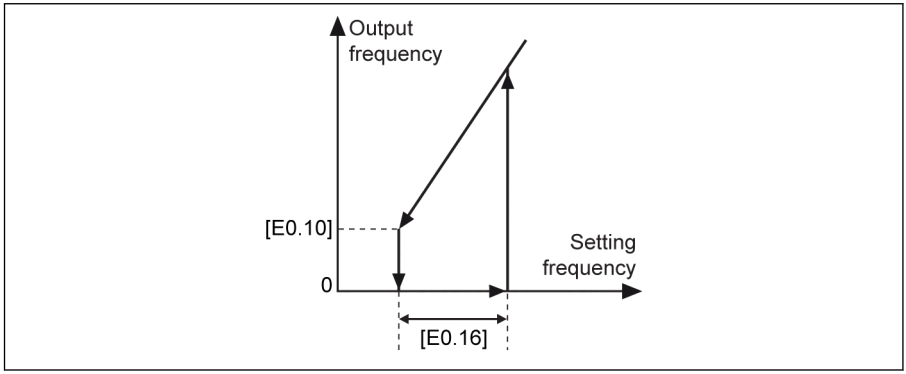



**Fig. 12-24:** Running at 0 Hz

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

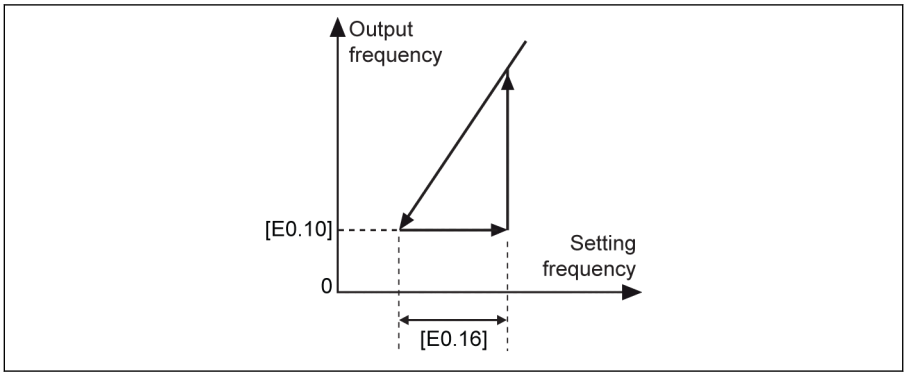



**Fig. 12-25:** Run with low limit frequency

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.

## 12.4.5 Frequency Setting Saving

With the 'Frequency setting saving' function, unexpected data loss of commissioning or actual application engineering process can be avoided.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.06 | Digital setting frequency saving mode | 0...4 | 0 | – | Stop |

- 0: Not saved when powered off or stopped

  By default, the setting frequency configured by <▲> / <▼> or digital inputs will not be saved either at power off or frequency converter stop during fine tuning of the setting frequency in the actual application engineering process.

  To avoid unexpected data loss of commissioning or actual application engineering process, one of the following three options may be set according to the actual application conditions:

- 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

# 12.5 Run- / Stop- / Direction Command Source

## 12.5.1 Function Description

The Run- / Stop- / Direction Command can be configured by the following means:

- First priority: PID control
- Second priority: Simple PLC
- Third priority: Jog function
- Fourth priority: Basic command sources
  - 0: Operating panel
  - 1: Digital inputs
  - 2: Communication

The basic Run- / Stop- / Direction command sources are shown in the figure below:

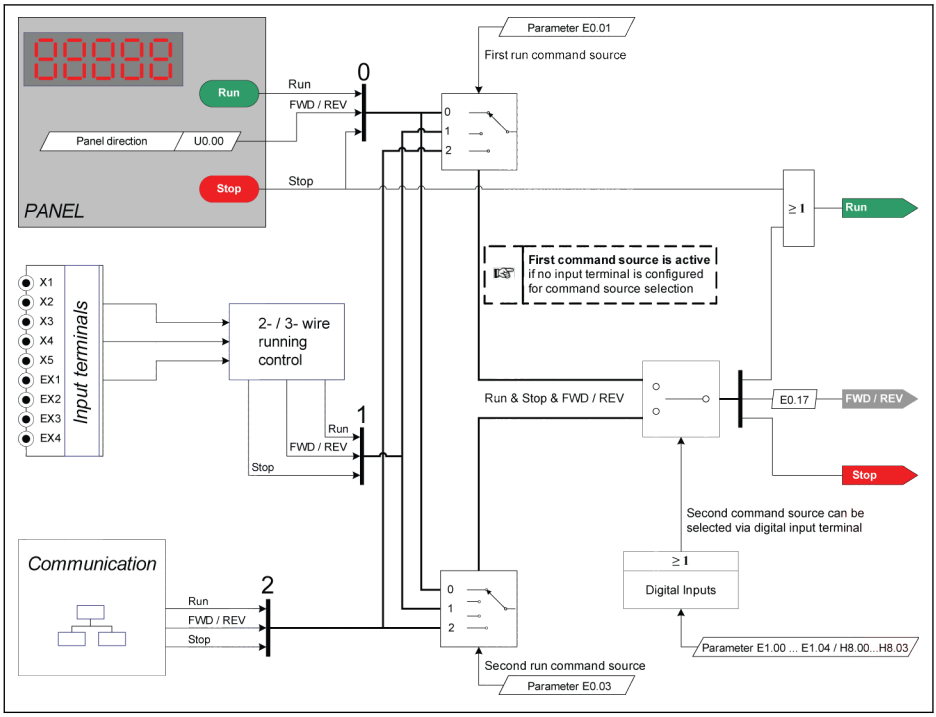



**Fig. 12-26:** Run command sources

## 12.5.2 Run Command Source

### First and second run command source configuration

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.01 | First run command source | 0...2 | 0 | – | Stop |
| E0.03 | Second run command source | 0...2 | 1 | – | Stop |

- 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.

### Switch between first and second run command source

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 31: Second run command source activation | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

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 active / inactive of digital input is triggered by voltage level.

### Stop command via panel <Stop> button

After the run command source configuration, set U0.01 'Stop button control' to define the function of **<Stop>** button on the operating panel.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| U0.01 | Stop button control | 0: Active only for operating panel control<br>1: Active for all control methods | 1 | – | Run |

## 12.5.3 Direction Control

### 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'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| U0.00 | Direction control by panel | 0: Forward<br>1: Reverse | 0 | – | Run |
| E0.17 | Direction control | 0: Forward / Reverse<br>1: Forward only<br>2: Reverse only<br>3: Swap default direction | 0 | – | Stop |

| | [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. 12-9:** Direction configuration

For error codes 'dir1', 'dir2' concerning direction control, see chapter 13.4 "Error Code" on page 279.

### Reverse running frequency

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.11 | Reverse running frequency | 0.00...[E0.09] Hz | 0.00 | 0.01 | Stop |

When the converter is running in reverse direction, the setting frequency will be defined by E0.11.

This reverse running frequency is **ONLY** active when converter is **NOT** running in multi-speed, simple PLC, or PID control mode.

### Direction change dead time

A dead time exists if the direction is changed from forward / reverse to reverse / forward, which can be defined according to actual application.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.18 | Direction change dead time | 0.0...60.0 s | 1.0 | 0.1 | Stop |

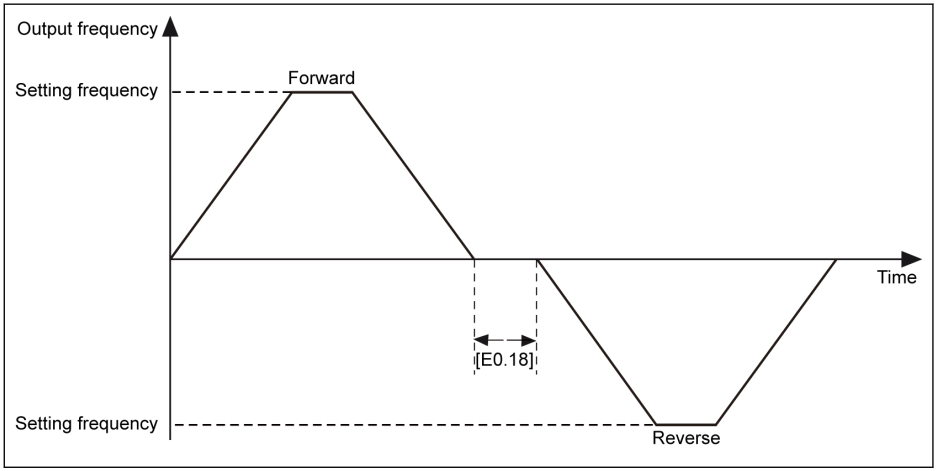



**Fig. 12-27:** Direction change dead time

## 12.5.4 Start Behavior Setting

### Start mode selection

| Code | Name | Setting range | Default | Min. | 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 |

### 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.

| 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 |

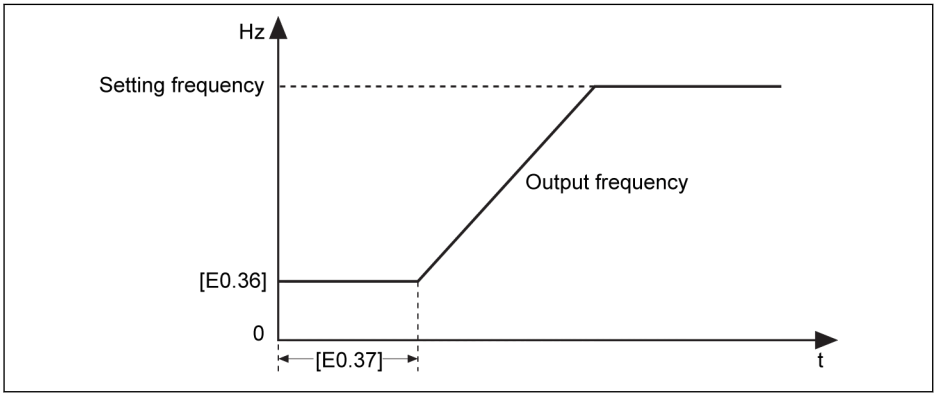



**Fig. 12-28:** Start directly

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 is used in applications, in which regular deceleration to stop or a quick stop is required. 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.

'DC-braking before start' is used in applications where the load may encounter forward / reverse rotation when the frequency converter is in stop mode.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.38 | Start DC-braking time | 0.0...20.0 s | 0.0 | 0.1 | Stop |
| E0.39 | Start DC-braking current① | 0.0...150.0 % | 0.0 | 0.1 | Stop |

①: percentage of frequency converter rated current.

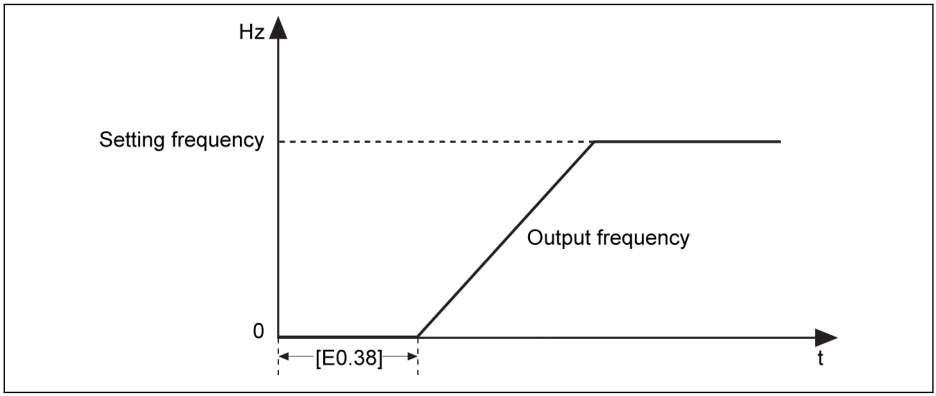



**Fig. 12-29:** DC-braking before start

When [E0.38] ≠ 0, DC-braking will be executed. After this, the frequency converter starting to accelerate to [E0.36] 'Start frequency' for a period of [E0.37], then accelerate to the setting frequency.

### Start with speed capture

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.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

E0.42 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 that set speed tracking action. Please set the deceleration time from the highest output frequency to the lowest output frequency.

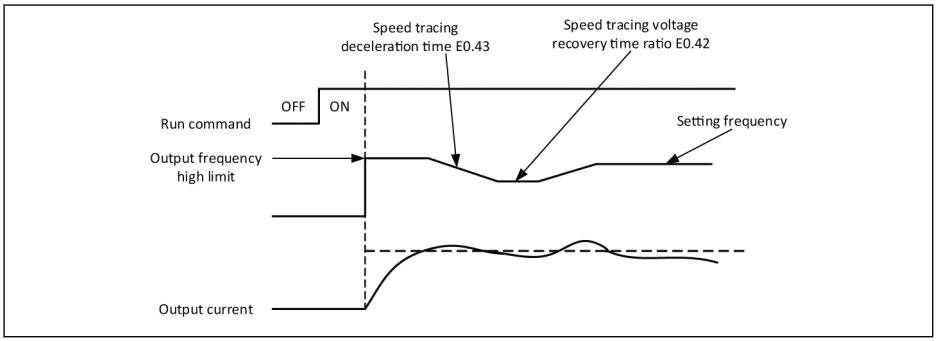



**Fig. 12-30:** Start with speed capture

When the frequency converter is starting and accelerating, if 'Setting frequency' is lower than [E0.36] 'Start frequency', the frequency converter firstly starts at 'Start frequency' and runs for [E0.37] 'Start frequency holding time', and then decelerates to 'Setting frequency'.

### 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'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.35 | Starting mode | 3: Auto start / stop according to setting frequency | 0 | – | Stop |
| E0.41 | Automatic start / stop frequency threshold | 0.01...[E0.09] Hz | 16.00 | 0.01 | Stop |
| E0.00 | First frequency setting source | 2: AI1 analog input | 0 | – | Stop |
| E0.02 | Second frequency setting source | 3: AI2 analog input<br>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 |

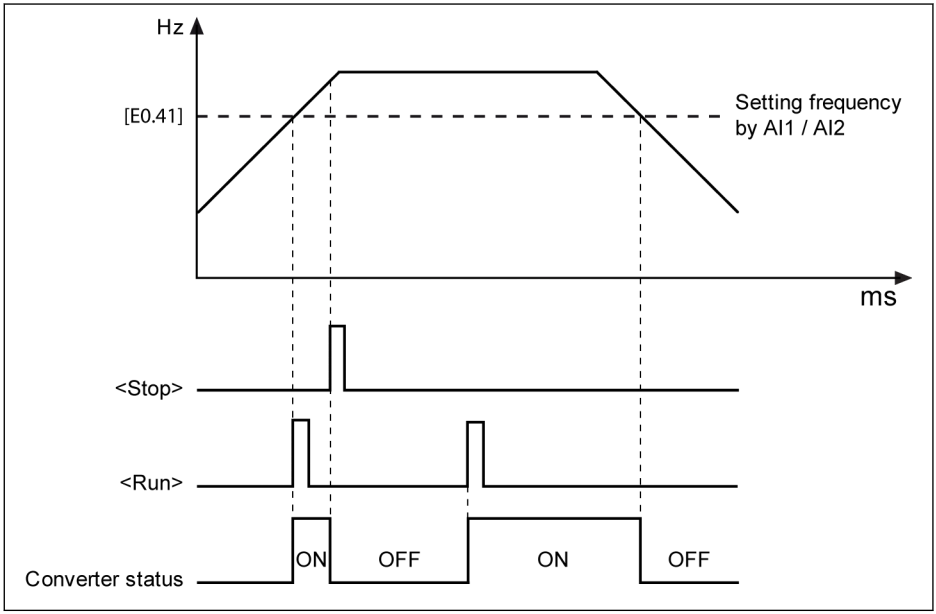



**Fig. 12-31:** Automatic start or stop according to frequency threshold

- When the setting frequency is higher than [E0.41], the frequency converter starts and runs to the setting frequency automatically.
  - Pressing <**Stop**> at this time, the frequency converter stops.
  - Pressing <**Run**> again, the frequency converter runs again.

When using this function, press <**Run**> firstly before setting the analog input.

- 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:
  - The first and the second run command sources are both via panel.
  - The active frequency setting source is via analog inputs.
  - 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.

## 12.5.5 Stop Behavior Setting

### Stop mode setting

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.50 | Stop mode | 0...2 | 0 | – | Stop |
| E1.00 | X1 input | 15: Freewheeling stop activation | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

- [E0.50] = 0: Deceleration stop

  The motor decelerates to stop according to the defined deceleration time.

  If 'Output frequency' is lower than [E0.52] 'Stop DC-braking initial frequency' and 'Stop DC-braking time' [E0.53] ≠ 0, and then DC-braking is activated. The 'Stop DC-braking current' is decided by [E0.54].

- [E0.50] = 1: Freewheeling stop

  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 with stop command, decelerating with direction change
  - 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.

### DC-braking during deceleration to stop

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.50 | Stop mode | 0: Decelerating stop | 0 | – | 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 |
| E1.00 | X1 input | 16: Stop DC-braking activation | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

①: percentage of frequency converter rated current.

'DC-braking to stop' can be activated in two ways:

- by parameter settings
  - [E0.50] = 0
  - [E0.53] > 0
  - [E0.54] > 0
  - [Output frequency] ≤ [E0.52]
- by digital inputs
  - 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 stops when it is inactive. There is no time limitation.

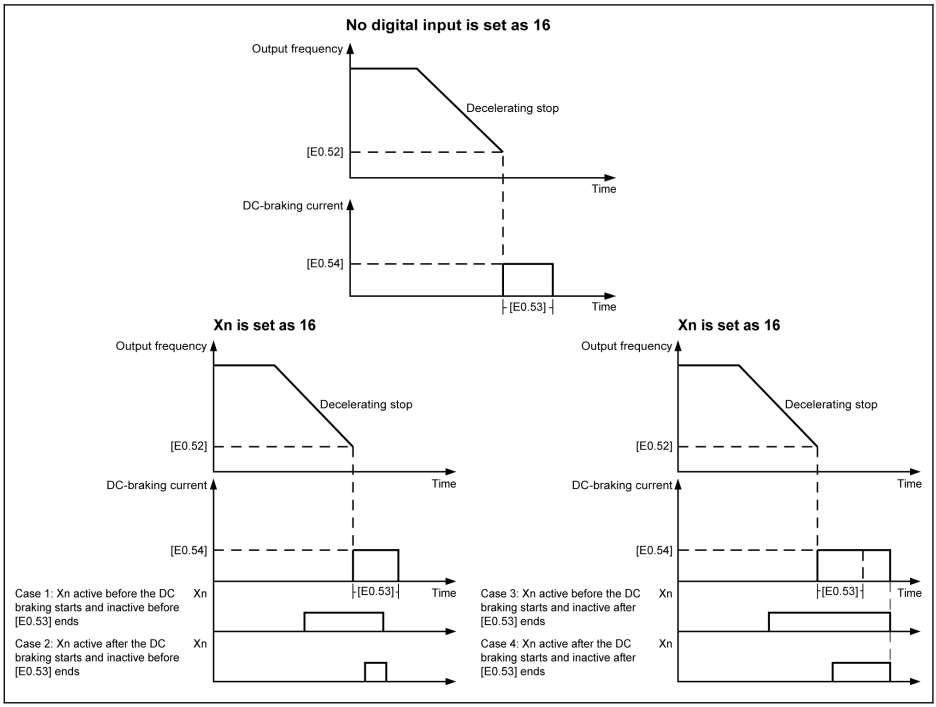



**Fig. 12-32:** Stop DC-braking

## Overexcitation braking

This function 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 | Min. | 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.

### Automatic voltage stabilization

| Code | Name | Setting range | Default | Min. | 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 | 1P 200 VAC: 180...264 V | 220 | 1 | Stop |
| | | 3P 200 VAC: 180...264 V | | | |
| | | 3P 380 VAC: 323...528 V | 380 | | |

C0.10 = 0: 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.

C0.10 = 1: Constant voltage control is disabled, then the output voltage will be in direct proportion to the input voltage.

Output voltage might higher than motor rated voltage.

C0.10 = 2: 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.

C0.11 is only active when constant voltage control is disabled and in deceleration process.

## 12.5.6 Resistor Braking

This function is used to obtain an optimized braking performance of the frequency converter in either V/f control mode or SVC control mode.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.25 | Overvoltage prevention mode | 2: Stall overvoltage protection disabled, resistor braking enabled<br>3: Stall overvoltage protection enabled, resistor braking enabled | 3 | – | Stop |
| C0.15 | Brake chopper start voltage | 1P 200 VAC: 300...390 V | 385 | 1 | Stop |
| | | 3P 200 VAC: 300...390 V | | | |
| | | 3P 380 VAC: 600...785 V | 770 | | |
| C0.16 | Brake chopper duty cycle | 1...100 % | 100 | 1 | Stop |

Parameters C0.15 and C0.16 are only available with models of 22K0 and below. For models of 30K0 and above an external brake chopper may be required. For more information on these external devices, see documentation R912007235.

To use this function, take the following steps:

**Step 1: Activate the resistor braking function**

Set [C0.25] = '2: Stall overvoltage protection disabled, resistor braking enabled' or '3: Stall overvoltage protection enabled, resistor braking enabled'.

**Step 2: Set the braking point based on model**

The default 'Braking start point' is different for 3P 380 VAC and 3P 200 VAC / 1P 200 VAC models, which needs to be adjusted by setting parameter C0.15 'Brake chopper start voltage' according to the actual situations.

**Step 3: Set the duty cycle**

Set parameter C0.16 'Brake chopper duty cycle' according to the actual situations:

- When the DC-bus voltage is higher than [C0.15] 'Brake chopper start voltage', the brake chopper switches On / Off according to the duty [C0.16] 'Brake chopper duty cycle' with an internal hysteresis.
- Excessive low setting of parameter C0.16 'Brake chopper duty cycle' may bring overvoltage error during braking.

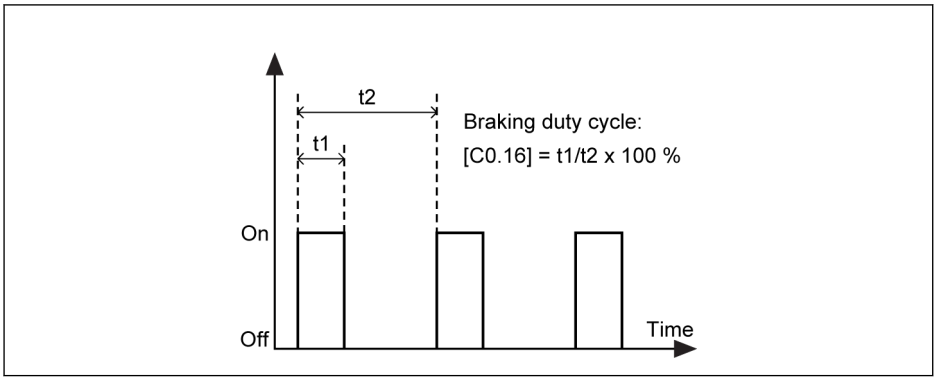



**Fig. 12-33:** Braking duty cycle

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

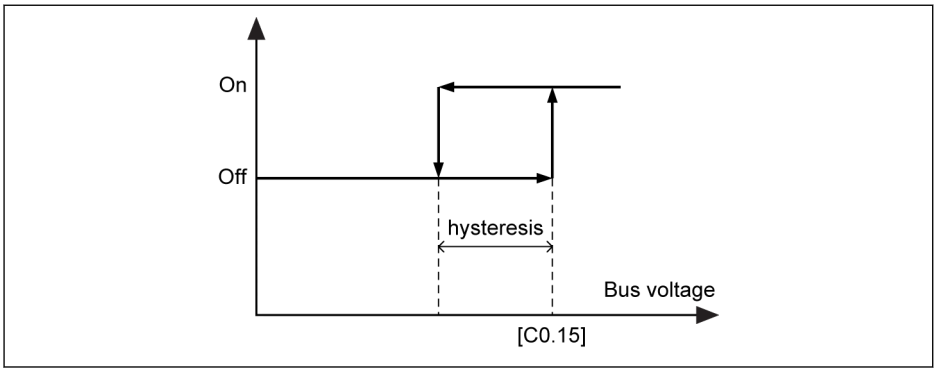



**Fig. 12-34:** Hysteresis

The hysteresis for different models is as listed below:

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

## 12.6 Special Running Behaviors

### 12.6.1 Skip Frequency

This function is used to avoid the mechanical resonance of the motor by definition of skip frequencies.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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:

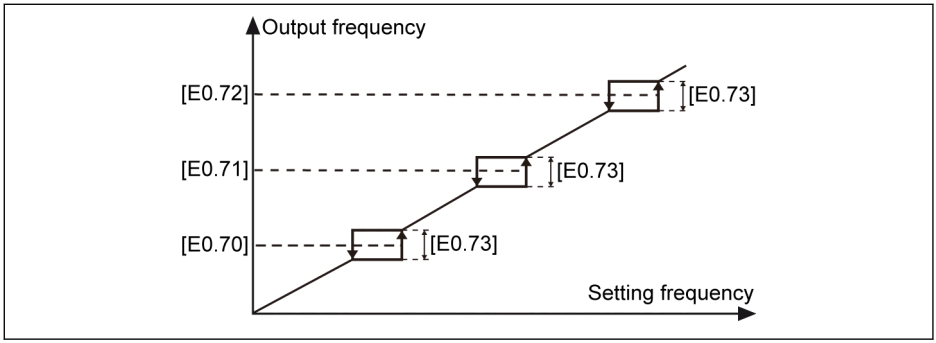



**Fig. 12-35:** Skip frequency

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 [E0.73] = 0.00, 'Skip frequency' function is inactive.
- Do **NOT** set E0.70, E0.71 and E0.72 overlapping or nesting in each other.

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.

## 12.6.2 Jog Function

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**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 37: Forward jog<br>38: Reverse jog | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

**Step 2: Set respective parameters**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

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 lower 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'.

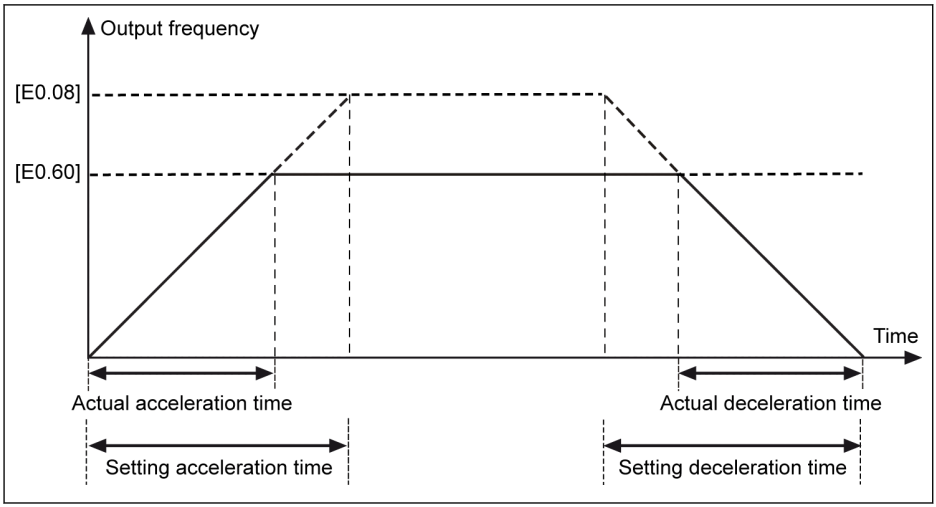



**Fig. 12-36:** Jog acceleration / deceleration time

| Forward jog | Reverse jog | Running status |
|---|---|---|
| Active | Active | Stop |
| Active | Inactive | Jog forward |
| Inactive | Active | Jog reverse |

**Tab. 12-10:** 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'.

## 12.6.3 2-wire / 3-wire Control (Forward / stop, reverse / stop)

### 2-wire control mode 1

**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)'.

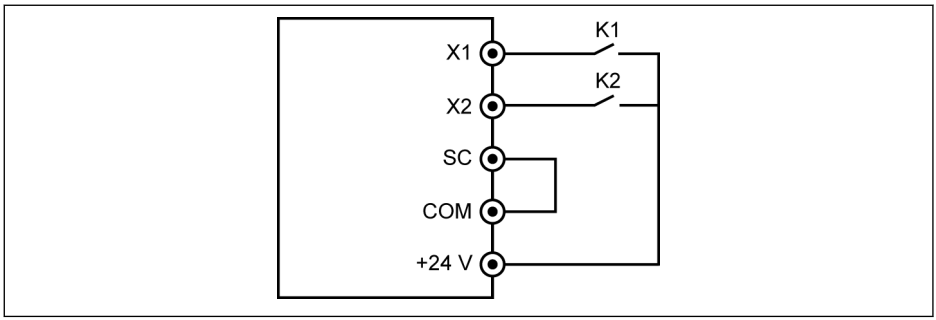



**Fig. 12-37:** 2-wire control mode 1

The control logic is shown in the table below:

| K1 | K2 | Running status |
|---|---|---|
| Open | Open | Stop |
| Closed | Open | Running forward |
| Open | Closed | Running reverse |
| Closed | Closed | Stop |

**Tab. 12-11:** 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.

### 2-wire control mode 2 (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)'.

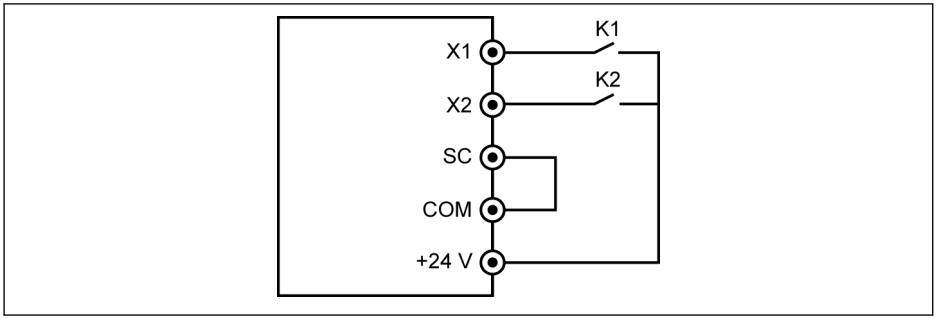



**Fig. 12-38:** 2-wire control mode 2

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. 12-12:** 2-wire control mode 2 configuration

### 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.

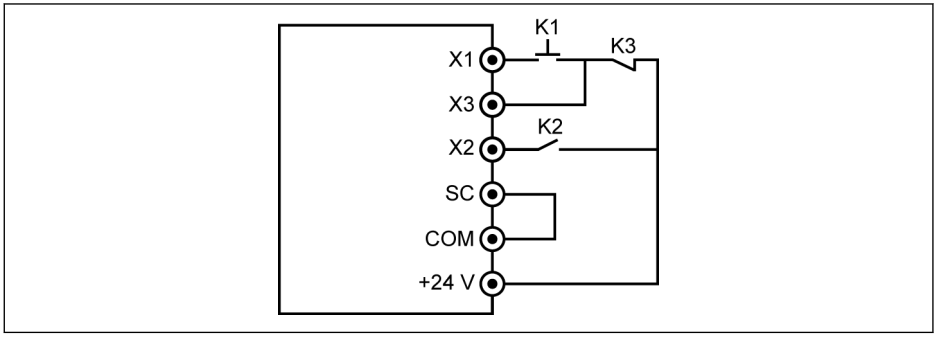



**Fig. 12-39:** 3-wire control 1

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. 12-13:** 3-wire control configuration

### 3-wire control mode 2

Different from the 3-wire control mode 1, 3-wire control mode 2 has a 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 mode 2' by setting '[E1.15] = 3'**

**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.

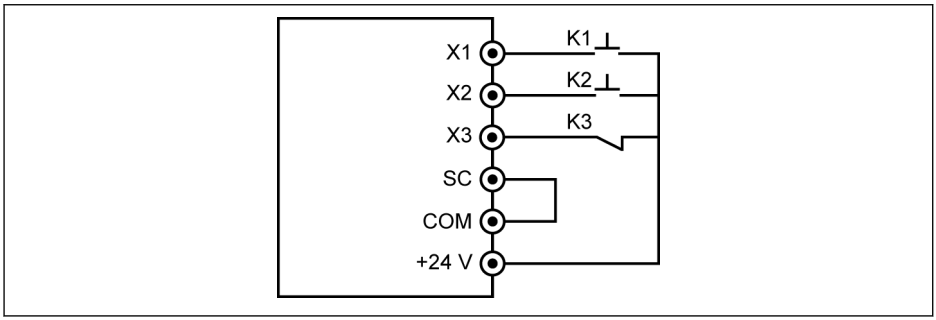



**Fig. 12-40:** 3-wire control mode 2

| 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. 12-14:** 3-wire control configuration

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.

### Run / Stop

For details of Run /Stop mode, see chapter "Adjust the setting frequency by multi-speed function" on page 164.

## 12.7 Special Functions

### 12.7.1 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'.

The 'Counter middle value arrival' or 'Counter target value arrival' output signal will be indicated via DO1 or Relay 1 output when the counter value equals to that of setting value.

The counter is cleared and the DO1 or Relay 1 output signal is reset by a valid edge signal of another digital input defined as 'Counter reset'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 39: Counter input<br>40: Counter reset | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |
| E2.80 | Counter middle value | 0...[E2.81] | 0 | 1 | Run |
| E2.81 | Counter target value | [E2.80]...9,999 | 0 | 1 | Run |
| E2.01 | DO1 output setting | 16: Counter target value arrival<br>17: Counter middle value arrival | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |

**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:

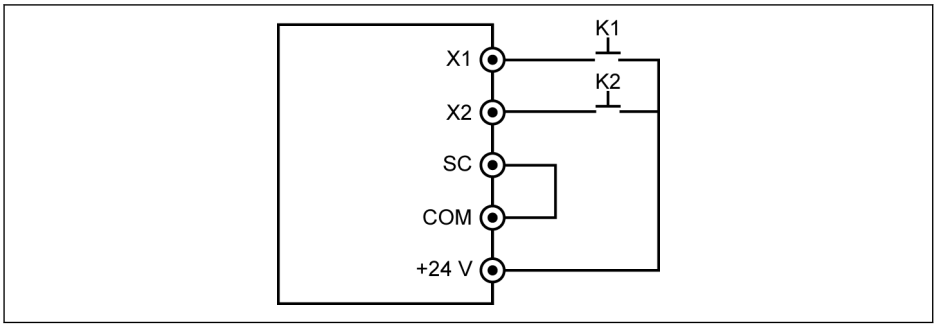



**Fig. 12-41:** Digital input configuration

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. 12-15:** 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:

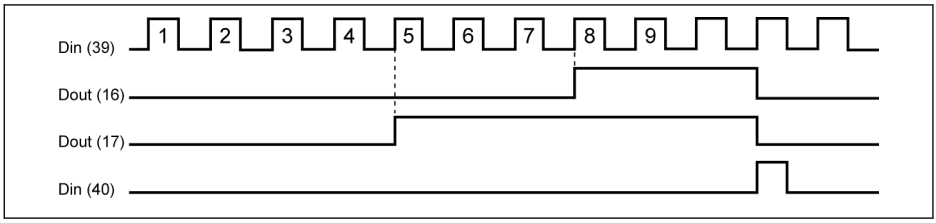



**Fig. 12-42:** Output behavior

- 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.

## 12.7.2 Frequency Arrival

This function is used to detect the difference between the output frequency and the setting frequency. When the difference is within the frequency detection width, an indication signal will be generated for further engineering in the application.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 4: Speed arrival | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |
| E2.70 | Frequency detection width | 0.00...400.00 Hz | 2.50 | 0.01 | Run |

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':

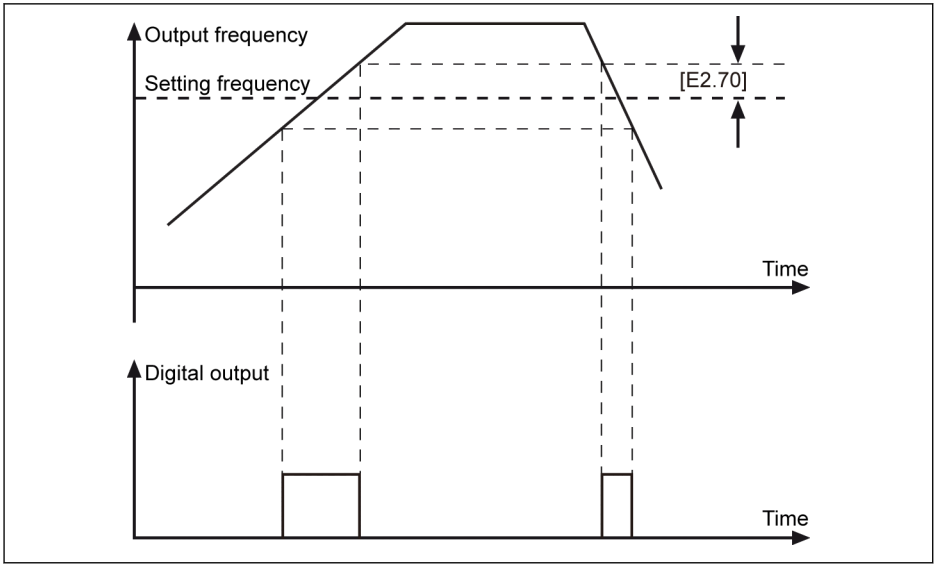



**Fig. 12-43:** Frequency arrival

### 12.7.3 Frequency Level Detection

This function is used to detect the difference between the output frequency and the setting frequency. An indication signal will be generated **ONLY** when the output frequency is **HIGHER** than the lower limit of the frequency detection level. The indication signal can be used for further engineering in the application.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 5, 6 | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |
| E2.71 | Frequency detection level FDT1 | 0.00...400.00 Hz | 50.00 | 0.01 | Run |
| E2.72 | Frequency detection level FDT1 width | 0.00...[E2.71] Hz | 1.00 | 0.01 | Run |
| E2.73 | Frequency detection level FDT2 | 0.00...400.00 Hz | 25.00 | 0.01 | Run |
| E2.74 | Frequency detection level FDT2 width | 0.00...[E2.73] Hz | 1.00 | 0.01 | Run |

The selected digital output signal and status are as below:

- [E2.01] / [E2.15] = 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]
- [E2.01] / [E2.15] = 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]

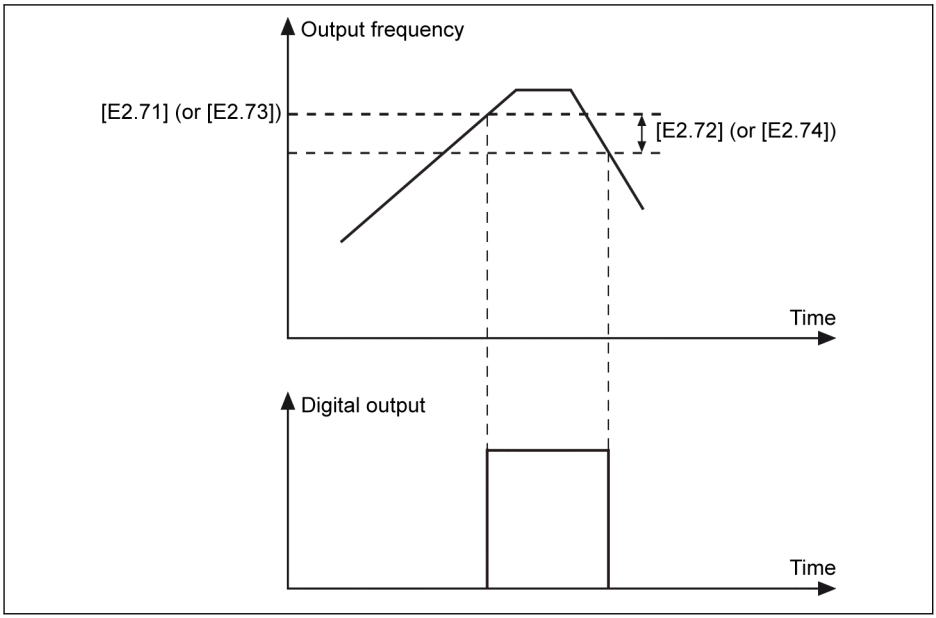



**Fig. 12-44:** Frequency level detection

## 12.7.4 High Resolution Current Display

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E5.01 | High resolution output current filter time | 5...500 ms | 40 | 1 | Run |
| d0.98 | High resolution output current | – | – | 0.01 | Read |

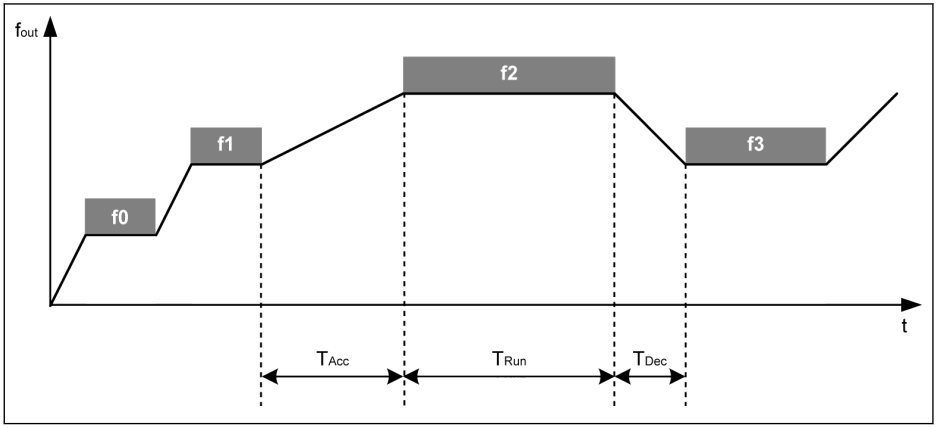
E5.01 is used to set the time constant of dynamic output current in applications where a high resolution value with two decimals are required for monitoring or control.

# 12.8 Simple PLC

## 12.8.1 Function Description

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. 12-45:** 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. 12-16:** Simple PLC configuration

## 12.8.2 Set the Simple PLC Mode

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E3.00 | Simple PLC running mode | 0...3 | 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 |

- [E3.00] = 0: 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.

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.

## 12.8.3 Set Speed / Direction / Acceleration and Deceleration Time

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.07 | Digital setting frequency | 0.00...[E0.09] Hz | 50.00 | 0.01 | 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 |
| 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 |
| E3.60 | 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |
| E0.26 | Acceleration time | 0.1...6000.0 s | DOM | 0.1 | Run |
| E0.27 | Deceleration time | 0.1...6000.0 s | DOM | 0.1 | Run |
| 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...6000.0 s | 10.0 | 0.1 | Run |
| E3.17 | Deceleration time 5 | 0.1...6000.0 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 |

For the stage definition, see chapter "Adjust the setting frequency by multi-speed function" on page 164.

- 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.

## 12.8.4 Stop and Pause Simple PLC Control

Active 'Simple PLC control' can be stopped or paused by configuration of digital inputs with functions of 'Simple PLC stop' or 'Simple PLC pause'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 26: Simple PLC stop<br>27: Simple PLC pause | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

- 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 |
| 4 | Inactive | Inactive | Stop | Stop according to [E0.50] |
| 5 | Inactive | Active | Run | Restart from 1st simple PLC stage |

**Tab. 12-17:** Typical simple PLC pause process

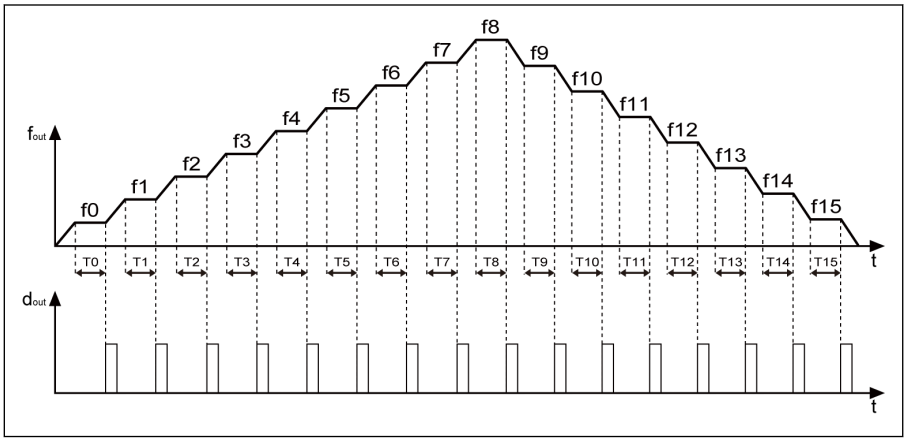
## 12.8.5 Indication of Simple PLC Status

An indication signal is active via 'DO1 output' or 'Relay 1 output' when a simple PLC cycle or stage is complete.

Define the output with respective indication signals as below:

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.01 | DO1 output setting | 7: Simple PLC stage complete<br>8: Simple PLC cycle complete | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |

- 7: Simple PLC stage complete




**$f_{out}$** Output frequency **t** Time
**$d_{out}$** Digital output

**Fig. 12-46:** Simple PLC stage complete

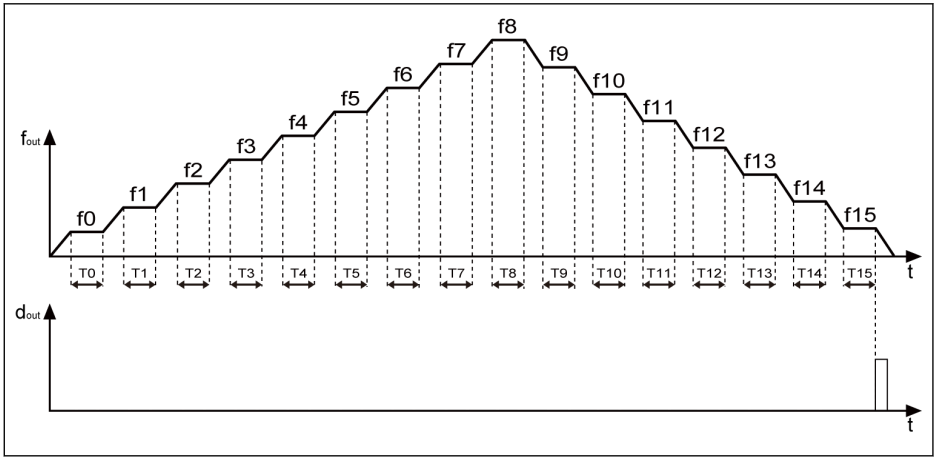
When a stage is complete, a pulse signal is active for the duration of 0.5 s. Any stage with running time of 0.0 s will be skipped without pulse output.

– 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.

– 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.

If the set 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




**$f_{out}$** Output frequency
**$d_{out}$** Digital out
**t** Time

**Fig. 12-47:** Simple PLC cycle complete

When a cycle is complete, a pulse signal is active for the duration of 0.5 s.

# 12.9 PID Control

## 12.9.1 Function Description

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.

The basic control principle is shown as the figure below:

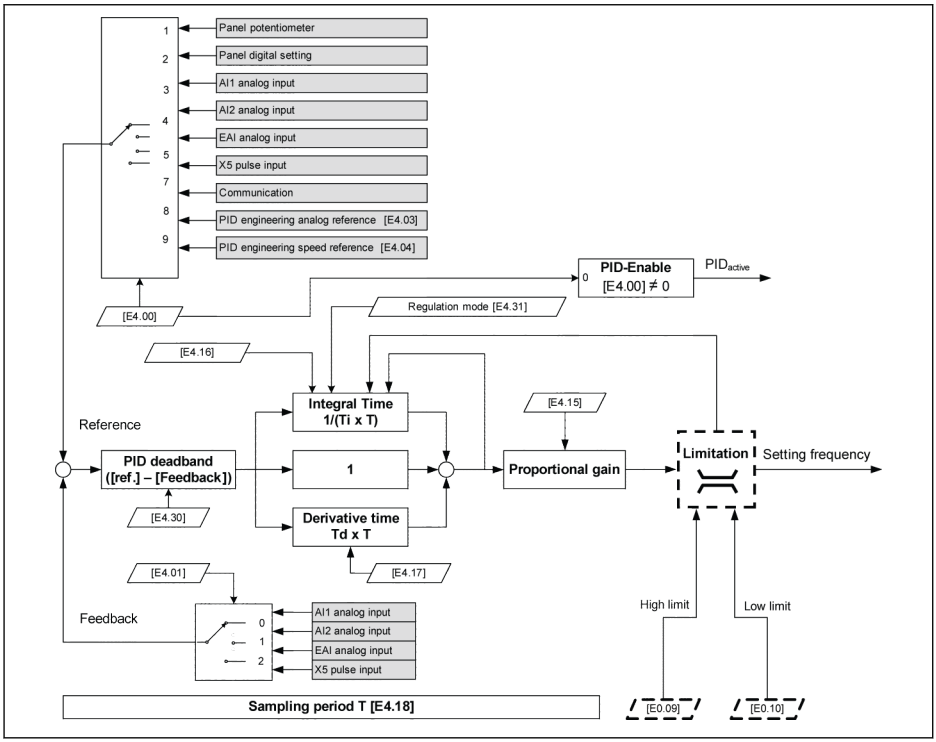



**Fig. 12-48:** PID control principle

## 12.9.2 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

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.00 | PID reference channel | 0...10 | 0 | – | Stop |
| 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 |

- [E4.00] = 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

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.01 | PID feedback channel | 0...5 | 0 | – | Stop |

- 0: AI1 analog input
  Feedback value is set by AI1 analog input.
- 1: AI2 analog input
  Feedback value is set by AI2 analog input.
- 2: X5 pulse input
  Feedback value is set by X5 pulse input.
- 3: EAI1 analog input
  Feedback value is set by EAI1 analog input.
- 4: Encoder card speed
  Feedback value is set by encoder card speed.
- 5: EAI2 analog input
  Feedback value is set by EAI2 analog input.

Any of analog inputs and X5 pulse input can **ONLY** be assigned with one function.

### 12.9.3 Control Loop Configuration

| Code | Name | Setting range | Default | Min. | 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 | 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 |

- 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.

### 12.9.4 PID Regulation Mode Setting

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.30 | PID deadband | 0.0...20.0 % | 2.0 | 0.1 | Run |

This parameter 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.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.31 | PID regulation mode | 0, 1 | 0 | – | Run |

When the PID output reaches [E0.09] 'Output frequency high limit' or [E0.10] 'Output frequency low limit' in PID control, following modes are available for PID regulation:

- 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.

- 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.

## 12.9.5 PID Feedforward Control

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 % | 2.00 | 0.01 | Run |
| E4.33 | PID feed forward settings | 0: Inactive; 1: Active | 0 | - | Stop |

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.

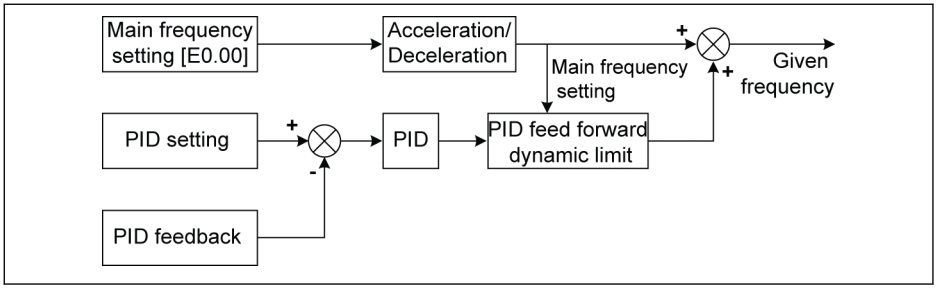



**Fig. 12-49:** PID feedforward

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]}

## 12.9.6 PID Deactivation by Digital Input

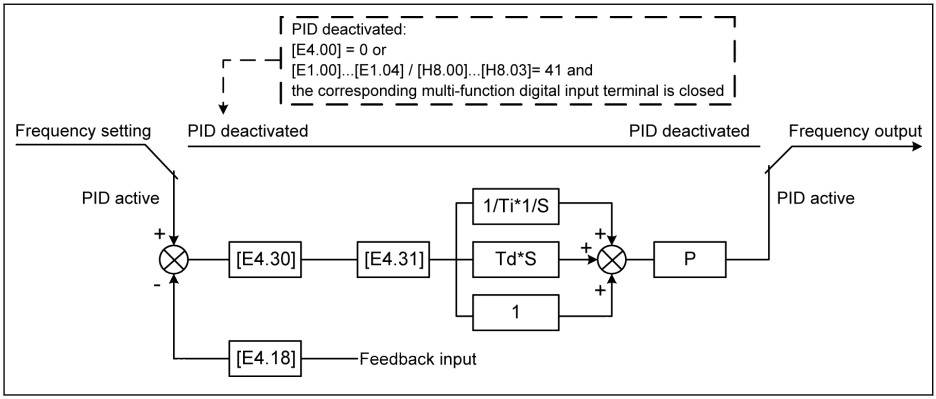



**Fig. 12-50:** PID deactivation by digital input

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.

## 12.9.7 PID Engineering Value Display

This function is used to display an engineering value which is convenient for the application engineering with scaling the output value, 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]

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E5.02 | User-defined speed scaling factor | 0.01...100.00 | 1.00 | 0.01 | Run |
| d0.01 | Actual speed | – | – | 1 rpm | 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 |
| d0.70 | PID reference engineering value | – | – | 0.1 | Read |
| d0.71 | PID feedback engineering value | – | – | 0.1 | Read |

[d0.70] = [E4.02] x [PID reference]

[d0.71] = [E4.02] x [PID feedback]

## 12.9.8 PID Status Indication

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E4.32 | PID engineering value detection width | 0.01...100.00 | 1.00 | 0.01 | Run |
| E2.01 | DO1 output setting | 18: PID reference engineering value arrival | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |

[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 feedback 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 %

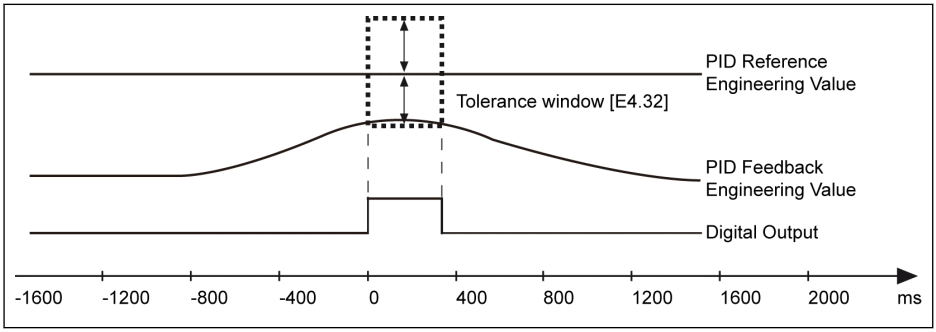



**Fig. 12-51:** PID engineering value detection width

### 12.9.9 Sleep / Wake 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 | Min. | Attri. |
|---|---|---|---|---|---|
| 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 | 0.2...60.0 s | 0.5 | 0.1 | Run |

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'

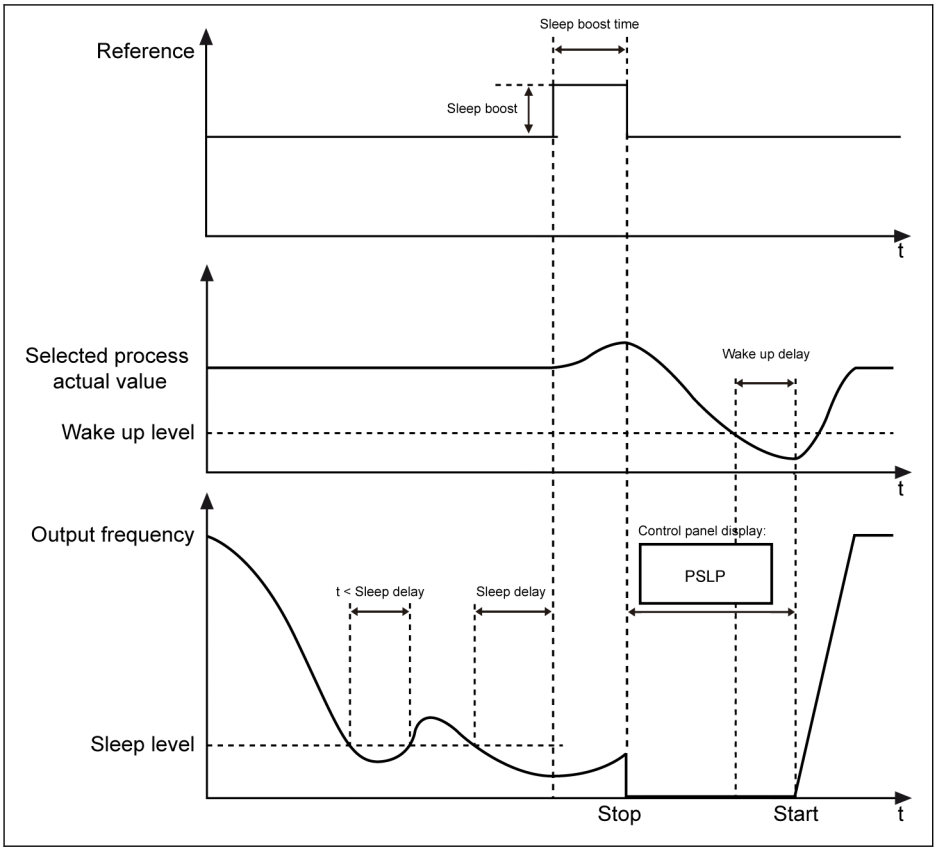



**Fig. 12-52:** Sleep and wake up process

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.

## 12.9.10 Pump Protection Function

Two modes of pump protection are available:

- 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 | Min. | 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<br>(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 | 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<br>(0.0 s: 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 |
| E9.05 | Last error type | 24: Pdr, pump dry | 0 | – | Read |
| E9.06 | Second last error type | | 0 | – | Read |
| E9.07 | Third last error type | | 0 | – | Read |

**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.

# 12.10 Protection Functions

## 12.10.1 Converter Protection

### Overload pre-warning

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].

The actual overload pre-warning level will be reduced by the output current de-rating by the equation:

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

Example: When [C0.29] = 50 %, the derating percentage of the output current at 15 kHz is 51 %, as shown in chapter "Derating and carrier frequency" on page 30.

- When the carrier frequency is 4 kHz, the output current is 100 % of the rated current, the actual overload pre-warning level is 50 % x 100 %, which equals to the [C0.29].
- When the carrier frequency is 15 kHz, the output current is derated to 51 % of the rated current, the actual overload pre-warning level is 50 % x 51 %.

| Code | Name | Setting range | Default | Min. | 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 s | 2.0 | 0.1 | Stop |
| E2.01 | DO1 output setting | 11: Converter overload pre-warning | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |

### Stall overvoltage prevention

This function is used to prevent the frequency converter from overvoltage during deceleration when the load is excessively heavy or the deceleration time is excessively short.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.24 | Stall overvoltage hysteresis voltage | 0...100 V | 1P: 30<br>3P: 50 | 1 | Stop |
| C0.25 | Overvoltage prevention mode | 1: Stall overvoltage protection enabled, resistor braking disabled<br>3: Stall overvoltage protection enabled, resistor braking enabled | 3 | – | Stop |
| C0.26 | Stall overvoltage prevention level | 1P 200 VAC: 300...390 V | 385 | 0 | Stop |
| | | 3P 200 VAC: 300...390 V | | | |
| | | 3P 380 VAC: 600...785 V | 770 | | |

With stall overvoltage prevention, the frequency converter detects the DC-bus voltage and compares it with [C0.26] 'Stall overvoltage prevention level' during deceleration:

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

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

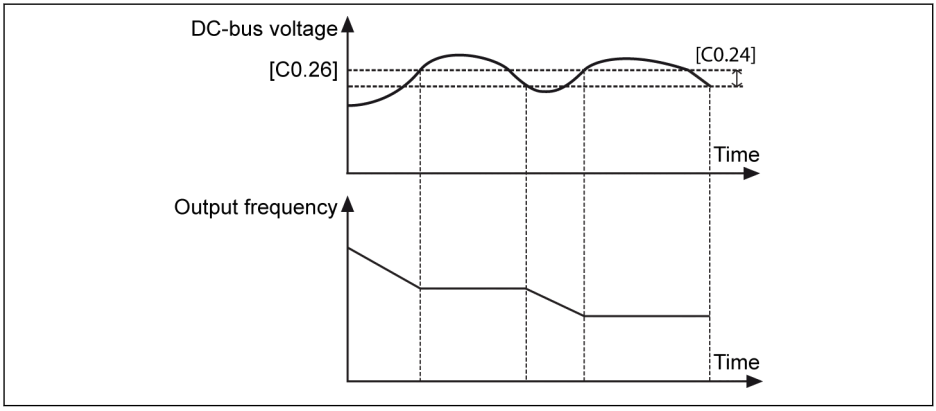



**Fig. 12-53:** Stall overvoltage prevention during deceleration

☞ If [C0.26] is too low, the deceleration process may fail.

### 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 | Min. | Attri. |
|---|---|---|---|---|---|
| C0.27 | Stall overcurrent prevention level | 20.0 %...[C2.42] | 150.0 | 0.1 | Stop |

The typical behavior of stall overcurrent during acceleration is shown as the figure below:

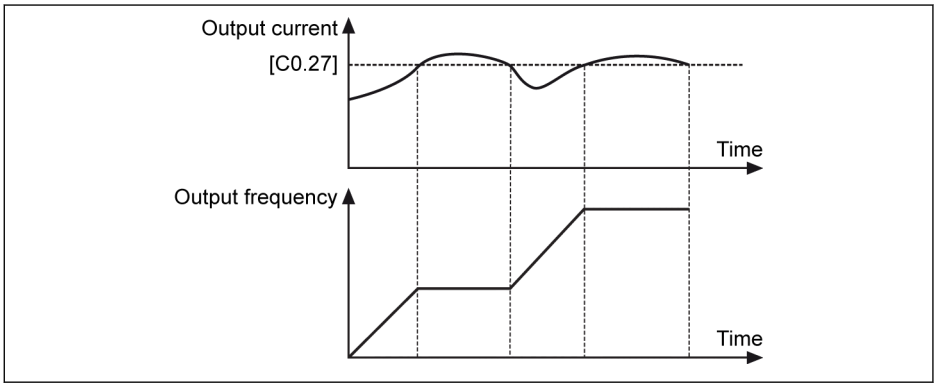



**Fig. 12-54:** Stall overcurrent during acceleration

- [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.

The typical behavior of stall overcurrent at constant speed is shown as the figure below:

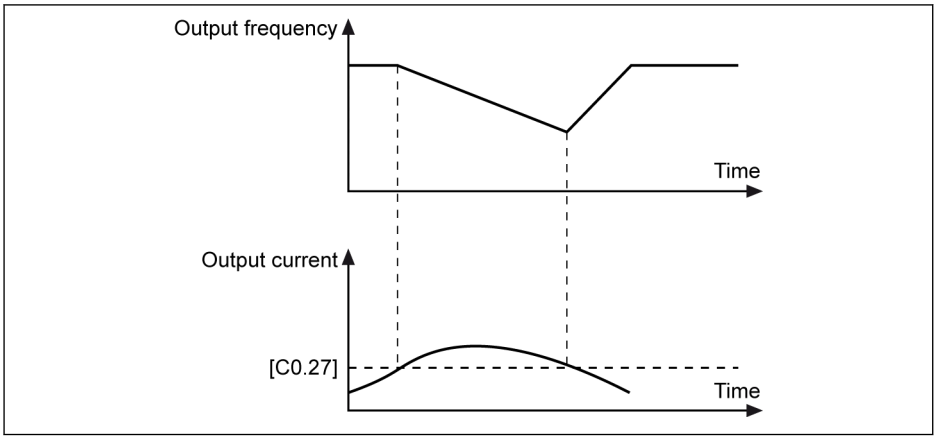



**Fig. 12-55:** Stall overcurrent at constant speed

- [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.

### Phase loss protection

Error code 'IPH.L' is displayed on the operating panel in case of input phase loss error occurs; error code 'OPH.L' is displayed on the operating panel in case of output phase loss error occurs.

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

- 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

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:

- No run command
- The real 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

### Analog Input Broken Wire Detection

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.61 | Broken wire protection | 0: Inactive<br>1: Warning<br>2: Error | 0 | – | Stop |

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.

For 4...20 mA analog input, if the current drops below 4mA – 10% = 3.6 mA, 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% = 1.85 V, the action according to the parameter E1.61will be performed.

### Reaction to External Error Signals

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...X4 input is defined as either 'Error signal N.O. contact input' or 'Error signal N.C. contact input'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.00 | X1 input | 32: Error signal N.O. contact input<br>33: Error signal N.C. contact input | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |
| 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 | 5.0 | 0.1 | Run |

- 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.

Frequency converter stops when external error signal is active. Stop mode is defined by parameter E0.56:

E0.56 = 0: Freewheeling stop

E0.56 = 1: Decelerating stop. The deceleration time is defined by parameter E0.57.

**Example:**

Set [E1.00] = '32: Error signal N.O. contact input' **or**

Set [E1.01] = '33: Error signal N.C. contact input'

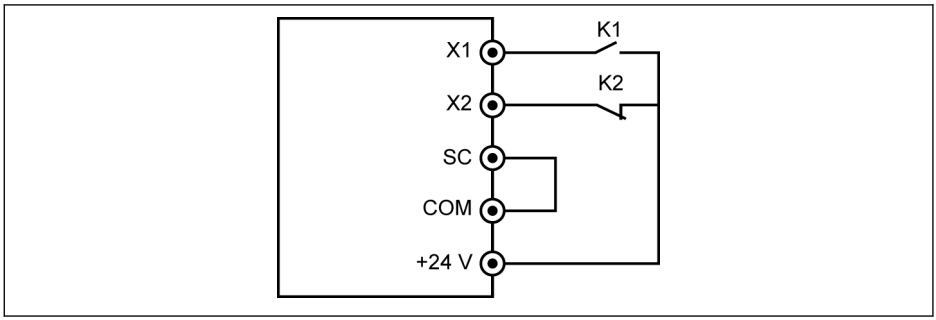



**Fig. 12-56:** Error signal

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.

### Power Fault Ride-through Setting

| Code | Name | Setting range | Default | Min. | 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 | 0 | – | 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 (1P: DC-bus voltage above 180 V; 3P: DC-bus voltage above 370 V). The power fault ride-through operation will be decided by the selected option as below:

When option 1 is selected, 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.

When option 2 is selected, the 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.

When option 3 is selected, the converter regains kinetic energy from the motor in generator mode with a defined ramp (defined by deceleration time (C0.44) that is the time from max frequency to 0 Hz). The converter continues to decelerate down to stop even when the bus voltage is restored.

When option 3 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 the problem of overvoltage a braking resistor may help.

## 12.10.2 Motor Protection

### UL and NEC requirements

EFC x610 provides the following functions to meet the motor protection safety requirements in accordance with NEC (article 430.126) and UL 508C (or UL 61800-5-1) specifications.

- Motor derating frequency at low speed
- Motor thermal protection without temperature sensor
- Motor overload pre-warning
- Motor thermal protection with temperature sensor

### 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 at rated speed.

| Code | Name | Setting range | Default | Min. | 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 |

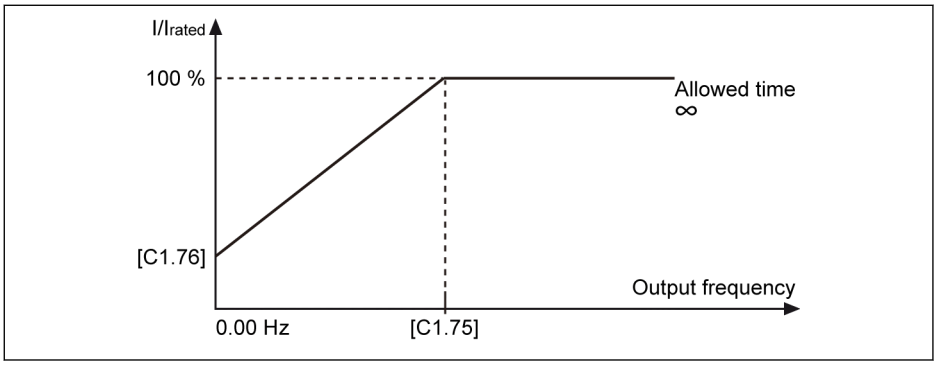



**Fig. 12-57:** Derating at low speed

- 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.

☞ For a motor with external cooling, [C1.76] 'Zero speed load' is set to 100 %, and the low speed derating function is inactive.

### Motor thermal protection without temperature sensor

This function is to realize the motor thermal protection based on the thermal model of motor.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.69 | Motor thermal model protection setting | 0: Inactive<br>1: Active | 0 | – | Stop |
| C1.74 | Motor thermal model protection time constant | 0.0...400.0 min | DOM | 0.1 | Stop |

[C1.74] is obtained by the equation below:

$$[C1.74] = \frac{Cv * M}{9 * [C1.21] * [C1.07]^2}$$

**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. 12-58:** 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 overload pre-warning

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 | 2.0 | 0.1 | Run |
| E2.01 | DO1 output setting | 12: Motor overload pre-warning | 1 | – | Stop |
| E2.15 | Relay 1 output selection | | 1 | – | Stop |
| H8.20 | EDO output setting | | 1 | – | Stop |
| H8.21 | Extended relay output selection | | 1 | – | Stop |
| H9.00 | Extended relay 1 output selection | | 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 |

When the output current exceeds the threshold defined by C1.70 'Motor overload pre-warning level' for [C1.71] 'Motor overload pre-warning delay', the pre-warning signal is active on DO1 or Relay 1 output. Users may use the indication of this pre-warning signal according to actual application situations. The signal is immediately deactivated when the output current is lower than the threshold.

### Motor thermal protection with temperature sensor

For a temperature sensor with voltage supply, use terminals +10 V, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

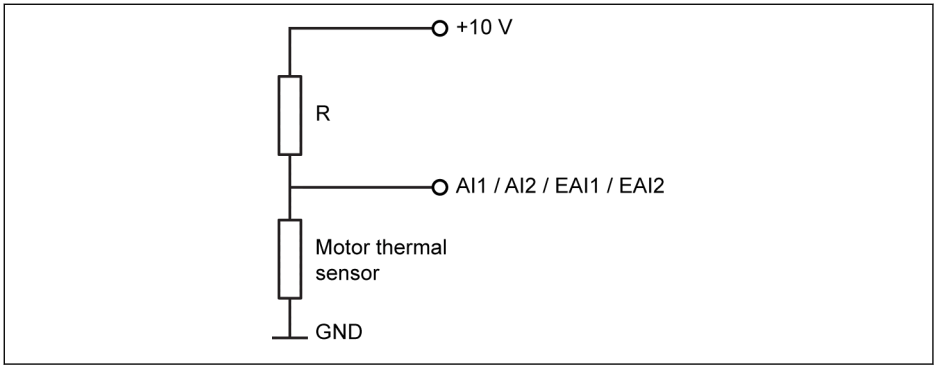



**Fig. 12-59:** Temperature sensor with voltage supply

For a temperature sensor with current supply, use terminals AO1 / EAO, AI1 / AI2 / EAI1 / EAI2 and GND on the frequency converter.

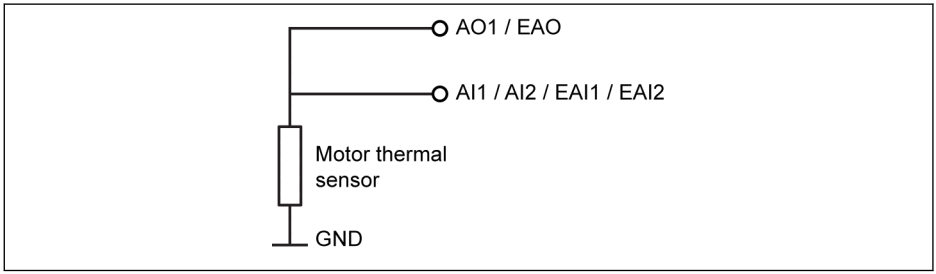



**Fig. 12-60:** Temperature sensor with current supply

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E1.60 | Motor temperature sensor channel | 0...5 (0: Inactive) | 0 | – | Stop |
| C1.72 | Motor thermal sensor type | 0, 2, 3, 4 | 0 | – | Stop |

| Code | Name | Setting range | Default | Min. | 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 |
| 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 |
| E2.25 | AO1 output mode | 0: 0...10 V<br>1: 0...20 mA | 0 | – | Run |
| E2.26 | AO1 output setting | 11: Motor temperature sensor power supply | 0 | – | Run |
| H8.26 | EAO output selection | | 0 | – | Run |
| H8.25 | EAO output mode | 0: 0...10 V<br>1: 0...20 mA | 0 | – | 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 |
| 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 |
| E1.69 | Analog input filter time | 0.000...2.000 s | 0.100 | 0.001 | Run |

**Activate the function of temperature monitoring with temperature sensor:**

- Set [E1.60] = '1: AI1 analog input' or
- Set [E1.60] = '2: AI2 analog input' or
- Set [E1.60] = '3: EAI1 analog input'
- Set [E1.60] = '4: EAI2 analog input'
- Set [E1.60] = '5: TSI input (only for IO plus card)'

☞ AI1 / AI2 / EAI1 / EAI2 will be automatically set as voltage input mode when [E1.60] = 1...4.

**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] = 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.

# 12.11 Asynchronous Motor(ASM) Control

## 12.11.1 Motor Parameterization

### Expert mode

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.02 | Expert mode | 0: Standard mode<br>1: Expert mode | 0 | - | Stop |

0: Every change of a motor parameter leads to a recalculation based on the ascending rule.

1: Every motor parameter will stay on its value even if a different parameter got written. So no recalculation based on the ascending rule.

### 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 | Min. | Attri. |
|---|---|---|---|---|---|
| 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 | DOM | 1 | Stop |
| C1.10 | Motor rated power factor | 0.00...0.99① | 0.00 | 0.00 | Stop |

①: 0.00: Automatically identified; 0.01...0.99: Power factor setting.

If the data for 'Motor rated power factor' C1.10 is not available on the motor nameplate, keep its default setting '0.00: Automatically identified'. However, the rotational auto-tuning performance may be affected.

### Motor slip frequency configuration

This function is available in both V/f control and SVC control, used to compensate the deviation between the motor speed and the synchronous speed caused by the load. In addition, the mechanical performance of the motor can be improved with this function.

For V/f control, slip compensation does not work in acceleration, deceleration, DC-braking processes or regenerative mode.

For SVC control, slip compensation is always active.

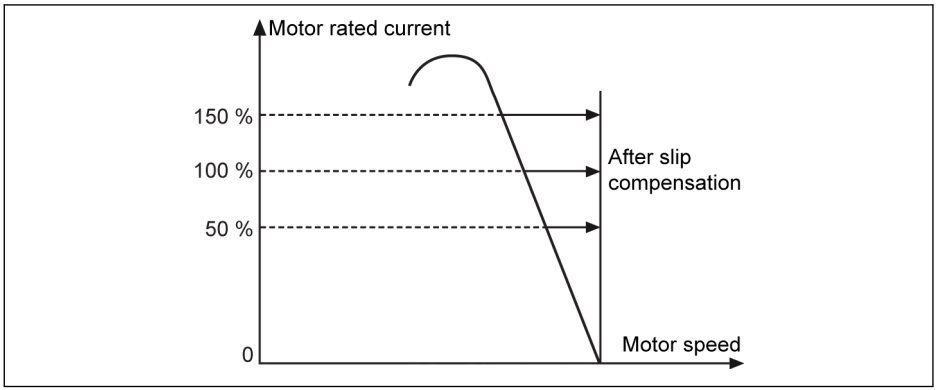



**Fig. 12-61:** Slip frequency compensation

If the slip frequency compensation is excessively large, the motor speed may exceed the synchronous speed.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.12 | Motor rated slip frequency | 0.00...60.00 Hz | DOM | 0.01 | Stop |

By default, this parameter 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 parameter auto-tuning

### Function description

With the configuration of motor nameplate parameters, the frequency converter can run in V/f control. In addition, the following parameters are calculated automatically based on the motor nameplate parameters:

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.20 | Motor no-load current | 0.00...[C1.07] A | DOM | 0.01 | Stop |
| C1.21 | Stator resistance | 0.00...200.00 Ω | DOM | 0.01 | Stop |
| C1.22 | Rotor resistance | 0.00...200.00 Ω | DOM | 0.01 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.23 | Leakage inductance | 0.00...200.00 mH | DOM | 0.01 | Stop |
| C1.24 | Mutual inductance | 0.0...3,000.0 mH | DOM | 0.1 | Stop |

For SVC control and applications with higher performance requirement 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 used **mainly** for SVC control.

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.

[C1.07] = 655.00, then set [C1.20] = 655.00, the actual setting value is 491.22.

### 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 | |
| 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 | |

| Code | Name | Level |
|---|---|---|
| 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 | |
| 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 | |
| C3.05 | Current loop proportional gain | |
| C3.06 | Current loop integral time | |

**Tab. 12-18:** The application level of motor parameters

The user shall follow the order as specified below to set or modify the parameters, 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 and C0.01, and next set the nameplate level parameters, C1.05...C1.09, 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 level, and next execute the modification 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.

Because of the change, the user would have to re-set the two parameter groups of bottom levels.

### 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 |
| – | √ | C1.13: Motor inertia mantissa① |
| – | √ | C1.14: Motor inertia exponent① |
| √ | √ | C1.20: Motor no-load current |
| √ | √ | C1.21: Stator resistance |
| √ | √ | C1.22: Rotor resistance |
| √ | √ | C1.23: Leakage inductance |
| √ | √ | C1.24: Mutual 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. 12-19:** Parameters obtained by auto-tuning

☞ ①: Only applicable for EFC 5610.

## 12.11.2 V/f Control

### V/f curve selection

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.00 | V/f curve mode | 0...3 | 0 | – | Stop |

The frequency converter provides three curve modes:

- 0: Linear

  This mode refers to linear voltage / frequency control, which is used for normal constant torque loads.

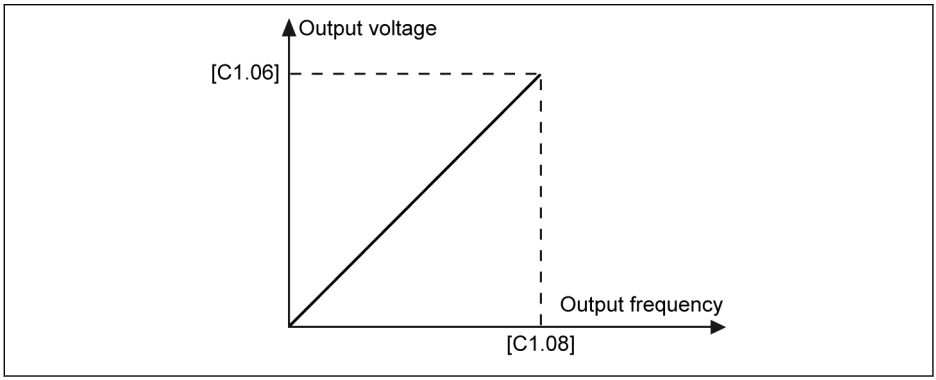



**Fig. 12-62:** Linear V/f curve

- 1: Square

  This mode refers to square voltage / frequency control, which is used for variable torque loads of fans, pumps, etc.

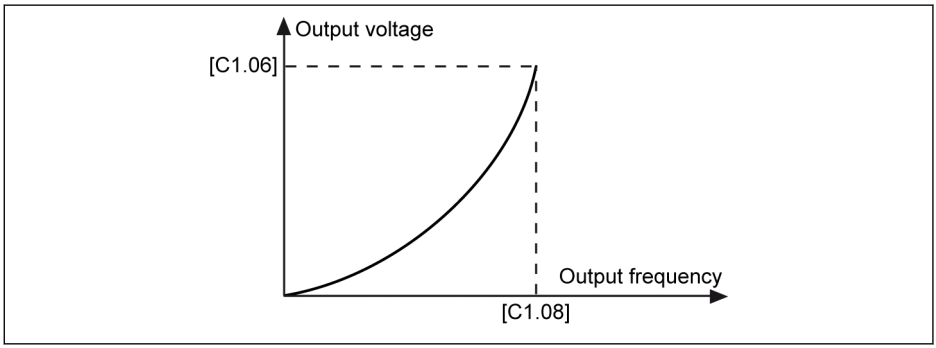



**Fig. 12-63:** Square V/f curve

- 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.

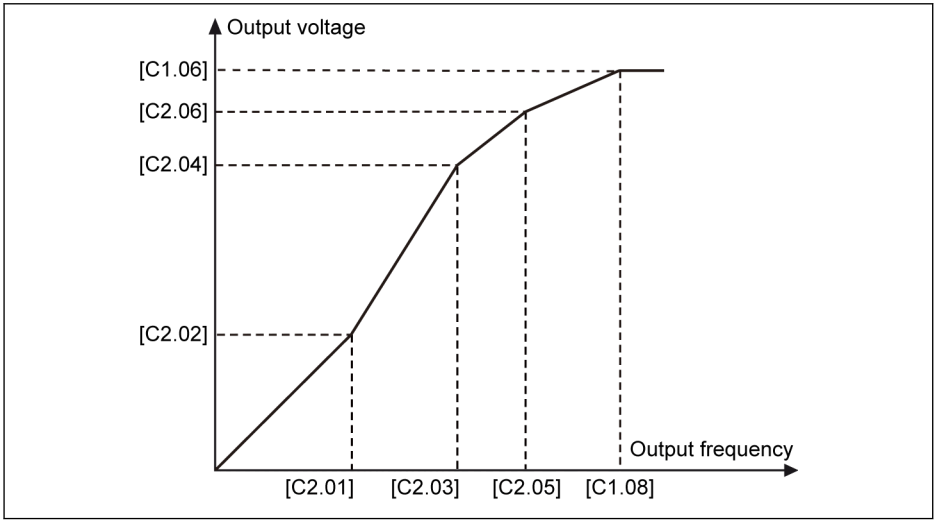



**Fig. 12-64:** User-defined V/f curve

- 3: V/f separation

**⚠ WARNING**

Excessively high voltage at low-frequency may cause the motor overheat or damage, and the frequency converter stall overcurrent or overcurrent protection.

### User-defined V/f curve configuration

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.01 | V/f frequency 1 | 0.00...[C2.03] Hz | 0.00 | 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 | 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 | 0.01 | Stop |
| C2.06 | V/f voltage 3 | 0.0...120.0 % | 100.0 | 0.1 | Stop |

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:

- 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 %.

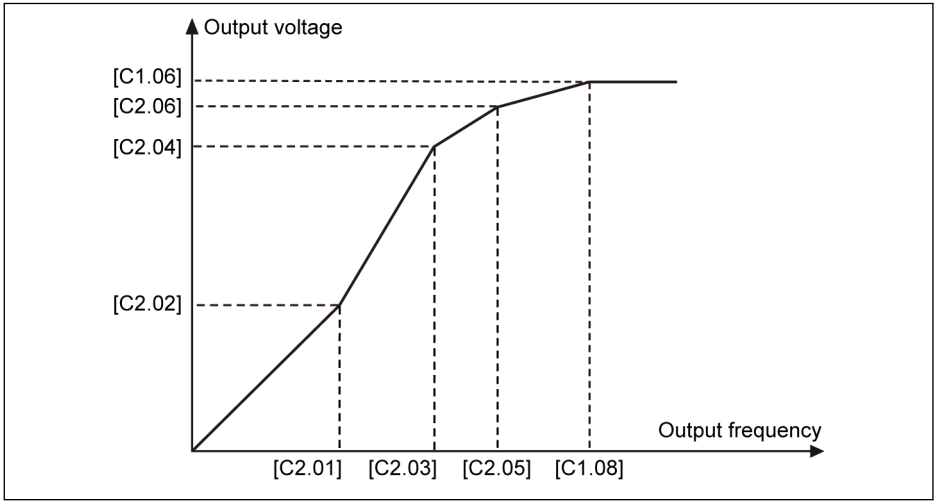



**Fig. 12-65:** User-defined V/f curve when [C2.05] ≤ [C1.08]

- 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 %.

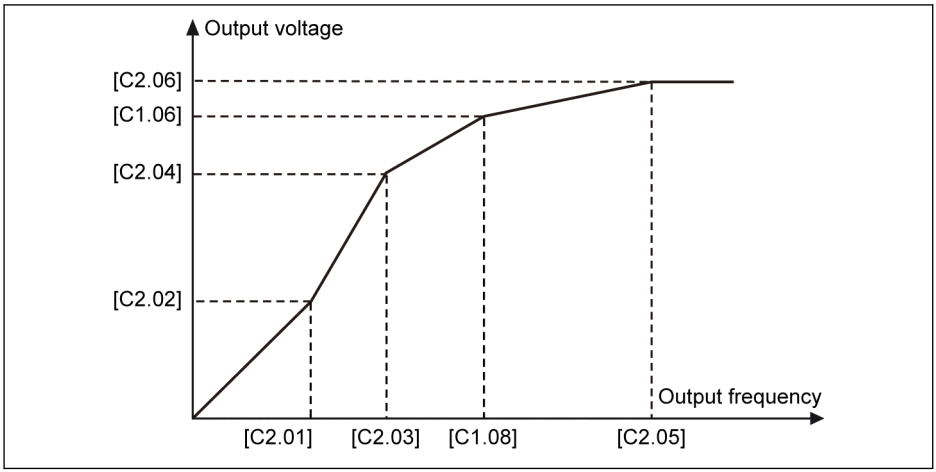



**Fig. 12-66:** User-defined V/f curve when [C2.05] ≥ [C1.08]

## V/f separation curve configuration

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

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.

0: Panel potentiometer

1: Panel button setting. The setting value will be saved to C2.09.

2: AI1 analog input

10: X5 pulse input

20: Communication. When the parameter C2.08 is selected as communication (20), 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. When the parameter C2.08 is selected as '22:Digital setting', parameter C2.09 is used for setting the voltage in percentage value through panel or ConverterWorks.

23: Voltage PID control. When the parameter C2.08 is selected as '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 0V 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 0V.

**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.

### Slip compensation factor configuration

This function is used to compensate [C1.12] 'Motor rated slip compensation' according to the actual applications in V/f control.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.07 | Slip compensation factor | 0...200 % | 0 | 1 | Run |

- 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 actual 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 actual slip compensation is 2.50 Hz x 200 % = 5.00 Hz.

### 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 | 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 |
| C2.00 | V/f curve mode | 0: Linear<br>1: Square<br>2: User-defined<br>3: V/f separation | 0 | – | Stop |
| C1.08 | Motor rated frequency | 5.00...400.00 Hz | 50.00 | 0.01 | Stop |

- 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.

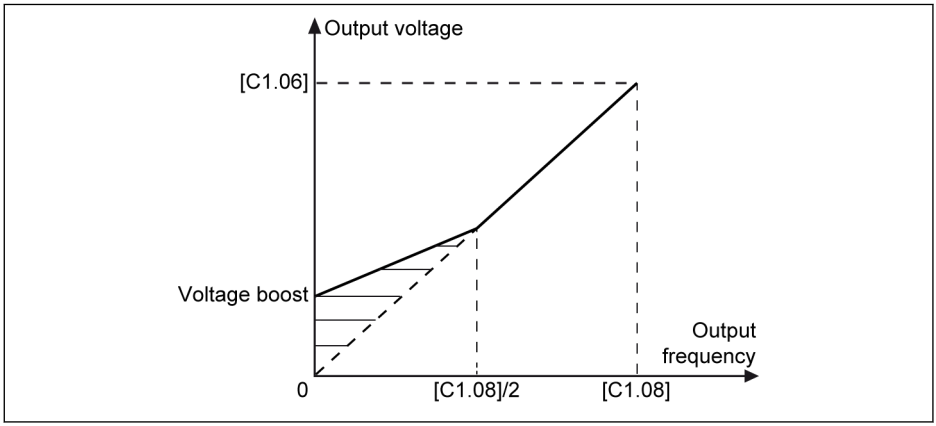



**Fig. 12-67:** Manual torque boost with linear or user-defined V/f curve

[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.

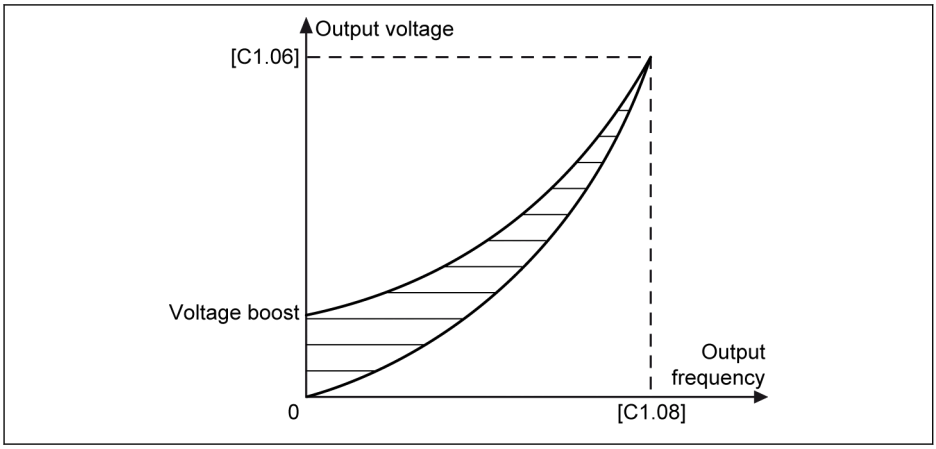



**Fig. 12-68:** Manual torque boost with square curve

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

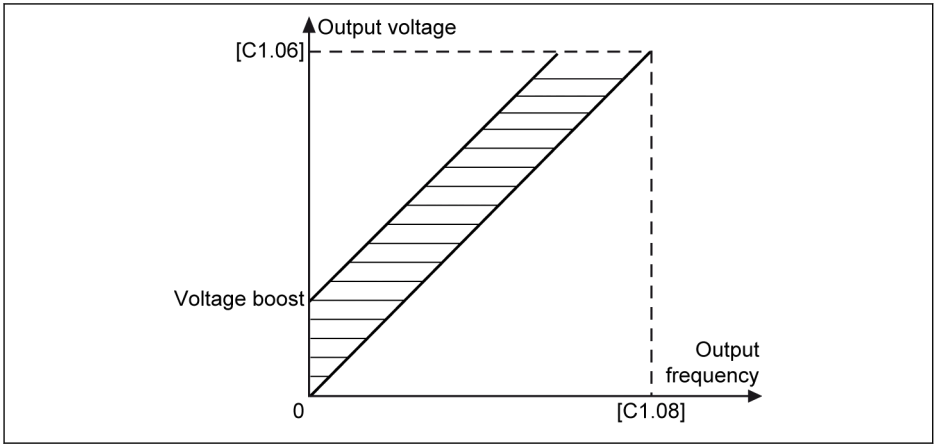



**Fig. 12-69:** Automatic torque boost with linear V/f curve

- Automatic torque boot with square V/f curve

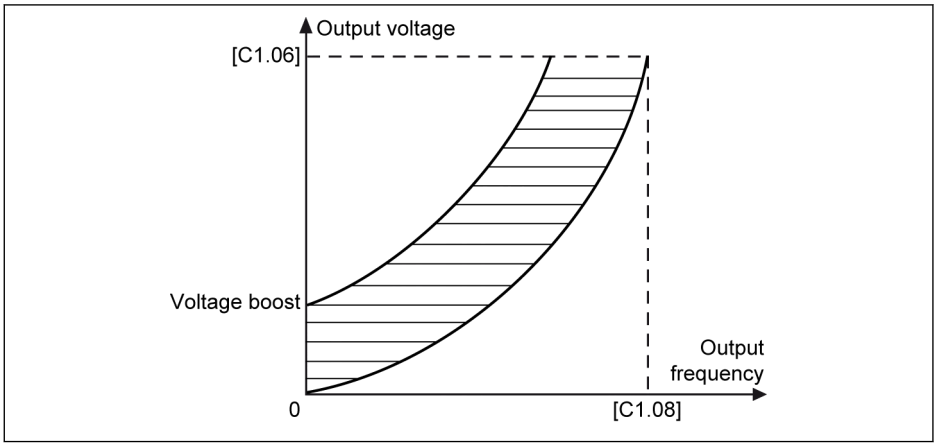



**Fig. 12-70:** Automatic torque boot with square V/f curve

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] = $\sqrt{3}$ x 0.5 x $I_1$ x $R_1$ x [C2.22]**

$R_1$: stator resistance

$I_1$: stator current

Thus $R_1$ should be preset or calculated or tuned, and then input to [C1.21].

## Optimization functions for V/f control

### Zero speed control selection

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.20 | 0 Hz output mode | 0: No output<br>1: Standard | 1 | - | Stop |

C2.20=0: No any torque output in this mode.

C2.20=1: There is certain torque output in this mode.

### Heavy load voltage stabilization

This function is used to suppress the output voltage and current oscillation caused by large impact to DC-bus voltage in case of heavy load.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C2.23 | Heavy load stabilization | 0: Inactive<br>1: Active | 1 | – | Run |

### 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 | Min. | Attri. |
|---|---|---|---|---|---|
| C2.24 | Light load oscillation damping factor | 0...5,000 % | 0 | 1 | Run |
| C2.25 | Light load oscillation damping filter factor | 10...2,000 % | 100 | 1 | Run |

- [C2.24] = 0 %: Oscillation suppression is inactive.
- Increasing [C2.24] brings a better effect of oscillation suppression, but excessive increase leads to unstable running of the motor.
- [C2.25] = 100 %: This setting can suppress oscillation in most situations.
- 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.

### Output 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 | Min. | Attri. |
|---|---|---|---|---|---|
| C2.40 | Current limitation mode | 0...2 | 2 | – | Stop |

- 0: Always inactive

  Current limitation control function is inactive.

- 1: Inactive at constant speed

  Current limitation control is active during acceleration and deceleration, but inactive at constant speed.

- 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.
- The higher value of C2.44 'Integral time', the more accurate of current suppression.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

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.

## 12.11.3 SVC Control (EFC 5610 ONLY)

### SVC control loop configuration

| 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 |
| C3.20 | 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 |

C3.04 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.

For vector control, if the encoder direction is wrong or the encoder is decoupled from motor the drive would behave unpredictable, it is needed to monitor the speed controller. If the speed controller difference is above the maximum allowed difference over certain time, the drive will shut down with 'SPE-' error.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |

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.

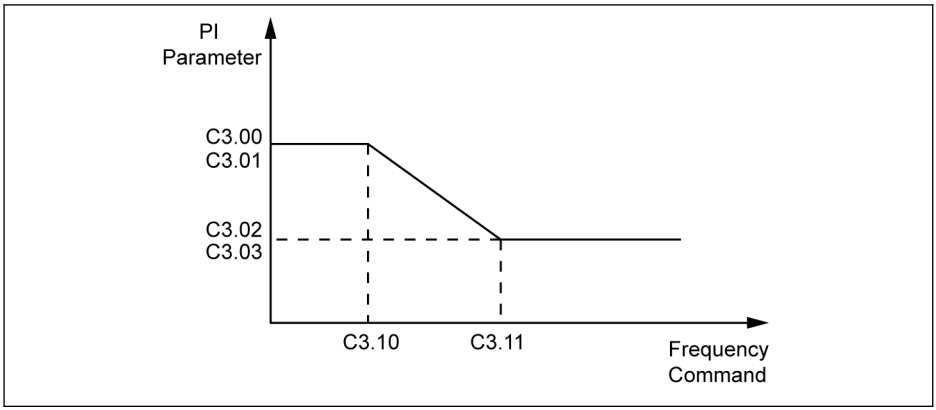



**Fig. 12-71:** PI parameters

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.

The default parameter value can be tuned according to the actual needs: increase the proportional gain to ensure the system dose not oscillation, then reduce the integral time, so that the system has a faster response characteristics and a smaller overshoot.

If the PI parameters are not set properly, it may lead to excessive overshoot or overvoltage fault during overshoot.

## Speed control mode

The frequency converter is by default running in speed control mode. In this mode, the frequency converter follows the frequency reference change, and the output torque changes with the load.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

C3.44 '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 'Inputting command with 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 'Inputting command via external terminals', 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'.

### Torque control mode

When torque control mode is active, the frequency converter follows the torque reference change. In torque control mode:

- The motor speed is limited by [E0.09] 'Output frequency high limit'.
- The torque reference is set by the selected channel with defined curve characteristic.
- The direction of the torque reference is set by the selected run command source.

To use the torque control mode, take the following steps:

**Step 1: Set the activation mode of torque control**

| 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 |
| E1.00 | X1 input | 23: Torque / speed control switch | 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 |
| H8.00 | EX1 input | | 0 | – | Stop |
| H8.01 | EX2 input | | 0 | – | Stop |
| H8.02 | EX3 input | | 0 | – | Stop |
| H8.03 | EX4 input | | 0 | – | Stop |

- [C3.40] = '0: Activated by digital inputs'

  In this mode, the corresponding parameter [E1.00]...[E1.04], [H8.00]... [H8.03] of the selected digital input needs to be set as '23: Torque / speed control switch'.
- [C3.40] = '1: Always active'
- [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

**Step 2: Set the torque reference**

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

Define the voltage / current mode for analog inputs before setting the torque reference.

- 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.
- When [C3.41]=0, 1, 2, 3 or 4, C3.42 and C3.43 are used to define curve.

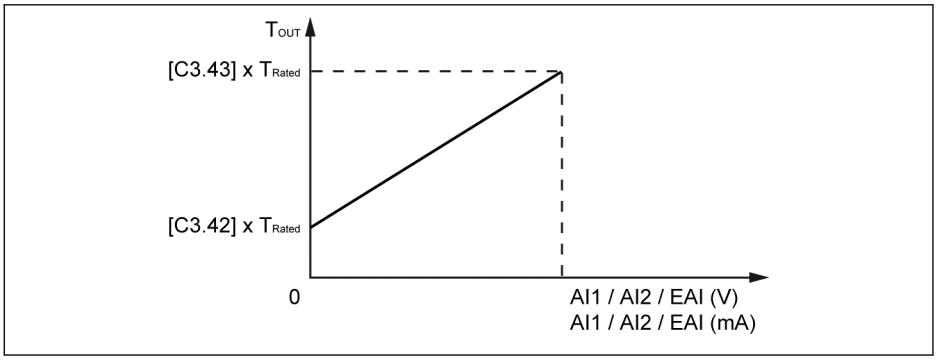



**Fig. 12-72:** Torque reference characteristic curve

### Step 3: Set the direction of torque reference

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E0.01 | First run command source | 0: Panel<br>1: Multi-function digital input<br>2: Communication | 0 | – | Stop |

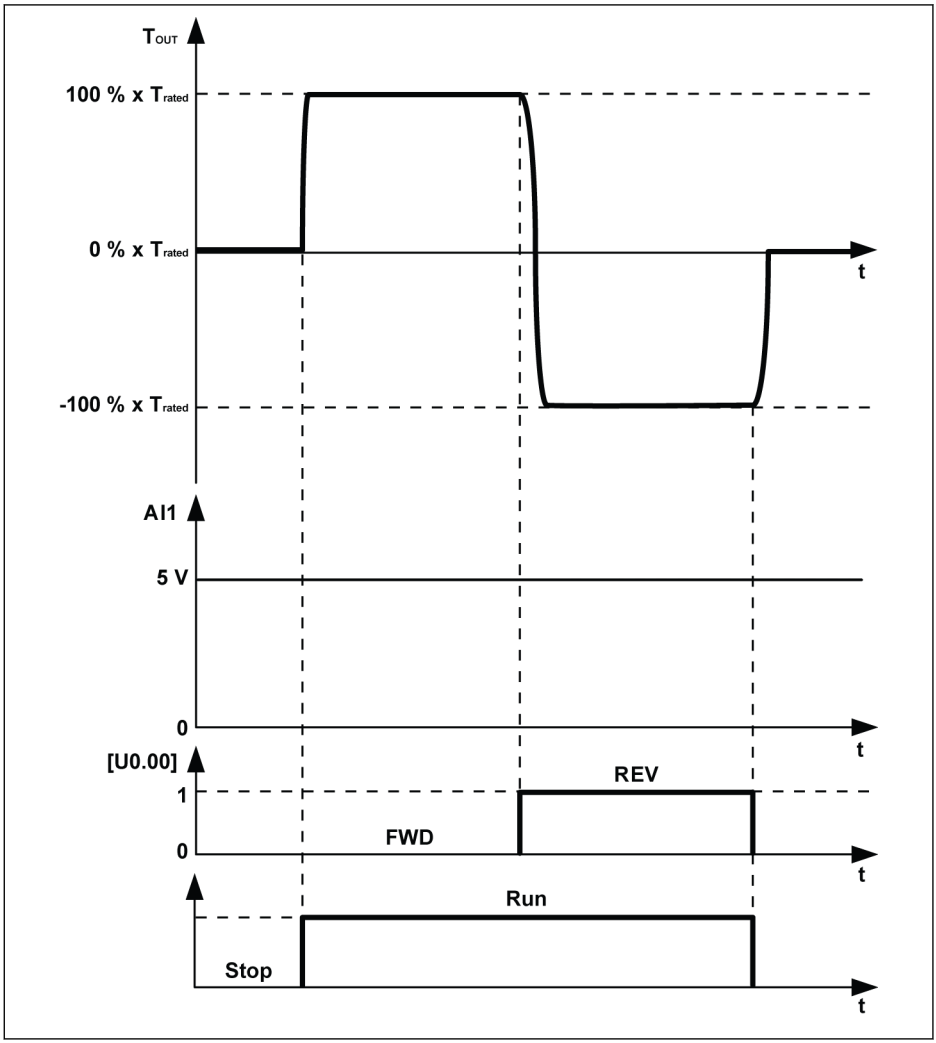
**Example 1:**

[E0.01] = '0: Panel'

[C3.41] = '0: AI1 analog input'

[C3.42] = 0.0 %

[C3.43] = 100.0 %




**$T_{OUT}$** Output torque
**$T_{rated}$** Rated torque
**t** Time
**FWD** Forward
**REV** Reverse
**Run** Run command
**Stop** Stop command

**Fig. 12-73:** Set the direction of torque reference by operating panel

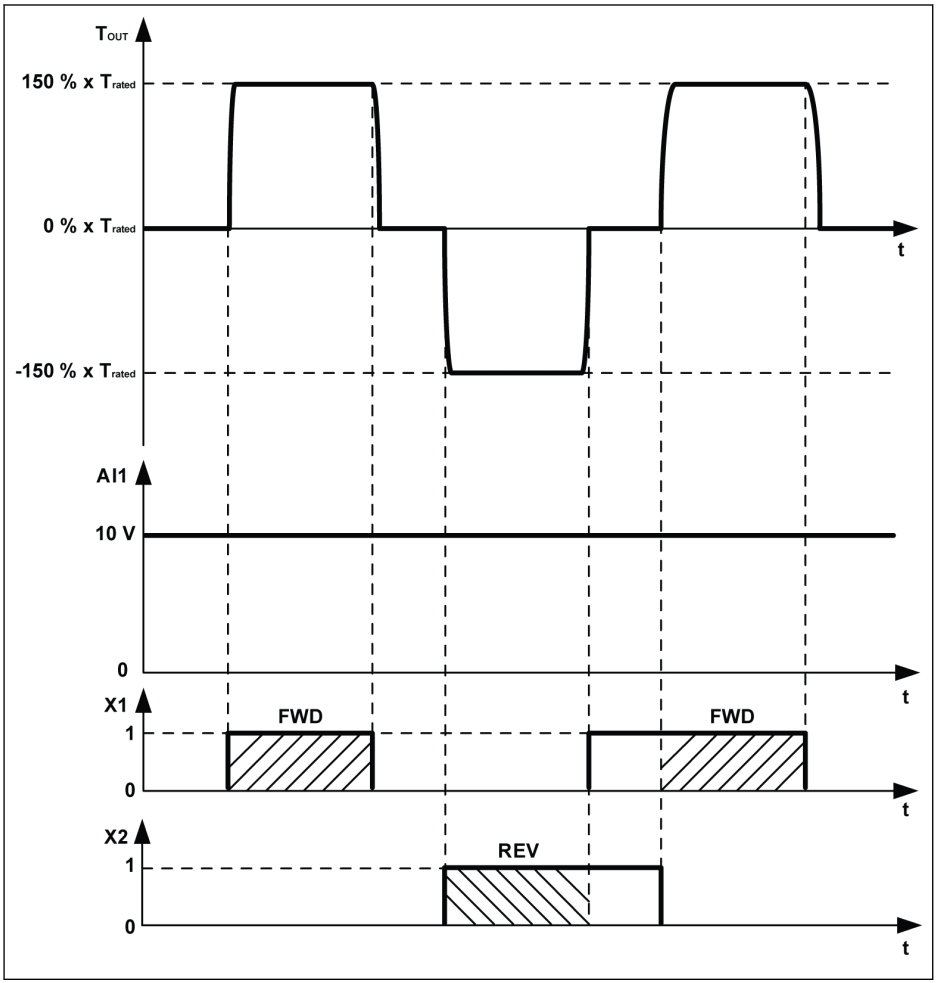
### Example 2:

[E0.01] = '1: Multi-function digital input'

[E1.15] = '0: 2-wire forward / stop, reverse / stop'

[E1.00] = '35: Forward running (FWD)', [E1.01] = '36: Reverse running (REV)'

[C3.41] = '0: AI1 analog input', [C3.42] = 0.0 %, [C3.43] = 150.0 %




**TOUT** Output torque
**Trated** Rated torque
**t** Time
**FWD** Forward
**REV** Reverse
**X1** X1 input
**X2** X2 input

**Fig. 12-74:** Set the direction of torque reference by digital input

For run command setting source information, see chapter 12.5 "Run- / Stop- / Direction Command Source" on page 176.

### 12.11.4 Vector Control with Encoder

For vector control with encoder, set the function as follows.

1. Install the encoder card in the power off state and power up after proper wiring.

2. Set parameter C0.00 to '2'.

3. Set motor related parameters, please refer to SVC mode.

4. Set parameter H7.20.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H7.20 | Pulses per revolution of encoder | 1...20,000 | 1 | 1,024 | Stop |

Parameter H7.20 is used to set the number of pulses per revolution of the ABZ encoder. Please correctly set this parameter under vector control with encoder before running.

5. Perform parameter auto-tuning.

For rotational auto-tuning, the encoder direction (H7.01) will be updated automatically after the setting is completed. For static auto-tuning, H7.01 will not be updated automatically, it is recommended to operate at low speed and limit torque to check whether the direction of the encoder is in accordance with the direction of the motor rotation. If this doesn't match, manual modification will be required.

# 12.12 Permanent Magnetized Synchronous Motor (PMSM) Control (Applicable for EFC 5610 Model)

## 12.12.1 The Setting of Motor Type

The motor type must be set properly. Before running PMSM, set C1.00 = '1'.

After setting C1.00 to '1', the parameter C0.00 (the control mode) will be modified automatically to '1'.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.00 | Motor type | 0...1 | 0 | – | Stop |

## 12.12.2 The Setting of Motor Parameter

### The Nameplate Parameter

The user can acquire most of the technical data from the motor nameplate. Those data shall be used to set the parameters for the motor of frequency converter. The information given below are the name plate parameters which must be set before the auto-tuning of motor parameters.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C1.05 | Motor rated power | 0.1...1,000.0 kW | DOM | 0.1 | Stop |
| C1.07 | Motor rated current | 0.01...655.00 A | DOM | 0.01 | Stop |
| C1.09 | Motor rated speed | 1...60,000 | DOM | 1 | Stop |
| C1.11 | Motor poles | 2...256 | 4 | 1 | Stop |

For Rexroth motor, the parameters above cannot be acquired from the motor nameplate. These parameters can be calculated according to the following steps.

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.

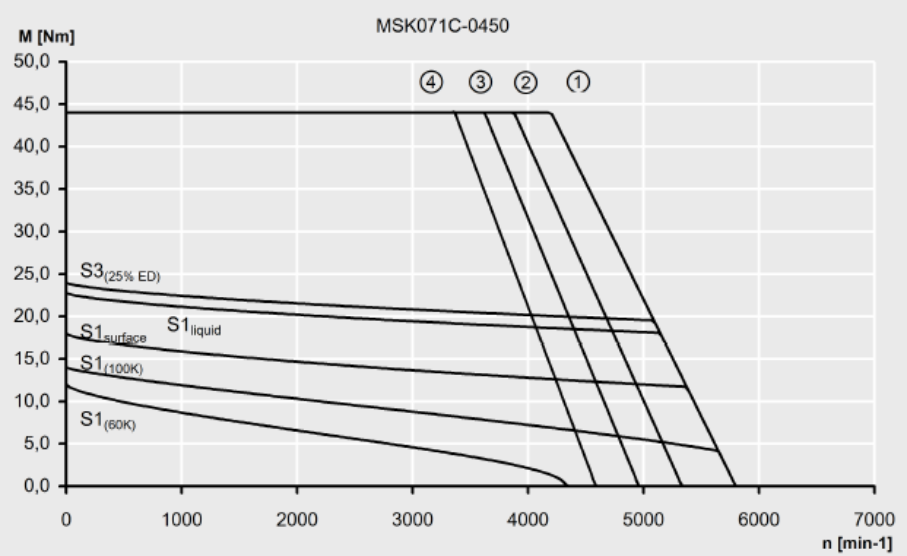



**Fig. 12-75:** Speed-torque characteristic curve

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**

Once the auto-tuning of motor parameters is completed, NO modification can be made to the nameplate parameters any more. If any change occurs to the nameplate parameters, re-execute the auto-tuning of motor parameters.

## Auto-tuning of Motor Parameters

### Function Description

When SVC control is used for the control of PMSM, motor parameters auto-tuning function shall be adopted. Two modes of auto-tuning are available, i.e. static auto-tuning and rotational auto-tuning.

Before running parameter auto-tuning on synchronous motor, make sure to set both motor type C1.00 and motor nameplate parameters correctly.

### The Application Level and Setting Order of Motor Parameters

Please refer to chapter "Motor parameter auto-tuning" on page 240.

### 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, C1.07, C1.09, C1.11 based on motor nameplate data.
- Set E0.08, E0.09 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

  It's recommended to run static auto-tuning or rotational auto-tuning for PMSM.

- 1: Static auto-tuning

  Static auto-tuning shall be used when the motor load is not removable. It's necessary to input inertia value manually in order to achieve the best control effect.

- 2: Rotational auto-tuning

  In condition the motor load is removable, it's recommended to move the load away and run rotational auto-tuning. This method allows the acquisition of all the motor and control parameters that are needed for the vector control and thus enable the best vector control effect.

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 |
|---|---|---|
| – | √ | C1.13: Motor inertia mantissa |
| – | √ | C1.14: Motor inertia exponent |
| √ | √ | C1.20: Motor no-load current |

| Static auto-tuning | Rotational auto-tuning | Parameters obtained by auto-tuning |
|---|---|---|
| √ | √ | C1.21: Stator resistance |
| √ | √ | C1.23: Leakage inductance |
| √ | √ | C3.05: Current loop proportional gain |
| √ | √ | C3.06: Current loop integral time |
| – | √ | C3.00: Speed loop proportional gain 1 |
| – | √ | C3.01: Speed loop integral time 1 |

**Tab. 12-20:** Parameters obtained by auto-tuning

No-load current C1.20 is auto-tuned to 25% of rated current.

Additionally, the motor rated voltage C1.06 and the motor rated frequency C1.08 will be updated automatically.

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 re-

quirement, only method 2 and method 3 shall be used for identifying the inertia value.

For EFC 5610, parameter C1.11 can be calculated by rated frequency and motor speed automatically.

## 12.12.3 PMSM SVC control

### SVC Control loop configuration

| 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 |
| C3.05 | 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 |
| C3.20 | Low speed torque limitation | 1...200 % | 100 | 1 | Stop |

### Torque Limit in Speed Control Mode

When the frequency converter is running in speed control mode, the frequency converter change with the frequency set value, and the output torque changes with the load.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

C3.44 '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 'Inputting command with 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 'Inputting command via external terminals', 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'.

### Initial Position Checking

Initial rotor position checking 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 | Min. | 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.

### 12.12.4 Vector Control with Encoder

For vector control with encoder, set the function as follows.

1. Install the encoder card in the power off state and power up after proper wiring.
2. Set parameter C0.00 to '2'.
3. Set motor related parameters, please refer to SVC mode.
4. Set parameter H7.20.
5. Perform parameter auto-tuning.

   For rotational auto-tuning, the encoder direction (H7.01) will be updated automatically after the setting is completed. For static auto-tuning, H7.01 will not be updated automatically, it is recommended to operate at low speed and limit torque to check whether the direction of the encoder is in accordance with the direction of the motor rotation. If this doesn't match, manual modification will be required.

## 12.13 ASF Function

### 12.13.1 Function Description

EFC x610 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 chapter introduce the relevant information of ASF. For detailed information about ASF function and operation, please refer to each ASF Instruction Manual.

### 12.13.2 ASF Parameter

The table below lists the ASF parameters loaded by frequency converter.

| Code | Name | Setting range | Default* | 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 | 0 | Read |
| F0.07 | ASF API version | – | *** | Read |
| F0.10 | ASF status | 0x0000H...0xFFFFH | 0x0000 | 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 |

- *: 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 |
| 8 | Error-Trial time expired |

| Bit | Definition |
|---|---|
| 7...3 | Reserved |
| 2 | ASF authenticated |
| 1 | API compatible |
| 0 | ASF activated |

**Tab. 12-21:** ASF status bit definition

When the frequency converter loaded an effective and certified ASF, the value of F0.10 is 0x0007.

F0.20...F0.23 are the parameters used by ASF platform and extension card interface. For detailed information about the definition and operation, please refer to the Instruction Manual for extension card and specific ASF.

The range of ASF parameter is F1.00...F5.99, each parameter and its group numbers are defined by ASF instance.

## 12.13.3 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:

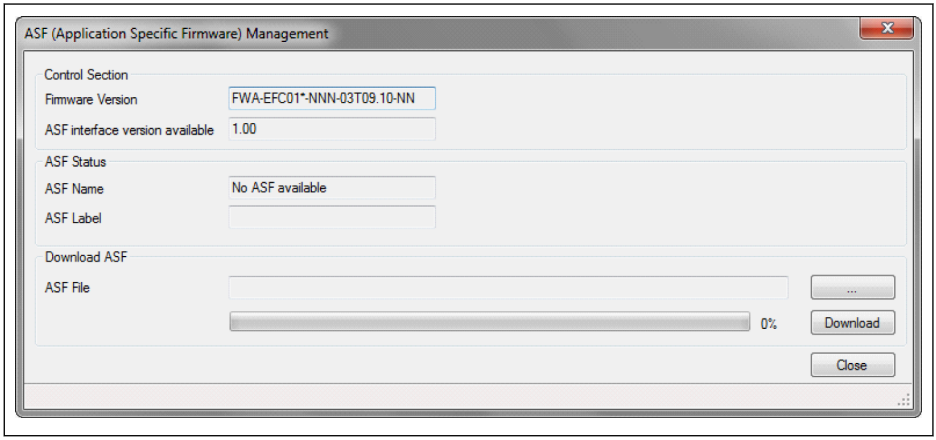



**Fig. 12-76:** ASF management menu

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.

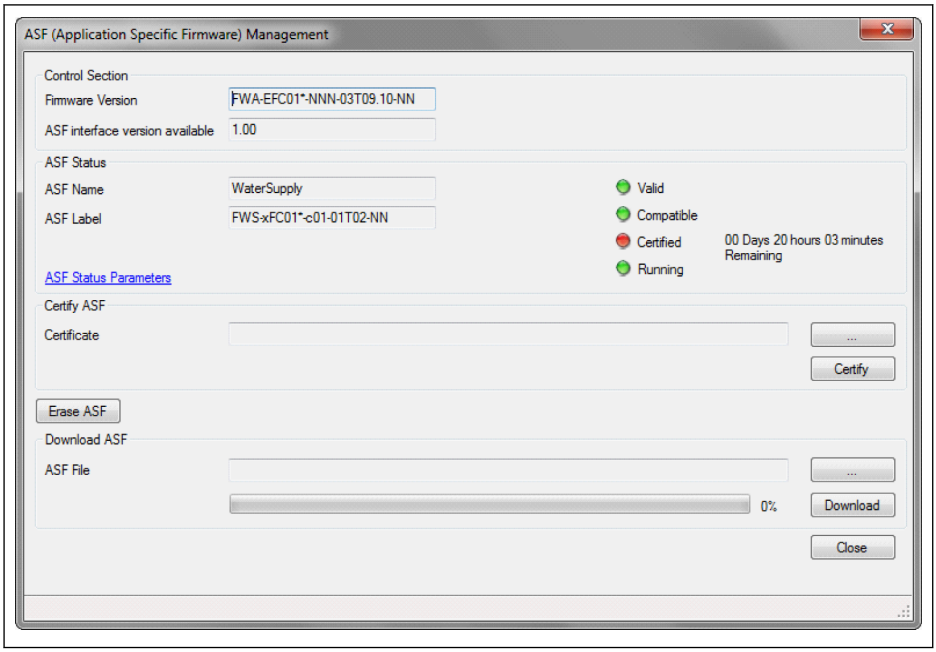



**Fig. 12-77:** ASF management window

## 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.

## 12.13.4 ASF Diagnosis

### ASF system error

| Error code | Display | Description |
|---|---|---|
| F8060 | ASF- | ASF error |

**Tab. 12-22:** 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.

# 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... |
| tUnE | Motor parameter tuning |
| PSLP | PID sleeping |
| -PF- | Modified parameters which are different from default value |
| -EP- | Parameters with invalid settings |
| PAr1 | Parameter set switching from set 2 to set 1 |
| PAr2 | Parameter set switching from set 1 to set 2 |
| StO-A | STO enabled in stop mode |

## 13.3 Warning Code

| Code | Description |
|---|---|
| P.oFF | Displayed only at power down / drop in stop state |
| S.Err | Parameter change blocked |
| C-dr | Communication disconnection |
| PrSE | Parameter setting contradiction |
| FLE | Fan maintenance period expired |
| noCP | No modified parameter |
| PLE | Pump leakage |
| Aib- | Analog input broken wire detection |
| OCi | Communication data exceeds value range |
| Fdi | Fieldbus process data invalid |

| Code | Description |
|---|---|
| APF1 | Warning which can be thrown by the application, description in application manual |
| APF2 | |
| APF3 | |
| APF4 | |
| APF5 | |
| UH-A | Converter under temperature |
| SLi- | Speed limit |

## 13.4 Error Code

### 13.4.1 Error 1 (OC-1): Overcurrent at Constant Speed

| Possible reason | Solution |
|---|---|
| Sudden load change in run mode | Reduce occurrence and scale of sudden change |
| Low mains voltage | Check input power supply |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Excessive inertia or load | Check power of motor and frequency converter, check load |
| The motor cable is too long | ● Decrease the carrier frequency (C0.05)<br>● Use a frequency converter with larger power |
| Excessive torque compensation | Reduce torque compensation setting (C2.22) till the current decreases |
| Excessive overexcitation braking factor | Reduce [E0.55] |

### 13.4.2 Error 2 (OC-2): Overcurrent during Acceleration

| Possible reason | Solution |
|---|---|
| Excessively short acceleration time | Increase acceleration time (E0.26) |
| 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 V/f curve related parameters | Adjust setting of V/f curve related parameters |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Excessive torque compensation | Reduce torque compensation setting (C2.22) till the current decreases |
| Wrong motor parameters setting | Correct motor parameters setting |
| Excessive overexcitation braking factor | Reduce [E0.55] |

### 13.4.3 Error 3 (OC-3): Overcurrent during Deceleration

| Possible reason | Solution |
|---|---|
| Excessively short deceleration time | Increase deceleration time (E0.27) |
| Excessive load rotation inertia | Use suitable brake components |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |

| Possible reason | Solution |
|---|---|
| Excessive overexcitation braking factor | Reduce [E0.55] |
| Wrong motor parameter setting | Correct motor parameters setting |

### 13.4.4 Error 4 (OE-1): Overvoltage at Constant Speed

| 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 |
| Excessive load rotation inertia | Use suitable brake components |
| Noise interference | Check wiring of control circuit, main circuit and grounding |

### 13.4.5 Error 5 (OE-2): Overvoltage during Acceleration

| 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) |

### 13.4.6 Error 6 (OE-3): Overvoltage during Deceleration

| Possible reason | Solution |
|---|---|
| Surge voltage from power supply | Check input power supply |
| Motor to earth short circuit causes<br>DC-bus capacitors overcharged | Check motor connection |
| Excessive load rotation inertia | Use suitable brake components |
| Excessively short deceleration time | ● Increase deceleration time (E0.27)<br>● Use a brake resistor or a brake resistor unit<br>● Enable stall overvoltage prevention during deceleration (C0.25) |
| Wrong wiring of brake resistor | Check the wiring of brake resistor |
| The brake chopper is damaged | Contact with service |

### 13.4.7 Error 7 (OE-4): Overvoltage during Stop

| Possible reason | Solution |
|---|---|
| Excessive inertia on the load | ● Increase deceleration time (E0.27)<br>● Use suitable brake components |
| Surge voltage from the power supply | Check input power supply |

### 13.4.8 Error 8 (UE-1): Undervoltage during Run

| Possible reason | Solution |
|---|---|
| Power failure during running | Check input power supply |
| Main circuit capacitor deterioration | Contact with service |

### 13.4.9 Error 9 (SC): Surge Current or Short Circuit

| Possible reason | Solution |
|---|---|
| External phase-phase short circuit of motor | Check motor wiring |
| Earth surge | Remove the short circuit and check motor |
| Internal error of power module | Contact with service |
| Surge current | Increase the acceleration time (E0.26), reduce the overexcitation braking factor (E0.55) |

### 13.4.10 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 |
| Main circuit capacitor deterioration | Contact with service |

### 13.4.11 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 motor |

### 13.4.12 Error 12 (ESS-): Soft Start Error

| Possible reason | Solution |
|---|---|
| Soft start resistor value has been changed due to over temperature | Contact with service |
| Power failure | Check the input power supply |
| Input phase loss occurs during start-up (3 phase) | Remove the input phase loss |
| Main circuit capacitor deterioration | Contact with service |

### 13.4.13 Error 20 (OL-1): Converter Overload

| Possible reason | Solution |
|---|---|
| Long time overload | Reduce overload time, reduce load |
| Wrong settings of V/f curve related parameters | Adjust settings of V/f curve related parameters |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| 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 (C2.22) till the current decreases |
| Excessive overexcitation braking factor | Reduce [E0.55] |

### 13.4.14 Error 21 (OH): Converter over Temperature

| Possible reason | Solution |
|---|---|
| Frequency converter (heat sink) temperature is higher than max. allowable temperature 95 ℃ | ● Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection (if available)<br>● Reduce load if necessary<br>● Reduce carrier frequency (C0.05) |
| Temperature detection circuit error | Contact with service |

### 13.4.15 Error 23 (FF): Fan Failure

| Possible reason | Solution |
|---|---|
| Fan defect | Contact with service |

### 13.4.16 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 |

### 13.4.17 Error 25 (CoL-): Command Value Lost

| Possible reason | Solution |
|---|---|
| Command value lost | Contact with service |

### 13.4.18 Error 26 (StO-r): STO request

| Possible reason | Solution |
|---|---|
| STO function is activated correctly in running mode, after re-energized input channels and reset the device, the device goes to normal state | Check the signal of STO input terminal |

### 13.4.19 Error 27 (StO-E): STO error

| Possible reason | Solution |
|---|---|
| STO function is activated incorrectly, it happens if one channel is energized but the other is deenergized | Check the signal of STO input terminal |

### 13.4.20 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) |

| Possible reason | Solution |
|---|---|
| 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 |

### 13.4.21 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) |

### 13.4.22 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 |

### 13.4.23 Error 33 (AdE-): Synchronous Motor Angle Detection Error

| Possible reason | Solution |
|---|---|
| Internal error occurs during synchronous motor angle detection | Contact with service |

### 13.4.24 Error 35 (SPE-): Speed Control Loop Error

| Possible reason | Solution |
|---|---|
| The speed loop difference is outside [C3.26] over a time of [C3.25] | Contact with service |

### 13.4.25 Error 38 (AibE): Analog Input Broken Wire Detection

| Possible reason | Solution |
|---|---|
| Analog input wire is disconnected | Check wiring of AI1, AI2 and EAI |

### 13.4.26 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 |

### 13.4.27 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 |

### 13.4.28 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 |

### 13.4.29 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 |

### 13.4.30 Error 43 (FFE-): Firmware Version Mismatch

| Possible reason | Solution |
|---|---|
| Operating panel may be placed to the frequency converter with older/newer firmware | Contact with service |
| Control board may be removed to another device | Contact with service |
| Extension card may be installed to the frequency converter with older/newer firmware | Contact with service |

### 13.4.31 Error 44 (rS-): Modbus Communication Error

| Possible reason | Solution |
|---|---|
| Device connection problem | Check device communication connection |
| Communication target error | Check status of communication target |

### 13.4.32 Error 45 (E.Par): Parameter Settings Invalid

| Possible reason | Solution |
|---|---|
| Parameter settings are invalid after firmware update or extension card removed or parameter copy | 1. Check parameter group '-EP-' and modify the parameter values appeared in '-EP-'<br>2. Initialize all parameters |

### 13.4.33 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 |

### 13.4.34 Error 48 (idA-): Internal Communication Error

| Possible reason | Solution |
|---|---|
| Internal error caused by communication between control boards | Contact with service |

### 13.4.35 Error 49 (idP-): Internal Parameter Error

| Possible reason | Solution |
|---|---|
| Internal error caused by parameter handling | Contact with service |

### 13.4.36 Error 50 (idE-): Converter Internal Error

| Possible reason | Solution |
|---|---|
| Internal error occurs | Contact with service |

### 13.4.37 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 | Contact with service |

### 13.4.38 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 |

### 13.4.39 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 |

### 13.4.40 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 |

### 13.4.41 Error 55 (PbrE): Parameter Backup / Restore Error

| Possible reason | Solution |
|---|---|
| Error occurs during parameter backup/restore process | Contact with service |

### 13.4.42 Error 56 (PrEF): Parameter Restore Error after Firmware Update

| Possible reason | Solution |
|---|---|
| Error occurs if parameter settings cannot be restored after firmware update | Contact with service |

### 13.4.43 Error 60 (ASF-): Application Firmware Error

| Possible reason | Solution |
|---|---|
| Error message if the application firmware was not loaded correctly or trail use is over | Contact with service |

### 13.4.44 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 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 signal' 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 |
| H8.04 | EX5 input | | 0 | – | Stop |

Set the respective parameter of any digital input as '34: Error reset signal'. For wiring diagram, please refer to chapter "Digital input NPN / PNP wiring" on page 74.

# 14 Communication

## 14.1 Brief Introduction

EFC x610 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; 1: Extension card | 0 | – | Stop |

☞ For Multi-Ethernet extension card configurations, please refer to documentation R912006860.

### 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 55 and chapter 8.3.2 "Control Terminals" on page 71.

### 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 EFC x610 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:** EFC x610 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 20.3.1 "Terminology and Abbreviation in Parameter List" on page 403.

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 EFC x610 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.

## 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 EFC x610 frequency converter, use register address 0x1014 (0x10 = Group d0, index 0x14 = 20).

To set V/f curve mode (C2.00) of EFC x610 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 297).

### 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. 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)

### 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. 14-27:** 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 |
|---|---|---|
| bit 15<br>.<br>.<br>.<br>bit 0 | 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 |
| | C | ESS-, soft start error |
| | 14 | OL-1, converter overload |
| | 15 | OH, converter over temperature |
| | 17 | FF, fan failure |
| | 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-, 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. 14-28:** 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 '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.

## 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.

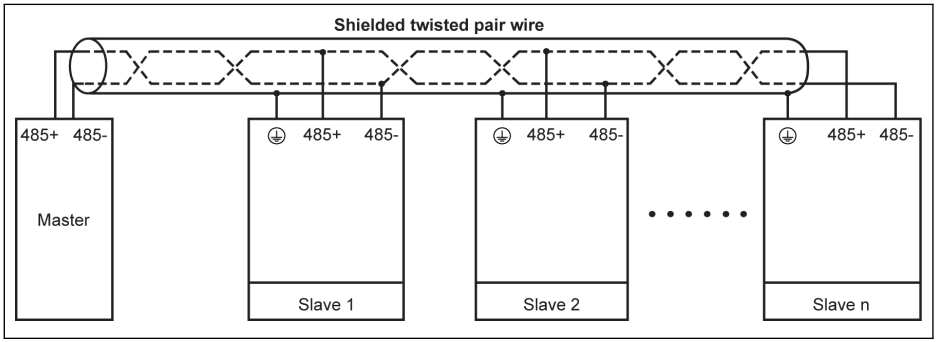



**Fig. 14-1:** Communication networking

- 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 EFC x610 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. 14-29:** 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 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. 14-30:** 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. 14-31:** 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.

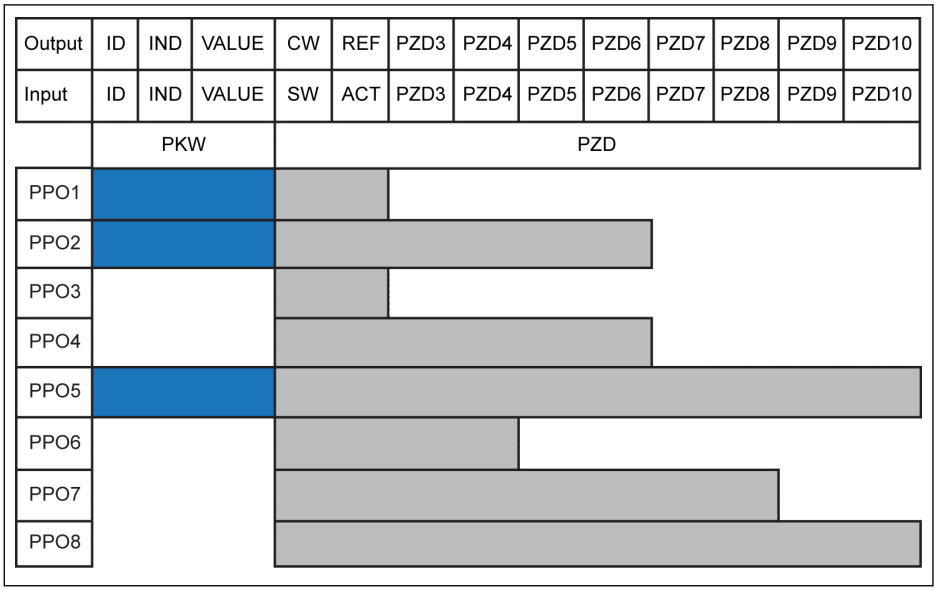
### 14.4.6 Periodical Data Communication

#### PPO telegram type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). Frequency Converter EFC x610 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. 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. 14-34 "PKW area error codes" on page 322 for details.

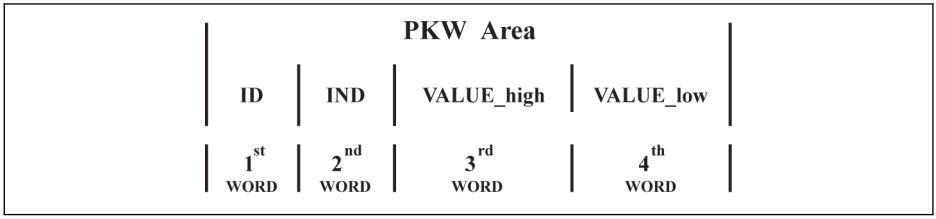



**Fig. 14-3:** PKW area data format

### 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. 14-32:** 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. 14-33:** 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. 14-34:** 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 320, 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 EFC 5610 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. 14-35:** 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. 14-36:** 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. 14-37:** 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 434.

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. 14-38:** 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. 14-39:** Status word

| bit | Value | Description |
|---|---|---|
| 15...1 | – | Reserved |
| 0 | 1 | 24 V mode |
| | 0 | Normal mode |

**Tab. 14-40:** Extended status word

For details on parameter addresses, see chapter 14.3 "Modbus Protocol" on page 295.

## 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 320.

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. 14-41:** 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. 14-42:** 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. 14-43:** PROFIBUS-DP communication parameters

①: See chapter "H1: PROFIBUS card parameters" on page 434 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 Safety Technology

## 15.1 Overview

### 15.1.1 Background

In the case of a standard drive, the axis / spindle / roll is moved according to the command values of the control unit. In this case, incorrect drive motion can be caused by operating errors, incorrect installation in the system, defects in parts or materials, failures in the system, etc. Incorrect drive motion - even if the errors only occur for a short time and occasionally - can endanger persons staying in the danger zone of the drive motion. You therefore have to take measures that limit the effects of errors on the drive motion to a minimum. The residual risk of danger to persons is then considerably reduced.

The integrated Rexroth safety technology provides the user the facilities, on the control unit and drive side, for realizing functions of personal and machine protection with a minimum of planning and installation work required.

### 15.1.2 Comparison with Conventional Safety Technology

A drive and control system with integrated safety technology differs from systems with conventional safety technology by the fact that the safety functions are directly integrated in the intelligent drives in the form hardware and software. This increases the functionality in all operation modes with a maximum of safety (short reaction times).

The power contactor between controller and motor required for the conventional safety technology is not included in drive and control systems with the integrated safety technology.

The integrated safety technology is not intended to replace conventional safety equipment, such as EMERGENCY STOP monitoring devices and safety door monitors.

Using the integrated safety technology increases the available personnel and machine safety, because the total reaction time of the system in the case of an error event, for example, is considerably reduced with regard to comparable systems with conventional safety technology. The safety signals are transmitted with conventional wiring.

Integrated safety technology is characterized by the following features:

- Complies with valid standards
- Increased system performance
- Reduced system costs
- Easy understanding of complex subjects
- Improved diagnostics
- Simplified certification
- Easy commissioning
- Independent of control units

### 15.1.3 Safe Torque Off (STO) Function Introduction

The normative definition of STO function is in §4.2.2.2 of the IEC 61800-5-2 (on the 2016 version):

"Power, that can cause rotation (or motion in the case of a linear motor), is not applied to the motor. The PDS (SR) (Power Drive System with safety-related functions) will not provide energy to the motor which can generate torque (or force in the case of a linear motor)."

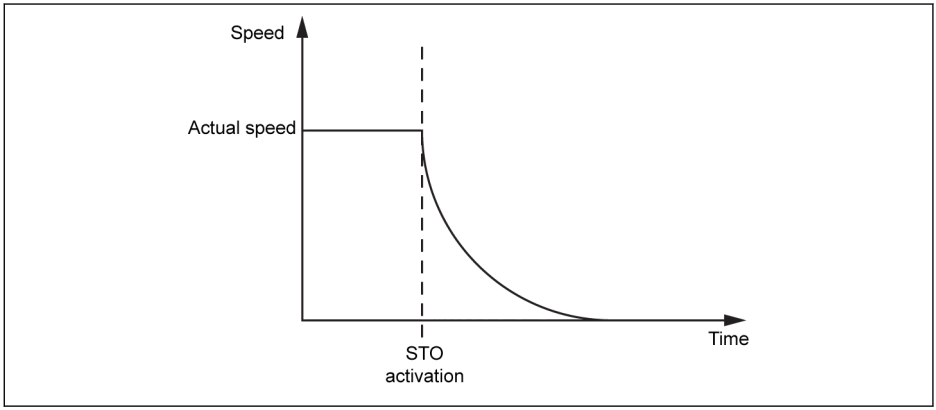



**Fig. 15-1:** STO function

The STO may be used where power removal is required to prevent an unexpected start. With this function, the energy supply to the motor can be safely interrupted. The drive in this case cannot generate any torque / force and, as a consequence, it cannot generate any dangerous movements.

The safety function corresponds to stop category 0 according to IEC 60204-1.

### 15.1.4 Safety Notes

**⚠ DANGER** **Lethal injury and / or property damage caused by unintended axis motion!**

If external force influences are to be expected with the safety function "Safe Torque Off", e.g. in case of a vertical axis, this motion has to be safely prevented by additional measures, e.g. a mechanical brake or a weight compensation.

**⚠ DANGER** **High electrical voltage! Danger to life, risk of injury due to electric shock!**

The STO function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive system from the main supply.

**⚠ WARNING** **Injury and / or property damage caused by deviation from standstill position!**

Even if the control unit has been safely locked, momentary axis motion, depending on the number of poles of the motor, can be triggered, when two errors are occurring simultaneously in the power section with the voltage DC bus being active:

- Breakdown of a power semiconductor and
- Breakdown of another semiconductor

In this case, two of six semiconductors are affected in such a way that the motor shaft is aligning.

**⚠ CAUTION** **Risk of injury and material damage due to improper operation!**

It is not recommended to stop the drive using the STO function. If a running drive is stopped with STO, the drive will trip and stop by coasting. If this is not acceptable, the drive and machinery must be stopped using the appropriate stopping mode before using STO.

### 15.1.5 Standard Relevant to Safety Function

EFC 5610 frequency converter is comply with the following relevant safety standards:

| Standard | Description |
|---|---|
| IEC 61508 2010-4 | Functional safety of electrical/electronic/programmable electronic safety-related systems |
| ISO 13849-1 2015 | Safety of machinery-safety-related parts of control systems-Part 1: General principles for design |
| ISO 13849-2 2012 | Safety of machinery-safety-related parts of control systems-Part 2: Validation |
| IEC 62061 2015 | Safety of machinery-Functional safety of electrical, electronic and programmable electronic control systems |
| IEC 61800-5-2 2016 | Adjustable speed power drive systems- Part 5-2: safety requirements-Functional |
| IEC 60204-1 2016 | Safety of machinery- Electrical equipment of machines |

**Tab. 15-1:** STO relevant safety standards

## 15.2 Installation

### 15.2.1 Terminal Definition

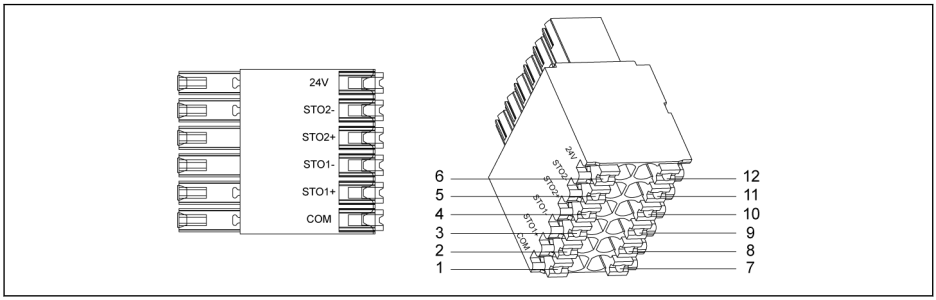



**Fig. 15-2:** STO terminals

| Connection | Signal name | Function |
|---|---|---|
| 1 / 7 | COM | COM is the reference of +24 V |
| 2 / 8 | STO1+ | Input channel 1 |
| 3 / 9 | STO1- | The reference of Input channel 1 |
| 4 / 10 | STO2+ | Input channel 2 |
| 5 / 11 | STO2- | The reference of Input channel 2 |
| 6 / 12 | +24 V | Power supply |

**Tab. 15-2:** Terminal definition

The 12-pin socket has two rows of connectors which are bridged for easy wiring.

### 15.2.2 Cable Definition

| Cable type | Cross-section | | Ferrule length | Stripped length |
|---|---|---|---|---|
| | $mm^2$ | AWG | mm | mm |
| Shielded cable, wire-end ferrule w/ plastic collar | 1.00 | 18 | 12 | 15 |
| | 0.75 | 18 | 12 | 14 |
| | 0.50 | 20 | 10 | 12 |
| | 0.34 | 22 | 8 | 10 |
| | 0.25 | 24 | 8 | 10 |
| | 0.14 | 24 | 8 | 10 |

**Tab. 15-3:** Cable definition for STO terminal

## 15.2.3 Application

There are several connection cases for using the STO function of EFC 5610, each have a different security level.

### Case 1: Dual-channel Wiring with External Power Supply (Mode 1)

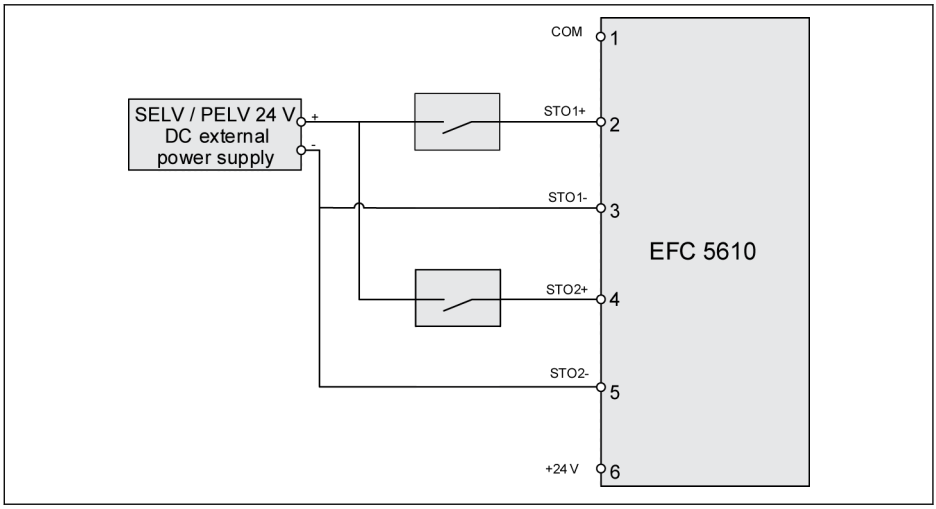



**Fig. 15-3:** Dual-channel wiring with external power supply (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

### Case 2: Dual-channel Wiring with External Power Supply (Mode 2)

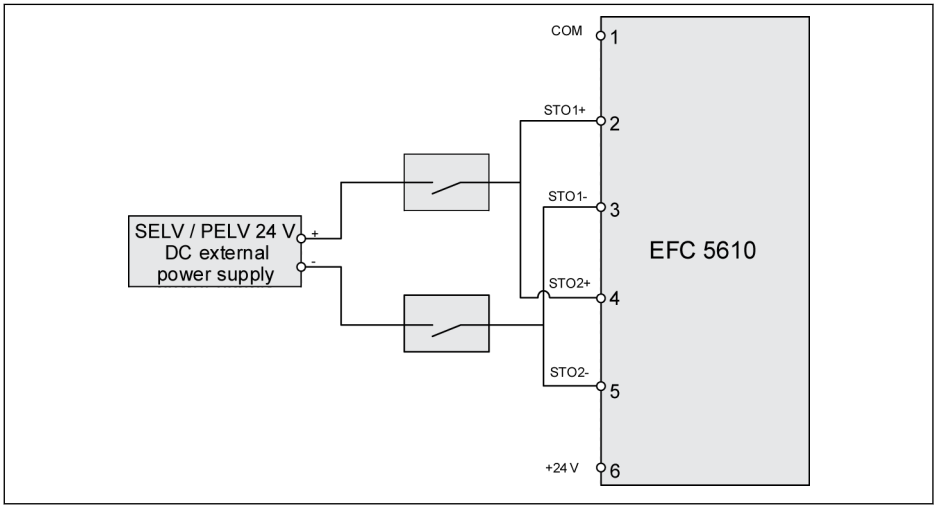



**Fig. 15-4:** Dual-channel wiring with external power supply (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

### Case 3: Dual-channel Wiring with Safety SPS

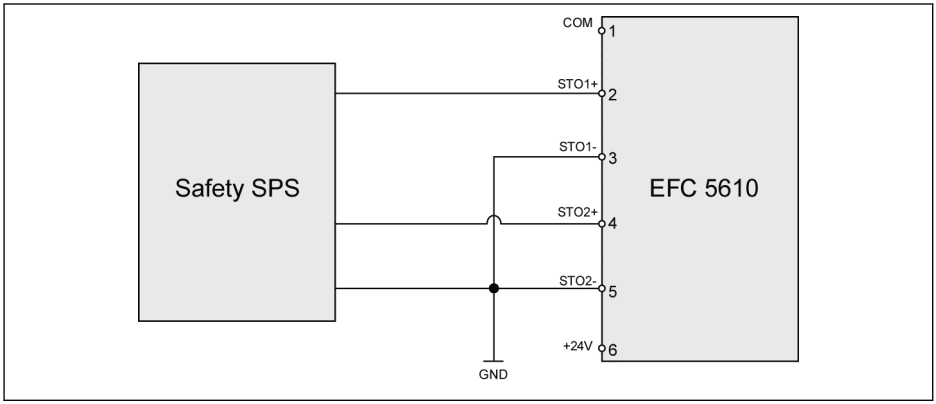



**Fig. 15-5:** Dual-channel wiring with safety SPS (SIL 3, Cat 4 / PLe)

### Case 4: Dual-channel Wiring to IndraDrive with Safety SPS

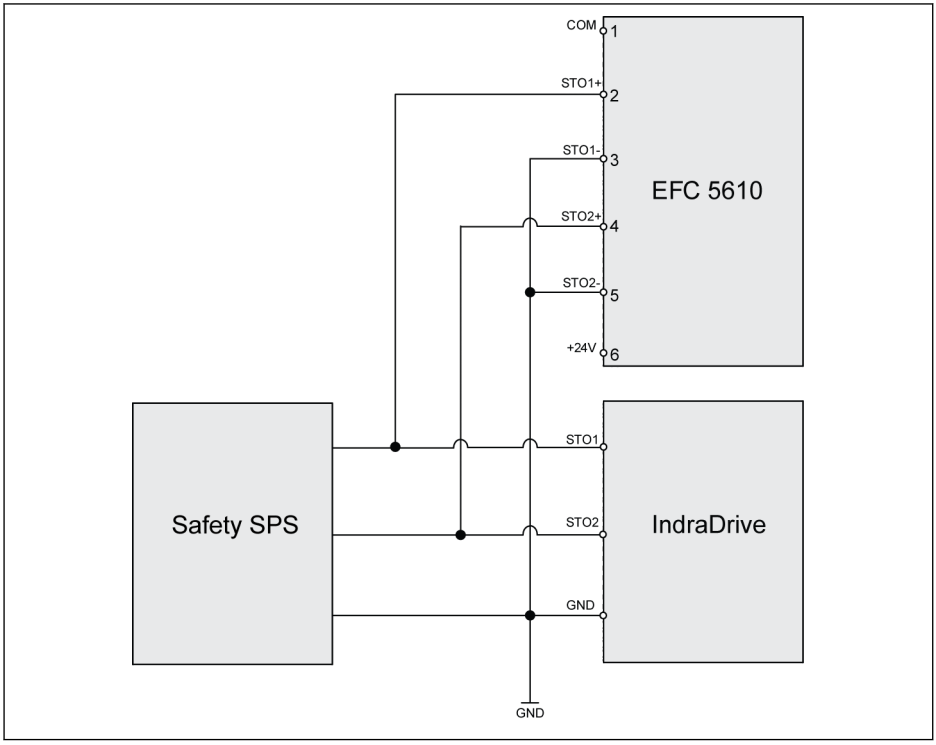



**Fig. 15-6:** Dual-channel wiring to Indradrive with safety SPS (SIL 3, Cat 4 / PLe)

## Case 5: Dual-channel Wiring to IndraDrive without Safety SPS

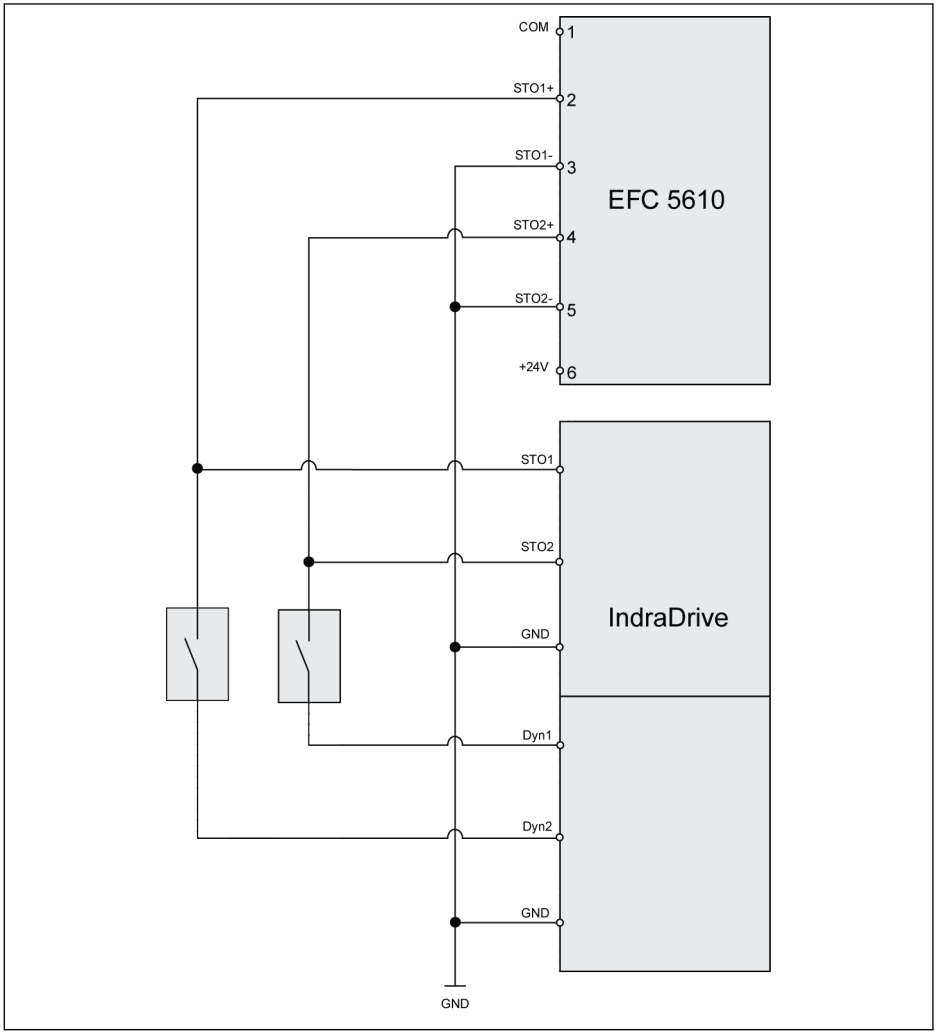



**Fig. 15-7:** Dual-channel wiring to IndraDrive without safety SPS (SIL 2, Cat 3 / PLd without fault exclusion wiring; SIL 3, Cat 4 / PLe with fault exclusion wiring)

### Case 6: Four-channel Wiring with External Power Supply

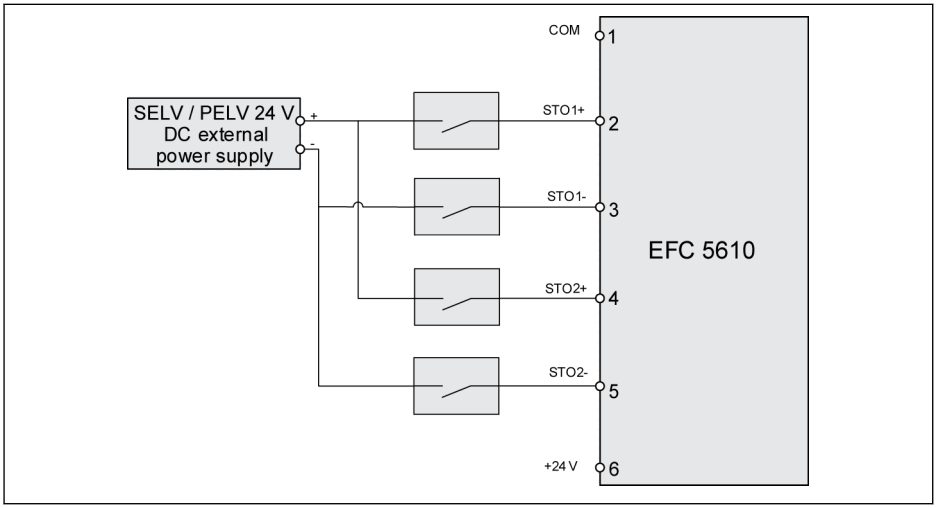



**Fig. 15-8:** Four-channel wiring with external power supply (SIL 3, Cat 4 / PLe)

## Case 7: Paralleled Connection Type

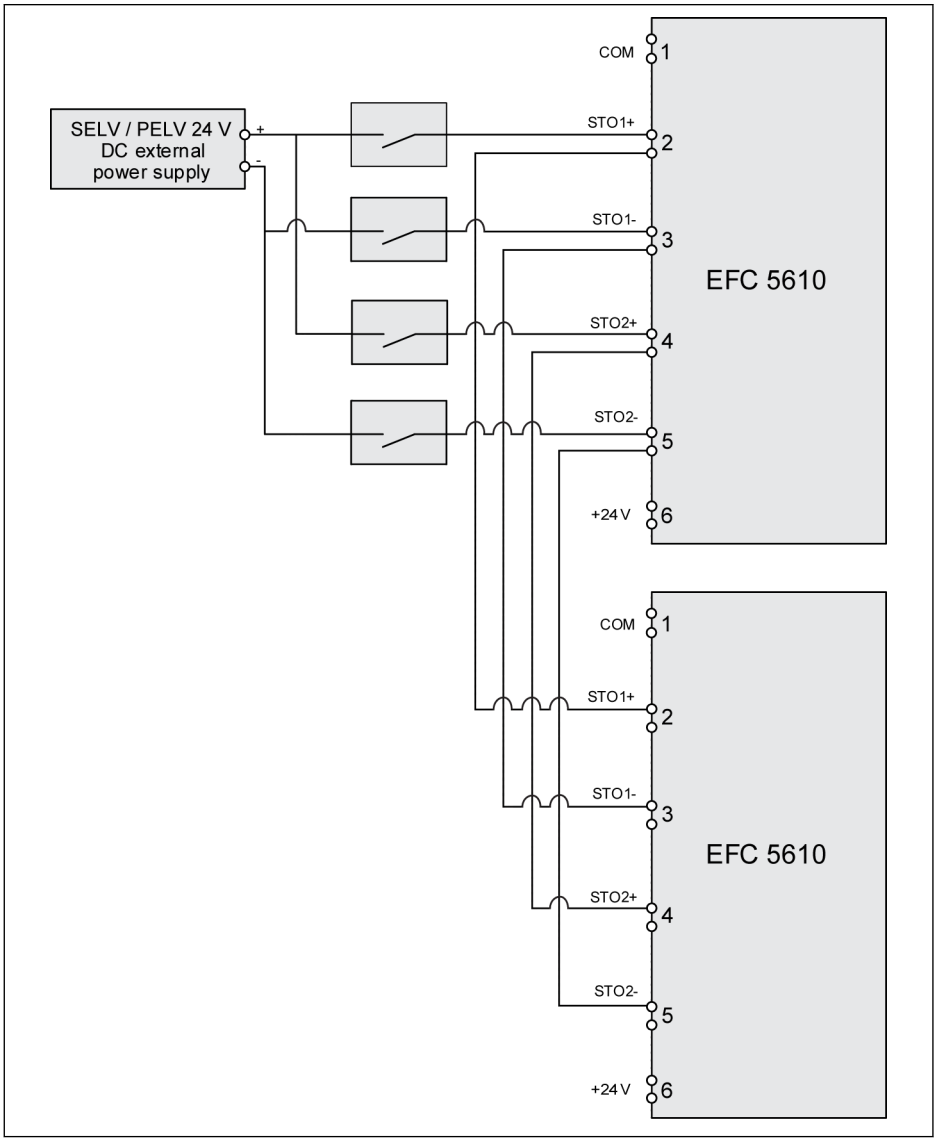



**Fig. 15-9:** Paralleled connection type (SIL 3, Cat 4 / PLe)

- To protect the drive against malfunction by dirt or moisture, it has to be mounted in a IP 54 cabinet.
- The +24 V DC external power supply has to meet SELV / PELV-requirements.
- The required supply current of maximum 15 mA for each circuit and the required voltage is +24 V DC + / - 10%.
- The paralleled connection type would decrease the total system safety fraction.

**⚠ CAUTION**

As the internal 24 V power supply is not SELV / PELV, it must not be used to supply the STO function, but only to disable STO!

### 15.2.4 STO Cable Connection

For the models of 110K and above, STO cable must be connected according to the following steps.

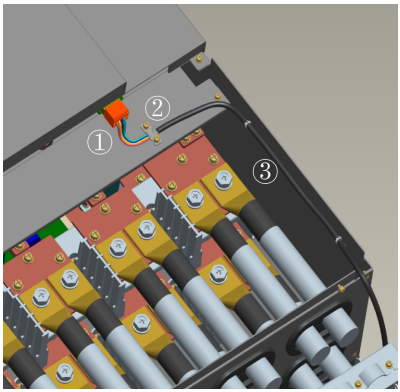



**Fig. 15-10:** STO Cable Connection 1

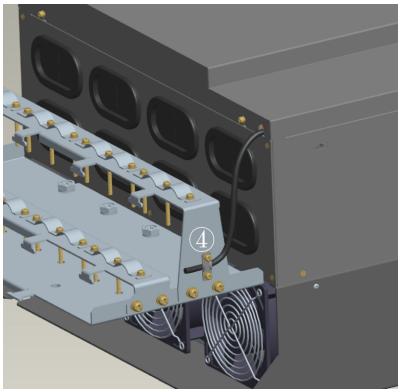



**Fig. 15-11:** STO Cable Connection 2

1. Connect STO cable to frequency converter with the STO terminal connector.
2. Fix STO cable on the metal plate with the clamp and make sure that the shielding layer reliable contact with the clamp.
3. Fix STO cable at the side panel.
4. Thread out the STO cable from the bottom of frequency converter and fix it to the side of shielding connector.

For more information about shielding connector, please see chapter 16.10 "Shielding Connector" on page 378.

### 15.2.5 Safety Function Disable

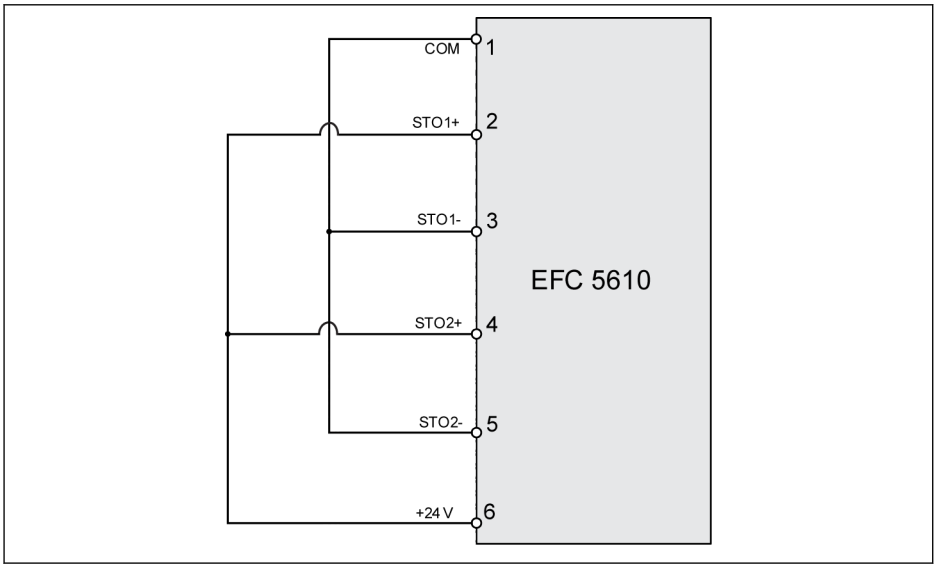



**Fig. 15-12:** Safety function disable

**⚠ CAUTION**

This is the default wiring of the device. STO is disabled in delivery state.

### 15.2.6 Input Channel Parameter

| Input signal | Unit | Min | Typ. | Max |
|---|---|---|---|---|
| Allowed input voltage | V | -3 | - | 30 |
| Logical 0 (Low) | V | -3 | - | 5 |
| Logical 1 (High) | V | 15 | - | 30 |
| Input current | mA | 2 | - | 15 |
| Impedance | kΩ | - | 3.8 | - |
| Filtering time① | ms | - | 3 | - |
| Response time② | ms | - | < 20 | - |
| Allowable switching time delay between channels | s | - | 1 | - |

**Tab. 15-4:** Input channel parameter

①: Filtering time (shown as "$t_p$" in figure below) refers to the width of the low level pulse input to STO channel. In actual application, when the input pulse width is less than or equal to 3 ms, there is no influence to the operation and device.

②: Response time indicates the time interval from the power-off time of any STO input channel to the stop time of device output.

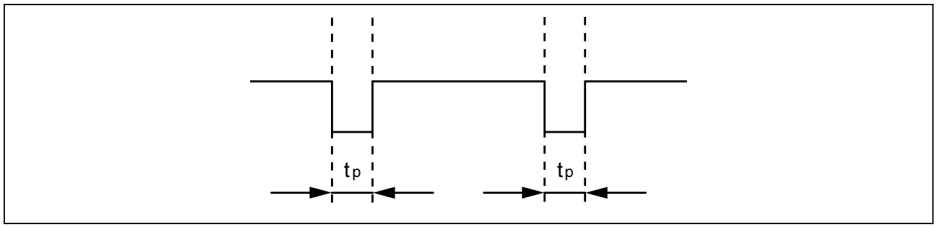



**Fig. 15-13:** Filtering time

## 15.3 Commission

Always test the operation and reaction of the STO function before commissioning.

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

Do not commission the installation without having it checked by a qualified person!

Before an installation with integrated safety technology is commissioned for the first time, the installation must be checked and approved in documented form by a qualified person.

Check the danger zone!

- Before commissioning, make sure that nobody is staying in the danger zone.
- Check the danger zone and secure it against access by persons (e.g., put up warning signs, install barriers or the like). Observe the applicable laws and local regulations.

## 15.4 STO Function Diagnosis and Status Indication

The normal state is that the device run normally and the STO function is in standby stage, if either of the input channels or both are de-energized, the STO function is activated and the device will go to safe state, at this state, the device shuts off the power semiconductor and disables start-up, no rotary field to generate any torque at the motor.

| Indication | STO event | Description | Input channel logic | |
|---|---|---|---|---|
| | | | Channel 1 | Channel 2 |
| StO-A | STO alarm | STO function is activated correctly in stop mode, after re-energized input channels, the device goes to normal state. | 0 | 0 |
| StO-r | STO request | STO function is activated correctly in running mode, after re-energized input channels and reset the device, the device goes to normal state. | 0 | 0 |
| StO-E | STO error | STO function is activated incorrectly, it happens if one channel is energized but the other is de-energized. | 1 | 0 |
| | | | 0 | 1 |

**Tab. 15-5:** STO function diagnosis and status indication

Parameter H0.03 is used to monitor the state of STO function, it is 'Read' only.

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H0.03 | STO safety status word | bit 0: STO-A<br>bit 1: STO-r<br>bit 2: STO-E<br>bit 3...15: Reserved<br>Modbus register: 0x7FA2 | 00000 | – | Read |

- Hardware damage of the channel may also cause “StO-E” error.
- The safety integrity level would decrease if only one input channel is used, please use two input channels.

## 15.5 Technical Data

### 15.5.1 Data Related to Safety Standards

| Standard | Parameter | Value |
|---|---|---|
| IEC 61508 2010-04<br>IEC 61800-5-2 2016 | SIL | 3 |
| | PFH | < 1 FIT |
| | Type | B |
| | PTI (Proof Test Interval) | 20 years |
| | MT (Mission Time) | 20 years |
| ISO 13849-1 2015 | PL | e |
| | Category | 4 |
| | MTTFd | 3.1E5 years |
| IEC 62061 2015 | SIL CL | 3 |

**Tab. 15-6:** Safety standard information

- The PFH only amounts to 2 % of the complete safety chain. The PFH < $2*10^{-9}$ 1/h (2 % SIL3).
- "Mission Time" and "Proof Test Interval":
  - The "Mission Time" of all components used must be observed and complied with. After the "Mission Time" of a component has elapsed, the component must be discarded or replaced. It is not allowed to continue operating the component!
  - After the component was discarded ("Mission Time" has elapsed), it must be ensured that it cannot be reused (e.g., by disabling it).
  - There is no specified "Proof Test Interval" for the drive system. Therefore, the "Mission Time" cannot be reset by a "Proof Test Interval".
- The safety function operates in High Demand Mode, where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year.

## 15.6 Maintenance

For preventive maintenance, the STO function must be activated once a year. The main power supply of the device must be turned off and then on again before this preventive maintenance. Active the STO function and confirm the operation and reaction of the STO function is normal.

## 15.7 Abbreviations

| Abbreviation | Reference | Description |
|---|---|---|
| Category | ISO 13849-1 | Classification of the safety-related parts of a control system |
| FIT | - | Failure In Time: 1E-9 hours |
| MTTFd | ISO 13849-1 | Mean Time To dangerous Failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions |
| PFH | IEC 61508 | Probability of Dangerous Failures per Hour |
| PL | ISO 13849-1 | Performance Level: Corresponds SIL, Levels a-e |
| PTI | IEC 61508 | Proof Test Interval |
| SIL | IEC 61508 | Safety Integrity Level |
| SIL CL | IEC 62061 | Safety Integrity Level Claim Limit |
| STO | IEC 61800-5-2 | Safe Torque Off |

**Tab. 15-7:** Abbreviations

Detailed description about each abbreviation, please refer to the content of corresponding standard.

# 16 Accessories

## 16.1 Optional Accessories

| Optional accessory | Type | Descriptions |
|---|---|---|
| **Operating panel:** | | |
| - LED panel | FPCC02.1-EANN-7P-NNNN | – |
| - LCD panel | FPCC02.1-EANN-LP-NNNN | – |
| - Dust cover | FPCC02.1-EANN-NN-NNNN | – |
| **Panel mounting plate** | FEAM02.1-EA-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-EA-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 | – |
| - Multi-Ethernet card | FEAE03.1-ET-NNNN | – |
| - Encoder card | FEAE04.1-EN1-NNNN | – |
| | FEAE04.1-EN2-NNNN | – |
| **Brake Chopper** | FEAE07.1-EA1-NNNN | – |
| | FEAE07.1-EA2-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** | FCAR01.1W□□□□-N□□□R0-□-0□-NNNN | See Appendix II |
| **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. 16-1:** Optional accessories

For definition of model and type in the following sub-chapters, see chapter 20.2 "Appendix II: Type Coding" on page 395.

## 16.2 Operating Panel

For details on operating panel, see chapter 10 "Operating Panel and Dust Cover" on page 104.

## 16.3 Panel Mounting Plate

### 16.3.1 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.

### 16.3.2 Recommended Opening Dimensions at Control Cabinet

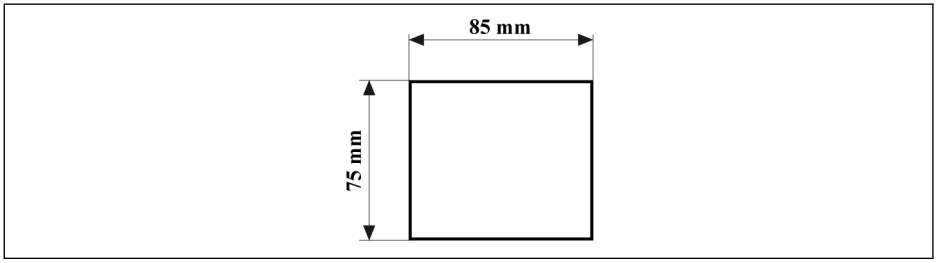



**Fig. 16-1:** Recommended opening dimensions at control cabinet

### 16.3.3 Mounting the Plate and the Operating Panel

#### Step 1

Push the mounting plate into the opening at the control cabinet:

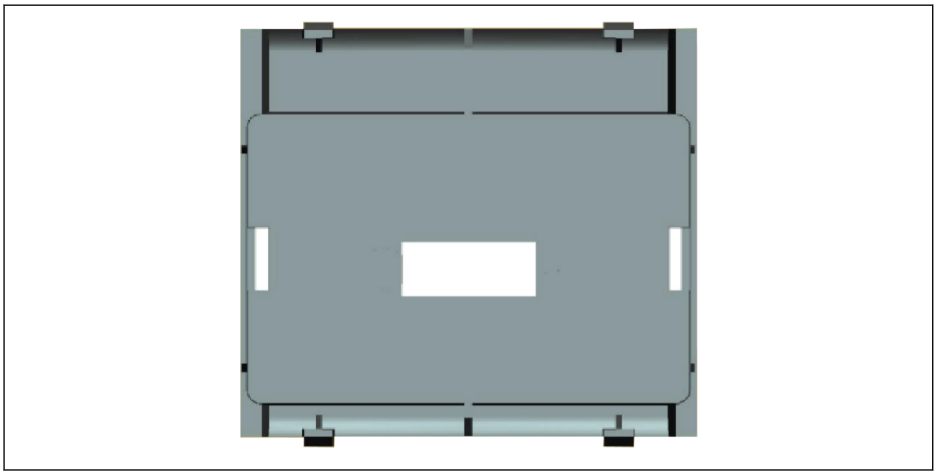


**Fig. 16-2:** Push the mounting plate into the opening (back view)

#### Step 2

Fix the mounting plate with a metal bar and 2 M4x8 screws:

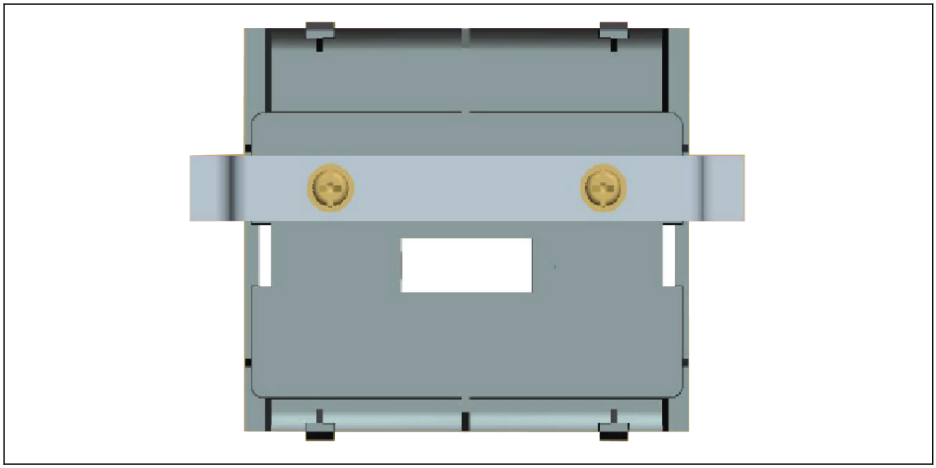


**Fig. 16-3:** Fix the mounting plate (back view)

### Step 3

Push the operating panel in the direction perpendicular to the mounting plate:

**Fig. 16-4:** 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:

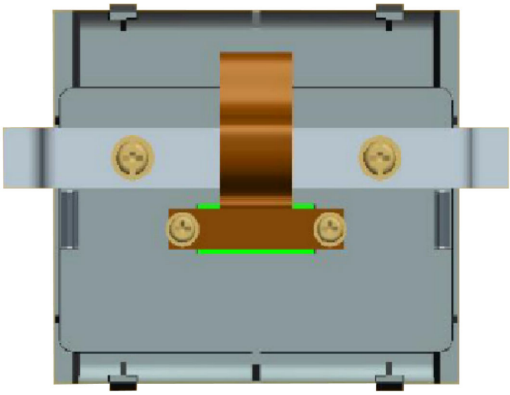


**Fig. 16-5:** Connect and fix the cable (back view)

## 16.4 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.

## 16.5 Extension Card Module

### 16.5.1 Dimensions of Extension Card Module

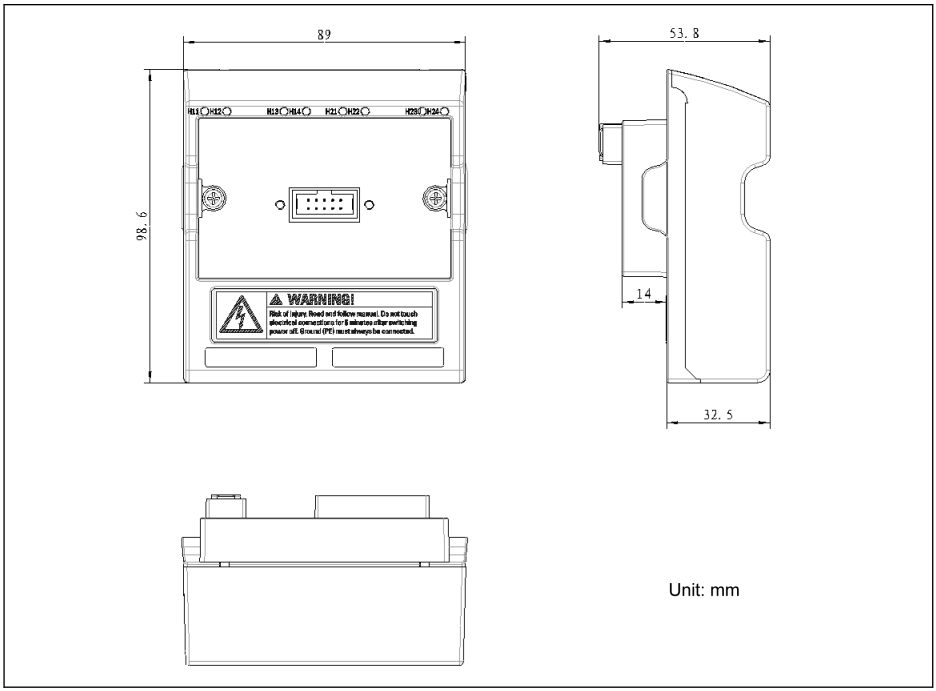



**Fig. 16-6:** Dimensions of Extension Card Module

## 16.5.2 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.

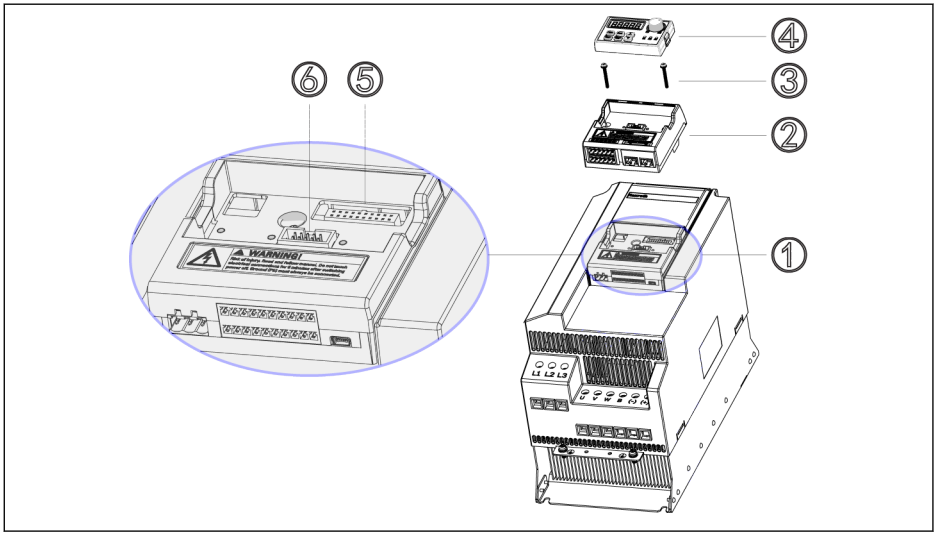



**Fig. 16-7:** Extension card module mounting

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 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

### 16.5.3 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.

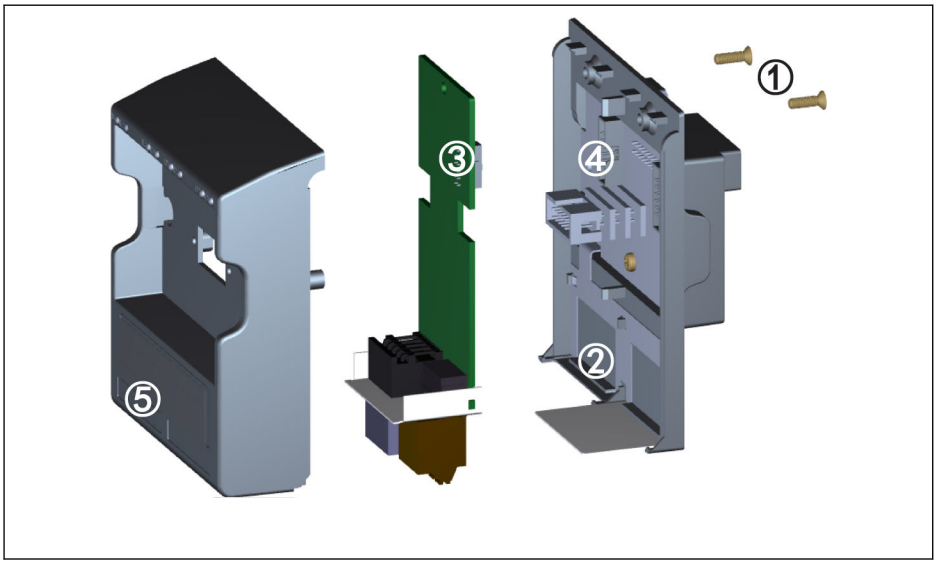



**Fig. 16-8:** Extension module mounting

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.

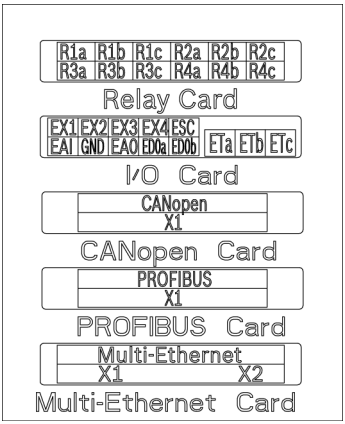



**Fig. 16-9:** Terminal labels of extension cards

- 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.

# 16.6 Communication Module

## 16.6.1 PROFIBUS Interface

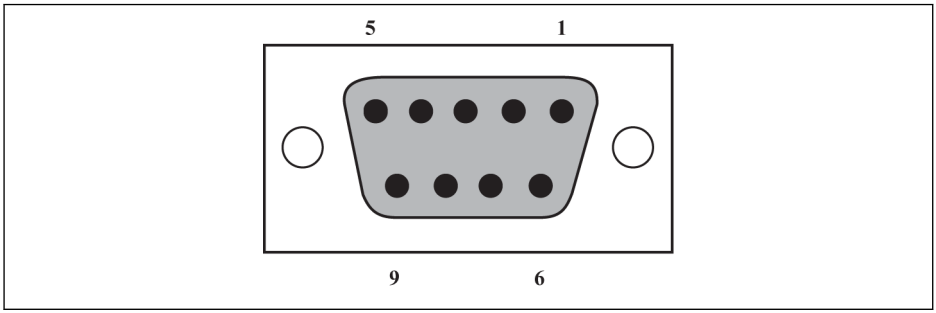



**Fig. 16-10:** PROFIBUS DB9 interface

| 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. 16-2:** Pin definition of PROFIBUS DB9 interface

## 16.6.2 PROFIBUS Card LED

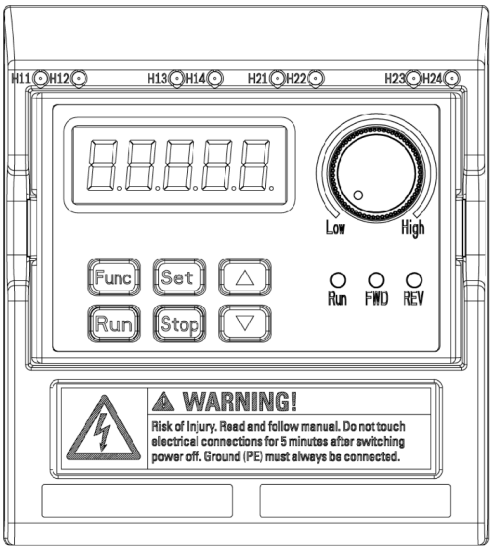



**Fig. 16-11:** PROFIBUS card LED

| 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. 16-3:** 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

## 16.7 Plug-in Connector for Control Section

For details on plug-in connector FEAE05.1-B2-NNNN, see fig. 8-9 "Control circuit terminals" on page 71.

## 16.8 External Mains EMC Filter

### 16.8.1 External Mains EMC Filter Type

| EFC x610 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) |
| 0K40-3P2 | FCAF01.1A-A050-E-0025-A-05-NNNN (0025-A-05) |
| 0K75-3P2 | |
| 1K50-3P2 | |
| 2K20-3P2 | |
| 3K00-3P2 | FCAF01.1A-A050-E-0036-A-05-NNNN (0036-A-05) |
| 4K00-3P2 | |
| 5K50-3P2 | FCAF01.1A-A050-E-0066-A-05-NNNN (0066-A-05) |
| 7K50-3P2 | |
| 11K0-3P2 | FCAF01.1A-A050-E-0090-A-05-NNNN (0090-A-05) |
| 0K40-3P4 | FCAF01.1A-A050-E-0025-A-05-NNNN (0025-A-05) |
| 0K75-3P4 | |
| 1K50-3P4 | |
| 2K20-3P4 | |
| 3K00-3P4 | |
| 4K00-3P4 | |
| 5K50-3P4 | FCAF01.1A-A050-E-0036-A-05-NNNN (0036-A-05) |
| 7K50-3P4 | |
| 11K0-3P4 | FCAF01.1A-A050-E-0050-A-05-NNNN (0050-A-05) |
| 15K0-3P4 | |
| 18K5-3P4 | FCAF01.1A-A050-E-0066-A-05-NNNN (0066-A-05) |
| 22K0-3P4 | FCAF01.1A-A050-E-0090-A-05-NNNN (0090-A-05) |
| 30K0-3P4 | FCAF01.1A-A100-E-0120-A-05-NNNN (0120-A-05) |
| 37K0-3P4 | |
| 45K0-3P4 | FCAF01.1A-A100-E-0250-N-05-NNNN (0250-N-05) |
| 55K0-3P4 | |

| EFC x610 model | External mains EMC filter type |
|---|---|
| 75K0-3P4 | FCAF01.1A-A100-E-0320-N-05-NNNN (0320-N-05) |
| 90K0-3P4 | |
| 110K-3P4 | FCAF01.1A-A100-E-0400-N-05-NNNN (0400-N-05) |
| 132K-3P4 | |
| 160K-3P4 | |

**Tab. 16-4:** 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 34.

## 16.8.2 Technical Data

### Dimensions

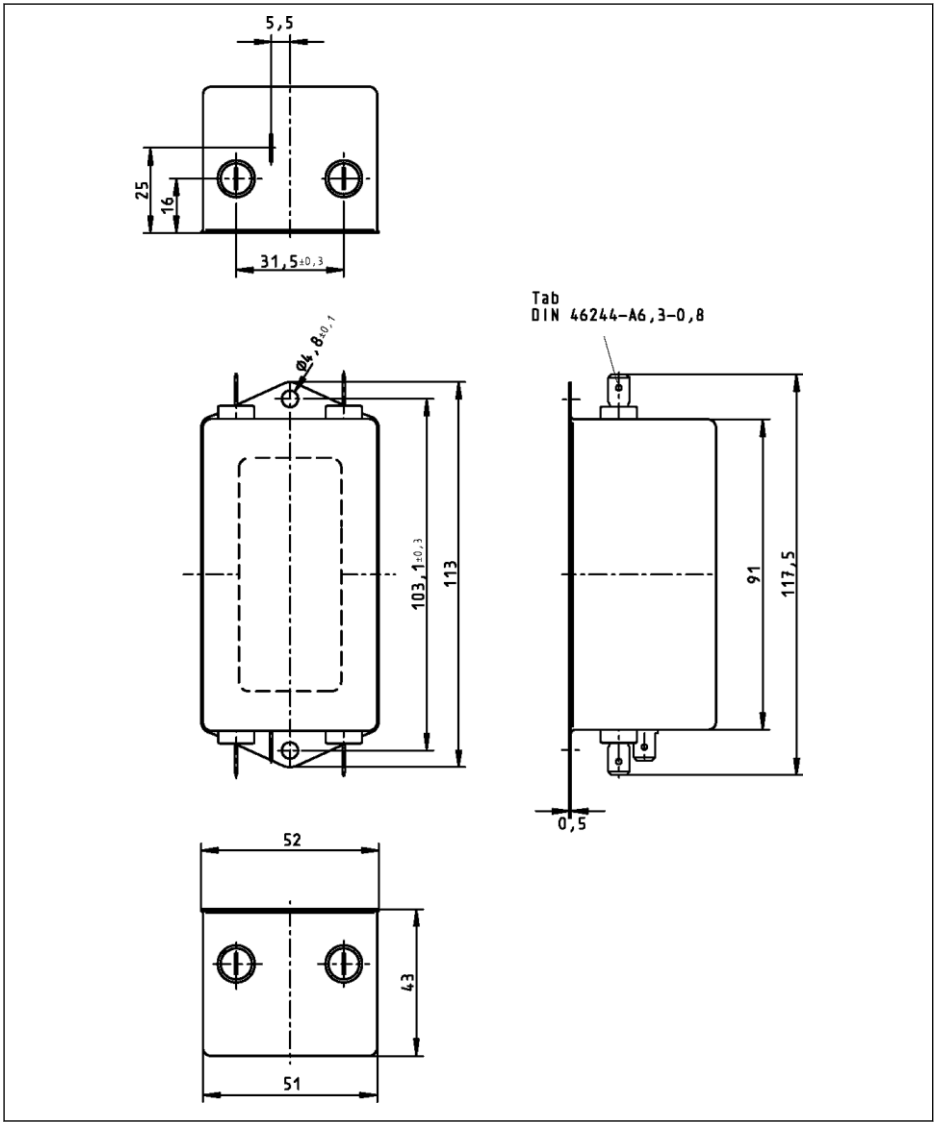



**Fig. 16-12:** 0010-N-03

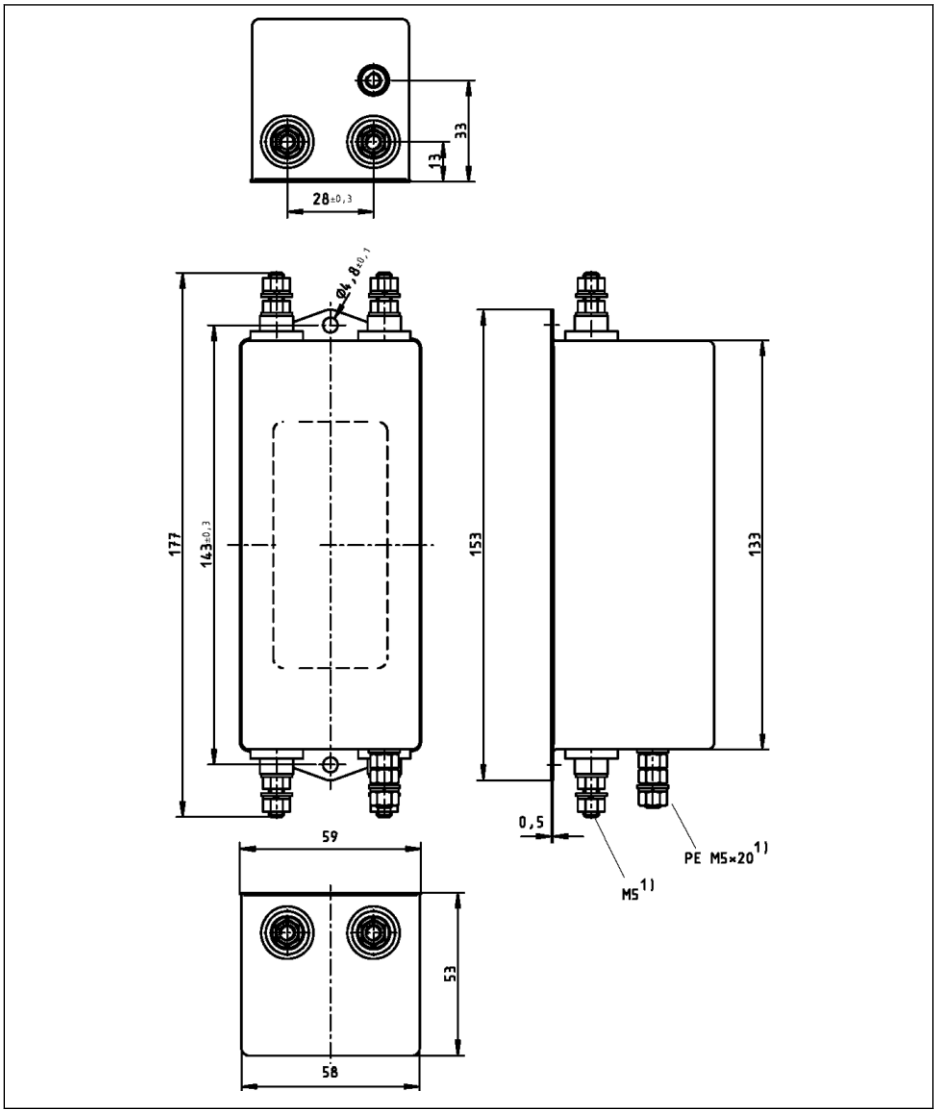



**Fig. 16-13:** 0020-N-03, 0025-N-03

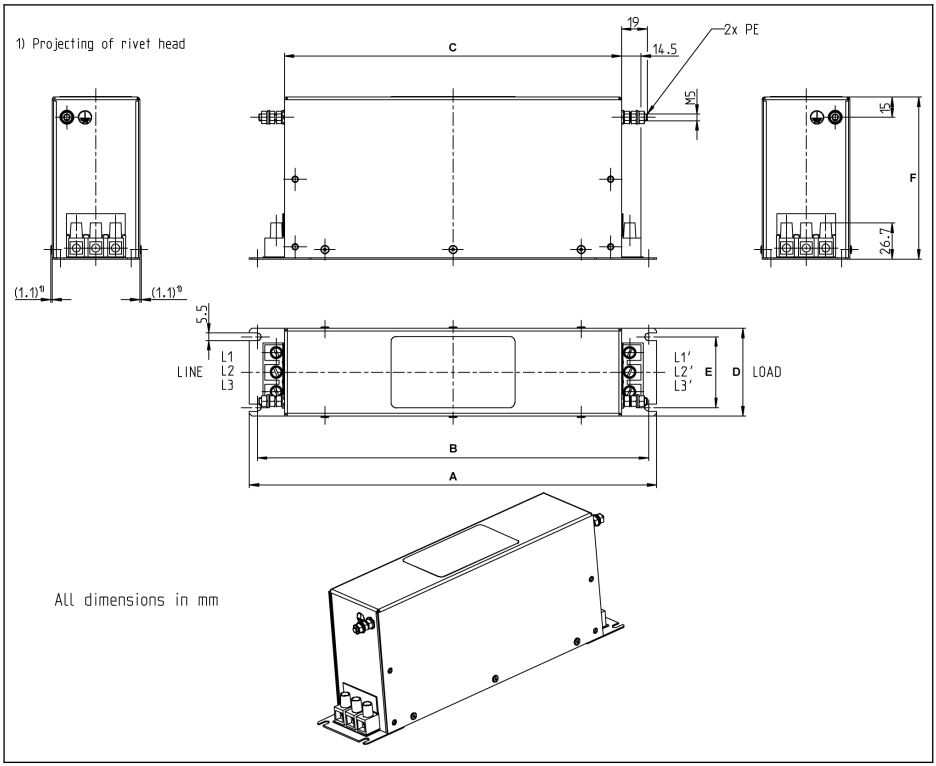



**Fig. 16-14:** 0025-A-05

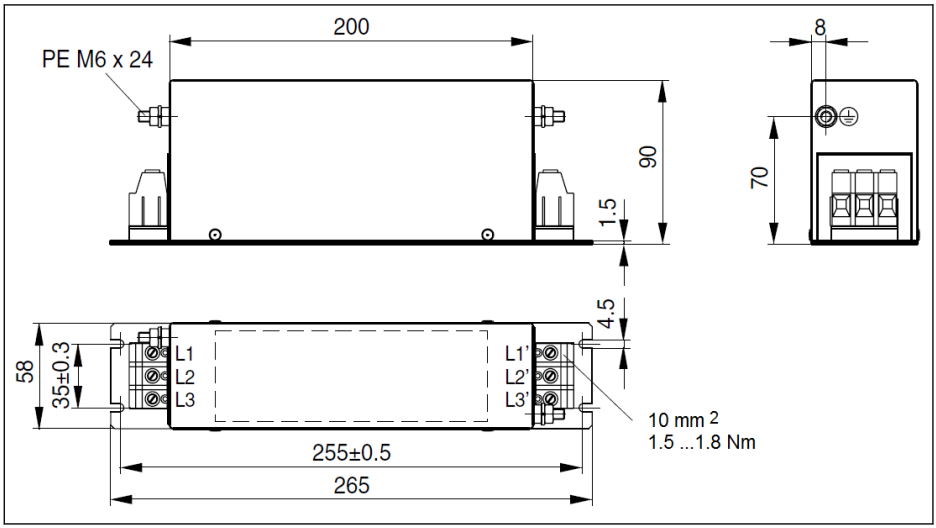



**Fig. 16-15:** 0036-A-05, 0050-A-05

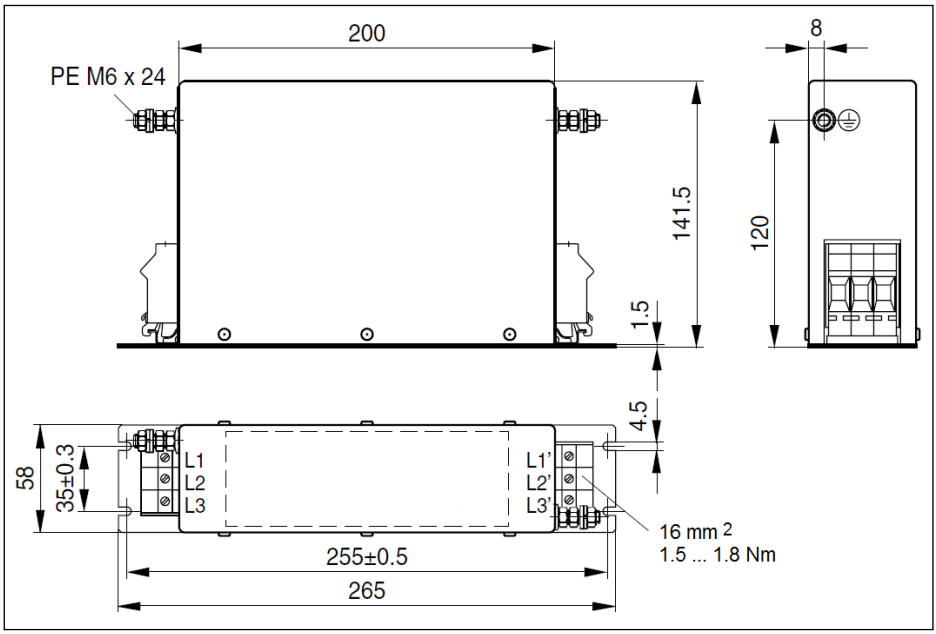



**Fig. 16-16:** 0066-A-05

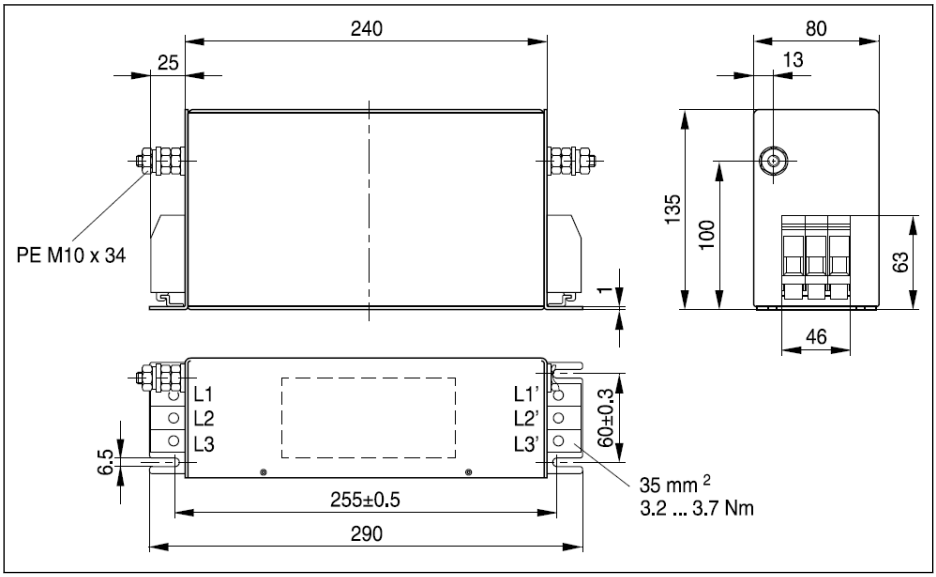



**Fig. 16-17:** 0090-A-05

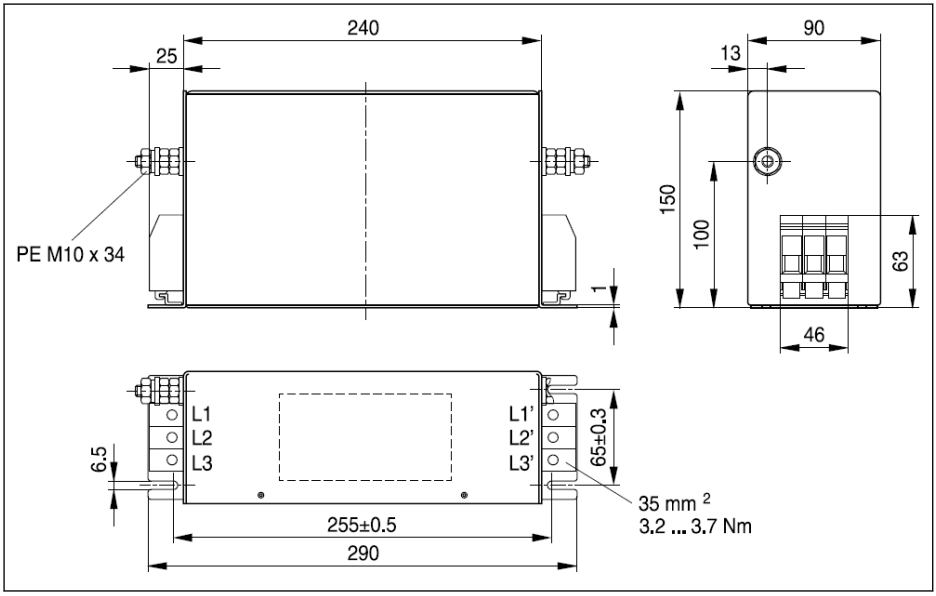



**Fig. 16-18:** 0120-A-05

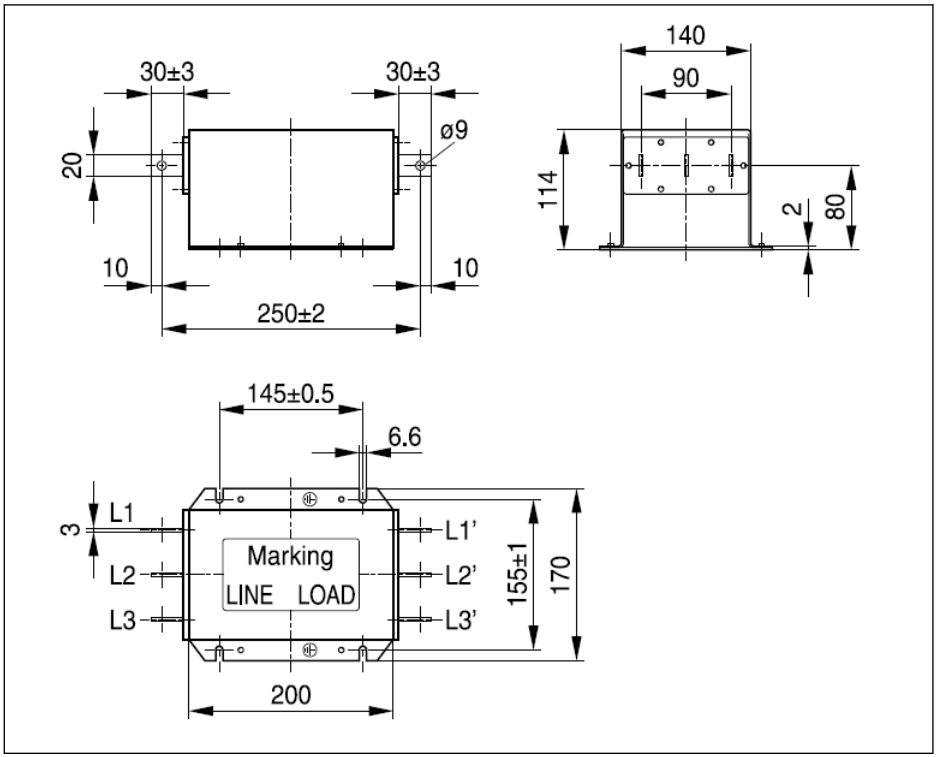



**Fig. 16-19:** 0250-N-05

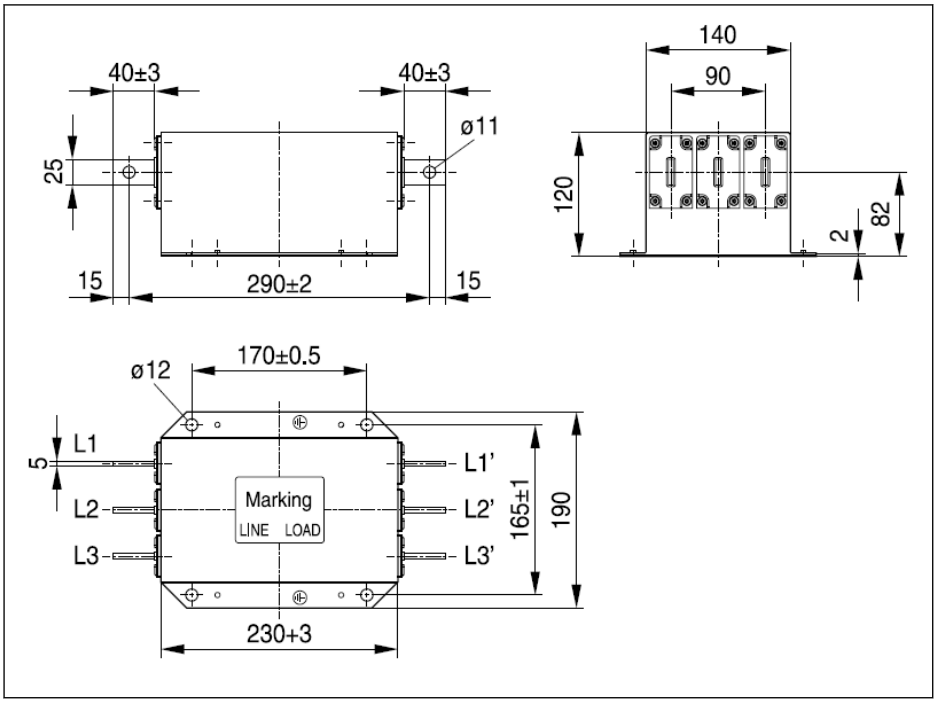



**Fig. 16-20:** 0320-N-05, 0400-N-05

## 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 | | |
| 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 |
| Required wire size according to UL 508 A (internal wiring); at $I_{L_cont}$ (UL) | $A_{LN}$ | AWG | 14 | 12 | 10 |

**Tab. 16-5:** 1P 200 VAC electric data

## Electric data of EMC filter for 3P 200 VAC / 3P 380 VAC models

| Description | Symbol | Unit | 0025-A-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 | 1.1 | 1.75 | 1.75 | 2.70 | 4.20 |
| Mains voltage three-phase at TN-S, TN-C, TT mains | $U_{LN}$ | V | 380...480 | | | | |
| Mains voltage three-phase at Corner- grounded-Delta mains | $U_{LN}$ | V | Not allowed | | | | |
| Mains voltage three-phase 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 | 25 | 36 | 50 | 66 | 90 |
| Calculation of leakage current | $I_{leak}$ | mA | 4.7 | 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 | 10 | 10 | 16 | 35 |
| Required wire size according to UL 508 A (internal wiring); at $I_{L_cont}$ (UL) | $A_{LN}$ | AWG | 10 | 6 | 6 | 6 (2) | 1 |

**Tab. 16-6:** 3P 200 / 3P 380 VAC electric data

| Description | Symbol | Unit | 0120-A-05 | 0250-N-05 | 0320-N-05 | 0400-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 |
| Mains voltage three-phase at TN-S, TN-C, TT mains | $U_{LN}$ | V | 380...480 | | | |

| Description | Symbol | Unit | 0120-A-05 | 0250-N-05 | 0320-N-05 | 0400-N-05 |
|---|---|---|---|---|---|---|
| Mains voltage three-phase at Corner-grounded-Delta mains | $U_{LN}$ | V | Not allowed | | | |
| Mains voltage three-phase 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 |
| Calculation of leakage current | $I_{leak}$ | mA | 5 | 14 | 14 | 14 |
| Required wire size according to IEC 60364-5-52; at $I_{L_cont}$ | $A_{LN}$ | $mm^2$ | 35 | 70 | 120 | 185.0 / 95.0*2 |
| Required wire size according to UL 508 A (internal wiring); at $I_{L_cont}$ (UL) | $A_{LN}$ | AWG | 1 | 4 / 0 | 350 kcmil | 500 kcmil |

**Tab. 16-7:** 3P 200 / 3P 380 VAC electric data

# 16.9 External Brake Resistor

## 16.9.1 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. 16-21:** Braking ratio

## 16.9.2 Brake Resistor Type for Braking Ratio of 10 %

| Converter model | | Brake resistor | | |
|---|---|---|---|---|
| | | Type | Specification | Number |
| 1P 200 VAC | 0K40 | FCAR01.1W0060-N400R0-B-03-NNNN | 400 Ω / 60 W | 1 |
| | 0K75 | FCAR01.1W0100-N190R0-B-03-NNNN | 190 Ω / 100 W | 1 |
| | 1K50 | FCAR01.1W0200-N095R0-B-03-NNNN | 95 Ω / 200 W | 1 |
| | 2K20 | FCAR01.1W0300-N065R0-B-03-NNNN | 65 Ω / 300 W | 1 |
| 3P 200 VAC | 0K40 | FCAR01.1W0100-N190R0-B-03-NNNN | 190 Ω / 100 W | 1 |
| | 0K75 | FCAR01.1W0200-N095R0-B-03-NNNN | 95 Ω / 200 W | 1 |
| | 1K50 | FCAR01.1W0300-N065R0-B-03-NNNN | 65 Ω / 300 W | 1 |
| | 2K20 | FCAR01.1W0500-N065R0-B-03-NNNN | 65 Ω / 500 W | 1 |
| | 3K00 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 4K00 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 5K50 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16 Ω / 4, 000 W | 1 |
| | 7K50 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16 Ω / 4, 000 W | 1 |
| | 11K0 | FCAR01.1W6K50-N010R0-A-05-NNNN | 10 Ω / 6,500 W | 1 |
| 3P 380 VAC | 0K40 | FCAR01.1W0080-N750R0-B-05-NNNN | 750 Ω / 80 W | 1 |
| | 0K75 | FCAR01.1W0080-N750R0-B-05-NNNN | 750 Ω / 80 W | 1 |
| | 1K50 | FCAR01.1W0260-N400R0-B-05-NNNN | 400 Ω / 260 W | 1 |
| | 2K20 | FCAR01.1W0260-N250R0-B-05-NNNN | 250 Ω / 260 W | 1 |
| | 3K00 | FCAR01.1W0390-N150R0-B-05-NNNN | 150 Ω / 390 W | 1 |
| | 4K00 | FCAR01.1W0390-N150R0-B-05-NNNN | 150 Ω / 390 W | 1 |
| | 5K50 | FCAR01.1W0780-N075R0-A-05-NNNN | 75 Ω / 780 W | 1 |
| | 7K50 | FCAR01.1W0780-N075R0-A-05-NNNN | 75 Ω / 780 W | 1 |
| | 11K0 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 15K0 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 18K5... 22K0 | FCAR01.1W3K50-N018R9-A-05-NNNN | 18.9 Ω / 3,500 W | 1 |
| | 30K0... 37K0 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16 Ω / 4,000 W | 1 |
| | 45K0... 55K0 | FCAR01.1W6K50-N010R0-A-05-NNNN | 10 Ω / 6,500 W | 1 |
| | 75K0... 90K0 | FCAR01.1W10K0-N006R0-A-05-NNNN | 6 Ω / 10,000 W | 1 |

**Tab. 16-8:** Brake resistor type for braking ratio of 10 %

Models 30K0 and up require an external brake chopper module (see documentation R912007235).

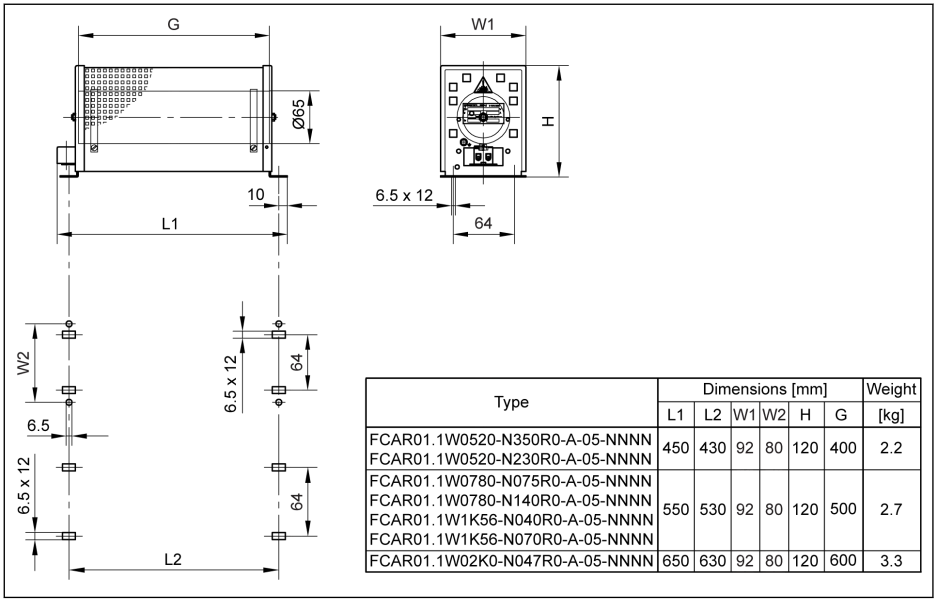
### 16.9.3 Brake Resistor Type for Braking Ratio of 20 %

| Converter model | | Brake resistor | | |
|---|---|---|---|---|
| | | Type | Specification | Number |
| 1P 200 VAC | 0K40 | FCAR01.1W0100-N400R0-B-03-NNNN | 400 Ω / 100 W | 1 |
| | 0K75 | FCAR01.1W0200-N190R0-B-03-NNNN | 190 Ω / 200 W | 1 |
| | 1K50 | FCAR01.1W0400-N095R0-B-03-NNNN | 95 Ω / 400 W | 1 |
| | 2K20 | FCAR01.1W0500-N065R0-B-03-NNNN | 65 Ω / 500 W | 1 |
| 3P 200 VAC | 0K40 | FCAR01.1W0200-N190R0-B-03-NNNN | 190 Ω / 200 W | 1 |
| | 0K75 | FCAR01.1W0400-N095R0-B-03-NNNN | 95 Ω / 400 W | 1 |
| | 1K50 | FCAR01.1W0780-N075R0-A-05-NNNN | 75 Ω /780 W | 1 |
| | 2K20 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 |
| | 3K00 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 4K00 | FCAR01.1W1K56-N040R0-A-05-NNNN | 40 Ω / 1,560 W | 1 |
| | 5K50 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16 Ω / 4,000 W | 1 |
| | 7K50 | FCAR01.1W4K00-N016R0-A-05-NNNN | 16 Ω / 4, 000 W | 1 |
| | 11K0 | FCAR01.1W6K50-N010R0-A-05-NNNN | 10 Ω / 6,500 W | 1 |
| 3P 380 VAC | 0K40 | FCAR01.1W0150-N750R0-B-05-NNNN | 750 Ω / 150 W | 1 |
| | 0K75 | FCAR01.1W0150-N750R0-B-05-NNNN | 750 Ω / 150 W | 1 |
| | 1K50 | FCAR01.1W0520-N350R0-A-05-NNNN | 350 Ω / 520 W | 1 |
| | 2K20 | FCAR01.1W0520-N230R0-A-05-NNNN | 230 Ω / 520 W | 1 |
| | 3K00 | FCAR01.1W0780-N140R0-A-05-NNNN | 140 Ω / 780 W | 1 |
| | 4K00 | FCAR01.1W0780-N140R0-A-05-NNNN | 140 Ω / 780 W | 1 |
| | 5K50 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 |
| | 7K50 | FCAR01.1W1K56-N070R0-A-05-NNNN | 70 Ω / 1,560 W | 1 |
| | 11K0 | FCAR01.1W02K0-N047R0-A-05-NNNN | 47 Ω / 2,000 W | 1 |
| | 15K0 | FCAR01.1W03K0-N034R0-A-05-NNNN | 34 Ω / 3,000 W | 1 |
| | 18K5 | FCAR01.1W10K0-N028R0-A-05-NNNN | 28 Ω / 10,000 W | 1 |
| | 22K0 | FCAR01.1W10K0-N028R0-A-05-NNNN | 28 Ω / 10,000 W | 1 |

**Tab. 16-9:** Brake resistor type for braking ratio of 20 %

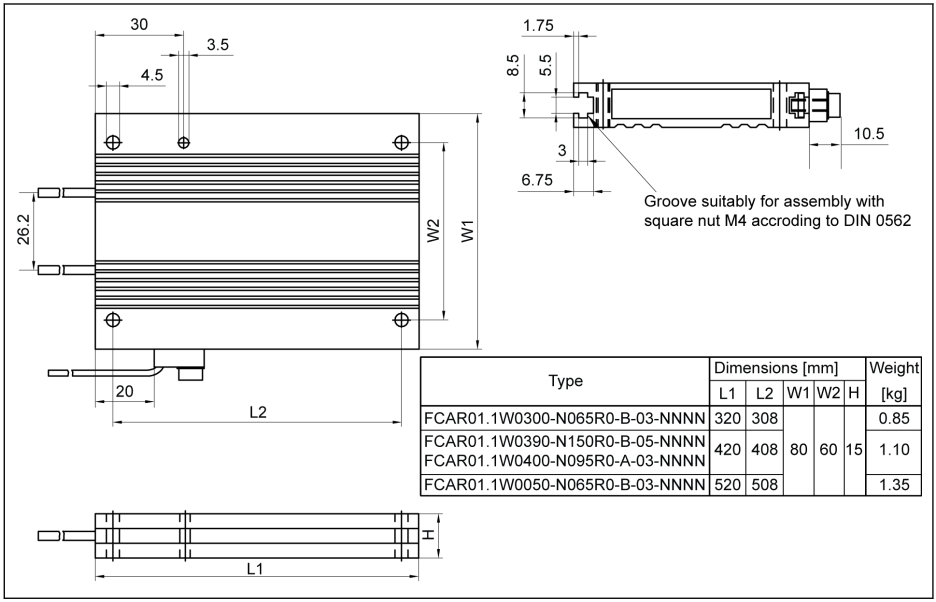
Models 30K0 and up require an external brake chopper module (documentation R912007235).

## 16.9.4 Brake Resistor Dimensions



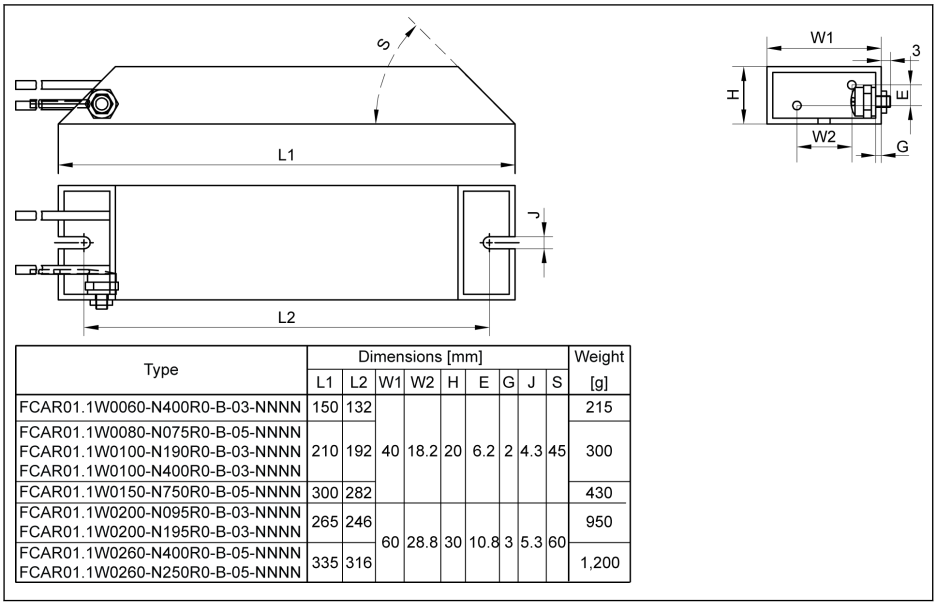

| Type | Dimensions [mm] | | | | | | Weight |
|---|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | G | [kg] |
| FCAR01.1W0520-N350R0-A-05-NNNN<br>FCAR01.1W0520-N230R0-A-05-NNNN | 450 | 430 | 92 | 80 | 120 | 400 | 2.2 |
| FCAR01.1W0780-N075R0-A-05-NNNN<br>FCAR01.1W0780-N140R0-A-05-NNNN<br>FCAR01.1W1K56-N040R0-A-05-NNNN<br>FCAR01.1W1K56-N070R0-A-05-NNNN | 550 | 530 | 92 | 80 | 120 | 500 | 2.7 |
| FCAR01.1W02K0-N047R0-A-05-NNNN | 650 | 630 | 92 | 80 | 120 | 600 | 3.3 |

**Fig. 16-22:** Brake resistor dimensions_1



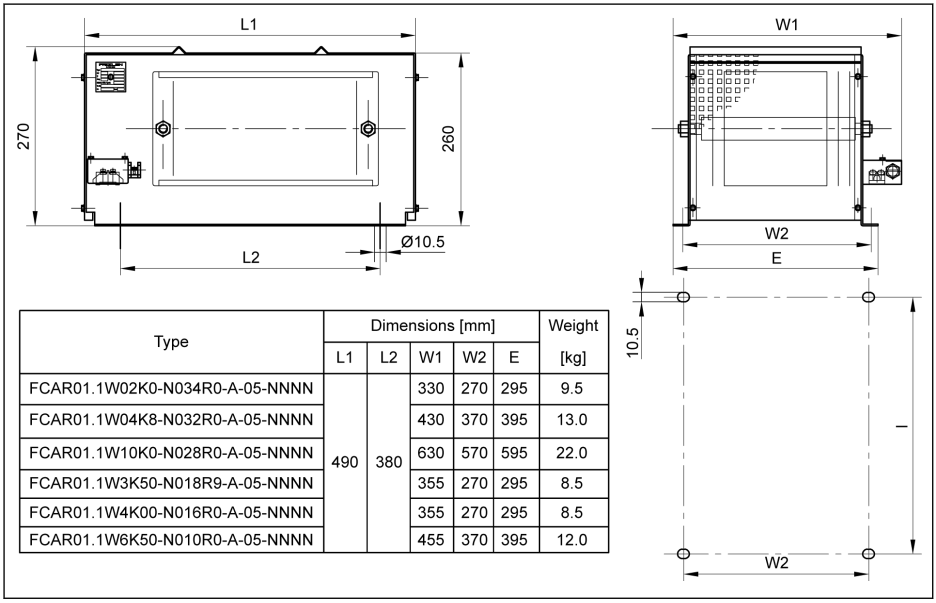

| Type | Dimensions [mm] | | | | | Weight |
|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | [kg] |
| FCAR01.1W0300-N065R0-B-03-NNNN | 320 | 308 | 80 | 60 | 15 | 0.85 |
| FCAR01.1W0390-N150R0-B-05-NNNN<br>FCAR01.1W0400-N095R0-A-03-NNNN | 420 | 408 | | | | 1.10 |
| FCAR01.1W0050-N065R0-B-03-NNNN | 520 | 508 | | | | 1.35 |

**Fig. 16-23:** Brake resistor dimensions_2



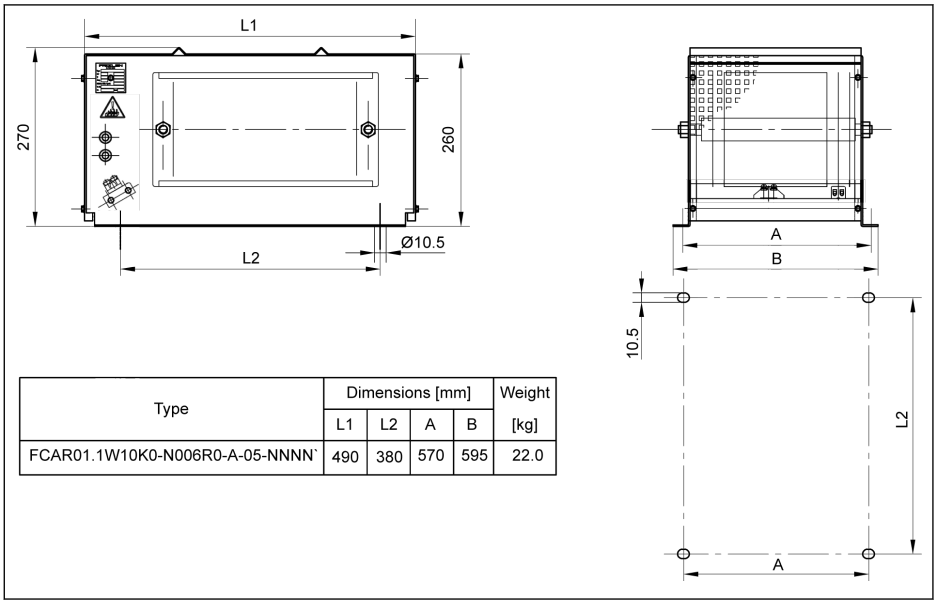

| Type | Dimensions [mm] | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | H | E | G | J | S | [g] |
| FCAR01.1W0060-N400R0-B-03-NNNN | 150 | 132 | 40 | 18.2 | 20 | 6.2 | 2 | 4.3 | 45 | 215 |
| FCAR01.1W0080-N075R0-B-05-NNNN<br>FCAR01.1W0100-N190R0-B-03-NNNN<br>FCAR01.1W0100-N400R0-B-03-NNNN | 210 | 192 | | | | | | | | 300 |
| FCAR01.1W0150-N750R0-B-05-NNNN | 300 | 282 | | | | | | | | 430 |
| FCAR01.1W0200-N095R0-B-03-NNNN<br>FCAR01.1W0200-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. 16-24:** Brake resistor dimensions_3




| Type | Dimensions [mm] | | | | | Weight |
|---|---|---|---|---|---|---|
| | L1 | L2 | W1 | W2 | E | [kg] |
| FCAR01.1W02K0-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. 16-25:** 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 |

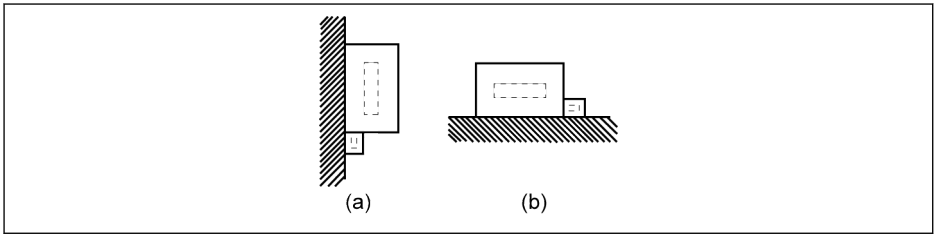
**Fig. 16-26:** Brake resistor dimensions_5

## 16.9.5 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. 16-27:** Mounting direction of brake resistor

## 16.10 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.

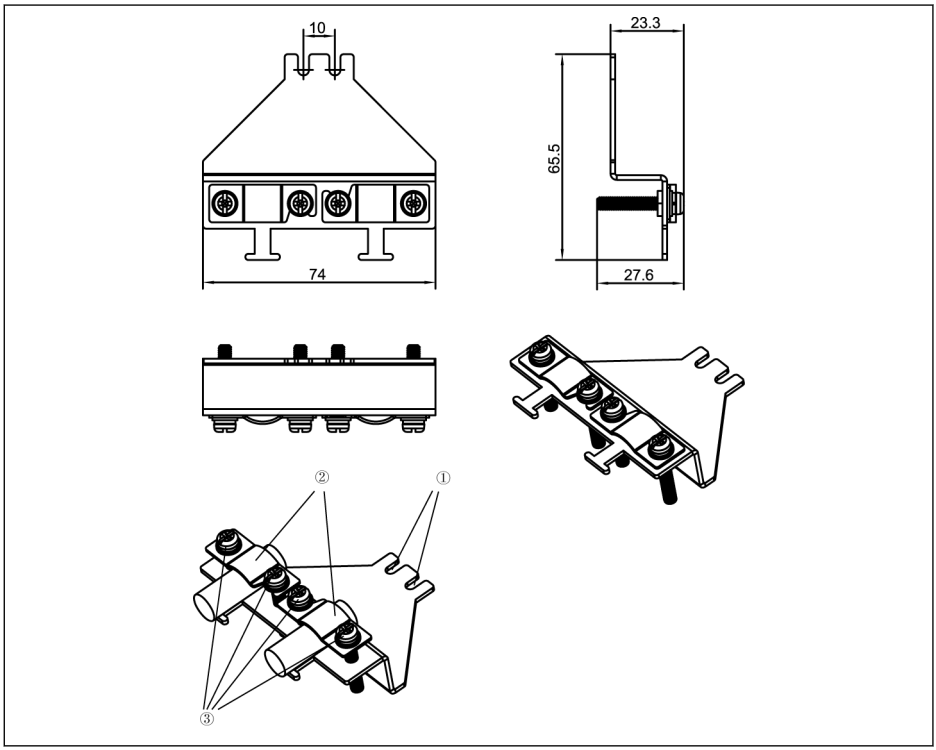



**Fig. 16-28:** Shielded cable connection with accessories for **B, C, D** housing (FEAM03.2-001-NN-NNNN)

### 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.

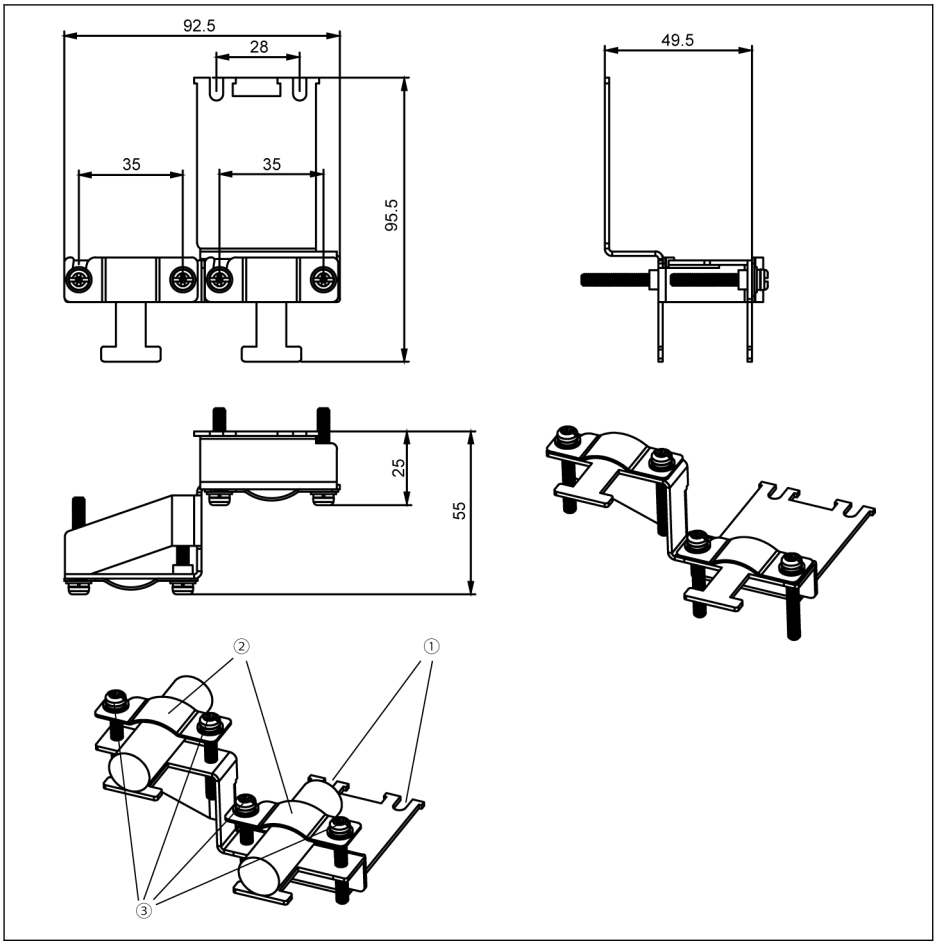



**Fig. 16-29:** Shielded cable connection with accessories for **E, F, G** housing (FEAM03.2-002-NN-NNNN)

### 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.

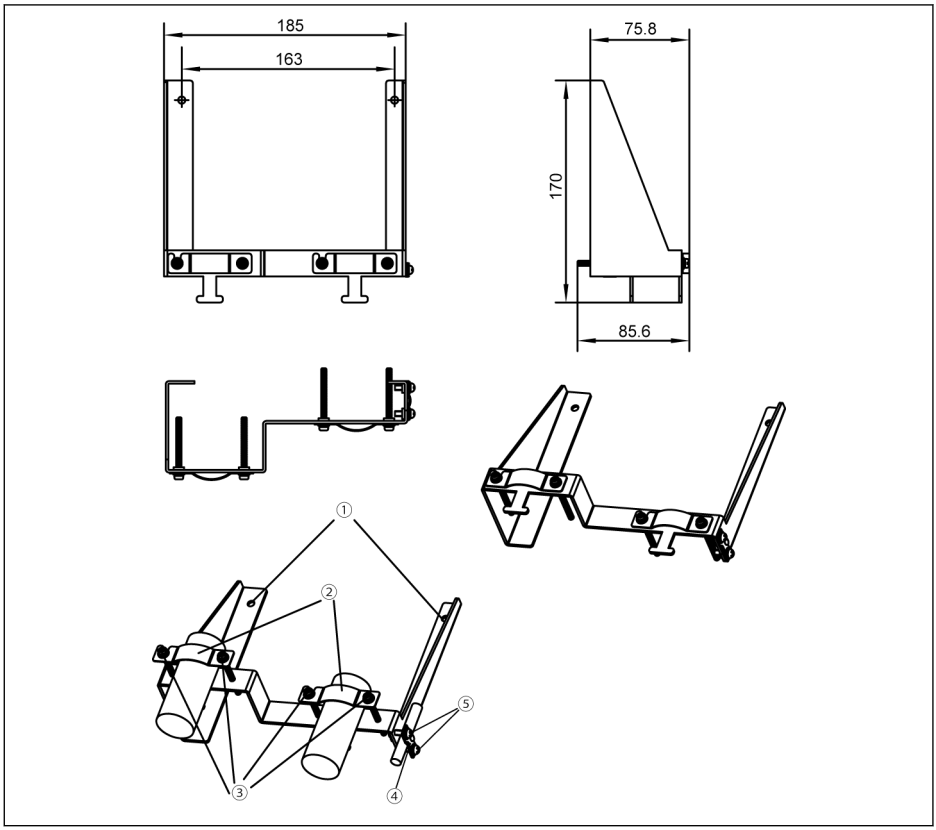



**Fig. 16-30:** Shielded cable connection with accessories for **H** housing (FEAM03.2-003-NN-NNNN)

### 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 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.

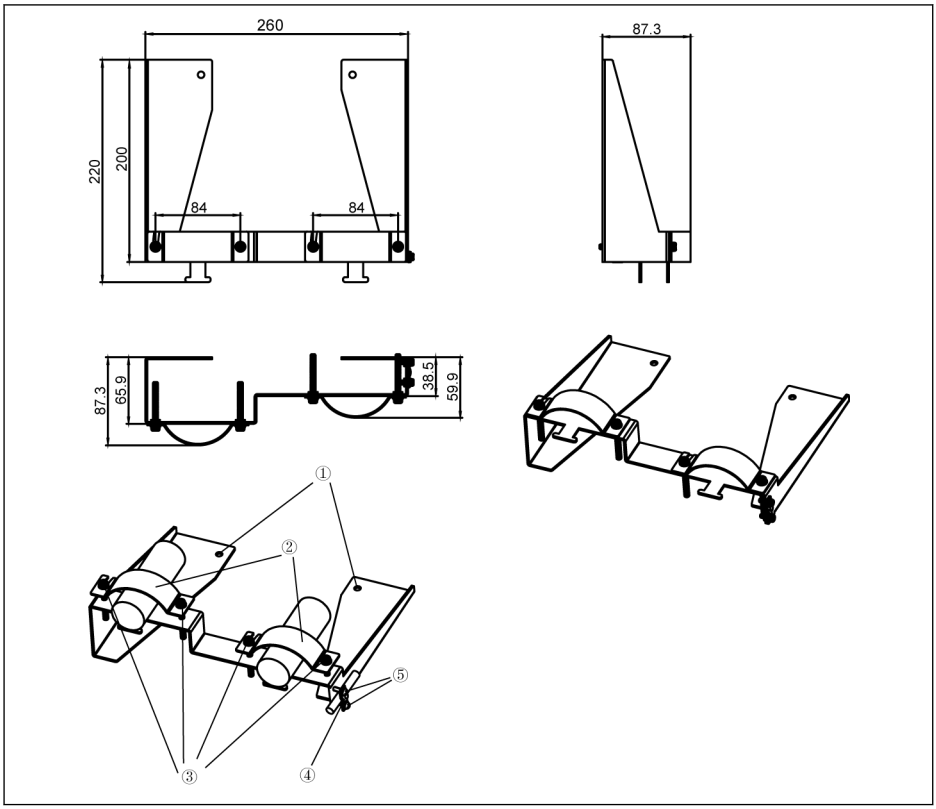



**Fig. 16-31:** Shielded cable connection with accessories for **I, J** housing (FEAM03.2-004-NN-NNNN)

### 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 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.

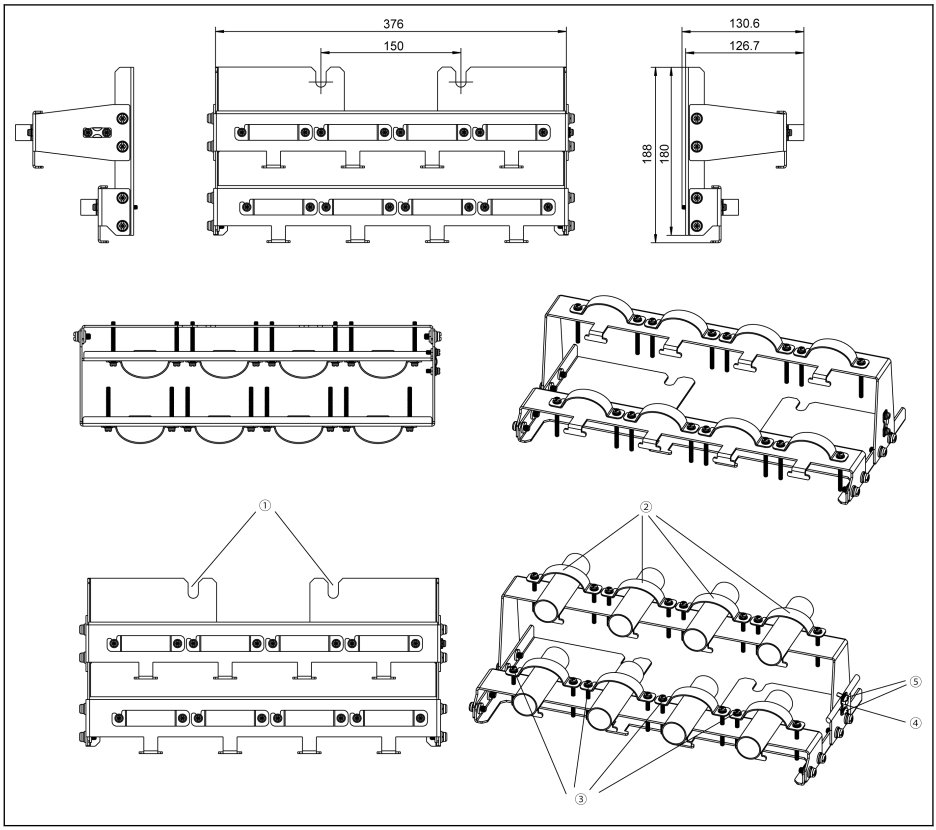



**Fig. 16-32:** Shielded cable connection with accessories for **K** housing (FEAM03.2-005-NN-NNNN)

### 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.

When double cables are used, put double cables in one clamp.

Step 3: Tighten sixteen screws of the accessories.

Step 4 (Optional): Fix the STO cable to the side of shielding connector.

Step 5 (Optional): Tighten two screws of the accessories.

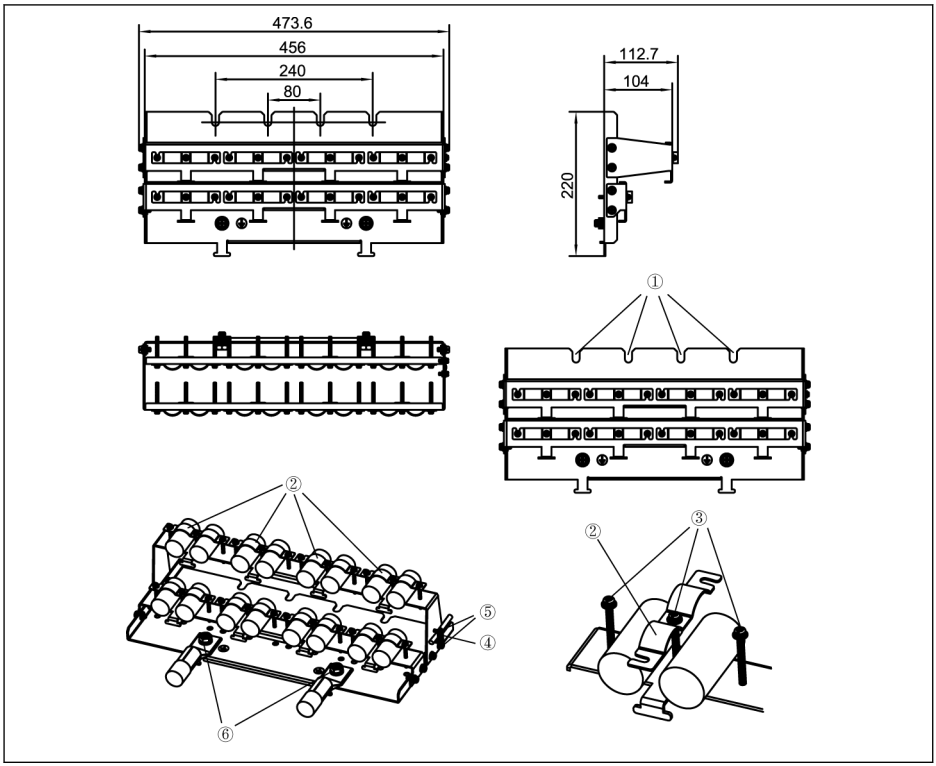



**Fig. 16-33:** Shielded cable connection with accessories for **L** housing (FEAM03.2-006-NN-NNNN)

### 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): Fix the STO cable to the side of shielding connector.

Step 5 (Optional): Tighten two screws of the accessories.

Step 6: Connect the grounding cable to component ⑥.

# 17 Maintenance

## 17.1 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 5 minutes.

## 17.2 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. 17-1:** Daily inspection list

## 17.3 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<br>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<br>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. 17-2:** Periodic inspection list

## 17.4 Expired replacement

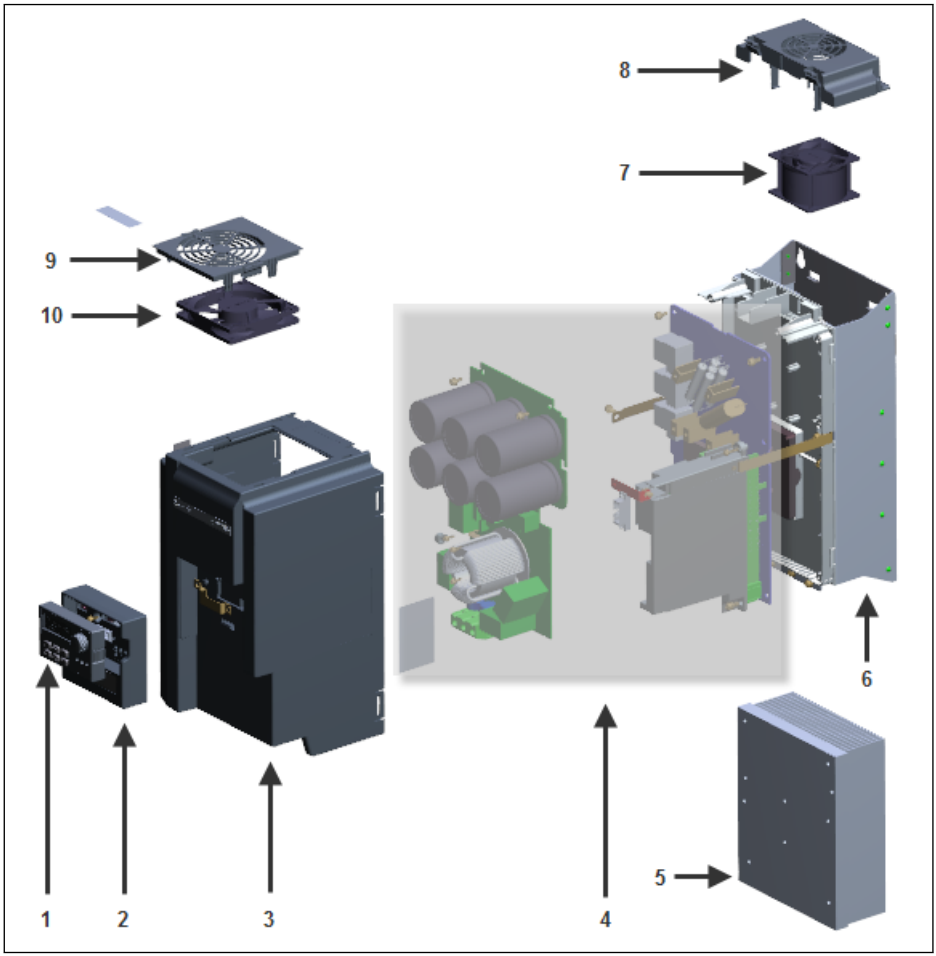
All electronic devices or equipment has certain service life, extended use will cause damage or change properties of devices, and even cause personal injury and property damage. Therefore, it is necessary to replace the device in time.

| Item | Replacement criteria |
|---|---|
| Fan | Replace the cooling fan that running time exceed thirty thousand hours |

**Tab. 17-3:** Device replacement

## 17.5 Removable Components Maintenance

### 17.5.1 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. 17-1:** Construction overview

### 17.5.2 Disassembly of the Operating Panel

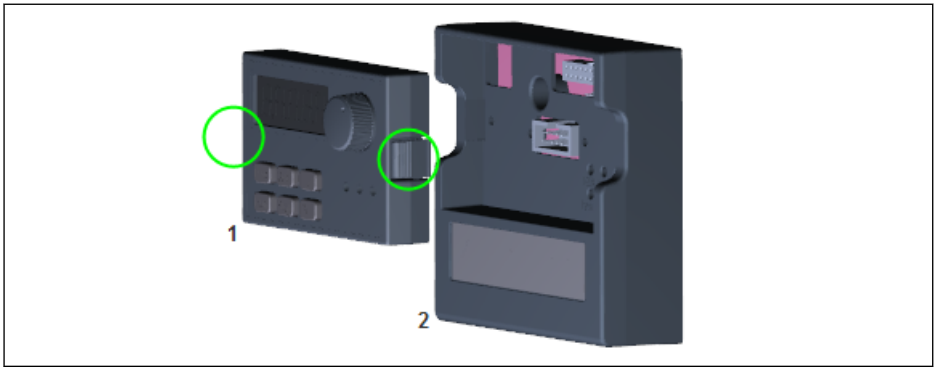



**Fig. 17-2:** Disassembly of operating panel

- 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

### 17.5.3 Disassembly of Fans

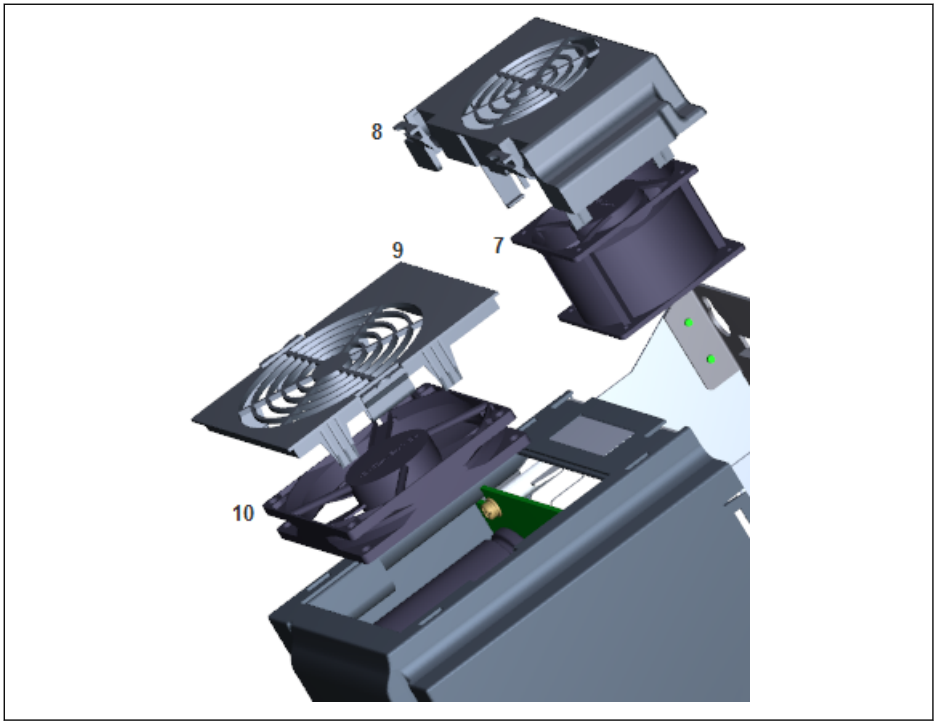



**Fig. 17-3:** Disassembly of fan

- 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

# 18 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)

# 19 Environmental protection and disposal

## 19.1 Environmental protection

### Production processes

The products are made with 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 the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

### Significant components

Basically, our products contain the following components:

**Electronic devices**
- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

**Motors**
- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

## 19.2 Disposal

### Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send 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

The packaging materials consist of cardboard, wood and polystyrene. These materials 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.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

### 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 modules.

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can 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 valid legal requirements.

# 20 Appendix

## 20.1 Appendix I: Abbreviations

- EFC x610: Frequency Converter EFC 3610 or EFC 5610
- 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

## 20.2 Appendix II: Type Coding

### 20.2.1 Frequency Converter Type Coding

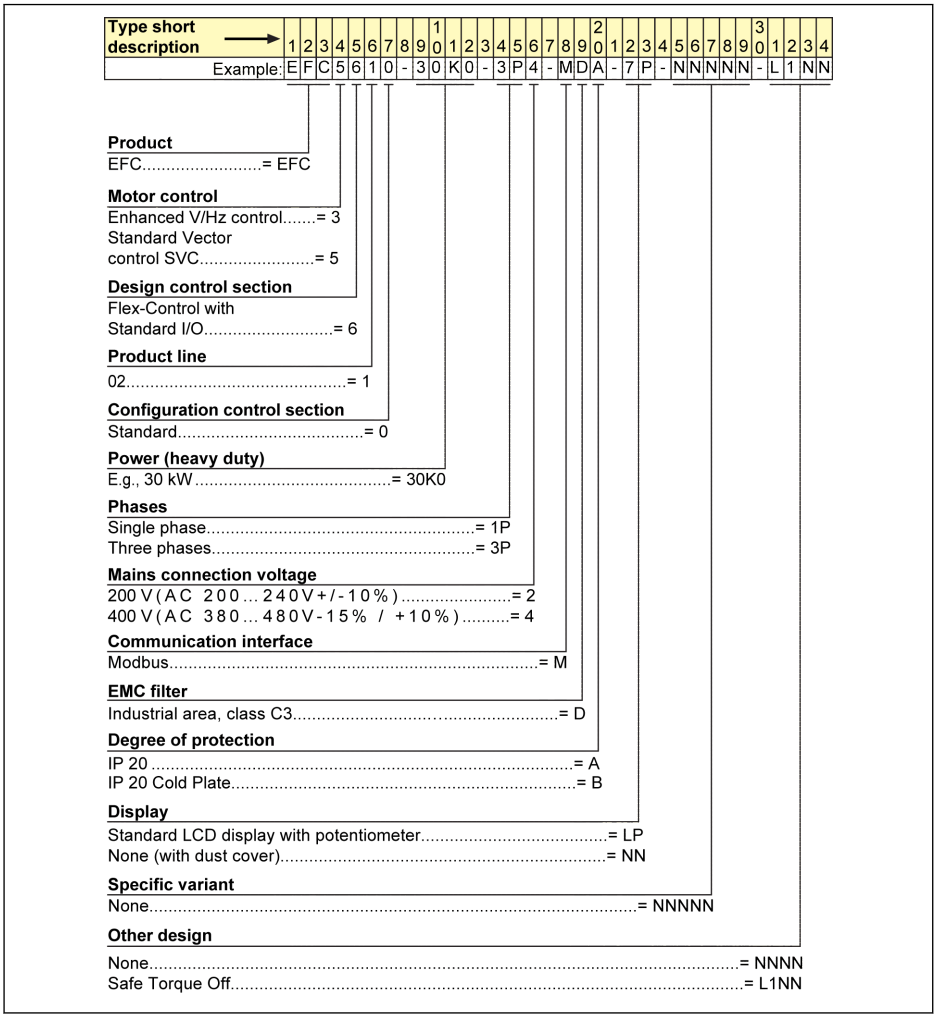



**Fig. 20-1:** Frequency converter type coding

## 20.2.2 Operating Panel Type Coding

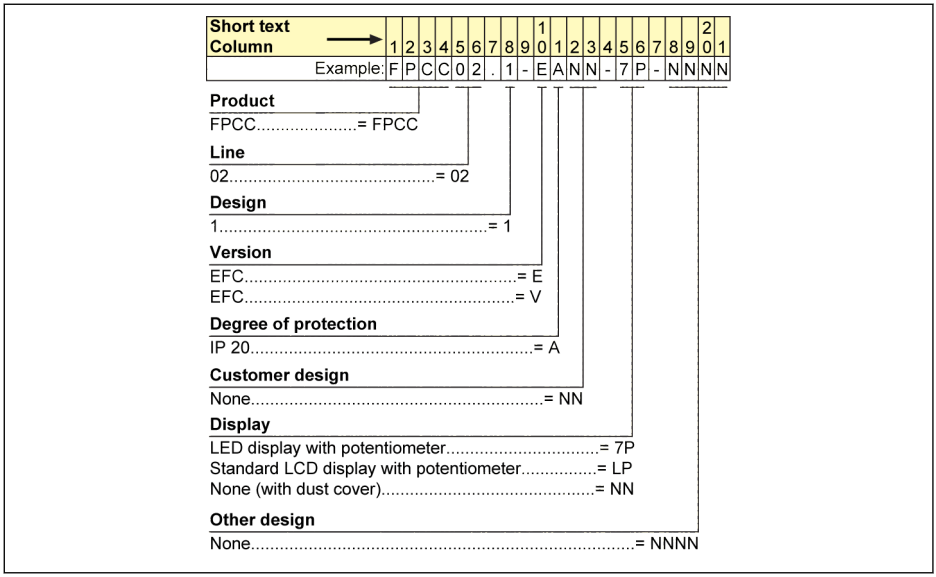



**Fig. 20-2:** Operating panel type coding

## 20.2.3 Panel Mounting Plate Type Coding

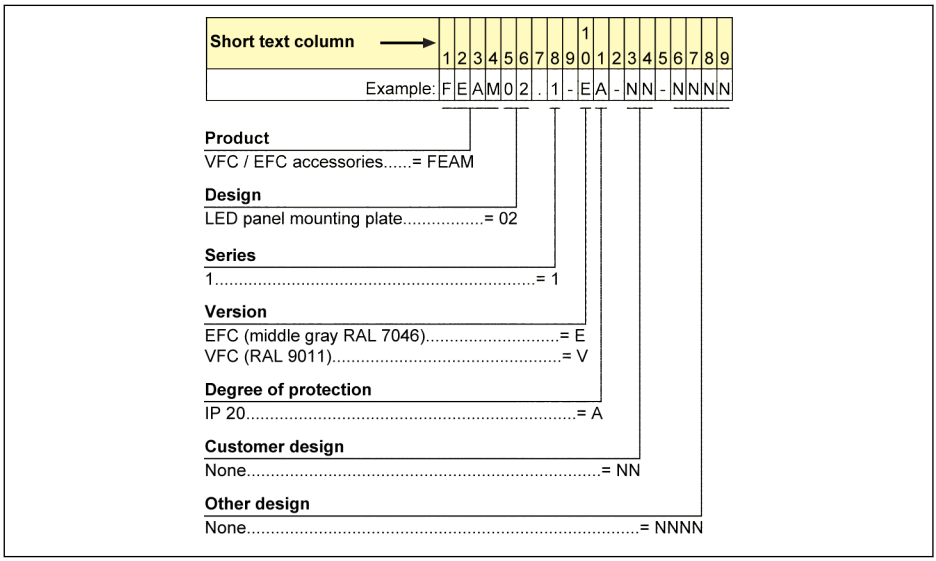



**Fig. 20-3:** Panel mounting plate type coding

## 20.2.4 Communication Cable for Control Cabinet Type Coding

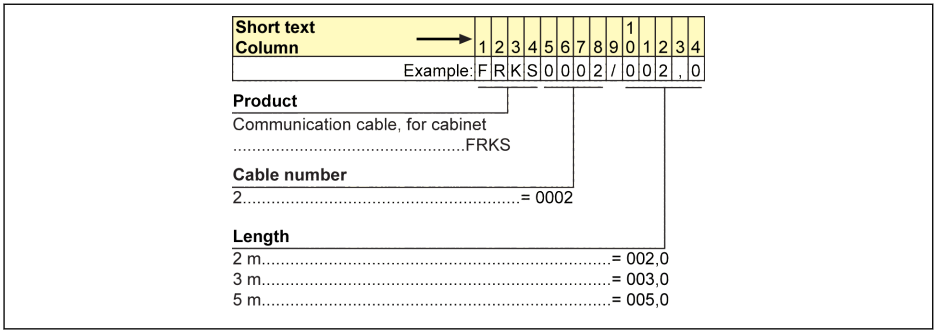



**Fig. 20-4:** Communication cable for control cabinet type coding

## 20.2.5 Extension Accessories Type Coding

| Short text Column → | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Example: | F | E | A | E | 0 | 2 | . | 1 | - | E | A | - | N | N | N | N |

**Product**
Accessory, electric..= FEAE

**Variant**
Extension card module.....= 02

**Line**
1.....= 1

**Version**
EFC.....= E
VFC.....= V

**Degrees of protection**
IP 20.....= A

**Other design**
None.....= NNNN
Left slot is integrated with Multi-Ethernet (ET) card and right slot is reserved.....= ETNN
Left slot is integrated with Multi-Ethernet (ET) card and right slot is integrated with I/O (IO1).....= ETI1
Left slot is integrated with Profibus (PB) Card and right slot is integrated with I/O (IO1).....= PBI1
Left slot is integrated with I/O (IO1) card and Right slot is reserved.....= I1NN

*Note:*

| | | Slot 1 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | NN | IO1 | IO2 | IO3 | EN1 | EN2 | CO | PB | ET |
| Slot 2 | NN | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| | IO1 | Y | N | Y | N | Y | Y | Y | Y | Y |
| | IO2 | Y | Y | N | Y | Y | Y | Y | Y | Y |
| | IO3 | Y | N | Y | N | Y | Y | Y | Y | Y |
| | EN1 | Y | Y | Y | Y | N | N | Y | Y | Y |
| | EN2 | Y | Y | Y | Y | N | N | Y | Y | Y |
| | CO | Y | Y | Y | Y | Y | Y | N | N | N |
| | PB | Y | Y | Y | Y | Y | Y | N | N | N |
| | ET | Y | Y | Y | Y | Y | Y | N | N | N |

**Fig. 20-5:** Extension card module type coding

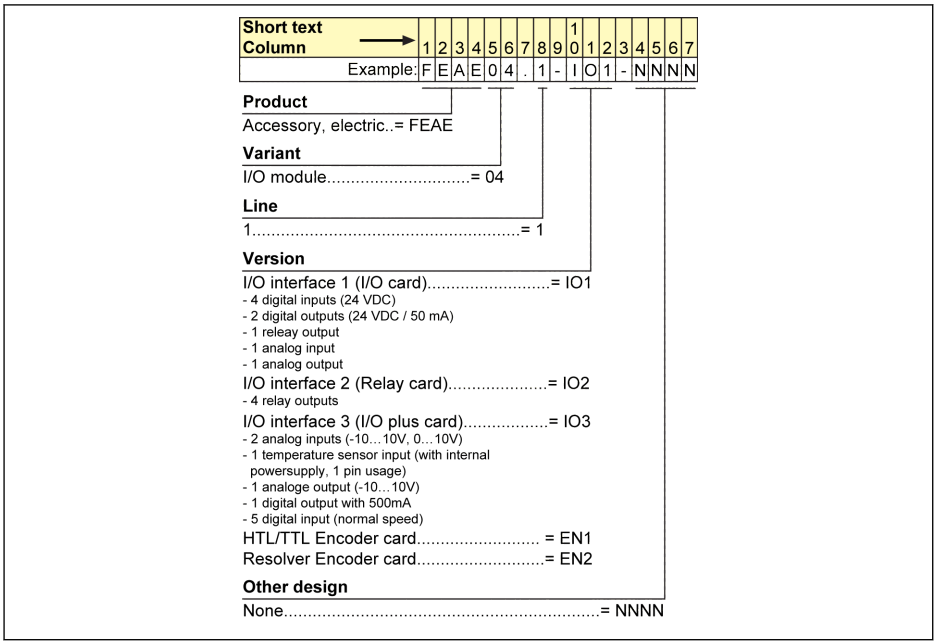



**Fig. 20-6:** I/O module type coding

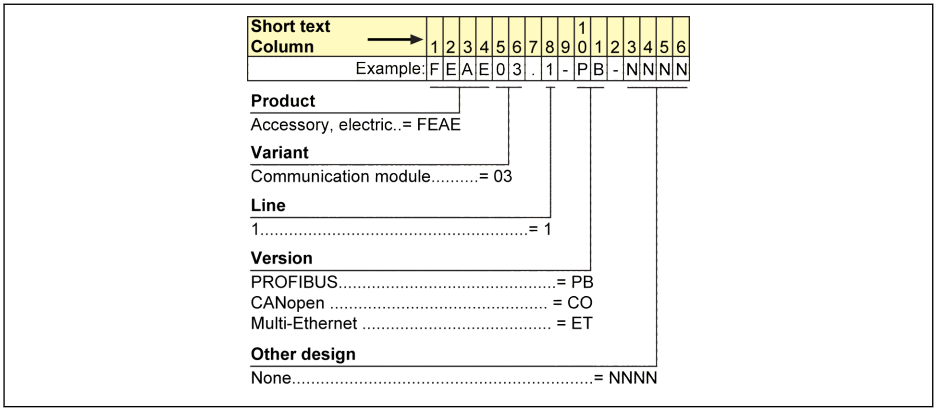



**Fig. 20-7:** Communication module type coding

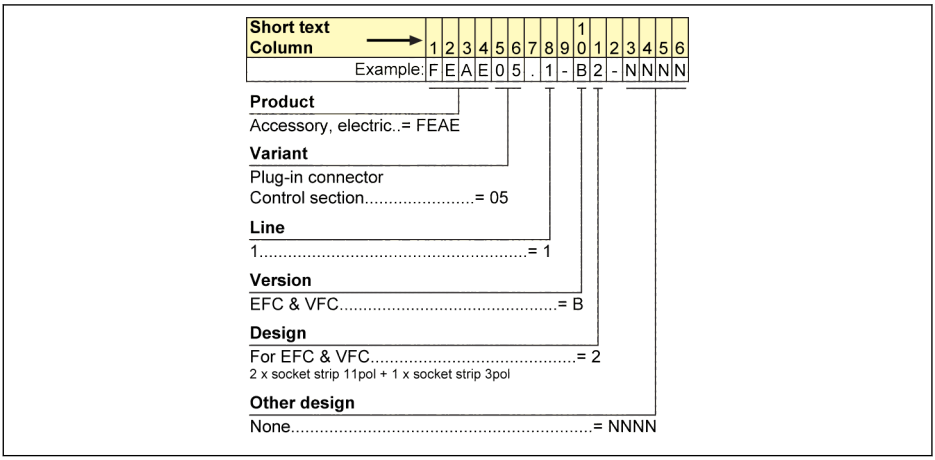



**Fig. 20-8:** Plug-in connector for control section type coding

## 20.2.6 External Mains EMC Filter Type Coding

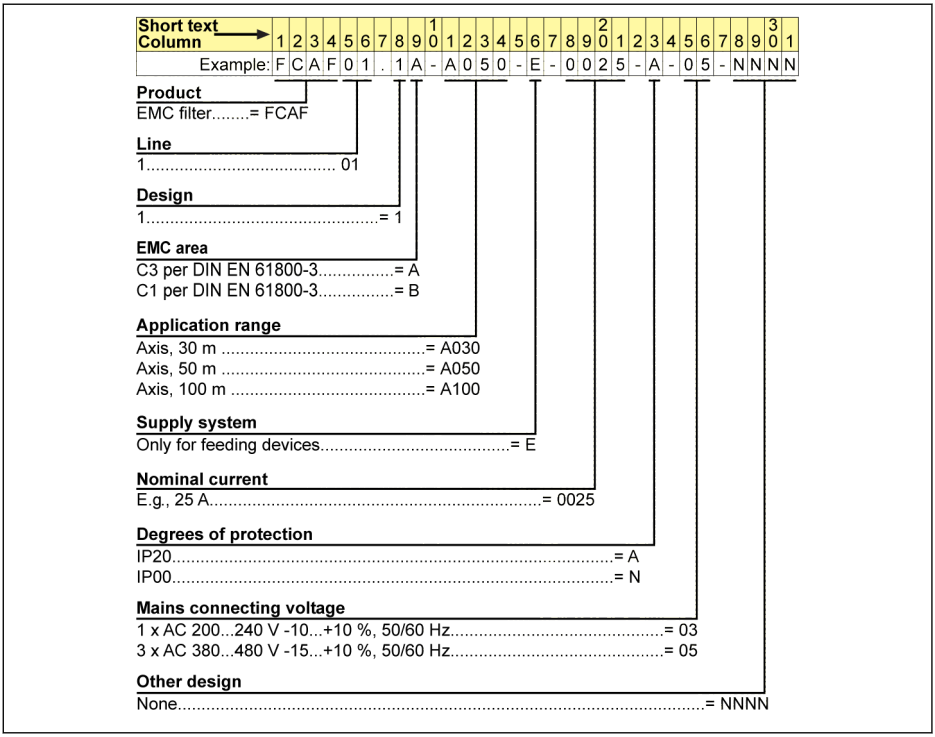



**Fig. 20-9:** External mains EMC filter type coding

## 20.2.7 External Brake Resistor Type Coding

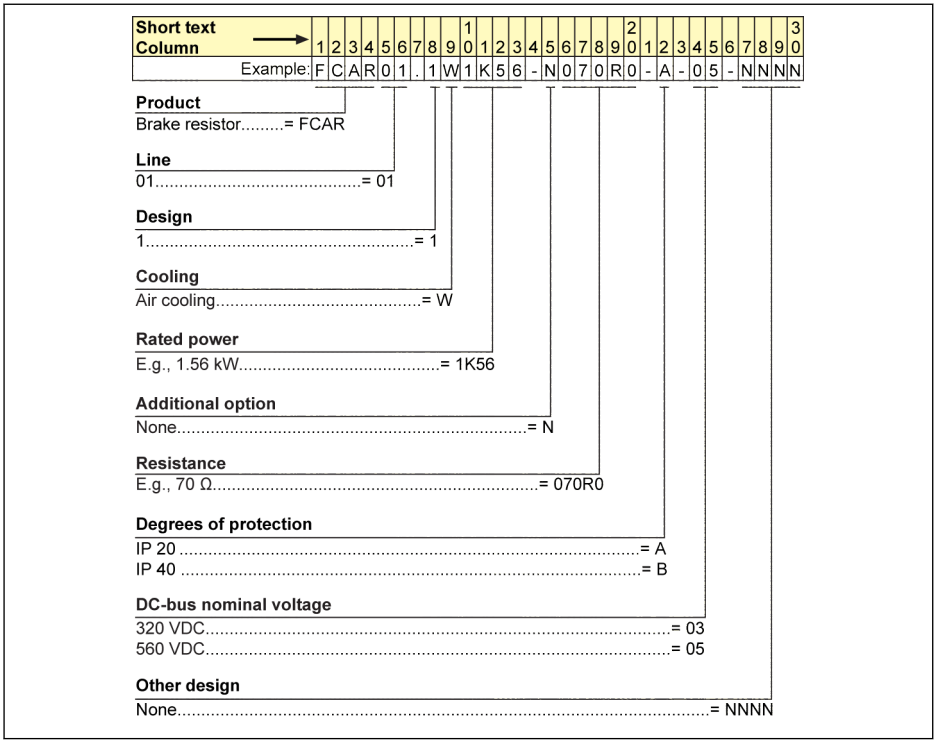



**Fig. 20-10:** External brake resistor type coding

## 20.2.8 Shielding Connector Type Coding

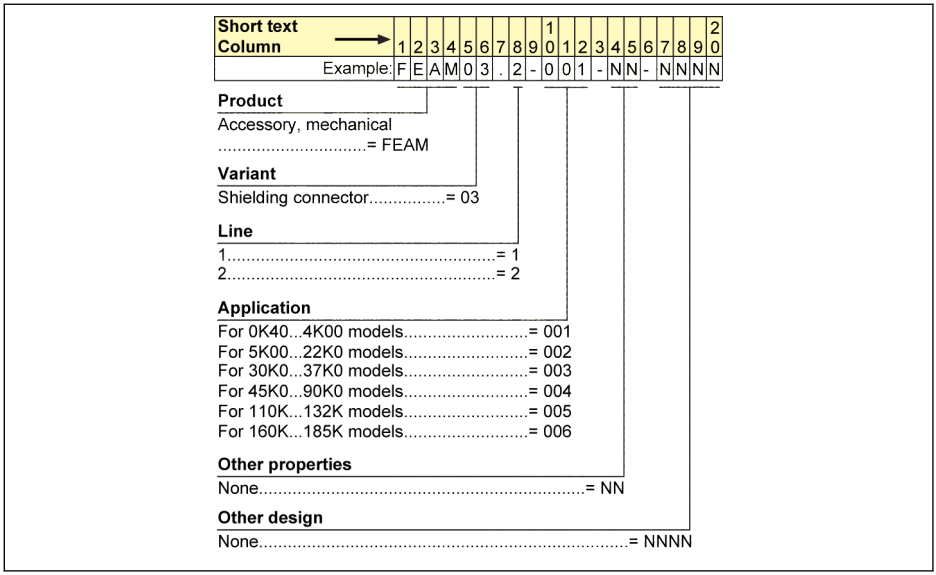



**Fig. 20-11:** Shielding connector type coding

## 20.3 Appendix III: Parameter List

### 20.3.1 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

## 20.3.2 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 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 1 KHz model.

## 20.3.3 Group C: Power Parameters

### C0: Power control parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.00 | Control mode<br>(EFC 5610 only) | 0: V/f control<br>1: Sensorless vector control<br>2: Vector control with encoder | 0 | – | Stop |
| C0.01 | Normal / Heavy duty setting① | 0: ND (Normal duty)<br>1: HD (Heavy duty) | 1 | – | Stop |
| C0.05 | Carrier frequency | 0K40...22K0: 1...15 kHz<br>30K0...160K: 1...12 kHz | 0K40...4K00: 6k<br>5K50...22K0 (HD): 6k<br>5K50...22K0 (ND): 4k<br>30K0...90K0: 4k<br>110K...160K: 2k | 1 | Run |
| C0.06 | Carrier frequency automatic adjustment | 0: Inactive<br>1: Active<br>2: Fixed carrier frequency | 1 | – | Stop |
| 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 200 VAC: 180...264 V | | | |
| | | 3P 380 VAC: 323...528 V | 380 | | |
| C0.15 | Brake chopper start voltage② | 1P 200 VAC: 300...390 V | 385 | 1 | Stop |
| | | 3P 200 VAC: 300...390 V | | | |
| | | 3P 380 VAC: 600...785 V | 770 | | |
| C0.16 | Brake chopper duty cycle② | 1...100 % | 100 | 1 | Stop |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.24 | Stall overvoltage hysteresis voltage | 0...100 V | 1P 200 VAC: 30<br>3P 200 VAC: 30<br>3P 380 VAC: 50 | 1 | Stop |
| C0.25 | Overvoltage prevention mode | 0...3 | 3 | – | Stop |
| C0.26 | Stall overvoltage prevention level | 1P 200 VAC: 300...390 V<br>3P 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 | 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<br>3P 200 VAC: 216...366 V | 240 | 1 | Stop |
| | | 3P 380 VAC: 406...739 V | 440 | | |
| C0.43 | Power loss ride-through recovery voltage | 1P 200 VAC: 223...373 V<br>3P 200 VAC: 223...373 V | 250 | 1 | Stop |
| | | 3P 380 VAC: 413...746 V | 450 | | |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| C0.44 | Power loss ride-through deceleration to stop time | 0.1...6,000.0 s | 5.0 | 0.1 | 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 models of 5K50 and above.

②: the parameters are only available with models of 22K0 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

**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 EFC 5610) | 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 |
| C1.05 | 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 |
| 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 |
| C1.20 | Motor no-load current | 0.00...[C1.07] A | DOM | 0.01 | Stop |
| C1.21 | Stator resistance | 0.00...200.00 Ω | DOM | 0.01 | Stop |
| C1.22 | Rotor resistance | 0.00...200.00 Ω | DOM | 0.01 | Stop |
| C1.23 | Leakage inductance | 0.00...200.00 mH | DOM | 0.01 | Stop |
| C1.24 | Mutual inductance | 0.0...3,000.0 mH | DOM | 0.1 | Stop |
| C1.25 | Rotor leakage inductance | 0.00...200.00 | DOM | 0.01 | Stop |
| C1.69 | Motor thermal model protection setting | 0: Inactive<br>1: 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; 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |

①: **ONLY** for EFC 5610, 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 | 1 | Run |
| C2.25 | Light load oscillation damping filter factor | 10...2,000 % | 100 | 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 |
| C3.20 | 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 |
| C3.38 | 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| C3.50 | 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 |

①: percentage of motor rated torque.

②: percentage of motor rated current.

All parameters in Group C3 are **ONLY** for EFC 5610.

## 20.3.4 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 only for 2-wire control | 0 | – | Stop |
| E0.46 | Power loss restart delay | 0.0...10.0 s | 1.0 | 0.1 | Stop |
| E0.50 | Stop mode | 0: Decelerating stop<br>1: Freewheeling stop 1<br>2: Freewheeling stop 2 | 0 | – | 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 | 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 |
| 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...51 | 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...51 | 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 |
| E1.68 | 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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
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

**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 | 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 |
| E2.28 | AO1 value in percentage from extension card fieldbus communication | 0.00...100.00 % | 0.00 | 0.01 | Run |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| E2.40 | Rated voltage | 1P 200...240 VAC | 220 | 1 | Stop |
| | | 3P 200...240 VAC | | | |
| | | 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

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 '21: 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 | 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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 | 0.2...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 |
| E8.10 | 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 |
| E9.05 | 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 |
| E9.97 | 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
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-, synchronous 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

### 20.3.5 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 | – | – | 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 |

### 20.3.6 Group H: Extension Card Parameters

#### H0: Extension card general parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H0.00 | Control word | 00000...0FFFF | 00000 | 1 | Run |
| H0.01 | Status word | – | 00000 | – | Read |
| H0.03 | STO safety status word | bit 0: STO-A<br>bit 1: STO-r<br>bit 2: STO-E<br>bit 3...15: Reserved<br>Modbus register: 0x7FA2 | 00000 | – | 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H0.18 | Opt 1 active interface version | – | – | 0.01 | Read |
| H0.19 | Opt 2 active interface version | – | – | 0.01 | Read |
| H0.20 | Extension card 1 type | 0: None | 0 | – | Read |
| H0.30 | Extension card 2 type | 1: PROFIBUS card<br>2: CANopen card<br>3: MEP (Multi-Ethernet)<br>7: Encoder 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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) | 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.

## H8: I/O card parameters

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| H8.00 | EX1 input | 0...51 | 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...2 | 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 | 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 | 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 | 1 | – | Stop |
| H8.32 | EAI2 filter time | 0.000...2.000 | 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 |
| 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 |

| Code | Name | Setting range | Default | Min. | Attri. |
|---|---|---|---|---|---|
| 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

**Setting range of H8.06:**

0: Polarity inactive
1: Polarity active without direction control
2: Polarity active with 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
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.

---

## 20.3.7 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
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

## 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
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

## 20.3.8 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 |
| d0.40 | 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 |
| d0.60 | Relay output | – |

| Code | Name | Minimum unit |
|---|---|---|
| d0.62 | I/O card relay output | – |
| d0.63 | Relay card output | – |
| 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.

## 20.4 Appendix IV: Certification

### 20.4.1 CE

#### Declaration of conformity

For Frequency Converters EFC x610 (0K40...160K), 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. 20-1:** EU directives and standards

#### CE label

**Fig. 20-12:** CE label

#### High-voltage test

According to standard EN 61800-5-1, EFC x610 (0K40...160K) components are tested with high voltage.

## 20.4.2 UL

Frequency Converters EFC x610 (0K40...160K) are listed by UL "Underwriters Laboratories Inc.®". You can find the evidence of certification on the Internet under http://www.ul.com under “Certifications” by entering the file number or the “Company Name: Rexroth”.

### UL listing

**Fig. 20-13:** UL listing

### UL standard

UL 508C (0K40...18K5), UL 61800-5-1 (22K0...160K)

### Company name

BOSCH REXROTH (XIAN) ELECTRIC DRIVES AND CONTROLS CO., LTD.

### Category name

Power Conversion Equipment

### File number

E328841

### UL ratings

For using the components in the scope of UL, take the UL ratings of the individual component into account.

An appropriate fuse must be used, which rating shall be equal to or greater than the SCCR (0K40...37K0: 5,000 Arms; 45K0...90K0: 10,000 Arms; 110K...132K: 18,000 Arms; 160K: 30,000 Arms) of the power supply being used.

### Wiring material UL

In the scope of UL, use only copper conductors rated 75 ℃ or above.

**Requirements for United States / Canadian installations (UL/cUL):**

Suitable for use on a circuit capable of delivering not more than 5,000 Arms Symmetrical Amperes, 480 VAC maximum, when protected by UL/cUL-certified Class J fuses only. Power cable use 75 °C or above copper wire. This equipment is capable of providing internal motor overload protection according to UL 508C.

**For Canadian (cUL) installations the drive mains supply must be fitted with any external recommended suppressor with the following features:**

- Surge-protective devices; device shall be a Listed Surge-protective device (Category code VZCA and VZCA7)
- Rated nominal voltage 480/277 VAC, 50/60 Hz, 3-phase
- Clamping voltage VPR = 2,000 V, IN = 3 kA min, MCOV = 508 VAC, SCCR = 5,000 A (0K40...37K0), 10,000 A (45K0...90K0), 18,000 A (110K...132K), 30,000 A (160K)
- Suitable for Type 2 SPD application
- Clamping shall be provided between phases and also between phase and ground

### 20.4.3 EAC

Frequency Converters EFC x610 (0K40...160K) have EAC certification. EAC marking is required for Custom Union, including Russia, Belarus and Kazakhstan.

**EAC marking**

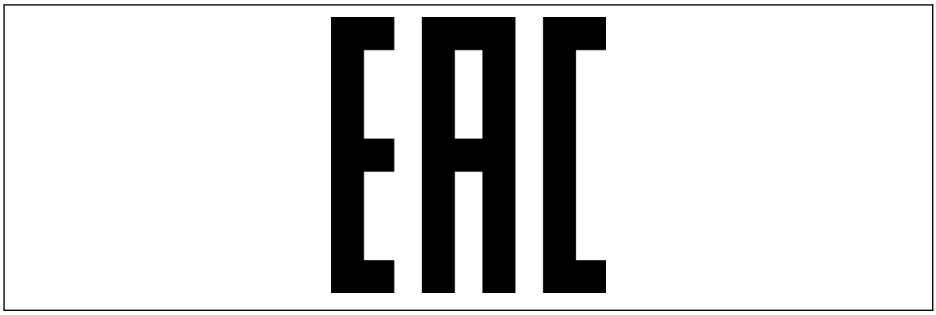



**Fig. 20-14:** EAC marking

## 20.4.4 RCM

Frequency Converters EFC x610 (0K40...90K0) comply with the relevant ACMA standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997.These standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.

### RCM label

**Fig. 20-15:** RCM label

### RCM standard

EN 61800-3: 2004+A1: 2012, Adjustable speed electrical power drive systems - Part3: EMC requirements and specific test methods

### ACMA supplier code

E1066

### CAN, ABN or ARBN

ABN / IRDN 89003258384

### Category

Frequency Converters EFC x610 (0K40...90K0) complies with the applicable requirements detailed in EN 61800-3: 2004+A1: 2012 (Category 3 limits) and is not intended to be used directly on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network, in which supplementary mitigation measures are required.

### 20.4.5 EU RoHS

The product meet the requirement of RoHS (Restriction on the use of certain Hazardous Substances) directive 2011/65/EU with the exemption per Annex of 2011/65/EU.

**EU RoHS marking**

**Fig. 20-16:** EU RoHS marking

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## 20.6 Appendix V: Parameter Change Record

Parameter changes between version 03V12 and 03V08 are shown as below:

| Change type | Code | Name | Change description |
|---|---|---|---|
| New-added | C0.41 | Power loss ride-through recovery delay | New-added parameters |
| | C0.42 | Power loss ride-through action voltage | |
| | C0.43 | Power loss ride-through recovery voltage | |
| | C0.44 | Power loss ride-through deceleration to stop time | |
| | E9.97 | Last detailed error type | |
| | E9.98 | Second last detailed error type | |
| | E9.99 | Third last detailed error type | |
| | F0.20 | ASF Command 1 | |
| | F0.21 | ASF Command 2 | |
| | F0.22 | ASF Command 3 | |
| | F0.23 | ASF Command 4 | |
| | d0.14 | Energy saving counter kWh | |
| | d0.15 | Energy saving counter MWh | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | C0.40 | Power loss ride-through mode | Added "3: Regain kinetic energy, decelerate to stop" to setting range |
| | C1.72 | Motor thermal sensor type | Added "3: PT1000" to setting range |
| | H8.15 | Input curve 0 minimum | Changed setting range to: "-120.0 %...[H8.17]"<br>Changed default value to: "0.0" |
| | H8.16 | Input curve 0 minimum frequency | Changed setting range to: "-[E0.09]...[E0.09] Hz" |
| | H8.17 | Input curve 0 maximum | Changed setting range to: "[H8.15]...120.0 %" |
| | H8.18 | Input curve 0 maximum frequency | Changed setting range to: "-[E0.09]...[E0.09] Hz"<br>Changed default value to: "50.0" |
| | H8.87 | I/O card output channel diagnosis | Changed parameter name to: "I/O card output channel diagnosis"<br>Changed setting range to:<br>0: Inactive<br>1: EAO diagnosis; 2: EDO diagnosis<br>3: ERO diagnosis; 4: All output diagnosis |
| | H9.02 | Extended relay 3 output selection | Changed attribute to: "Stop" |
| | H9.03 | Extended relay 4 output selection | Changed attribute to: "Stop" |
| | H9.97 | Relay card output channel diagnosis | Changed parameter name to: "Relay card output channel diagnosis"<br>Changed setting range to:<br>0: Inactive; 1: Relay1 diagnosis<br>2: Relay2 diagnosis; 3: Relay3 diagnosis<br>4: Relay4 diagnosis; 5: All output diagnosis |
| | U1.00 | Run monitoring display | Added "14: Energy saving counter kWh" and "15: Energy saving counter MWh" to setting range |
| | U1.10 | Stop monitoring display | Added "14: Energy saving counter kWh" and "15: Energy saving counter MWh" to setting range |
| Deleted | None | | |

Parameter changes between version 03V20 and 03V12 are shown as below:

| Change type | Code | Name | Change description |
|---|---|---|---|
| New-added | C0.10 | Automatic voltage stabilization | New-added parameters |
| | C0.24 | Stall overvoltage hysteresis voltage | |
| | C1.25 | Rotor leakage inductance | |
| | C2.20 | 0 Hz output mode | |
| | C3.02 | Speed loop proportional gain 2 | |
| | C3.03 | Speed loop integral time 2 | |
| | C3.10 | Speed loop switching frequency 1 | |
| | C3.11 | Speed loop switching frequency 2 | |
| | C3.21 | Encoder speed filter time | |
| | C3.22 | Communication encoder offset | |
| | C3.25 | Speed monitor timeout | |
| | C3.26 | Speed monitor max speed difference | |
| | C3.38 | Forward frequency limitation at torque control mode | |
| | C3.39 | Reverse frequency limitation at torque control mode | |
| | C3.46 | Digital torque reference setting | |
| | C3.47 | Torque limitation reference selection at speed control mode | |
| | C3.48 | Speed limitation reference selection at torque control mode | |
| | d0.82...d0.89 | ASF display 02...ASF display 09 | |
| | Group U2 | LCD panel parameters | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | b0.21 | Manufacturer password | Changed attribute to: "Run" |
| | C0.00 | Control mode | Added "2: FOC" to setting range |
| | C0.05 | Carrier frequency | Changed setting range to: "0K40...22K0: 1...15 kHz 30K0...90K0: 1...12 kHz"<br>Changed default value to:<br>0K40...4K00: 6k<br>5K50...22K0 (HD): 6k<br>5K50...22K0 (ND): 4k<br>30K0...90K0: 4k |
| | C1.69 | Motor thermal model protection setting | Changed default value to: "0" |
| | C2.21 | Torque boost setting | Changed default value to: "DOM" |
| | C3.00 | Speed loop proportional gain 1 | Changed parameter name to: "Speed loop proportional gain 1" |
| | C3.01 | Speed loop integral time 1 | Changed parameter name to: "Speed loop integral time 1" |
| | C3.40 | Torque control mode | Added "2: Communication" to setting range |
| | C3.41 | Torque reference channel | Added "4: Pulse input via DI5", "5: Parameter setting C3.46" and "6: Communication" to setting range |
| | E0.11 | Reverse running frequency | Changed attribute to: "Stop" |
| | E0.37 | Start frequency holding time | Changed default value to: "0.0" |
| | E0.55 | Overexcitation braking factor | Changed setting range to: "1.00...2.00" |
| | E2.01 | DO1 output setting | Added "25: Converter error or warning" to setting range |
| | E2.15 | Relay1 output selection | |
| | H8.20 | EDO output setting | |
| | H8.21 | Extended relay output selection | |
| | H9.00...H 9.03 | Extended relay 1 output selection...Extended relay 4 output selection | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | E3.59 | Stage 0 frequency source | Added "6: Panel potentiometer" and "7: Digital input up/down command" to setting range |
| | E4.01 | PID feedback channel | Added "4: Encoder card speed" to setting range |
| | E9.05 | Last error type | Added "35: SPE-, speed control loop error" to setting range |
| | E9.06 | Second last error type | |
| | E9.07 | Third last error type | |
| | U1.00 | Run monitoring display | Added options 82...89 to setting range |
| | U1.10 | Stop monitoring display | |
| Deleted | None | | |

Parameter changes between version 03V24 and 03V20 are shown as below:

| Change type | Code | Name | Change description |
|---|---|---|---|
| New-added | C1.02 | Expert mode | New-added parameters |
| | C2.08 | V/f separation output voltage source selection | |
| | C2.09 | V/f separation output voltage digital setting | |
| | C2.10 | V/f separation output voltage acceleration time | |
| | C2.11 | V/f separation output voltage deceleration time | |
| | C2.12 | V/f separation stop mode selection | |
| | C2.13 | V/f separation boost factor | |
| | E2.20 | DO1/relay1 output values from extension card fieldbus communication | |
| | E2.28 | AO1 value in percentage from extension card fieldbus communication | |
| | F0.20...F0.27 | ASF Command 1...ASF Command 8 | |
| | H0.12 | Torque control reference from fieldbus | |
| | H0.14 | FWD torque limitation reference from fieldbus | |
| | H0.15 | REV torque limitation reference from fieldbus | |
| | H0.16 | Speed limitaion at torque control mode from fieldbus | |
| | H0.50 | Fieldbus voltage command | |
| | H8.07 | EAI1 dead zone filter value | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| New-added | H8.22 | EDO2 output selection | New-added parameters |
| | H8.23 | Extended digital output value from extension card fieldbus communication | |
| | H8.28 | EAO value in percentage from extension card fieldbus communication | |
| | H8.30 | EAI2 input mode | |
| | H8.31 | EAI2 input polarity setting | |
| | H8.32 | EAI2 filter time | |
| | H8.33 | EAI2 gain | |
| | H8.34 | EAI2 curve minimum | |
| | H8.35 | EAI2 curve minimum value | |
| | H8.36 | EAI2 curve maximum | |
| | H8.37 | EAI2 curve maximum value | |
| | H8.38 | EAI2 dead zone filter value | |
| | H8.39 | EAO curve minimum | |
| | H8.40 | EAO curve minimum value | |
| | H8.41 | EAO curve maximum | |
| | H8.42 | EAO curve maximum value | |
| | H9.10 | Relay output setting value | |
| | d0.09 | V/f separation setting voltage | |
| | d0.34 | I/O card EAI2 input | |
| | d0.48 | I/O card EDO2 output | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | C0.05 | Carrier frequency | Added the information of 132 kW |
| | C1.11 | Motor poles | Changed setting range from "2...128" to "2...256" |
| | C1.72 | Motor thermal sensor type | Added "4: TDK G1551_8320 (NTC)" to setting range |
| | C2.00 | V/f curve mode | Added "3: V/f seperation" to setting range |
| | C3.38 | Forward frequency limitation at torque control mode | Changed attribute to: "Run" |
| | C3.39 | Reverse frequency limitation at torque control mode | |
| | C3.41 | Torque reference channel | Changed setting range |
| | C3.47 | Torque limitation reference selection at speed control mode | Changed setting range |
| | C3.48 | Speed limitation reference selection at torque control mode | Changed setting range |
| | E0.00 | First frequency setting source | Changed setting range |
| | E0.02 | Second frequency setting source | Changed setting range |
| | E1.00... E1.04 | X1 input...X5 input | Changed setting range |
| | E1.60 | Motor temperature sensor channel | Changed setting range |
| | E2.01 | DO1 output setting | Added "21: Parameter setting from communication" to setting range |
| | E2.02 | DO1 pulse output setting | Added "3: Setting torque", " 4: Output torque" to setting range |
| | E2.15 | Relay1 output selection | Added "21: Parameter setting from communication" to setting range |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | E2.26 | AO1 output setting | Added "9: EAI2 analog input", " 12: Parameter setting from communication", "13: Setting torque", "14: Output torque" to setting range |
| | E3.59 | Stage 0 frequency source | Changed setting range |
| | E4.01 | PID feedback channel | Changed setting range |
| | E8.03 | Communication process data loss behavior | Added "3: Keep running without warning" to setting range |
| | H1.10...<br>H1.19 | Output PZD 1...Output PZD 10 | Changed setting range |
| | H8.00...<br>H8.04 | EX1 input...EX5 input | Added "48: Motor overheat detection" to setting range |
| | H8.05 | EAI1 input mode | Changed parameter name to: "EAI1 input mode" |
| | H8.06 | EAI1 input polarity setting | Changed parameter name to: "EAI1 input polarity setting" |
| | H8.09 | EAI1 filter time | Changed parameter name to: "EAI1 filter time" |
| | H8.10 | EAI1 gain | Changed parameter name to: "EAI1 gain" |
| | H8.15 | EAI1 curve minimum | Changed parameter name to: "EAI1 curve minimum" |
| | H8.16 | EAI1 curve minimum value | Changed parameter name to: "EAI1 curve minimum value" |
| | H8.17 | EAI1 curve maximum | Changed parameter name to: "EAI1 curve maximum" |
| | H8.18 | EAI1 curve maximum value | Changed parameter name to: "EAI1 curve maximum value" |
| | H8.20 | EDO1 output selection | Added "21: Parameter setting from communication" to setting range |
| | H8.21 | Extended relay output selection | |
| | H8.25 | EAO output mode | Added "2: -10...10 V (only for IO plus card)" to setting range |
| | H8.26 | EAO output selection | Added "9: EAI2 analog input", " 12: Parameter setting from communication", "13: Setting torque", "14: Output torque" to setting range |
| | H9.00...<br>H9.03 | Extended relay 1 output selection...Extended relay 4 output selection | Added "21: Parameter setting from communication" to setting range |
| | d0.33 | I/O card EAI1 input | Changed parameter name to: "I/O card EAI1 input" |
| | d0.47 | I/O card EDO1 output | Changed parameter name to: "I/O card EDO1 output" |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Deleted | H8.08 | EAI curve selection | Deleted parameter |

Parameter changes between version 03V26 and 03V24 are shown as below:

| Change type | Code | Name | Change description |
|---|---|---|---|
| New-added | C0.11 | Automatic voltage stabilization reference voltage | New-added parameters |
| | C3.04 | Speed observer harmonics damping factor | |
| | E0.42 | Speed tracing voltage recovery ratio | |
| | E0.43 | Speed tracing deceleration time | |
| | E0.56 | Emergency stop action | |
| | E0.57 | Emergency stop deceleration time | |
| | E9.02 | Automatic error reset attempts restart time | |
| | H0.03 | STO safety status word | |
| | d0.18 | Opt 1 active interface version | |
| | d0.19 | Opt 2 active interface version | |

| Change type | Code | Name | Change description |
|---|---|---|---|
| Modified | C0.06 | Carrier frequency automatic adjustment | Added "2: Fixed carrier frequency" to setting range |
| | C0.50 | Fan control | Added "2: On when converter run" to setting range |
| | C1.09 | Motor rated speed | Changed setting range |
| | C1.12 | Motor rated slip frequency | |
| | C1.15 | Torque constant | |
| | C1.21 | Stator resistance | |
| | C1.22 | Rotor resistance | |
| | C2.08 | V/f separation output voltage source selection | |
| | C3.22 | Encoder commutation offset | Changed parameter name |
| | C3.48 | Speed limitation reference selection at torque control mode | Changed item "0: Parameter C3.38 and C3.39" in setting range |
| | E0.04 | Frequency setting source combination | Added items "3, 4, 5, 6" to setting range |
| | E0.06 | Digital setting frequency saving mode | Added "4: Not saved when powered off; memorized when stopped" to setting range |
| | E8.02 | Communication error protection mode | Added "2: Emergency stop" to setting range |
| | H8.26 | EAO output selection | Changed item "0: Output frequency" in setting range |
| Deleted | None | | |

## Notes

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