Emotron AFR/AFG 2.1

AFR - Low harmonic/Regenerative Active Front End

AFG - Active Front End for renewable generation

Instruction manual

English

2021-05-31

emotron

DEDICATED DRIVE

A CG Product

Emotron AFR/AFG 2.1

AFR - Low harmonic/Regenerative Active Front End
AFG - Active Front End for renewable generation

Instruction manual - English

Valid from software version V5.04-097-10

Document number: 01-7690-01
Edition: r0
Date of release: 2021-05-31
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Safety Instructions

Instruction manual

Read this instruction manual before using the system.

The following symbols can appear in this manual. Always read these first before continuing:

NOTE:
Additional information as an aid to avoid problems.

CAUTION!
Failure to follow these instructions can result in malfunction or damage to the active front end or motor inverter.

WARNING!
Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the active front end or motor inverter.

HOT SURFACE!
Failure to follow these instructions can result in injury to the user.

Handling the Active front end unit

Installation, commissioning, demounting, taking measurements, etc, of or on the active front end may only be carried out by personnel technically qualified for the task. The installation must be carried out in accordance with local standards.

Opening the Active front end unit

WARNING!
Always switch off the mains voltage before opening the drive unit and wait at least 7 minutes to allow the buffer capacitors to discharge.

Always take adequate precautions before opening the active front end. Although the connections for the control signals and the switches are isolated from the main voltage, do not touch the control board when the active front end is switched on.

Precautions to be taken with a connected load (motor)

If work must be carried out on a connected load (motor) or on the driven machine, the mains voltage must always be disconnected from the active front end first. Wait at least 7 minutes before starting work.

Earthing

The active front end must always be earthed via the mains safety earth connection.

Earth leakage current

CAUTION!
This active front end has an earth leakage current which does exceed 3.5 mA AC.
Therefore the minimum size of the protective earth conductor must comply with the local safety regulations for high leakage current equipment which means that according to the standard IEC61800-5-1 the protective earth connection must be assured by one of following conditions:

PE conductor cross-sectional area shall for phase cable size ≤ 16 mm^2 (6 AWG) be >10 mm^2 Cu (16 mm^2 Al) or use a second PE conductor with same area as original PE conductor.
For cable size above 16 mm^2 (6 AWG) but smaller or equal to 35mm^2(2 AWG) the PE conductor cross-sectional area shall be at least 16mm^2(6 AWG).
For cables >35 mm^2 (2 AWG) the PE conductor cross-sectional area should be at least 50 % of the used phase conductor.
When the PE conductor in the used cable type is not in accordance with the above mentioned cross-sectional area requirements, a separate PE conductor should be used to establish this.

Residual current device (RCD) compatibility

This product cause a DC current in the protective conductor. Where a residual current device (RCD) is used for protection in case of direct or indirect contact, only a Type B RCD is allowed on the supply side of this product. Use RCD of 300 mA minimum.

EMC Regulations

In order to comply with the EMC Directive, it is absolutely necessary to follow the installation instructions. All installation descriptions in this manual follow the EMC Directive.

Mains voltage selection

The active front end may be ordered for use with the mains voltage range listed below.

VFXR/FDUL/AFR46: 380-460 V
VFXR/FDUL/AFR69: 480-690 V
VFXG/FDUG/AFG46: 380-460 V
VFXG/FDUG/AFG69: 480-690 V

Voltage tests (Megger)

Do not carry out voltage tests (Megger) on the motor, before all the motor cables have been disconnected from the active front end and variable speed drive.

Condensation

If the active front end or motor inverter is moved from a cold (storage) room to a room where it will be installed, condensation can occur. This can result in sensitive components becoming damp. Do not connect the mains voltage until all visible dampness has evaporated.

Incorrect connection

The Active front end or motor inverter drive is not protected against incorrect connection of the mains voltage, and in particular against connection of the mains voltage to the motor outputs U, V and W. The Active front end or motor inverter can be damaged in this way.

Power factor capacitors for improving cosφ

Remove all capacitors from the motor and the motor outputs.

Precautions during Auto-reset

When the automatic reset is active, the motor will restart automatically provided that the cause of the trip has been removed. If necessary take the appropriate precautions.

Transport

To avoid damage, keep the active front end and motor inverter in its original packaging during transport. This packaging is specially designed to absorb shocks during transport.

IT Mains supply

The Active front end can be modified for an IT mains supply, (non-earthed neutral), please contact your supplier for details.

Heat warning

Be aware of specific parts on the Active front end and motor inverter having high temperature.

DC-link residual voltage

WARNING!
After switching off the mains supply, dangerous voltage can still be present in the Active front end-AFR/AFG or motor inverter-AC drive. When opening the equipment for installing and/or commissioning activities wait at least 7 minutes. In case of malfunction a qualified technician should check the DC-link or wait for one hour before dismantling the AFR/AFG or AC drive for repair.

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1. Introduction

NOTE:
Read this instruction manual carefully before starting installation, connection or working with the active front end or motor inverter.

Users

This instruction manual is intended for:

- installation engineers
- maintenance engineers
- operators
- service engineers

Active front end loads

Active front end is suitable for connecting to three phase electrical networks where it allows bi-directional power flow to DC load or from DC power source.

Motors

Motor inverter (VSI) is suitable for use with standard 3-phase asynchronous motors. Under certain conditions it is possible to use other types of motors. Contact your supplier for details.

1.1 Delivery and unpacking

Check for any visible signs of damage. Inform your supplier immediately of any damage found. Do not install the active front end or motor inverter if damage is found.

1.2 Using of the instruction manual

Within this instruction manual the abbreviation "AFR" and "AFG" is used in the following sense:

AFR: To indicate the complete active front end for low harmonic and regenerative applications with no grid code support.

AFG: To indicate the complete active front end for generation applications with full/advanced grid code functionality.

For detail see section 2.1 page 12.

Check that the software version number on the first page of this manual matches the software version in the active front end. See section 11.9.1 page 122 for more information

With help of the Index and the Table of contents in this manual, it is easy to track individual functions and to find out how to use and set them.

1.3 Warranty

The warranty applies when the equipment is installed, operated and maintained according to instructions in this instruction manual. Duration of warranty as per contract.

Faults that arise due to faulty installation or operation are not covered by the warranty.

1.4 Type code number

Fig. 1 gives an example of the type code numbering used on all active front ends. With this code number the exact type of the drive can be determined. This identification will be required for type specific information when mounting and installing. The code number is located on the product label, on the front of the unit.

Fig. 1 Type code number

Position	Configuration	
1	AFE type	AFR = “AFR” AFG = “AFG”
2	Supply voltage	46=400 V mains 69=690 V mains
3	Rated current (A) continuous	-175=175 A - -1K5=1500 A
4	Protection class	20=IP20 54=IP54
5	Control panel	–=Blank panel D=4-line panel E=4-line panel + BLE
6	EMC option	E=Standard EMC (Category C3) F=Extended EMC (Category C2) I=IT-Net
7	Brake chopper option	- =No chopper B=Chopper built in
8	Stand-by power supply option	–=24V Standby supply input standard on control board
9	Safe Torque Off (STO) option	– =No STO option O=STO Option included
10	Brand label	A=Standard
11	Coated boards, option	- =Standard boards V=Coated boards

Position	Configuration	
12	Option position 1	N=No option P=PTC/PT100 I=Extended I/O
13	Option position 2	
14	Option position 3	
15	Option position, Communication	N=No option D=DeviceNet P=Profibus S=RS232/485 M=Modbus/TCP E= EtherCAT A=Profinet IO 1-port B=Profinet IO 2-port G= EtherNet/IP 2-port
16	Software type	A=Standard AFR/AFG
17	CE Approved	-
18	Cooling type	L=Liquid cooled A=Air cooled

1.5 Standards

The active front ends and variable speed drives described in this instruction manual comply with the standards listed in Table 1. For the declarations of conformity and manufacturer's certificate, contact your supplier for more information or visit www.cgglobal.com or www.emotron.com.

1.5.1 Product standard for EMC

Product standard EN(IEC)61800-3, second edition of 2004 defines the:

First Environment (Extended EMC) as environment that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low voltage power supply network that supplies buildings used for domestic purposes.

Category C2: Power Drive System (PDS) of rated voltage<1.000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional.

Second environment (Standard EMC) includes all other establishments.

Category C3: PDS of rated voltage <1.000 V, intended for use in the second environment and not intended for use in the first environment.

Category C4: PDS or rated voltage equal or above 1.000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

The active front end complies with the product standard EN(IEC) 61800-3:2004 (Any kind of metal screened cable may be used). The active front end is designed to meet the requirements according to category C3.

By using the optional "Extended EMC" filter the active front end fulfils the requirements according to category C2.

For the distributive regeneration applications, Emotron AFG also complies with TR-61000-3-15.

WARNING!
In a domestic environment this product may cause radio interference, in which case it may be necessary to take adequate additional measures.

WARNING!
The AC drive, complying with category C3, is not intended to be used on a low-voltage public network which supplies domestic premises; radio interference is expected if used in such a network. Contact your supplier if you need additional measures.

Table 1 Standards

Market	Standard	Description
European	EMC Directive	2014/30/EU
	Low Voltage Directive	2014/35/EU
	WEEE Directive	2012/19/EU
	Grid connection of generators	2016/631/EC
All	EN 60204-1	Safety of machinery - Electrical equipment of machines Part 1: General requirements.
	EN(IEC) 61000-6-2 EN(IEC) 61000-6-4	Electromagnetic compatibility (EMC) Part 6-2: Generic standards - Immunity standard for industrial environments. Part 6-4: Generic standards - Emission standard for industrial environments.
	EN(IEC)61800-3:2004	Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods. EMC Directive: Declaration of Conformity and CE marking
	IEC/TR 61000-3-15	Electromagnetic compatibility (EMC) - Part 3-15: Limits assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation system in LV network.
	EN(IEC)61800-5-1 Ed. 2.0	Adjustable speed electrical power drive systems Part 5-1. Safety requirements - Electrical, thermal and energy. Low Voltage Directive: Declaration of Conformity and CE marking
	IEC 60721-3-3	Classification of environmental conditions. Air quality chemical vapours, unit in operation. Chemical gases 3C2, Solid particles 3S2. Optional with coated boards Unit in operation. Chemical gases Class 3C3, Solid particles 3S2.
	IEC-50549	IEC-50549-1 Requirements for generating plants to be connected in parallel with distribution networks Part 1: Connection to a LV distribution network above 16 A. IEC-50549-2 Requirements for generating plants to be connected in parallel with distribution networks Part 2: Connection to a MV distribution network.
	IEC-62116	IEC 62116:2014 Utility-interconnected photovoltaic inverters - Test procedures of islanding prevention measures.

1.6 Dismantling and scrapping

The enclosures of the drives are made from recyclable material as aluminum, iron and plastic. Each drive contains a number of components demanding special treatment, for example electrolytic capacitors. The circuit boards contain small amounts of tin and lead. Any local or national regulations in force for the disposal and recycling of these materials must be complied with.

1.6.1 Disposal of old electrical and electronic equipment

This information is applicable in the European Union and other European countries with separate collection systems.

This symbol on the product or on its packaging indicates that this product shall be taken to the applicable collection point for the recycling of electrical and electronic equipment. By ensuring this product is disposed of correctly, you will help prevent potentially negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. The recycling of materials will help to conserve natural resources. For more detailed information about recycling this product, please contact the local distributor of the product.

1.7 Glossary

1.7.1 Abbreviations and symbols

In this manual the following abbreviations are used:

Table 2 Abbreviations

Abbreviation/ symbol	Description
AC drive	Frequency converter
AFE	Active front end (electronics, control board and power module part)
AFG	Active front end for generation with full/ advanced grid code functionality
AFR	Low harmonic/regenerative front end with no grid support
AID	Anti-Islanding detection
BLE	Blue tooth
Comm	Command sourced from serial communication
CP	Control panel, the programming and presentation unit on the AC drive
DFE	Diode front end
DPF	Displacement power factor
EInt	Communication format
FDUG	Complete power drive train, including AFG and VSI (FDU)
FDUL	Low harmonic FDU drive, including AFR and VSI (FDU)
FRT	Fault-ride through
GC	Gride Code
Int	Communication format (Integer)
Keyb	Command sourced from keyboard
LCL-filter	Inductance - Capacitance - Inductance type filter
LFSM-O	Limited frequency sensitivity mode - over-frequency
Long	Communication format (4 byte integer)
OFRT	Over-frequency ride-through
OVRT	Over-voltage ride-through
PLL	Phase locked loop
ROCOF	Rate of change of frequency
SVMB	Supply voltage measurement board
THD	Total harmonic distortion
UFRT	Under-frequency ride-through
UInt	Communication format (Unsigned integer)
UVRT	Under-voltage ride-through

Table 2 Abbreviations

Abbreviation/ symbol	Description
VFXG	Complete power drive train, including AFG and VSI (VFX)
VFXR	Regenerative VFX drive, including AFR and VSI (VFX)
VSI	Voltage source inverter (motor inverter)
🔒	The function cannot be changed in run mode

1.7.2 Definitions

In this manual the following definitions for current, torque and frequency are used:

Table 3 Definitions

Name	Description	Quantity
I_{IN}	Nominal input current of AFR/AFG	A_{RMS}
I_{NOM}	Nominal output current of VSI	A_{RMS}
I_{MOT}	Nominal motor current	A_{RMS}
P_{NOM}	Nominal power of VSI	kW
P_{MOT}	Motor power	kW
T_{NOM}	Nominal torque of motor	Nm
T_{MOT}	Motor torque	Nm
f_{OUT}	Output frequency of VSI	Hz
f_{MOT}	Nominal frequency of motor	Hz
n_{MOT}	Nominal speed of motor	rpm
I_{CL}	Maximum output current	A_{RMS}
Speed	Actual motor speed	rpm
Torque	Actual motor torque	Nm

2. General description

The Emotron active front end (AFE) is a regenerative active front end unit designed to be used either in combination with Emotron motor inverter (VSIs) i.e. VFX/FDU or without Emotron motor inverter (VSIs). The main objective of the Emotron AFE is to rectify the supply AC voltage into DC voltage to be fed to or regenerated from the VSIs. This is achieved with the minimal impact on the supply by the control of the active rectifier module which provides sinusoidal input currents with a very low harmonic content, typically a THD(I) below 5%. Different variants of Emotron active front end drives are:

AFR: Regenerative, low harmonic active front end without Emotron motor inverter.

AFG: Regenerative, low harmonic active front end without Emotron motor inverter. AFG offers full/ advance grid support functionality.

FDUL: Non-regenerative, low harmonic drive including active front end (AFR) together with Emotron motor inverter FDU.

VFXR: Regenerative, low harmonic drive including active front end (AFR) together with Emotron motor inverter VFX.

FDUG: Non-regenerative, low harmonic drive including active front end for generation (AFG) together with Emotron motor inverter FDU. FDUG offers full/ advance grid support functionality.

VFXG: Regenerative, low harmonic drive including active front end for generation (AFG) together with Emotron motor inverter VFX. VFXG offers full/ advance grid support functionality.

CAUTION!
Always consult CG Drives & Automation before connecting an Emotron AFR/AFG to a standard VSI.

2.1 AC drive types

2.1.1 Standard AC drive (as comparison)

A standard AC drive consists of a rectifier module and an inverter module. The rectifier module (front-end) consists of a 6-pulse diode bridge, i.e. diode front-end (DFE) while the inverter module (VSI) consists of IGBTs with anti-parallel free wheeling diodes, see Figure 2. The main advantages of DFEs are the simple and robust design together with their high efficiency, i.e. low losses. The main disadvantages are unidirectional power flow and the high harmonic content in the line current, typically THD 30- 40%.

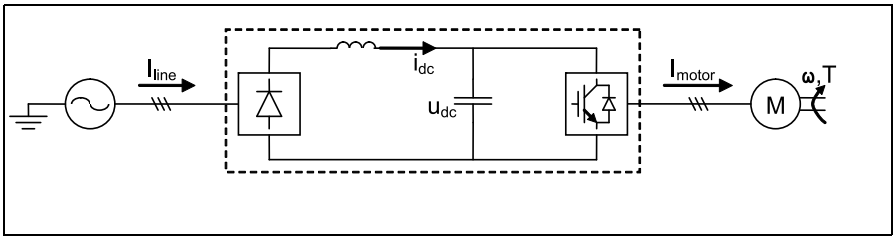


Fig. 2 Standard AC drive.

2.1.2 AC drive with AFR or AFG (FDUL/VFXR/FDUG/VFXG)

An AFE unit is basically a VSI towards the supply (via a filter) where the IGBTs are used as an active rectifier, see Figure 3. The main advantages are inherent 4Q-operation, i.e. bi-directional power flow, and sinusoidal supply currents, i.e. low harmonics, regeneration and improved power factor.
The AFE unit is controlled in such a way to keep the energy between motor and supply in balance. This is achieved by controlling the DC-link voltage (U_{dc}). Other features are the possibility for reactive power compensation and boosted DC-link voltage.

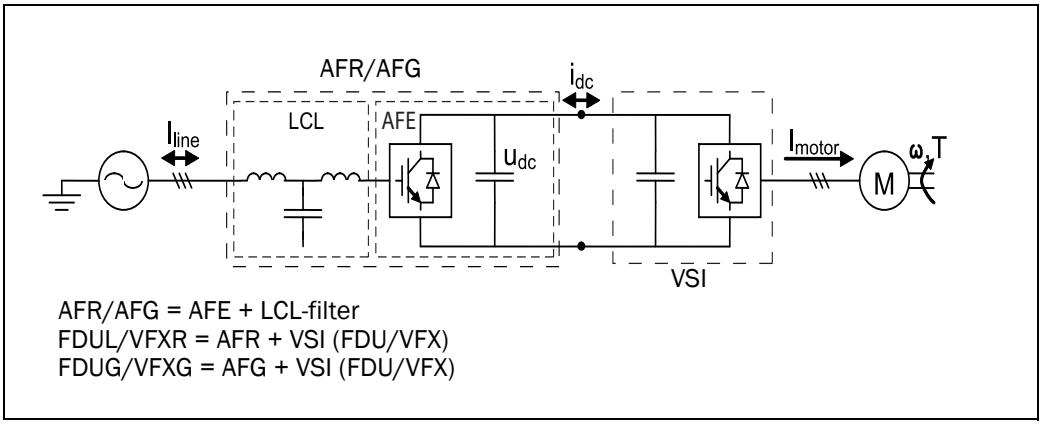


Fig. 3 VSI with AFR/AFG.

2.1.3 AFR

AFR consists of Emotron power electronic module (AFE) connected to grid through LCL filter as shown in Figure 4. The main objective of the Emotron AFR is to rectify the supply AC voltage into the DC voltage to be fed to or regenerated from the VSIs (motor inverter). It also keeps the harmonic content of the current exchanged with grid at low level, maintaining the THD(I) below 5%. AFR offers standard AFE functionality such as:

- Active power control.
- Reactive power control.
- Low harmonic operation.

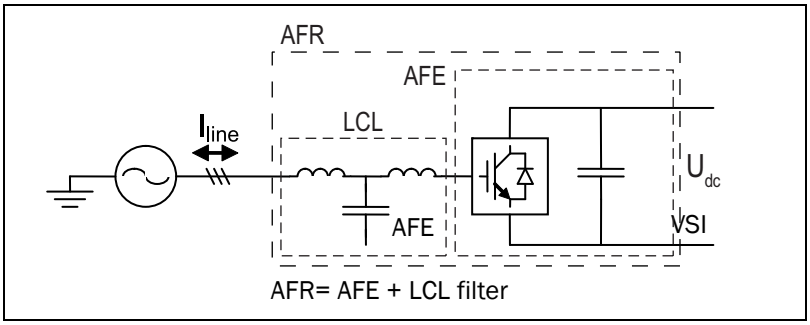


Fig. 4 AFR

2.1.4 AFG

AFG is an AFE variant that offers full/advance grid code functionality. This variant (AFG) is dedicated for generation applications where generated energy (through DC-link) is fed into the utility grid. AFG consists of Emotron power electronic module (AFE) including voltage measurement board and brake chopper switch (optional) connected to grid through LCL filter as shown in Figure 5. Main objective of AFG is to feed in generated power from DC-link to utility grid fulfilling the grid code requirements. AFG offers standard AFE functionality along with full grid support features such as:

- Grid voltage and frequency (U, F) protection.
- Reactive power (Q) control.
- Anti-islanding protection.
- Grid fault ride through (FRT) capability.

NOTE:
Supply voltage measurement board is mandatory requirement for fulfilling the basic and advanced grid code functionality. AFG has internal supply voltage measurement board (SVMB) connected to K2.

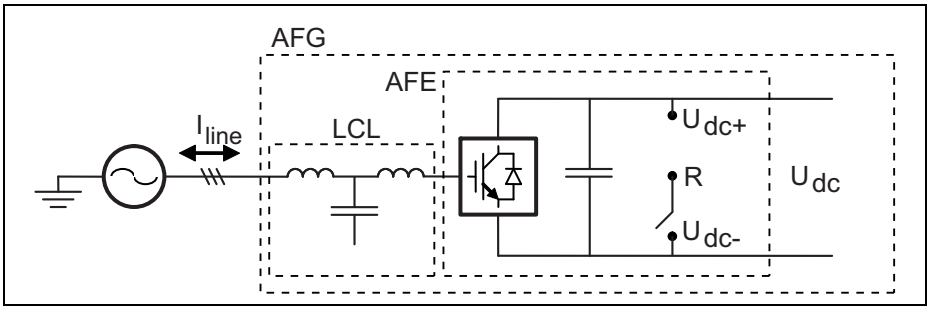


Fig. 5 AFG

2.2 Emotron single drive cabinet concept

2.2.1 FDUL/VFXR/FDUG/VFXG (single drive) applications

The Emotron low harmonic and regenerative AC drive i.e. FDUL/VFXR/FDUG/VFXG is comprised by an AFR or AFG unit i.e. AFE and filters and a VSI, i.e. Emotron VFX or FDU. The concept is designed as a cabinet solution, see Figure 6.

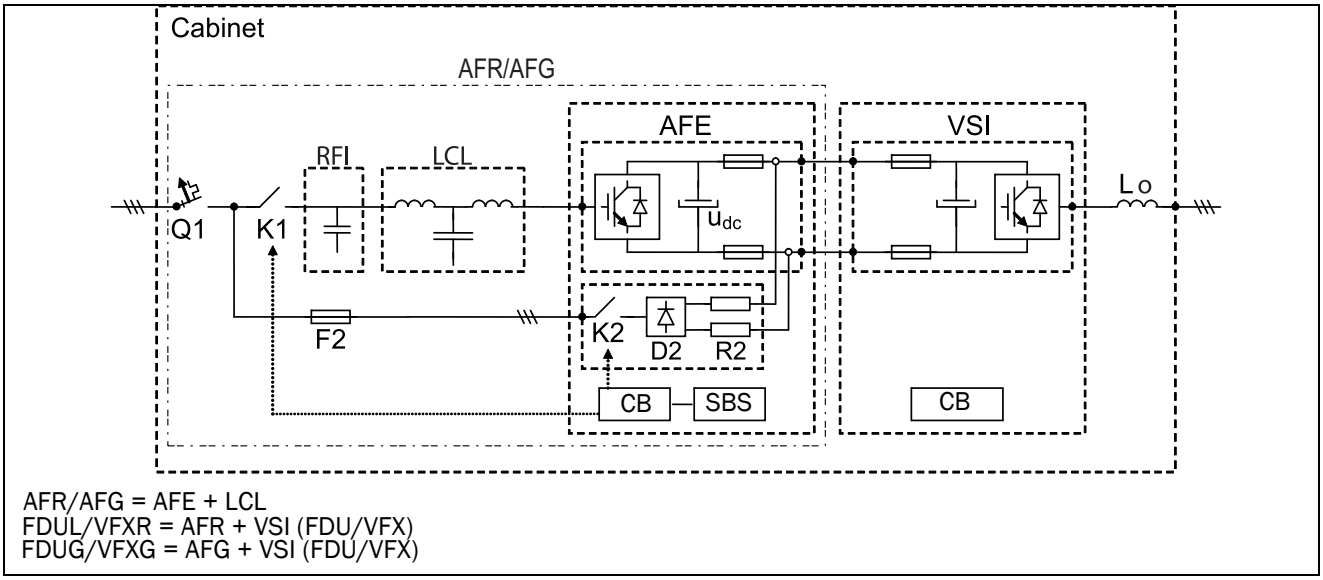


Fig. 6 Single drive in cabinet

where

- Cabinet - IP54 cabinet with door fans
- Q1 - Main switch *
- K1 - Main contactor *
- RFI - EMC filter
- LCL - LCL filter
- F2 - MCB (Miniature circuit breaker) for pre-charge circuit
- AFE - Emotron AFE module with 24V standby supply board, voltage measurement board (optional), brake chopper switch (optional) and integrated pre-charge circuit (K2,D2,R2)
- AFR/AFG - Emotron AFE and filters
- VSI - DC-voltage fed VSI module, i.e. Emotron VFX or FDU
- CB - Control board
- SBS - Standby supply board
- Lo - Output coil

* For larger units, Q1 Main switch and K1 Main contact are replaced by Q1 Motorized circuit breaker.

NOTE:
For AFG/FDUG/VFXG, supply voltage measurement board (SVMB) is mandatory. It is mounted and connected internally to K2.

2.2.2 Common DC-bus applications

For common DC-bus applications, the cabinet will contain only the AFR/AFG part of Figure 6, i.e. all except the VSI & Lo.

2.3 Emotron AFR/AFG concept

Emotron also offers only AFR/AFG solution for the applications where complete FDUL/VFXR/FDUG/VFXG drive train is not required. In this concept, the DC power load/source is connected to the DC-terminals of AFR/AFG. AFR/AFG consists of AFE power electronic module and LCL filters as main components along with other necessary components. AFR/AFG concept is shown in Figure 7.

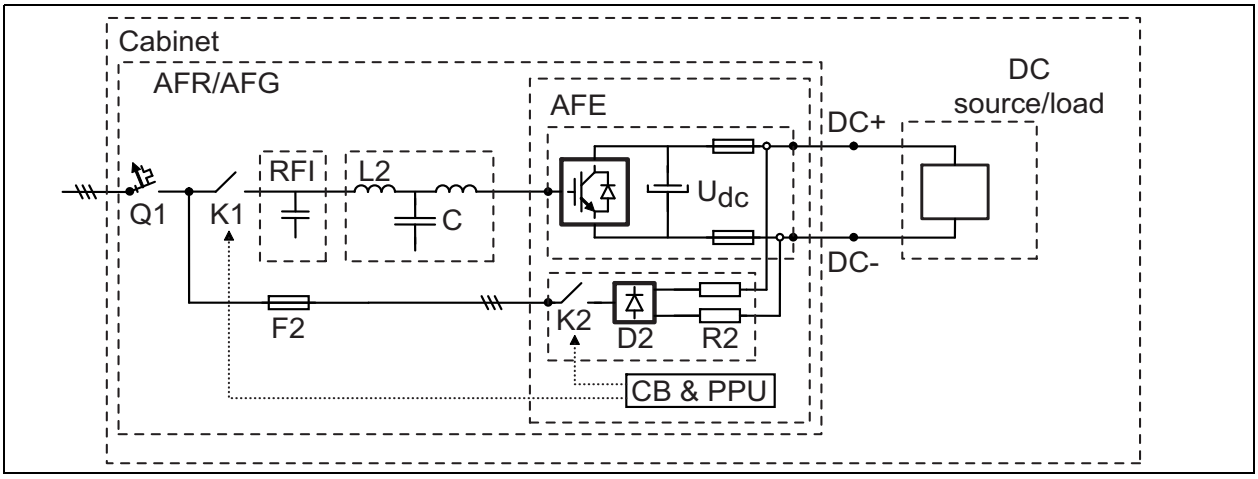


Fig. 7 AFR/AFG concept

where

- Cabinet - outer cabinet (for example IP54)
- Q1 - Main switch *
- K1 - Main contactor *
- RFI - EMC filter
- LCL - LCL filter
- F2 - MCB (Miniature circuit breaker) for pre-charge circuit
- AFE - Emotron AFE module with 24V standby supply board, voltage measurement board (optional for AFR and mandatory for AFG), optional brake chopper switch and integrated pre-charge circuit (K2, D2, R2)
- AFR/AFG - Emotron AFE and filters
- DC source/load - External DC power source or load based on the application.
- CB - Control board
- SBS - Standby supply board

* For larger units, Q1 Main switch and K1 Main contact are replaced by Q1 Motorized circuit breaker.

NOTE:
For AFG/FDUG/VFXG, supply voltage measurement board (SVMB) is mandatory. It is mounted and connected internally to K2.

3. Mounting

This chapter describes how to mount the AC drive.
Before mounting it is recommended that the installation is planned first.

- Be sure that the AC drive suits the mounting location.
- The mounting site must support the weight of the AC drive.
- The AC drive shall be mounted in vertical position.
- Will the AC drive continuously withstand vibrations and/or shocks?
- Check ambient conditions, ratings, required cooling air flow, compatibility of the motor, etc.
- Know how the AC drive will be lifted and transported.

3.1 Lifting instructions

The easiest way to move or lift the equipment is to use the lifting eyes on top of the cabinet, see Fig. 8.
When lifting, be careful not to damage the air outlets.

Note:
To prevent personal risks and any damage to the unit during lifting, it is advised to use the lifting eyes on top of the equipment.

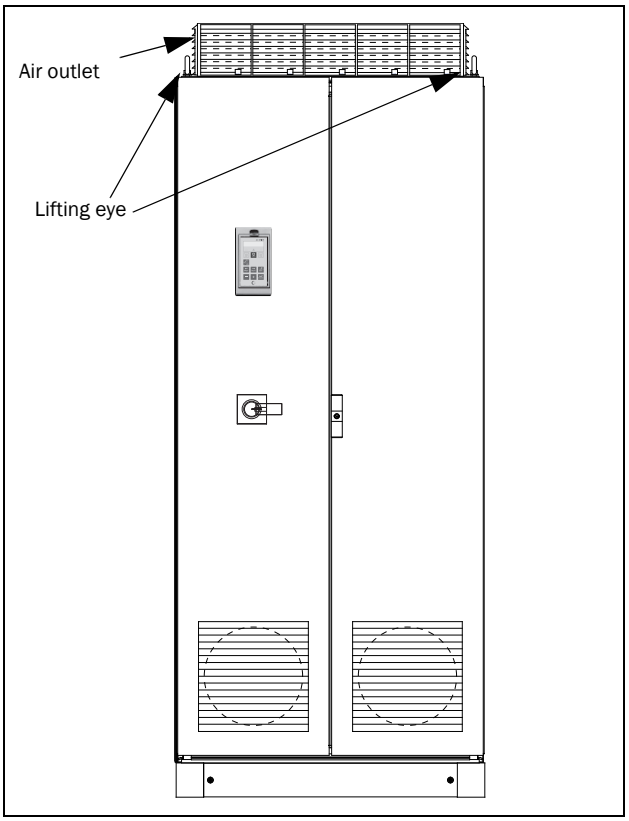


Fig. 8 Use the lifting eyes.

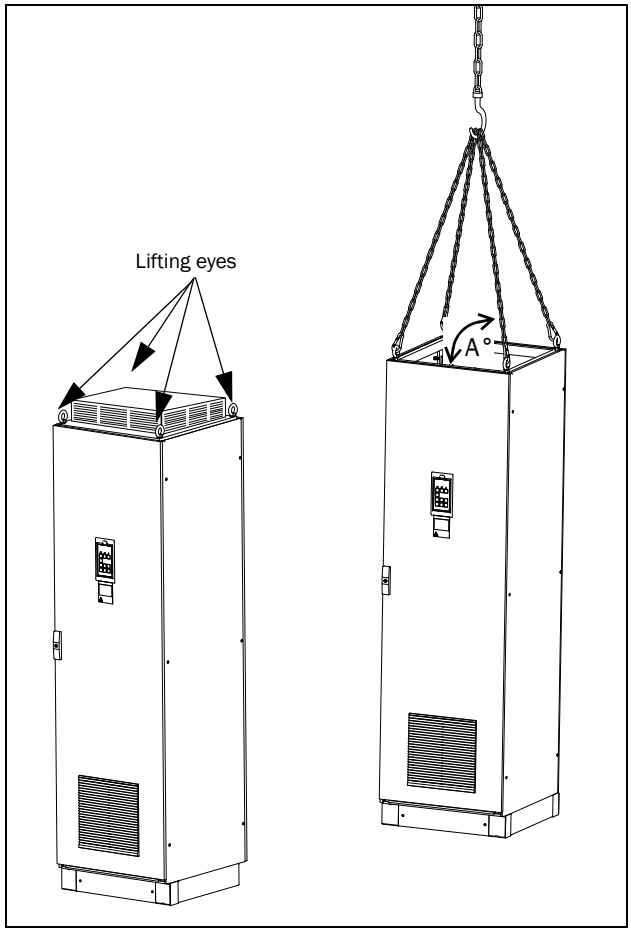


Fig. 9 Remove the roof unit and use the lifting eyes to lift single unit 600 mm and 900 mm.

Single cabinet drives can be lifted/transported safely using the eyebolts supplied and lifting cables/chains as in illustration Fig. 9 above.
Depending on the cable/chain angle A (in Fig. 9), following loads are permitted:

Cable/chain angle A	Permitted load
45 °	4 800 N
60 °	6 400 N
90 °	13 600 N

Regarding lifting instructions for other cabinet sizes, please contact Emotron.

3.1.1 Cooling

Fig. 10 below shows the minimum free space required above the AFR/AFG or VSI cabinets in order to guarantee adequate cooling. Normally the cabinet can be placed close to a wall or another cabinet, however 65 mm space to the wall is required in order to open the cabinet door with main switch handle at least 90 for maintenance.

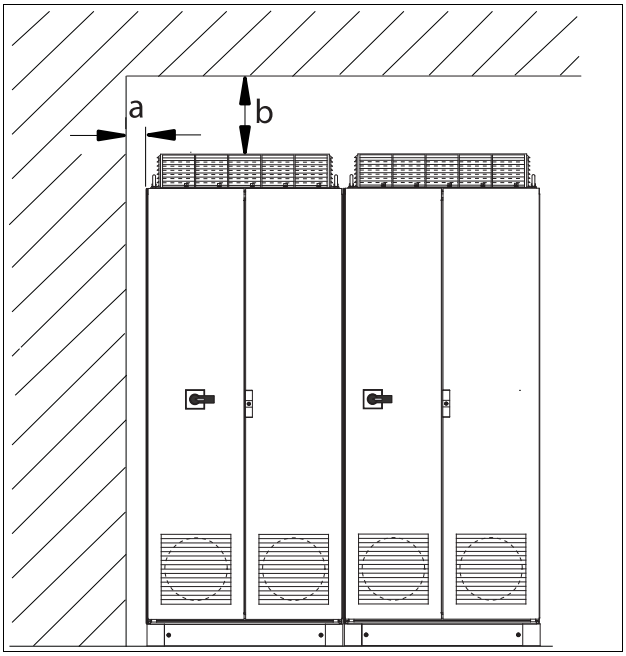


Fig. 10 Required free space around cabinet

Position	Free space
a	65 mm (2.6 in)
b	200 mm (7.9 in)

NOTE:
When a cabinet is placed between two walls, a minimum distance at each side of 200 mm (7.9 in) must be maintained.

3.2 Cabinet mounting

3.2.1 Cooling

If the AFR/AFG or VSI is installed in a cabinet, the rate of airflow supplied by the cooling fans must be taken into consideration. Frame sizes are listed in chapter 14.1 page 161.

Table 4 Flow rate cooling fans

Frame	AFR/AFG Model	Flow rate m^3/hour (ft^3/min)
E46	175/175	510 (300)
F46	250/250	800 (471)
F69	175/146	
G46	375/350	1020 (600)
H46	500/500	1600 (942)
H69	350/292	
I46	750/750	2400 (1413)
I69	525/438	
J46	1K0/1K0	3200 (1883)
J69	700/584	
K46	1K5/1K5	4800 (2825)
K69	1K05/876	

NOTE:
For the models 1K0 to 1K5 the mentioned amount of air flow should be divided equally over the two cabinets.

3.2.2 Mounting schemes

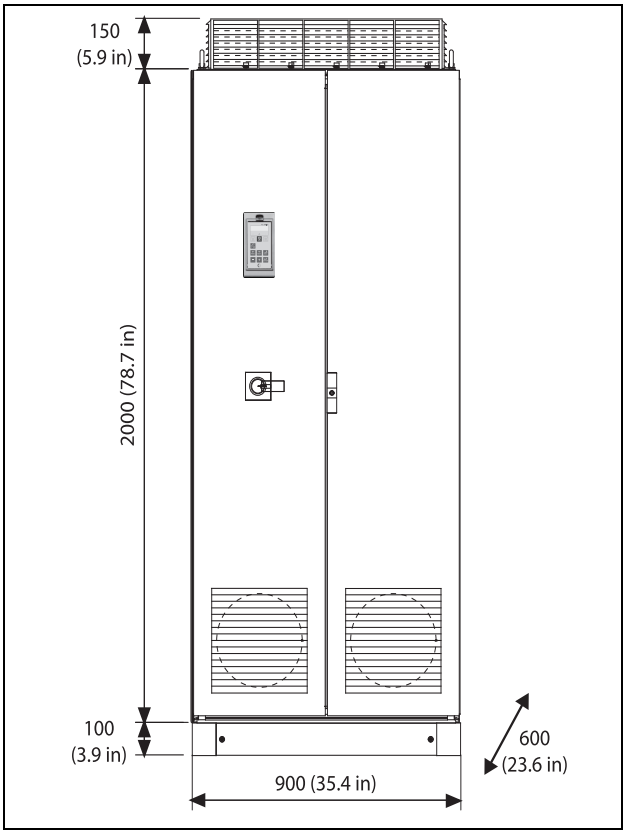


Fig. 11 FDUL/VFXR46, FDUG/VFXG46: Model 175 to 250

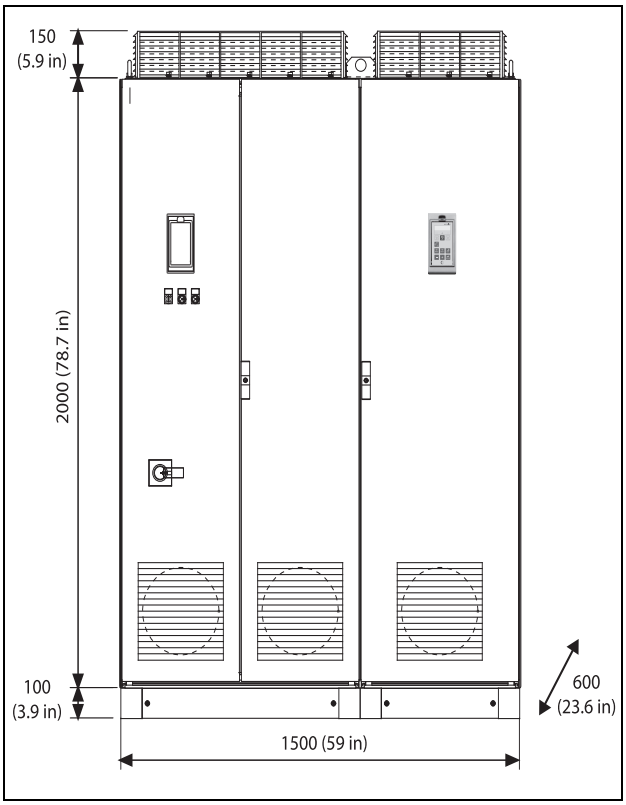


Fig. 12 FDUL/VFXR46, FDUG/VFXG46: Model 375 to 500

3.2.3 Recommended free space in front of cabinet

The cabinet mounted AC drives are designed in modules, so called PEBBs. These PEBBs can be folded out to be replaced. To be able to remove a PEBB in the future, we recommend 1.30 meter (39.4 in) free space in front of the cabinet, see Fig. 13.

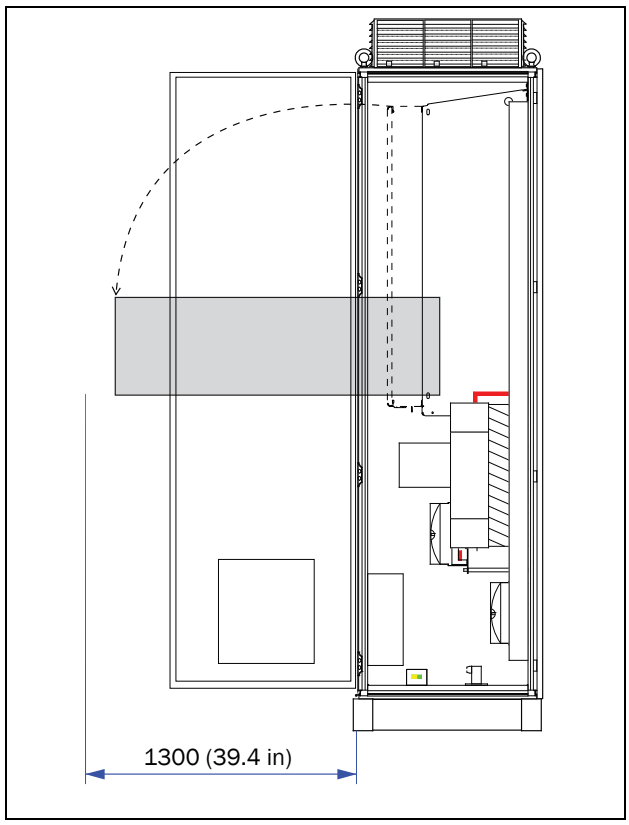


Fig. 13 Recommended free space in front of the cabinet.

3.3 Mounting AFR/AFG/VSI power modules (inside the cabinet)

Following figures provide mounting guidelines when mounting AFR/AFG/VSI power modules inside the cabinet.

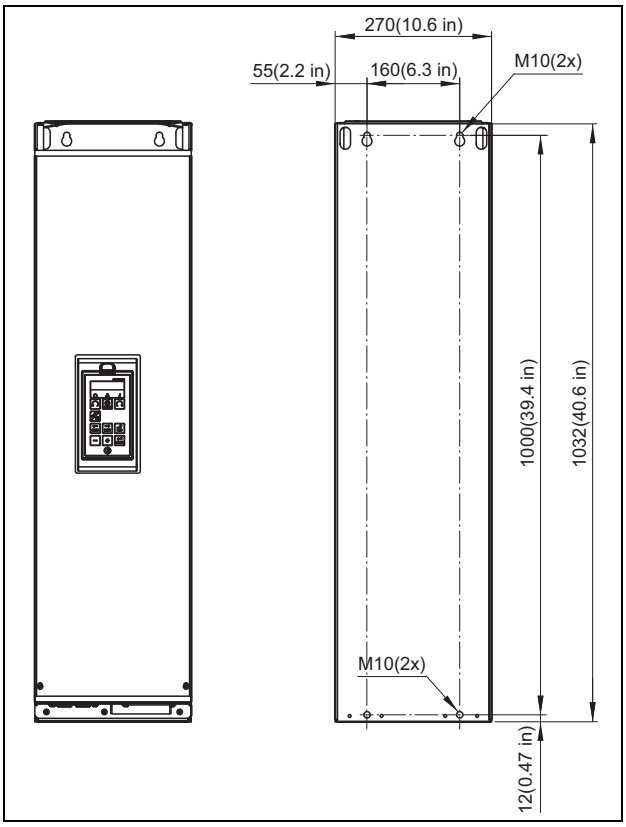


Fig. 14 Single PEBB frame (frame size FS), models AFR/AFG46-175 to AFR/AFG46-250

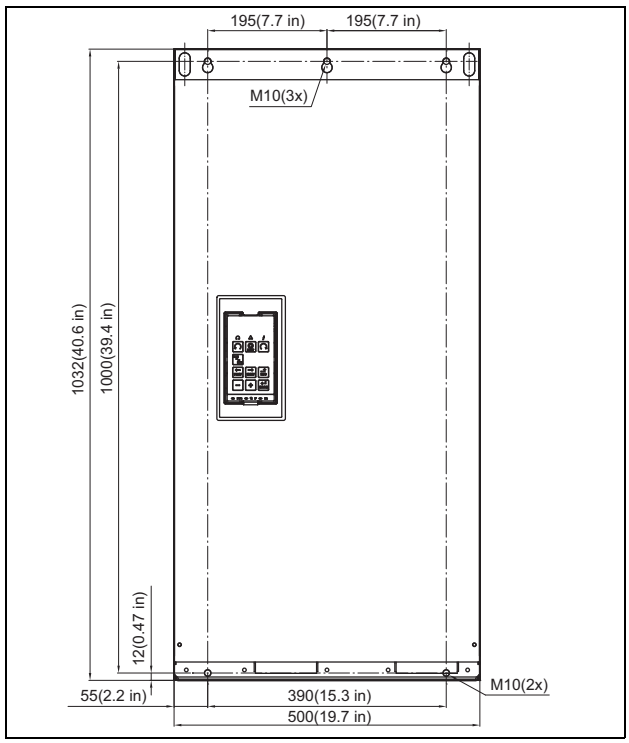


Fig. 15 Dual PEBB frame (frame size H), models AFR/AFG46-275 to AFR/AFG46-500

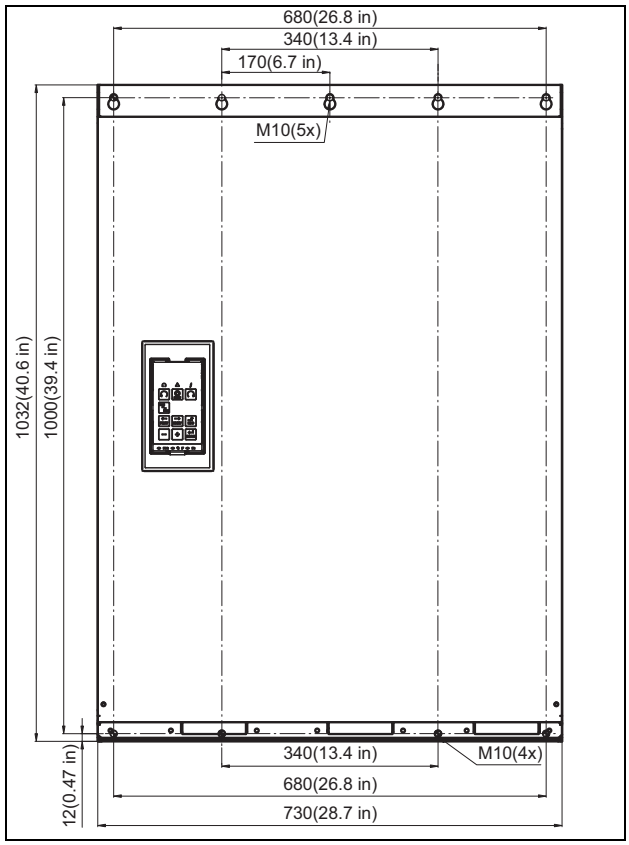


Fig. 16 Three PEBB frame (frame size I), models AFR/AFG46-750

For the higher model dimensions, contact your supplier for more information or visit www.cgglobal.com or www.emotron.com.

4. Installation

The description of installation in this chapter complies with the EMC standards and the Machine Directive.

Select cable type and screening according to the EMC requirements valid for the environment where the AFR/AFG and VSI is installed.

CAUTION!
Always consult CG Drives & Automation before connecting an AFR/AFG to a standard AC drive.

4.1 Before installation

Read the following checklist and prepare for your application before installation.

- Local or remote control.
- Functions used.
- Suitable AFR/AFG and VSI size in proportion to the motor/application.
- Mount separately supplied option boards according to the instructions in the appropriate option manual.

If the AFR/AFG and AC drive is temporarily stored before being connected, please check the technical data for environmental conditions. If the AFR/AFG and VSI is moved from a cold storage room to the room where it is to be installed, condensation can occur on it. Allow the AFR/AFG and VSI to become fully acclimatised and wait until any visible condensation has evaporated before connecting the mains voltage.

4.2 Connect motor and mains

4.2.1 Single drives

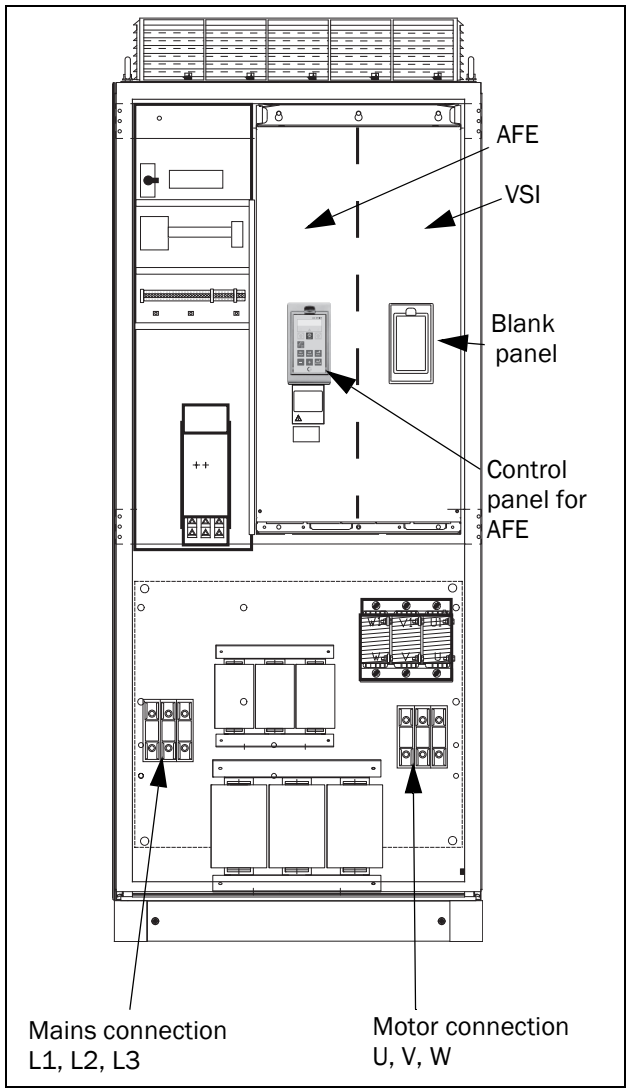


Fig. 17 Connecting motor and mains cables for FDUL/VFXR46-109 to 250 and FDUG/VFXG46-109 to 250

Table 5 Mains and motor connection

L1,L2,L3 PE	Mains supply, 3 -phase Safety earth (protective earth)
⏚ U, V, W	Motor earth Motor output, 3-phase
DC-,DC+	DC-link connections (optional)

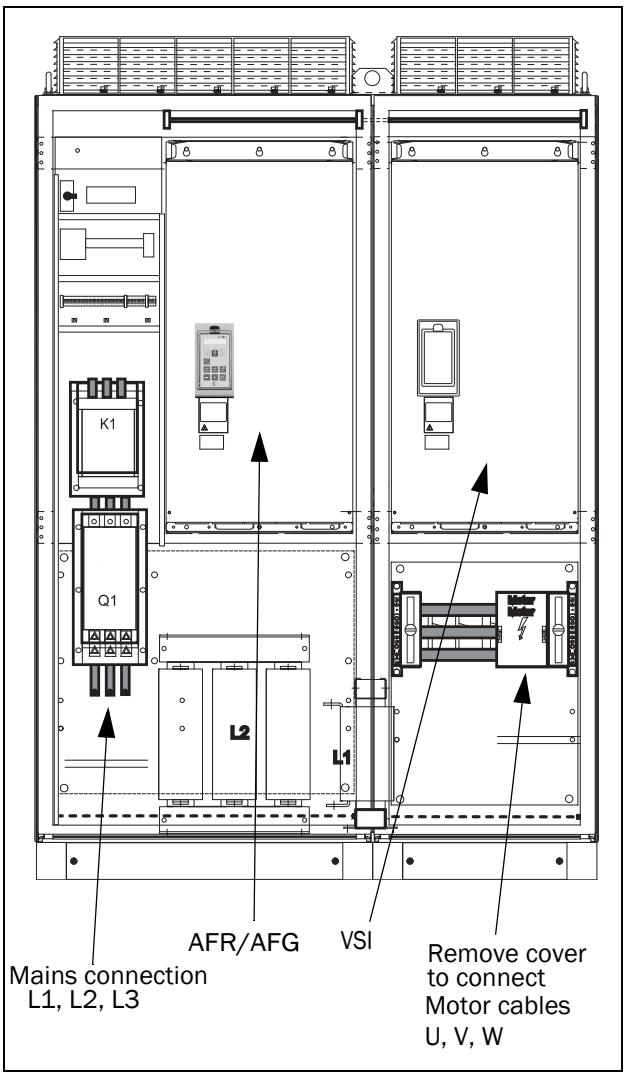


Fig. 18 Connecting motor and mains cables for FDUL/VFXR46-375 to 500 and FDUG/VFXG46-350-500

4.2.2 Common DC-bus

For common DC-bus applications, the cabinet will contain only the AFR/AFG part.

4.2.3 AFR/AFG

For the AFR/AFG deliveries, the cabinet only contains AFR/AFG parts.

4.3 Cable specifications

Table 6 Cable specifications

Cable	Cable specification
Mains	Power cable suitable for fixed installation for the voltage used.
Motor	Symmetrical three conductor cable with concentric protection (PE) wire or a four conductor cable with compact low-impedance concentric shield for the voltage used.
Control	Control cable with low-impedance shield, screened.

5. Control connections

5.1 Control board

Fig. 19 shows the layout of the control board which is where the parts most important to the user are located. Although the control board is galvanically isolated from the mains, for safety reasons do not make changes while the mains supply is on!

WARNING!
Always switch off the mains voltage and wait at least 7 minutes to allow the DC capacitors to discharge before connecting the control signals or changing position of any switches. If the option External supply is used, switch of the mains to the option. This is done to prevent damage on the control board.

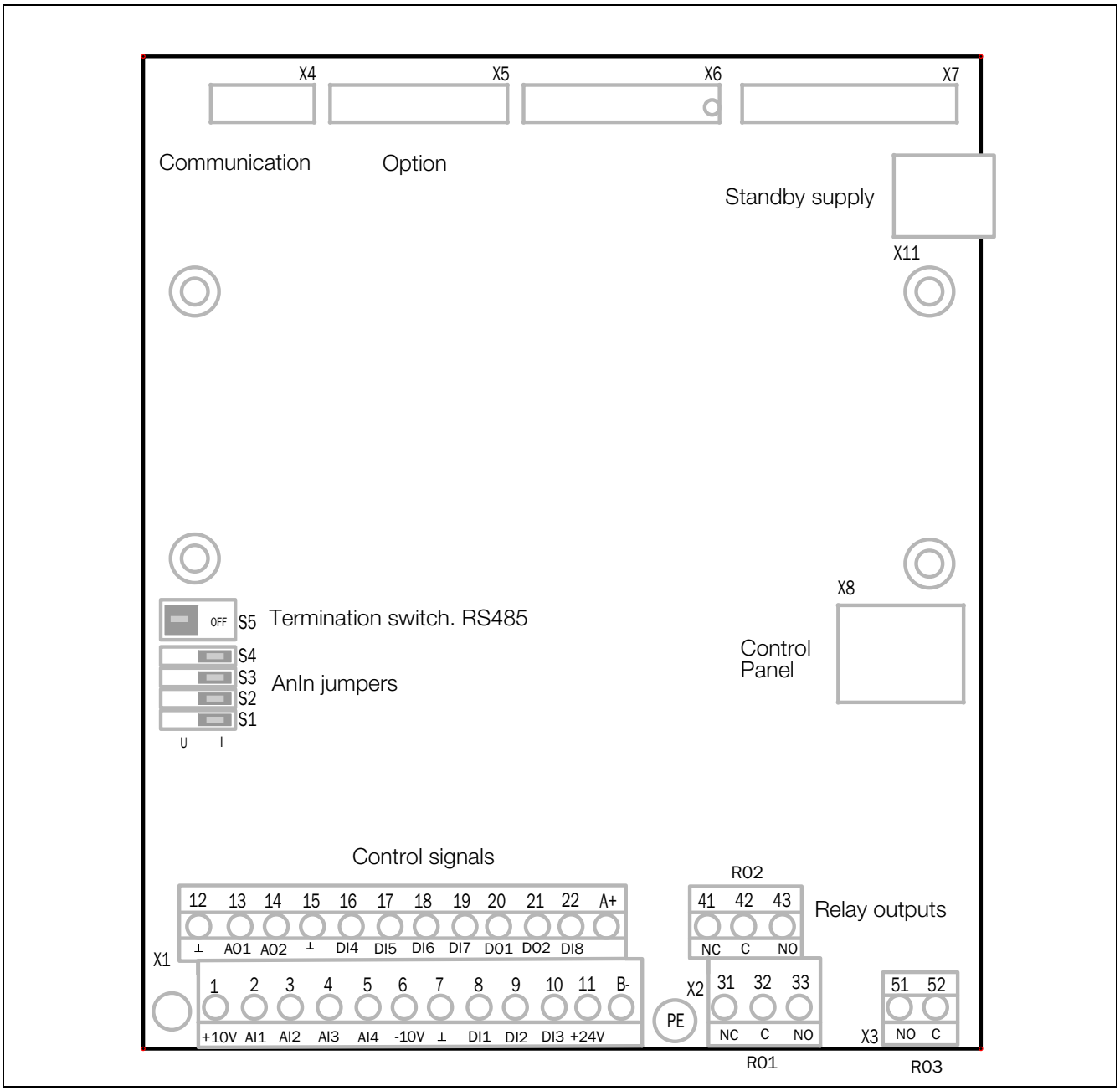


Fig. 19 Control board layout

NOTE:
AnIn switches (S1 to S4) should be in U position when any particular AnIn is used for supply voltage measurement board (SVMB).

5.2 Terminal connections for AFR/AFG

The terminal strip for connecting the control signals is accessible after opening the front door.
The table describes the default functions for the signals. The inputs and outputs are programmable for other functions as described in chapter 11. page 69. For signal specifications refer to chapter 14. page 161.
For VSI, refer to instruction manual for Emotron FDU or VFX.

NOTE:
The maximum total combined current available for outputs 11, 20 and 21 is 100 mA. Supply voltage measurement board (SVMB) when connected (for example in AFG) takes 50 mA out of that total available (100 mA) current.

Table 7 Control signals for AFR/AFG

Terminal	Name	Function (Default)
Outputs		
1	+10 V	+10 VDC supply voltage
6	-10 V	-10 VDC supply voltage
7	Common	Signal ground
11	+24 V	+24 VDC supply voltage
12	Common	Signal ground
15	Common	Signal ground
Digital inputs		
8	DigIn 1	RunL (reverse)
9	DigIn 2	RunR (forward)
10	DigIn 3	Enable
16	DigIn 4	Off
17	DigIn 5	Off
18	DigIn 6	Off
19	DigIn 7	Off
22	DigIn 8	RESET
Digital outputs		
20	DigOut 1	NOT2 Active when AFE not running or DC-link voltage has not reached reference value
21	DigOut 2	L1 (Trip pulse of 1s)
Analogue inputs		
2	AnIn 1	Process Ref
3	AnIn 2	AFR: Off AFG: U(L1)
4	AnIn 3	AFR: Off AFG: U(L2)
5	AnIn 4	AFR: Off AFG: U(L3)

Table 7 Control signals for AFR/AFG

Terminal	Name	Function (Default)
Analogue outputs		
13	AnOut 1	0 to nominal current
14	AnOut 2	0 to Electrical Power
Integrated RS-485[1]		
A+	A+	RS-585 Differential transmit and receive
B-	B-	
Relay outputs		
31	N/C 1	Relay 1 output Dedicated for Charge contactor K2.
32	COM 1	
33	N/O 1	
41	N/C 2	Relay 2 NOT2 Active when AFE not running or DC-link voltage has not reached reference value
42	COM 2	
43	N/O 2	
51	COM 3	Relay 3 output Dedicated for Main contactor K1
52	N/O 3	

[1] The integrated RS-485 interface is a isolated interface supporting Modbus RTU protocol with baudrates ranging from 2400 bit/s up to 115.2 kbit/s. Termination and fail-safe can be activated via switch S5 when applicable. Note that proper termination and fail-safe is critical for a stable RS-485 network. It is recommended to use screened RS-485 cable which protects the signals from EMI. The cable screen should (in normal cases) be connected to inverter PE via provided screen clamps, see fig. 57. For further information about Modbus RTU protocol and physical network connection see Emotron option manual for Serial communication RS-232/485 available on our website.

NOTE:
N/C is opened when the relay is active and N/O is closed when the relay is active.

5.2.1 Stand by supply interface (SBS)

The control board mounted standby supply, X11 connector, provides the possibility of keeping the communication system up and running without having the 3-phase mains connected. Another advantage is that the system can be set up without mains power. The option will also give backup for communication failure if main power is lost.

The standby supply should be supplied with a 24 VDC ±10% double isolated transformer capable of supplying 1A continues current. Recommended fuse is 2A. Cable length limited to 30 m. If the cable is longer than 30 m, a shielded cable must be used.

Table 8 X11 terminal

Terminal	Name	Function
1	+	24 VDC ±10%
2	-	0 V

NOTE: In case the isolated DC measurement board (that incorporate stand by supply [SBS] functionality) the control-board SBS should not be used. Rather the SBS on the isolated DC measurement board should be used. Failure to comply with this will break DC-link voltage measurement.

5.3 Configuration with jumpers and switches

5.3.1 Analouge input configuration (S1-S4)

The switches S1 to S4 are used to set the input configuration for the 4 analogue inputs AnIn1, AnIn2, AnIn3 and AnIn4 as described in Table 9.
The switches on the Control board are accessible after opening the door and removing the PPU cover plate.

Table 9 Switch settings

Input	Signal type	Switch
AnIn1	Voltage	S1
	Current (default)	S1
AnIn2	Voltage	S2
	Current (default)	S2
AnIn3	Voltage	S3
	Current (default)	S3
AnIn4	Voltage	S4
	Current (default)	S4

NOTE:
Scaling and offset of AnIn1 - AnIn4 can be configured using the software. See menus [512], [515], [518] and [51B].

NOTE:
Switches for AnIn2 to AnIn4 must be in U (Voltage position) when using Voltage measurement board. Switches must be in I (Current) position if current source is used for analogue input.

5.3.2 RS-485 termination (S5)

Switch S5 is used to activate termination and fail-safe resistors for the integrated RS-485-interface on terminal X1: A+ and B-. See fig. 20 for the location of the switch.

Table 10 Settings switch S5

Input	Termination	Selector configuration
RS-485	Off	S5
	Activated	S5

NOTE: It is important to have termination and fail-safe activated on at least one node on the network to secure proper function. The termination shall ONLY be enabled in the cable ends of a RS-485 network. The termination resistor is used to avoid reflections of transmitted signals and the fail-safe resistors will keep A+ and B- terminals at a steady state when no node is transmitting. It is important not to enable any additional termination apart from the two in each cable end as it will impose as an additional load for a transmitting transceiver and may cause malfunctioning.

5.4 Control connections for Emotron FDUL/VFXR/ FDUG/VFXG

Fig. 30 shows typical control signal connections required for basic functionality. For more detailed information, see drawings in cabinet and instruction manual for the Emotron VFX, chapter “Control connections”.

WARNING!
Always switch off the mains voltage and wait at least 7 minutes to allow the DC capacitors to discharge before connecting the control signals or changing position of any switches. If the option External supply is used, switch of the mains to the option. This is done to prevent damage on the control board.

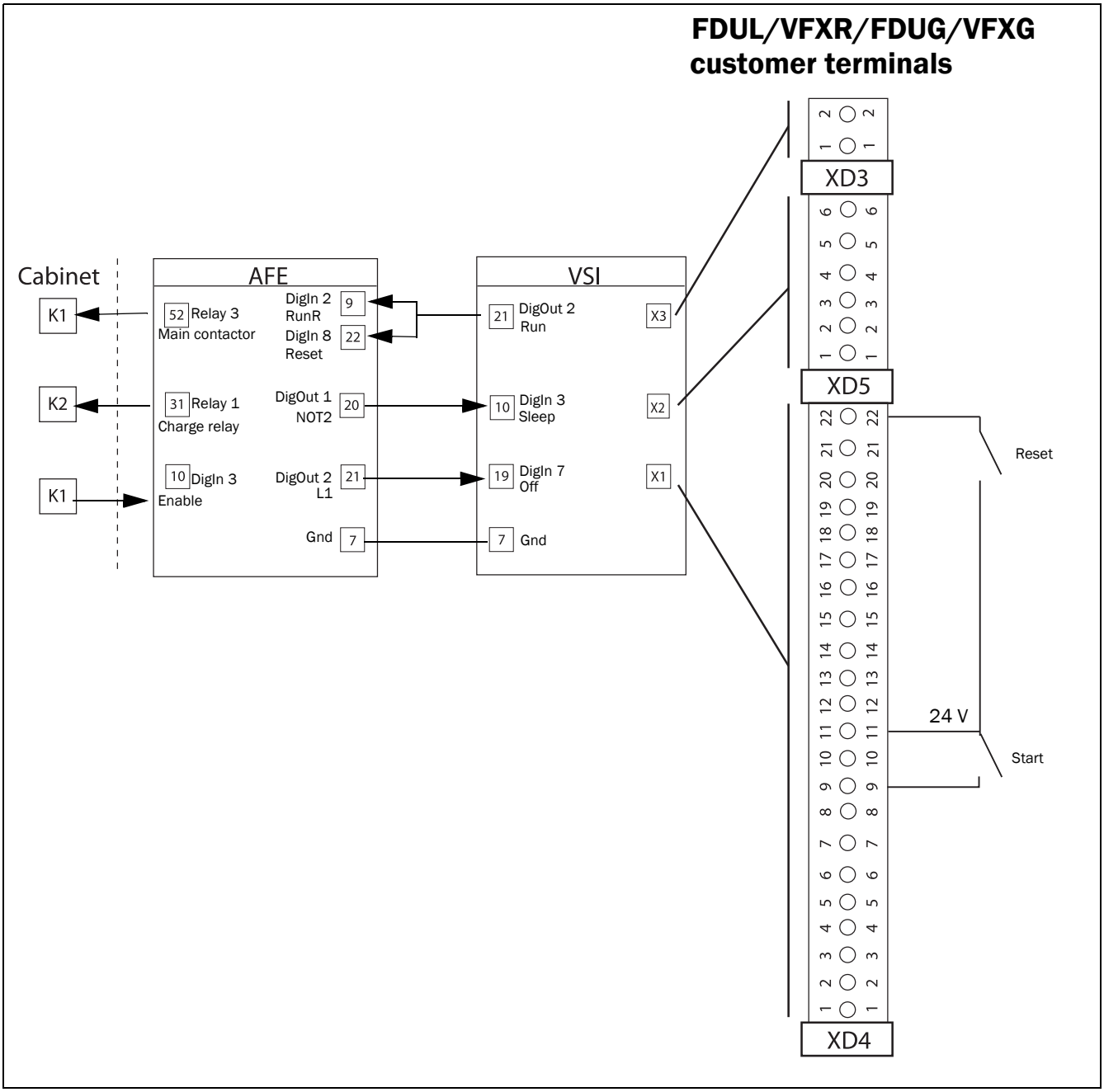


Fig. 20 Recommended control signals

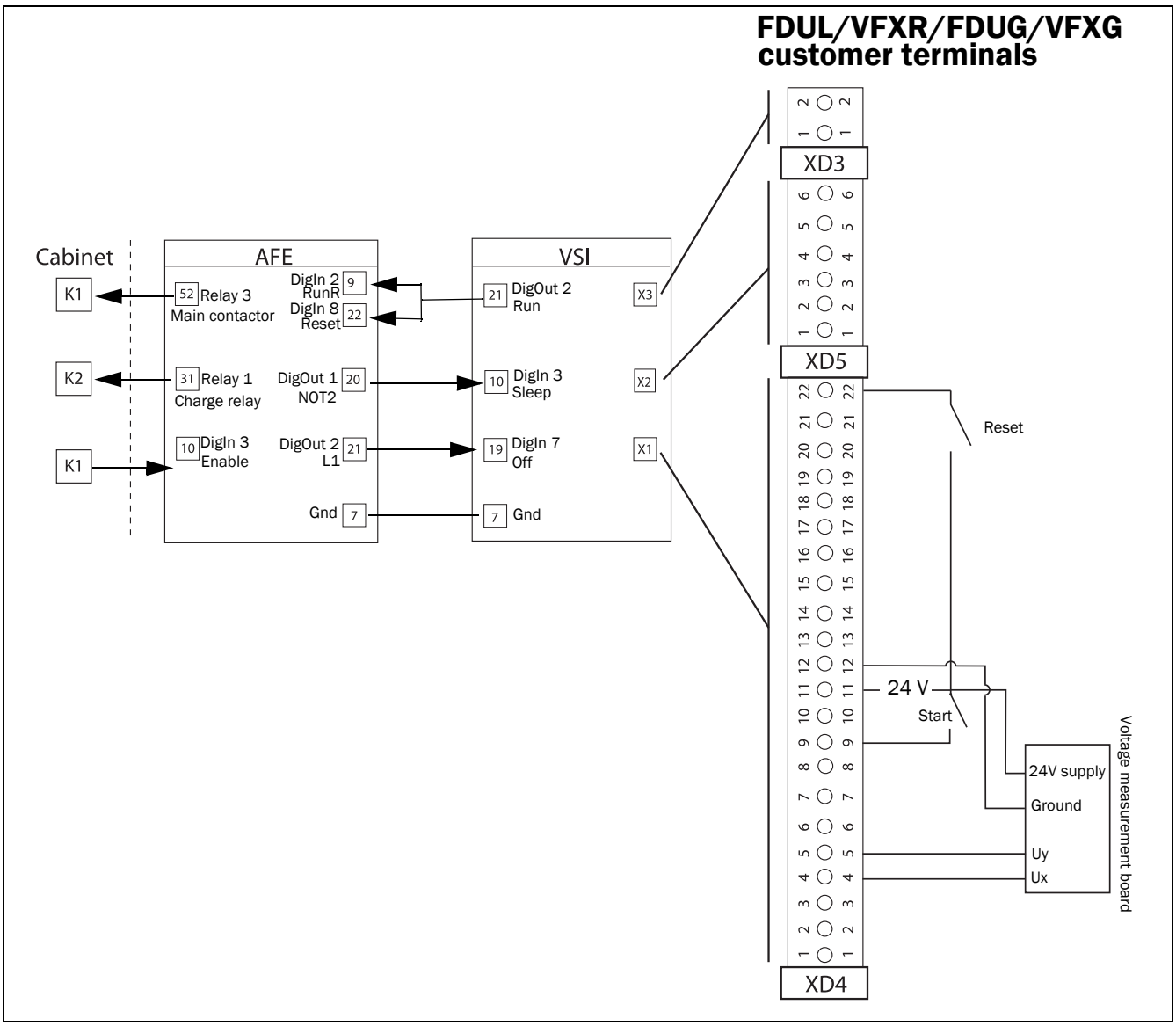
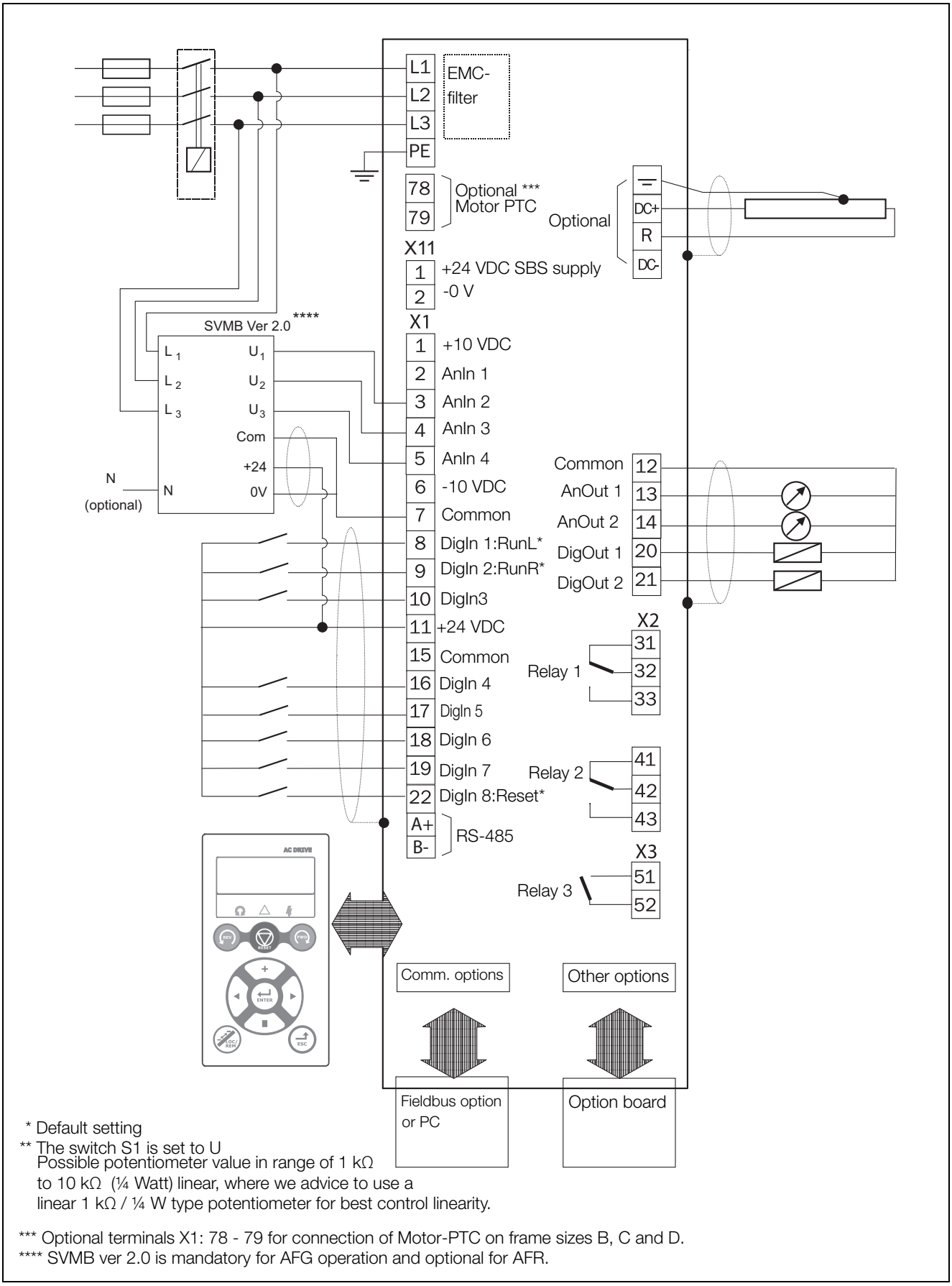


Fig. 21 Alternative wiring scheme with Voltage measurement board.



* Default setting
** The switch S1 is set to U
Possible potentiometer value in range of 1 kΩ to 10 kΩ (¼ Watt) linear, where we advice to use a linear 1 kΩ / ¼ W type potentiometer for best control linearity.

*** Optional terminals X1: 78 - 79 for connection of Motor-PTC on frame sizes B, C and D.
**** SVMB ver 2.0 is mandatory for AFG operation and optional for AFR.

Fig. 22 AFR/AFG drive connection example

5.5 Connecting the control signals

5.5.1 Cables

The standard control signal connections are suitable for stranded flexible wire up to 1.5 mm^2 and for solid wire up to 2.5 mm^2.

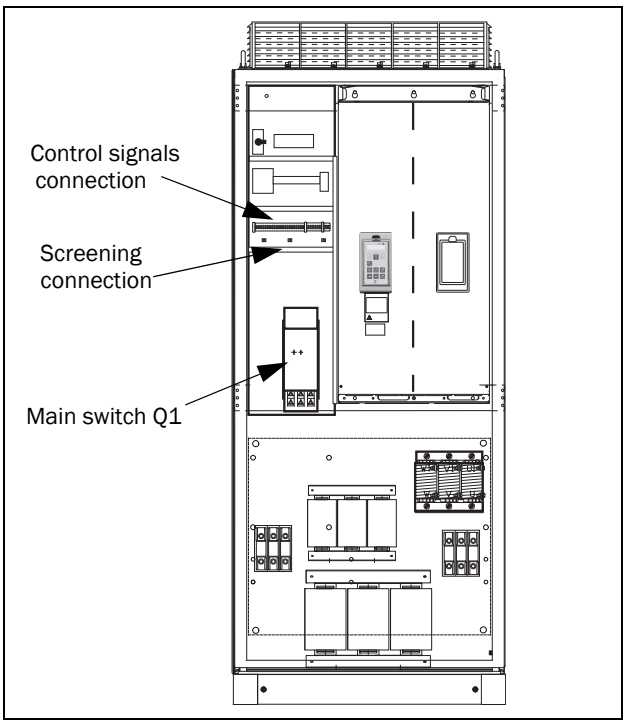


Fig. 23 Connecting the control signals FDUL/VFXR46 - 109 to 250 and FDUG/VFXG46 - 109 to 250.

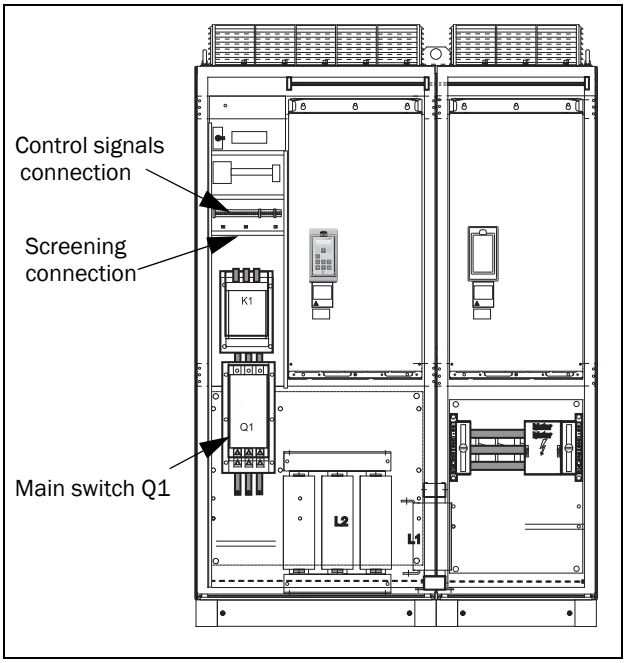


Fig. 24 Connecting control signal FDUL/VFXR46-375 to 500 and FDUG/VFXG46-350 to 500.

NOTE:
The screening of control signal cables is necessary to comply with the immunity levels given in the EMC Directive (it reduces the noise level).

NOTE:
Control cables must be separated from motor and mains cables.

5.5.2 Types of control signals

Always make a distinction between the different types of signals. Because the different types of signals can adversely affect each other, use a separate cable for each type. This is often more practical because, for example, the cable from a pressure sensor may be connected directly to the motor inverter.

We can distinguish between the following types of control signals:

Analogue inputs

Voltage or current signals, (0-10 V, 0/4-20 mA) normally used as control signals for speed, torque and PID feedback signals.

Analogue outputs

Voltage or current signals, (0-10 V, 0/4-20 mA) which change slowly or only occasionally in value. In general, these are control or measurement signals.

Digital

Voltage or current signals (0-10 V, 0-24 V, 0/4-20 mA) which can have only two values (high or low) and only occasionally change in value.

Data

Usually voltage signals (0-5 V, 0-10 V) which change rapidly and at a high frequency, generally data signals such as RS232, RS485, Profibus, etc.

Relay

Relay contacts (0-250 VAC) can switch highly inductive loads (auxiliary relay, lamp, valve, brake, etc.).

Signal type	Maximum wire size	Tightening torque	Cable type
Analogue	Solid wire: 0.14-2.5 mm^2 (AWG 26 - 14) Flexible wire: 0.14-1.5 mm^2 (AWG 26 - 16) Wire with ferrule: 0.25-1.5 mm^2 (AWG 24 - 16)	0.5 Nm (4.4 LB-in)	Screened
Digital			Screened
Data			Screened
Relay			Not screened

Example:
The relay output from a motor inverter which controls an auxiliary relay can, at the moment of switching, form a source of interference (emission) for a measurement signal from, for example, a pressure sensor. Therefore it is advised to separate wiring and screening to reduce disturbances.

5.5.3 Screening

For all signal cables the best results are obtained if the screening is connected to both ends: the VSI side and at the source (e.g. PLC, or computer). See Fig. 35.

It is strongly recommended that the signal cables be allowed to cross mains and motor cables at a 90° angle. Do not let the signal cable go in parallel with the mains and motor cable.

5.5.4 Single-ended or double-ended connection?

In principle, the same measures applied to motor cables must be applied to all control signal cables, in accordance with the EMC-Directives.

For all signal cables as mentioned in section 5.5.2 the best results are obtained if the screening is connected to both ends. See Fig. 35.

NOTE:
Each installation must be examined carefully before applying the proper EMC measurements.

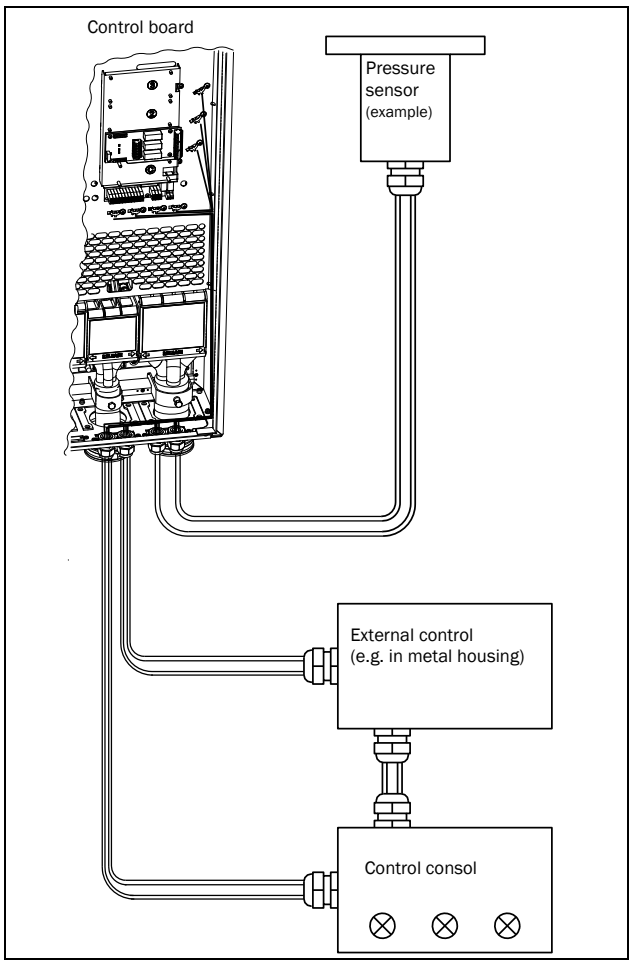


Fig. 25 Electro Magnetic (EM) screening of control signal cables.

5.5.5 Current signals ((0)4-20 mA)

A current signal like (0)4-20 mA is less sensitive to disturbances than a 0-10 V signal, because it is connected to an input which has a lower impedance (250 Ω) than a voltage signal (20 kΩ). It is therefore strongly advised to use current control signals if the cables are longer than a few metres.

5.5.6 Twisted cables

Analogue and digital signals are less sensitive to interference if the cables carrying them are “twisted”. This is certainly to be recommended if screening cannot be used. By twisting the wires the exposed areas are minimised. This means that in the current circuit for any possible High Frequency (HF) interference fields, no voltage can be induced. For a PLC it is therefore important that the return wire remains in proximity to the signal wire. It is important that the pair of wires is fully twisted over 360°.

5.6 Connecting options

The option cards are connected by the optional connectors X4 or X5 on the control board see Fig. 19, page 23 and mounted above the control board. The inputs and outputs of the option cards are connected in the same way as other control signals.

6. Getting Started

This chapter is a step by step guide that will show you the quickest way to get the AFR/AFG running and motor shaft turning in case of FDUL/VFXR/FDUG/VFXG. We will show you setup with remote control.

We assume that the AFR/AFG and VSI is mounted in a cabinet as in the chapter 3. page 17.

First there is general information of how to connect mains, motor and control cables. The next section describes how to use the function keys on the control panel. The subsequent remote control example describe how to program/set the motor data and run the AFR/AFG, the VSI and motor.

6.1 Connect the mains and motor cables

Dimension the mains and motor cables according to local regulations. The cables must be able to carry the AFR/AFG and VSI load current.
Connect mains cables and motor cables according to chapter 4.2 page 21.

CAUTION!
Always switch off the main voltage before opening the drive.

6.2 Using the function keys

For more information regarding the control panel and menu system, see chapter 9. page 57.

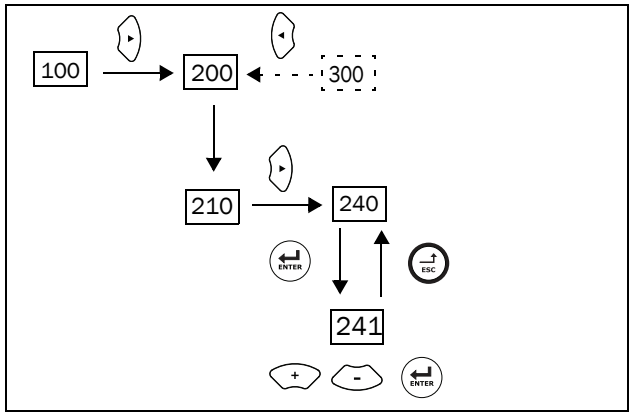


Fig. 26 Example of menu navigation when entering motor voltage

ENTER	step to lower menu level or confirm changed setting
ESC	step to higher menu level or ignore changed setting
▸	step to next menu on the same level
◂	step to previous menu on the same level
+	increase value or change selection
-	decrease value or change selection

6.3 Remote control

In this example external signals, an external start button and an analogue reference, are used to control the VSI and motor. The AFR/AFG is controlled from the VSI in case of FDUL/VFXR/FDUG/VFXG.

In order to perform the setup examples, you will use the control panels for the AFR/AFG (inside cabinet) and VSI (cabinet door), see Fig. 51, page 57. For further information about the control panel (CP) and menu structure, see chapter 9. page 57.

6.3.1 Set up AFR/AFG

WARNING!
Always switch off the mains voltage before opening the drive unit and wait at least 7 minutes to allow the buffer capacitors to discharge.

Make sure that the main supply is switched off and open the AFR/AFG or FDUL/VFXR/FDUG/VFXG door. For FDUL/VFXR/FDUG/VFXG case check wiring according to Fig. 20, page 27.

NOTE: Wiring is pre-made from factory.
In this case, wiring is made for Charge method [O21] "Supply-NC" via NC terminal (31) on CB Relay 1.

1. If other Charge method [O21] than default "Supply-NC" = Charge at power supply via NC terminal on Relay 1 is to be used then
   a) Connect Charge Relay control signal to NO terminal (33)
   b) Connect external 24V supply. Required for all Charge methods [O21] using NO terminal (33).
   c) Setup required Charge method [O21].
2. Switch on the power supply. Once the mains is switched on, the internal fans of the AFR/AFG and VSI will run for 5 seconds. Menu [100] Preferred view is displayed in CP after power up.

WARNING!
While power is supplied to the inverter, do not touch any terminal or internal part of the inverter. Do not connect or disconnect any wire or connector. Otherwise, you run the risk of electric shock resulting in serious injury!
In addition this could cause serious damage to the active front end or motor inverter.

3. Perform a supply ID-run [O15]
   a) [Set [O15] Supply ID run to On, confirm with ENTER
   b) Give start command .
   c) The AFE will now measure and setup supply parameters
   * [O11] Supply volatge
   * [O13] Supply frequency
   * [O14] Supply phase sequence
   d) After successful ID-run ("Test Run OK" is displayed)
   e) Verify the new settings for [O11]-[O14].
   f) Mains supply voltage [O11] can preferably be manually set back to the average mains supply voltage value after ID-run. This is recommended if the mains supply voltage fluctuates much over time.
4. For 1st run, setup AFE to start from CP.
   a) Set Reference control [214] to "Keyboard"
   b) Set Run/Stop control [215] to "Keyboard"
   c) Set Reset control [216] to "Keyboard"
   d) Set Process Ref [310] to 0%.
   e) Disable reactive power compensation by setting Q max [O41] to 0%.
   f) Start AFR/AFG by pressing or . Note that the both run directions, i.e. RunR and RunL, are accepted independent of the actual phase sequence.
   g) Verify operation via menus [710].
   h) Stop AFR/AFG by pressing Stop/Reset.

Set up AFR/AFG to be controlled from VSI

After validating the AFR/AFG operation (following steps in 6.3.1), follow the below given steps to setup the AFR/AFG to be controlled from VSI.

5. Setup AFR/AFG to start from VSI command via I/O.
   a) Change Ref control [214] to "Remote"
   b) Change Run/Stop control [215] to "Remote"
   c) Change Reset control [216] to "Remote" or "Remote+Keyb"
   d) Verify parameter setup according to Table 11 below.

Table 11 Parameter setup for AFR/AFG to controlled from VSI

Parameter	Setup	Comment
[214] Ref Control	Remote	AFE command setup Q (cos φ) reference
[215] Run/Stp Ctrl	Remote	
[216] Reset Ctrl	Remote	
[310] Set/View ref	0%	
[522] DigIn 2	RunR	AFE/VSI command/ feedback
[528] DigIn 8	Reset	
[541] DigOut 1	NOT2	
[542] DigOut 2	L1	
[523] DigIn 3	Enable	Cabinet hardware control/feedback
[551] Relay 1	Charge relay (K2)	
[552] Relay 2	NOT2	
[553] Relay 3	Main relay (K1)	

Table 11 Parameter setup for AFR/AFG to controlled from VSI

Parameter	Setup	Comment
[6521] Timer2 Trig	Trip	AFE 1s trip pulse
[6522] Timer2 Mode	Delay	
[6523] Timer2 Delay	1.0 sec	
[631] NOT1 Input	T2Q	
[6412] L1 Input 1	Trip	
[6413] L1 Op1	&	
[6414] L1 Input 2	NOT1	
[6415] L1 Op2	.	
[6416] L1 Input 3	Off	
[6417] L1 Op3	.	
[632] NOT2 Input	Udc OK	Feedback signal to VSI that AFE is running or not.

6. Now the AFR/AFG is set to be controlled from the VSI.
7. Close the AFR/AFG cabinet door.

6.3.2 Set up VSI

Menu [100], Preferred View is displayed when started.

1. Enter correct motor data for the connected motor. The motor data is used in the calculation of complete operational data in the VSI.
   a) Set motor voltage [221]
   b) Set motor frequency [222]
   c) Set motor power [223]
   d) Set motor current [224]
   e) Set motor speed [225]
   f) Set motor power factor (cos φ) [227]
   g)Select supply voltage level used [21B]
   h) [229] Motor ID run: Choose Short, confirm with and give start command .
   The VSI will now measure some motor parameters. The motor makes some beeping sounds but the shaft does not rotate. When the ID run is finished after about one minute ("Test Run OK!" is displayed), press to continue.
2. Use AnIn1 as input for the reference value. The default range is 4-20 mA. If you need a 0-10 V reference value, change switch (S1) on control board and set [512] Anln 1 Set-up to 0-10V.
3. Setup VSI to control the AFR/AFG via I/O, see Table 12.
   a) Set digital output 2 [542] to "Run". Gives start command to AFR/AFG from VSI.
   b) Set digital input 3 [523] to "Sleep". Feedback to VSI that AFR/AFG is running.
   c) Adapt AFR/AFG trip pulse polarity for VSI Extern Trip polarity.
   * Set digital input 7 [527] to "Off". Feedback to VSI that AFR/AFG is tripped (pulse if 1s).
   * Set digital comparator 1 [6151] to "DigIn7".
   * Set virtual I/O 1 Source [562] to "!D1".
   * Set virtual I/O 1 Destination [561] to "Ext Trip". see Table 12.

Table 12 Default parameter setup for VSI (VFX/FDU 2.0)

Parameter	Setup	Comment
[523] DigIn 3	Sleep	Feedback signal to VSI that AFE is running or not.
[542] DigOut 2	Run	Command AFE run
[527] DigIn 7	Off	Feedback AFE trip via Ext Trip
[561] VIO 1 Dest	External trip	
[562] VIO 1 Source	NOT2	
[632] NOT2 Input	DigIn 7	

4. Switch off power supply.

WARNING!
Always switch off the mains voltage before opening the drive unit and wait at least 7 minutes to allow the buffer capacitors to discharge.

5. Connect digital and analogue inputs/outputs as in Fig. 27.
   a) Connect a reference value between terminals 7 (Common) and 2 (AnIn 1).
   b) Connect an external start button between terminal 11(+24 VDC) and 9 (DigIn2, RUNR).
   c) Connect a reset signal between terminal 11 (+24 VDC) and 22 Reset.

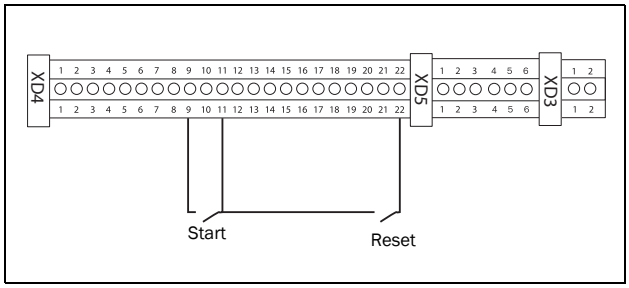


Fig. 27 Wiring

6. Close the door and switch on the power supply. Once the mains is switched on, the internal fans of the AFR/AFG and VSI will run for 5 seconds. Menu [100] Preferred view, is displayed in the Control panel after power up.

6.3.3 Run the VSI

Now the installation is finished, and you can press the external start button to start the motor.

When the AFR/AFG, VSI and motor are running the main connections are OK.

7. FDUL/VFXR/FDUG/ VFXG/AFR/AFG Main features

This chapter contains descriptions of the main features of the AFR/AFG drive.

7.1 Autoreset at trip

For several non-critical application-related failure conditions, it is possible to automatically generate a reset command to overcome the fault condition. The selection can be made in menu [250]. In this menu the maximum number of automatically generated restarts allowed can be set, see menu [251], after this the AC drive will stay in fault condition because external assistance is required.

Example

The motor is protected by an internal protection for thermal overload. When this protection is activated, the AC drive should wait until the motor is cooled down enough before resuming normal operation. When this problem occurs three times in a short period of time, external assistance is required.

The following settings should be applied:

- Insert maximum number of restarts; set menu [251] to 3.
- Activate Over temp to be automatically reset; set menu [252] to 300 s.
- Set relay 2, menu [552] to “AutoRst Trip”; a signal will be available when the maximum number of restarts is reached and the AC drive stays in fault condition.
- The reset input must be constantly activated.

7.2 Power-up and DC-link charging

Power up and charge control of the Emotron AFR/AFG and DC-link (U_{dc}) is handled via the dedicated control board (CB) relays 1 and 3, where Charge contactor (K2) control is fixed to CB Relay1 and Main contactor (K1) is fixed to CB Relay3.

Typical charge time is 3-5 s and an additional delay after K1 activation of 1s is added before Run (or Auto ID) command is acknowledged.

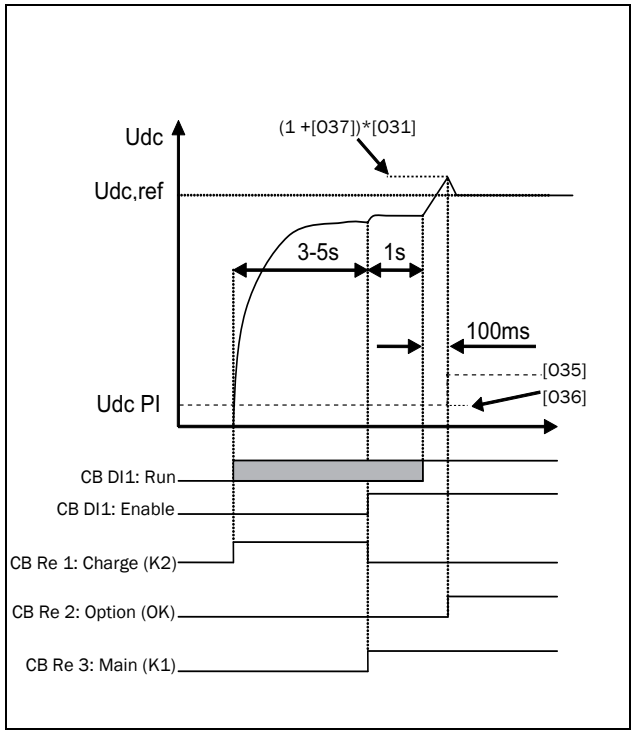


Fig. 28 DC-link voltage (U_{dc}) charge control.

Signal Running OK, i.e. U_{dc} under control can be signalled via digital output or CB Relay2 selection “UDC_Ok”.

If Auto ID mode[O16] is used an additional delay of 1s is inserted before Run command is acknowledged.

Table 13 I/O connection for AFR/AFG charge operation

AFR/AFG I/O	Contactor K1/K2	Comment
Re1=’Charge contactor’ {NC/NO}	K2.A1 (coil/ctrl)	
Re3=’Main contactor’ {NO}	K1.A1 (coil/ctrl)	
DI3=’Enable’	K1.NO (aux)	Enable AFR/AFG only if K1 OK. Preferably used also for “Emergency Stop”input.

7.3 Automatic power supply parameter detection

The AFR/AFG can automatically detect power supply parameters voltage [O11], frequency [O12] and phase sequence [O14] by separately activated function either manually [O15] or automatically at every power up [O16].

The power supply parameters are detected by running a network measurement routine. See chapter AFE Option [O00] for detailed information about AFR/AFG parameters.

7.4 Power supply synchronisation

The AFR/AFG synchronises to the power supply when starting by making test measurement. Synchronisation during operation is handled via the U_{dc} [O30], Q [O40] and frequency [O50] controllers. See chapter AFE Option [O00] for detailed information about AFR/AFG parameters.

Synchronisation methods

- Standard sync (Default), extended sync routine. This routine also verifies supply network. Takes approx. 50 ms.
- Voltage sync, i.e. via supply voltage measurement.
- Fast sync (fast measurement).

Fast sync method can be enabled via a service menu. Voltage sync requires supply voltage measurement option and is enabled via [O25].

7.5 Start command

The AFR/AFG can be started from digital I/O, control panel (CP) or via serial communication options. Typically the AFR/AFG is started via digital I/O either automatically at power up or by the VSI when the VSI have a run command.

In order to avoid unnecessary losses it is preferred only to run the AFR/AFG when needed, i.e. when the VSI has a run command. Fig. 20, page 27.

NOTE:
To protect AFE against damage an internal protection has been added so that it does not allow AFE to start if DC-link is already loaded. Sending start command generates "Start_Denied" warning if there exists load on DC-link. It is based on current measurement of AFR/AFG.
If required, customer can turn this protection off with the help of service/commissioning engineer.

If starting is required with loaded DC-link then it is recommended to use voltage measurement board (bypass/sync) option for starting/synchronization of AFE.

7.6 Start on regeneration demand

The AFR/AFG can be started on regeneration demand [O22], i.e. when the DC-link voltage increases due to generated power from the VSIs. In motoring operation the AFR/AFG modulation is deactivated and the free wheeling diodes operates as a DFE and in regenerating operation the AFR/AFG is activated and regenerates the energy back to the supply.

Regeneration start/stop operation

- The AFR/AFG will start (DFE stop) when DC-link voltage rises due to energy flow from load towards DC-link.
- The AFR/AFG will stop (DFE start) when energy flow from supply is positive (into the AFR/AFG) during stop delay time [O23].

NOTE:
Requires supply voltage measurement.

7.7 Under voltage ride through for AFR/FDUL/VFXR

AFR/FDUL/VFXR running with voltage measurement board, can withstand momentary power dips. The time to which the system (drive) can stay alive depends on the inertia of the application (load). If the system stays alive based on the energy stored in the inertia, the system (AFR/FDUL/VFXR) can continue its operation smoothly on returning of the supply.

NOTE: During the momentary dip, AFR/FDUL/VFXR unit will not be able to maintain THDI below 5%. However on returning the supply and during smooth operation the low harmonic or low THDI operation will be restored.

NOTE: For under voltage ride through function of AFR/FDUL/VFXR, menus [O25] and [O51] must be set to 'Sensor' and corresponding auto-reset functions must be configured in menu [25x].

NOTE: For staying alive, corresponding settings must be done on the AFR/FDUL/VFXR and on VSI control board. Contact your local supplier for assistance.

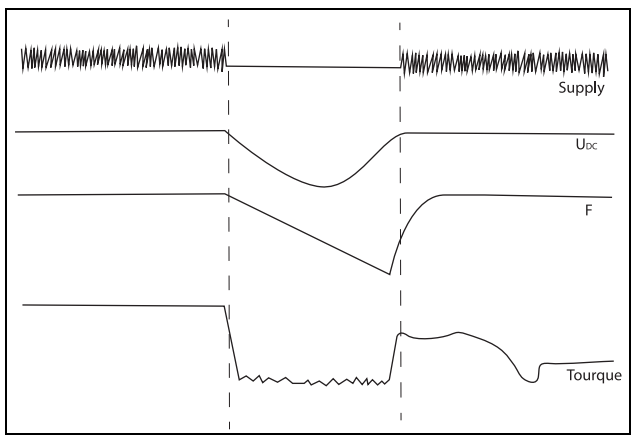


Fig. 29 Under voltage override

NOTE: AFG/FDUG/VFXG offer more advance features of fault ride though based on grid code requirements. For more details read section 7.17.

7.8 PWM modulation

The AFR/AFG uses carrier wave based PWM modulation for controlling the IGBTs.

7.9 Active power (Energy) control

The energy control is utilized by the DC-link voltage controller [O30] which balances the active power flow from supply to load, see Fig. 30

It is possible to set/change

- U_{DC} reference value - limited by the requirement of operation, i.e. voltage amplitude control.
- U_{DC} ramp time
- U_{DC} margin value
- U_{DC} controller parameters.

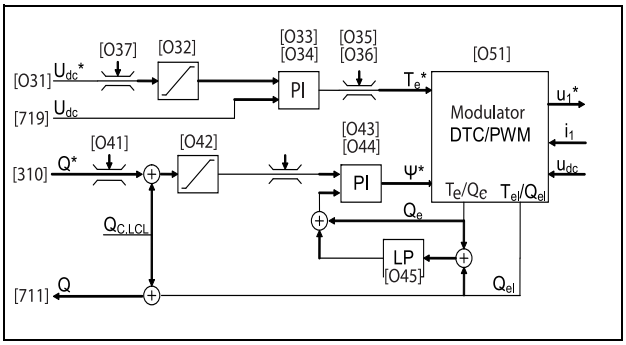


Fig. 30 U_{dc} and Q controllers in AFR.

PI - PI regulator

LP - Low pass filter

T_e - Active power

Q_e - Reactive power

*) Reference

7.10 Limit the regeneration capability of AFR/AFG

It is possible to limit the amount of energy fed back to the grid while braking. This feature can be utilized in cases where grid (or generator) can not handle all braking energy. Part of braking energy is fed to the grid and remaining part of energy needs to be burnt across the braking resistor.

NOTE: Brake IGBT and resistor are required in this case. For proper selection of brake resistor please see in chapter "Brake chopper" on page 157.

NOTE: Contact local supplier if assistance is required.

7.11 Reactive power (Q or cos φ) control (normally not used)

The reactive power (Q or cos φ) control can be used for reactive power compensation of other loads, i.e. motors. The amount of reactive power compensation possible is dependent on the unused capacity of the AFR/AFG, i.e. over capacity not used for active power control. The reactive power control is utilised via the Q controller [O40], see Fig. 30.

It is possible to set/change

- Q reference value via standard reference source (Remote, CP or COM)
- Q max limit
- Q ramp time
- Q controller parameters

7.12 Frequency (f) control

The AFR/AFG handles frequency variations via the supply frequency observer [O50].

7.13 Energy actual value signals

The AFR/AFG provides separate signals for: consumed, generated and total energy in group[O80] of the AFR/AFG.

7.14 Power factor calculations

The AFR/AFG- unit also presents the power factor at the connection terminals of the unit.

$$Cos\varphi = \frac{Q}{|Q|}\frac{|P|}{\sqrt{P^2+Q^2}}$$

P = Active Power

Q = Reactive Power

+ve value of Cosφ indicated the over excited state of operation whereas -ve value indicate the under-excited state of operation of AFR/AFG.

7.15 Fault signals

The AFR/AFG provides separate fault signals for specific AFR/AFG related trips:

- Supply error - Synchronization failure due to supply error problems.
- Sup Chk Err - Synchronization failure due to frequency or phase sequence mismatch.
- Sync error - Synchronization failure due to overcurrent.
- AutoID error - Failure during Auto Identification Run, i.e. supply not correctly identified.
- Sup F Err - Failure due to too much variation in supply frequency.
- Sup U Err - Failure due to too much variation in supply voltage.
- GCP xxx - Fault signal indicating that grid code related protection is activated/triggered.
- URVT - Under voltage ride through error. Grid voltage went outside the permitted voltage-time zone of Fig. 44
- OVRT - Over-voltage ride through error. Grid voltage went outside the permitted voltage-time zone of Fig. 44.
- Passive AID - Island detection error based on passive method.
- Active AID - Island detection error based on active method.
- Resistor Err - Brake resistor over load protection error.
- Open CB - Open circuit breaker detected on the supply side.
- PLL Not lock - AFR/AFG waiting for the PLL to be locked. (PLL not ready yet).
- GC starting - Grid parameters (voltage and frequency) are not with in the range defined in [G37x].
- High Freq I - High frequency components (resonance) are detected in the current.

7.16 Supply voltage measurement board (SVMB) (synchronizing/ bypass option)

Supply voltage measurement board (SVMB) is mandatory for AFG/FDUG/VFXG operation whereas it is optional for AFR/FDUL/VFXR operation. In case of AFR/FDUL/ VFXR, as mentioned in section 7.7 voltage measurement is required for under voltage ride through function. Adding voltage measurement board offers following additional features

- AFR/FDUL/VFXR as regenerative unit i.e. DFE mode used in motor operation and AFR active in generator operation.
- Faster supply ID-Run and supply synchronization.
- Improved performance/synchronization if VSI (DC-link) is already loaded before synchronization.
- In case of AFG/FDUG/VFXG, SVMB ver.2 adds grid code functionality.

SVMB exists in two different variants i.e. ver.1 and ver.2. SVMB ver.2 is developed for AFG/FDUG/VFXG applications but can be used with AFR/FDUL/VFXR.

7.16.1 Supply voltage measurement board (hardware) - ver.1

For AFR/FDUL/VFXR applications, the grid voltage can be measured using ver.1 of SVMB. Figure x shows how to connect SVMB ver.1. Grid phase voltages should be connected on high voltage side L1, L2 and L3. X and y component of grid voltage generated from SVMB ver.1 should be connected to analogue inputs on the AFE control board as shown in figure x. SVMB ver.1 takes +24V supply from the AFE control board as shown in figure x. It should be noted that the SVMB ver.1 draws 50 mA (out of 100 mA) from the AFE control board.

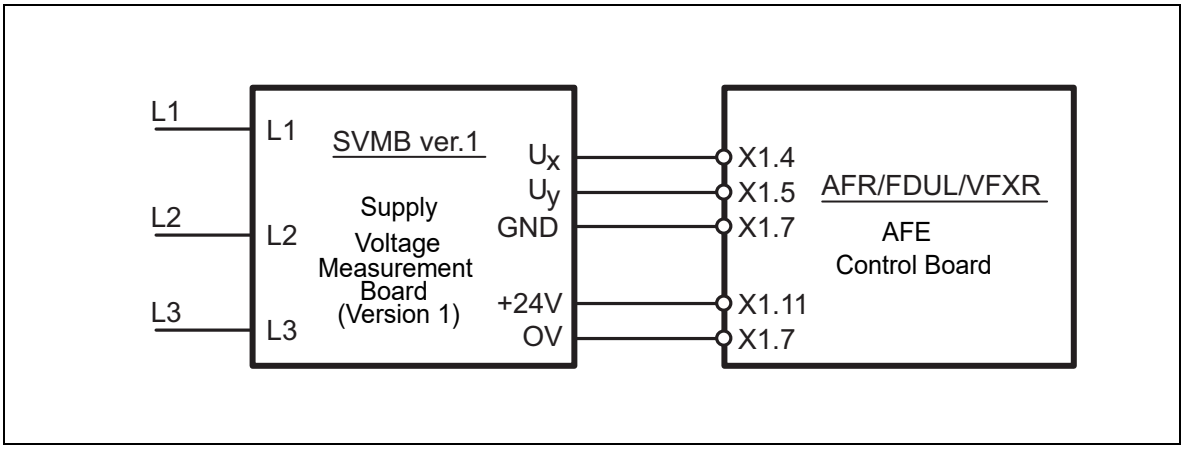


Fig. 31 Grid measurement circuit by means of SVMB ver.1

7.16.2 Supply voltage measurement board (hardware) - ver.2

The grid voltage is measured by means of the AFE option "Supply Voltage Measurement Board version 2' (SVMB ver.2). The SVMB ver.2 is a mandatory AFE option requirement in order to fulfill the basic grid codes, i.e. grid voltage and frequency protection functions. The SVMB ver.2 should be connected to the grid phase voltages on the high voltage (HV) side and provides for galvanically isolated conversion to the low-voltage (LV) side which should in turn be connected to (and fed from) the user I/O on the AFE control board (CB), see Fig. 32.

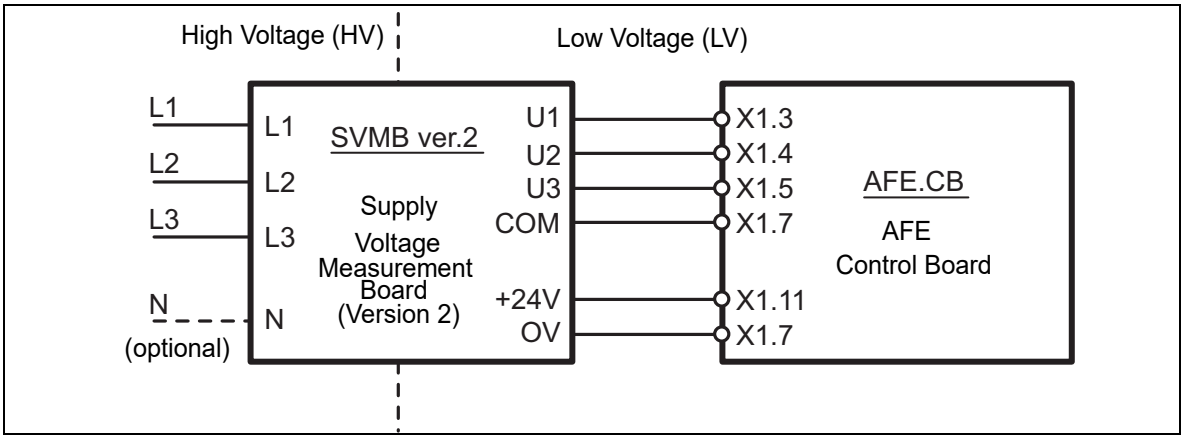


Fig. 32 Grid measurement circuit by means of SVMB ver.2 for AFE

It should be noted that the connection of the grid neutral to the N-input is optional BUT required if true phase-to-neutral voltages are to be monitored.

7.17 Grid code functionality

AFG offers grid code functionality for generation applications where AFG is connected to the utility grid.
It includes:

- Grid monitoring or Protective functions (voltage and frequency protections)
- Reactive power support.
- Grid fault ride through and Anti-Islanding

7.17.1 Grid monitoring or protective functions

Grid voltage and frequency monitoring and protective functions are standard requirements for fulfilling the basic grid codes for distributed renewable generation systems (DRGS) connected to either the low-voltage (200-690 V) or medium voltage networks (1-25 kV), i.e. IEEE 1547, IEC 50438/50549, BDEW etc. This section gives a detailed description of the monitoring and protective functions with respect to voltage and frequency implemented in the CG/Emotron Active Front-End (AFE) intended for renewable energy sources (RES). The protective function features are implemented in AFE SW option version 97.09 and later, and requires the SVMB version 2, see section 7.16 for grid voltage measurement.

7.17.1.1 Grid voltage and frequency protection

The grid voltage and frequency protective functions operate on the extracted information of the phase voltages (or line-line voltages) and the frequency from the SVMB, see the block-diagram of the grid protection functionality in Fig. 33.

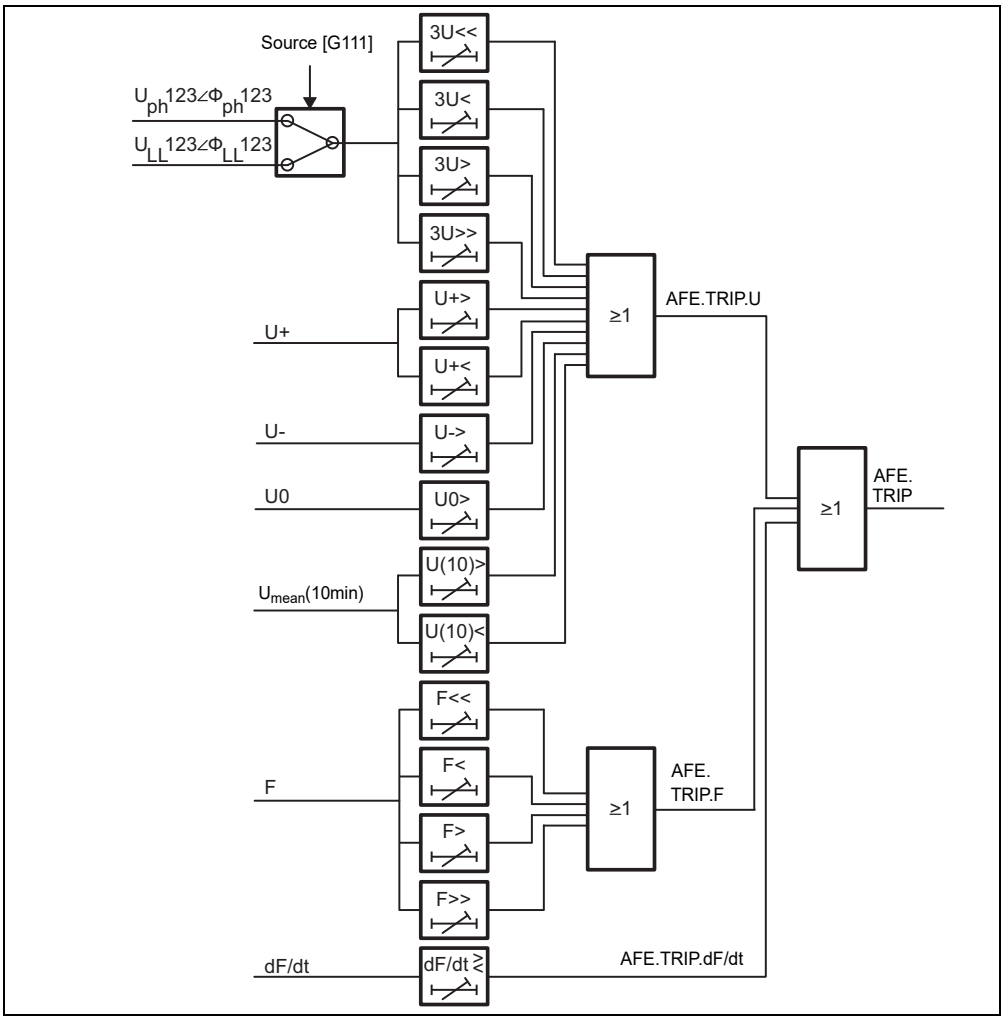


Fig. 33 Block diagram of voltage and frequency protection functionality in the AFE.

The over- and under-voltage protection contains two stages (3U>, 3U>> and 3U<, 3U<<), each with independently settable trip levels and trip times, see Fig. 34. The voltage protections are all of three phase type and contain one common hysteresis limit and reset timer. The source for voltage protection can be the phase voltages or line to line voltages.

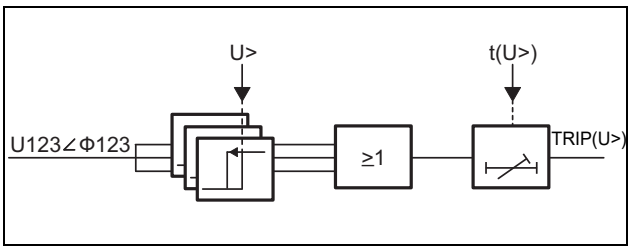


Fig. 34 Detailed block diagram of the three phase over-/under-voltage protection (First over-voltage stage [3U>] is shown).

The additional over- and under-voltage protection based on the symmetrical voltages (U+, U- or U0) or the 10 minute mean value (Umean(10min)) contains one stage with independently settable trip levels and trip times. The additional voltage protections are all of single type and uses the same common hysteresis limit and reset timer as the three phase voltage protection.

The over- and under-frequency protection contains two stages (F>, F>> and F<, F<<), each with independently settable trip levels and trip times, see Fig. 35. The frequency protection contains one common hysteresis limit and reset timer.

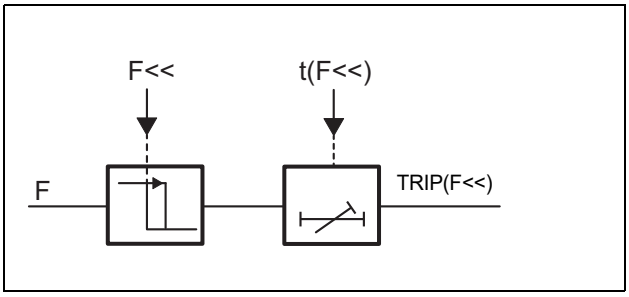


Fig. 35 Detailed block diagram of the over-/under-frequency protection (Second under-frequency stage [F<<] is shown).

The rate of change of frequency (ROCOF) protection contains one stage (dF/dt<>), within settable trip level and trip time, see Fig. 36. The ROCOF protection contains hysteresis limit and reset timer.

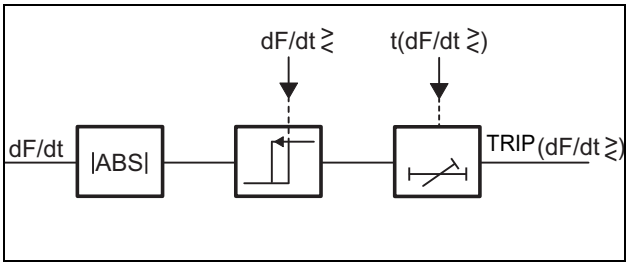


Fig. 36 Detailed block diagram of ROCOF protection functionality.

Voltage protection and frequency protection can be configured in menus [G11] and [G12] respectively. Details of these menus can be found in section 11.

7.17.2 Reactive power (Q) support

Often it is desired by the network operator that generating plants connected to network operators network must be able to provide voltage or reactive power support. For that, generating plants should have the possibility of supplying or consuming reactive power to/from the network. To fulfill the reactive power support requirements, Emotron AFR/AFG offers number of different operating modes i.e.

- Q fix
- Cosθ fix
- Q (U)
- Cosθ(U)
- Q (P)
- Cosθ (P)

Q fix

AFR/AFG controls reactive power output according to the set point.

Cosθ fix

AFR/AFG controls Cosθ at the supply terminals of AFR/AFG according to the set point.

Q (U)

AFR/AFG controls reactive power output as a function of measured supply voltage. For voltage related control mode, a characteristic (Q-U) curve can be configured using 4 configurable points (user parameters) which defines the reactive power behavior as a function of voltage. Response of Q(U) control matches the dynamics of first order filter.

Cosθ(U)

AFR/AFG controls Cosθ of the output as a function of measured supply voltage. For voltage related control mode, a characteristic (Cosθ -U) curve can be configured using 4 configurable points (user parameters) which defines the Cosθ behavior as a function of voltage. Response of Cosθ (U) control matches the dynamics of first order filter.

Q (P)

AFR/AFG controls reactive power output as a function of supplied active power. For power related control mode, a characteristic (Q-P) curve can be configured using 4 configurable points (user parameters) which defines the reactive power behavior as a function of active power. Response of Q(P) control matches the dynamics of first order filter.

Cosθ (P)

AFR/AFG controls Cosθ of the output as a function of supplied active power. For power related control mode, a characteristic (Cosθ -P) curve can be configured using 4 configurable points (user parameters) which defines the Cosθ behaviour of the output as a function of active power. Response of Cosθ (P) control matches the dynamics of first order filter.

Fig. 37 shows the derivation of reactive power reference [310] in different operating modes. Only one mode can be active at a time. Fig. 38 shows the typical Q - U or Cosθ - U characteristics curve. Characteristics curve can be configured by defining 4-points in Q-U (Cosθ-U) reference frame.

NOTE:
Q_{ref} [310] derived from reactive power (Q) support functions ([G22] ... [G27]) is further limited by maximum reactive power limit (Q limit) defined in menu [041].

NOTE:
In case of Cosθ-U, Cosθ fix and Cosθ-P, Q_{ref} stays at 0% if P_{active} is close to 0% as Q_{ref} is derived from equation

$$\frac{\sqrt{P^2 . (1-cos^2\theta)}}{cos\theta}$$

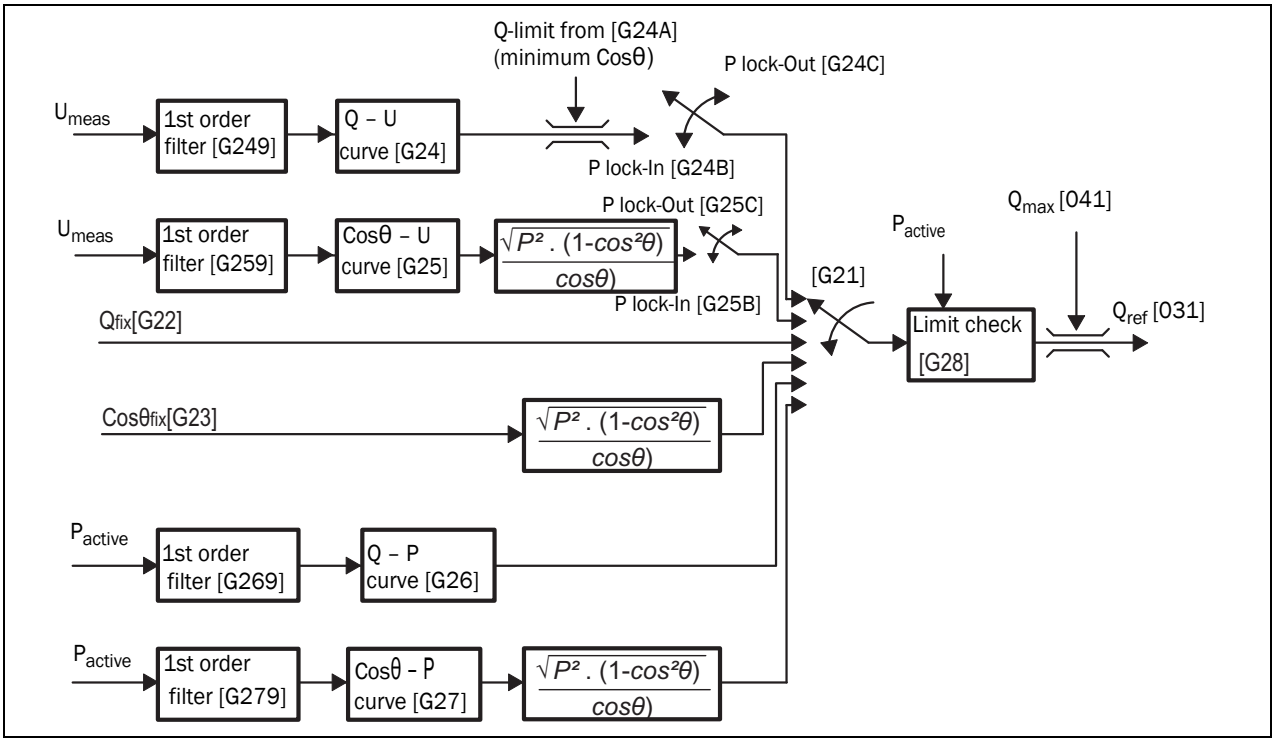


Fig. 37 Derivation of reactive power reference

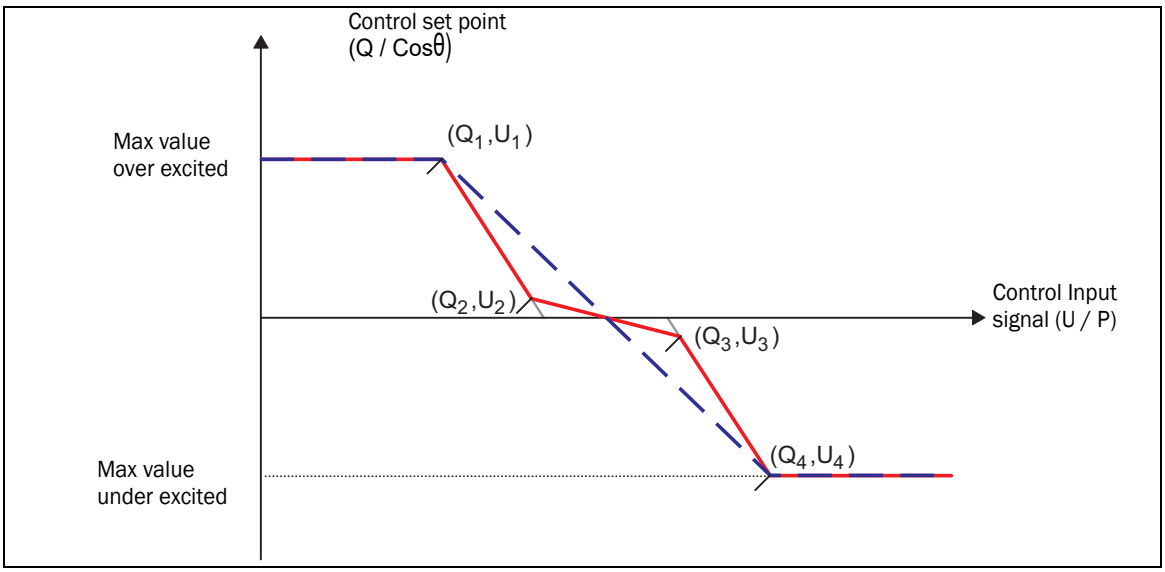


Fig. 38 Typical Q-U and Cosθ-U characteristics curve

NOTE:
Actual reactive power capability of AFR/AFG is limited by the ratings of the inverter. Therefore, the AFR/AFG must be rated properly in order to have enough reactive power available to fulfill the requirements laid by the grid codes or grid operator.

Active/reactive power priority

AFR/AFG can be configured to prioritize the active or reactive power for the case when kVA (or current) limit is reached for AFR/AFG unit. Prioritizing active power (P) means that reactive power (Q) will be limited to the AFR/AFG current capacity available after producing/consuming the active power. Similarly prioritizing reactive power (Q) means that active power (P) will be limited to the AFR/AFG current capacity available after producing/consuming the reactive power. P/Q priority can be configured in menu [G283]. By default, AFR/AFG prioritize the active power over reactive power.

Lock-In and Lock-Out active power levels

Lock-In and Lock-Out active power levels can be configured for Q(U) and Cosθ (U) modes.

Lock-In active power level

Q(U) and Cosθ (U) modes are turned on when the actual (filtered) active power level is higher than the set value of lock-in active power [G24B] or [G25B] respectively.

Lock-Out active power level

Q(U) and Cosθ (U) modes are turned off when the actual (filtered) active power level is lower than the set value of lock-out active power [G24C] or [G25C]respectively.

Fig. 39 shows a typical example of lock-in and lock-out values for Q(U) mode.

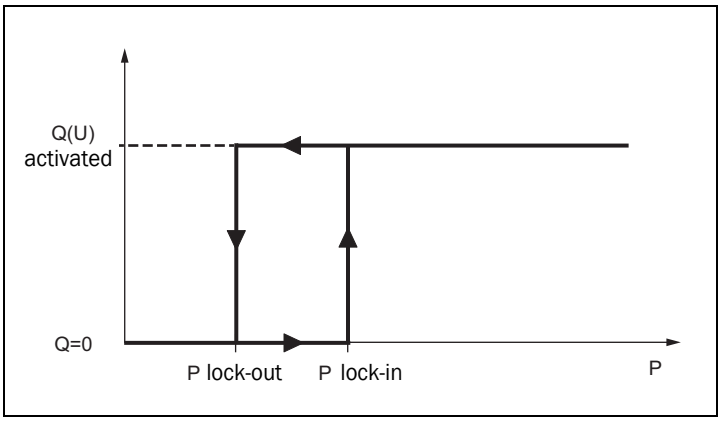


Fig. 39 Example of lock-in and lock-out values for Q(U) mode. (Source IEC 50549-2)

NOTE:
Hysteresis between lock-in and lock-out is available only if lock-in is higher than the lock-out value. In that cases, the difference between lock-in and lock-out acts as a hysteresis.

7.17.3 Grid fault ride through and Anti Islanding

Grid voltage and frequency disturbance handling such as grid fault ride-through (FRT) and anti-islanding detection (AID) are standard requirements for fulfilling the grid codes for distributed renewable generation systems (DRGS) connected to either the low-voltage (200-690 V) or medium voltage networks (1-25 kV), i.e. IEEE 1547, IEC 50438/ 50549, BDEW etc. This section gives a detailed description of the FRT and AID functionality implemented in the CG/Emotron Active Front-End for Generation (AFG) intended for renewable energy sources (RES). The FRT and AID features are implemented in AFE software (SW) option version 97.10 and later, and requires the SVMB version 2, see section for grid voltage measurement.

The AFG continuous and transient operation capabilities are listed in Table 14 and should be considered as the absolute maximum operation capability.

Table 14

Electrical Quantity	Continuous operating range	Comment
Voltage (U)	85 - 110% of U_N	340 - 440 V @ UN = 400 V
Current (I)	0 - 110% of I_N	
Active power (P)	0 - 100% of S_N(limited by I_N)	100% @ cosΦ = 1.0 90% @ cosΦ = ±0.9
Reactive power (Q)	±100% of S_N (limited by I_N) Q > 0% (over-excited) Q < 0% (under-excited)	±100% @ P = 0% ±48% @ P = 90% (cos? = ±0.9) ±0% @ P = 100% (cos? = 1.0)
Power factor (cosΦ)	±0.01 - ±1.0 cosΦ > 0 (over-excited) cosΦ < 0 (under-excited)	
Frequency (F)	85 - 115% of F_N (absolute maximum)	42.5 - 57.5 Hz @ FN = 50 Hz 51 - 69 Hz @ FN = 60 Hz
	92 - 108% of F_N (normal maximum)	46 - 54 Hz @ FN = 50 Hz 55 - 65 Hz @ FN = 60 Hz
Rate-of-change-of-frequency (dF/dt)	±5%/s	±2.5 Hz/s @ FN = 50 Hz ±3.0 Hz/s @ FN = 60 Hz
	±5% step	±2.5 Hz step @ FN = 50 Hz ±3.0 Hz step @ FN = 60 Hz

7.17.3.1 Grid fault ride through (FRT)

This section specifies the transient operation capability of the AFG during FRT, i.e. during grid disturbances. The absolute FRT capability of AFG is developed in order to include as many grid codes as feasible but priority has been given to fulfill the requirements for Europe (EN 50549-1 and EN 50549-2) and US (UL 1741- Supplement SA).

Grid fault ride through (FRT) capability of AFG includes following main functions.

- Over voltage ride through (OVRT)
- Under voltage ride through (UVRT)
- Over frequency ride through (OFRT)
- Under frequency ride through (UFRT)

For grid fault ride through (FRT) (both voltage and frequency) the AFG can (by own control means) handle grid disturbances that limits the actual AC output generated power by dissipating the possible excessive energy (feed into the AFG) into a brake resistor via the integrated brake chopper IGBT.

7.17.3.1.1 Over voltage ride through (OVRT)

The AFG OVRT capability is shown in Fig. 40. The capability applies to all kind of over voltages, i.e. 1-, 2- and 3-phase over voltages.

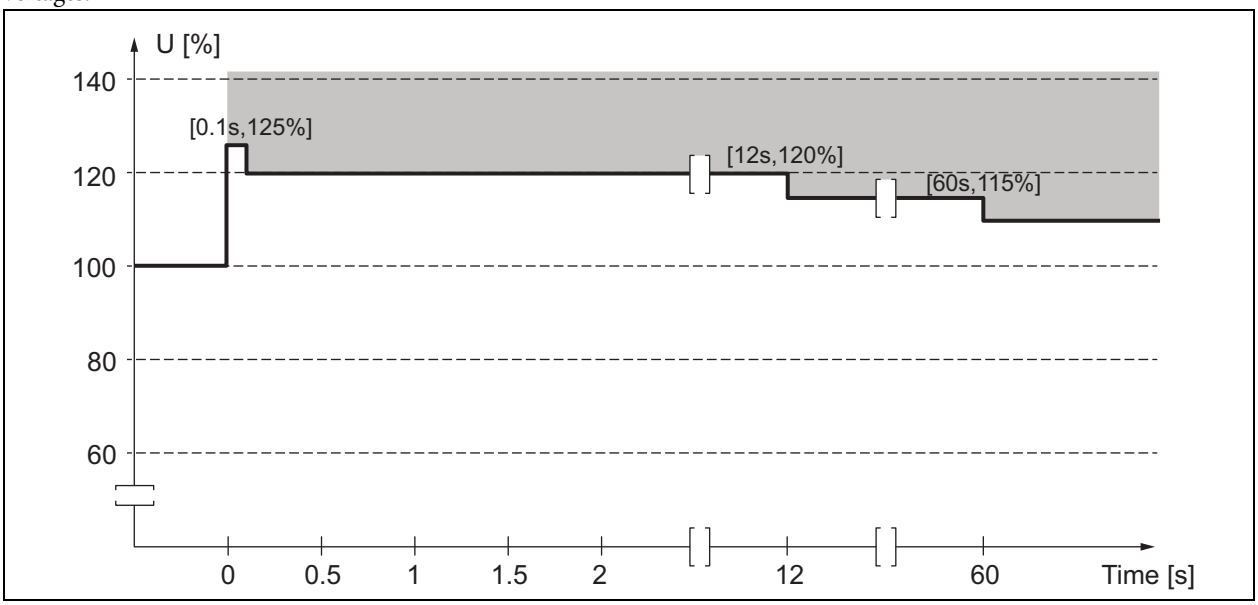


Fig. 40 OVRT capability

NOTE:
The upper voltage capability depends on ratio between the AFG voltage rating and the nominal grid voltage. For case with nominal grid voltage 400V, the OVRT capability with type AFG46 up to 125% is possible but for case with nominal grid voltage of 440V, the OVRT capability with type AFG46 is only possible up to 120%.

7.17.3.1.2 Under voltage ride through (UVRT)

The AFG UVRT capability is shown in Fig. 41. The capability applies to all kind of faults causing under voltages, i.e. 1-, 2- and 3-phase faults with/without simultaneous ground fault.

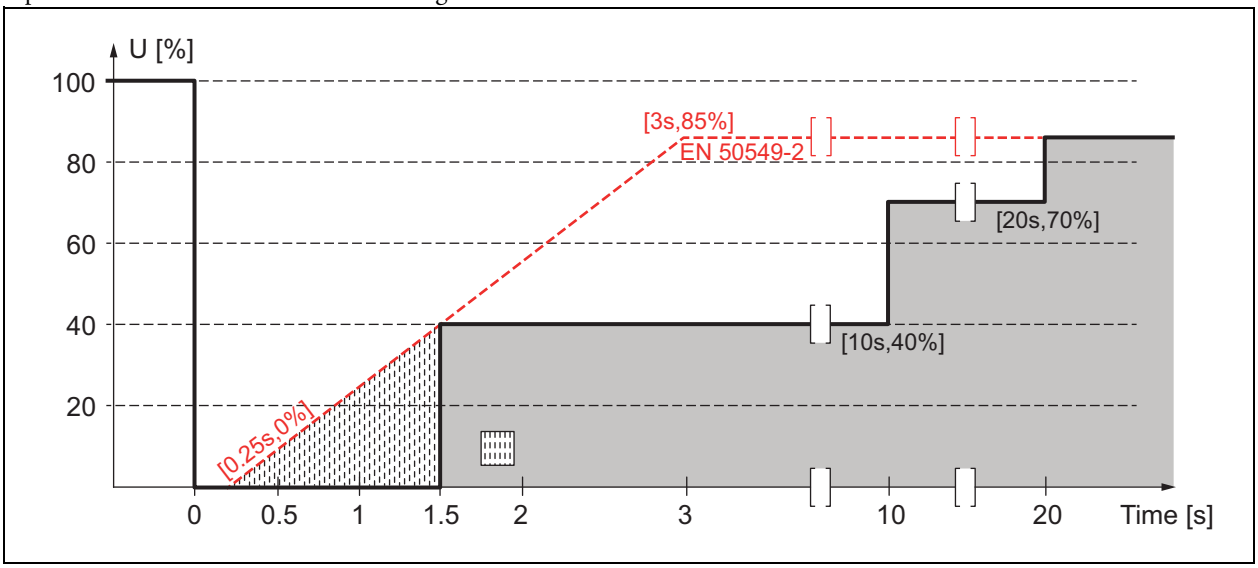


Fig. 41 UVRT capability

NOTE:
The FRT mode I(zero) is required for UVRT with long duration in combination with a remaining grid voltage <40%.

7.17.3.1.3 Dynamic voltage support during UVRT and OVRT

The AFG grid voltage FRT detection is always performed based on the measured/estimated positive sequence (U+) and the negative sequence (U-) voltage components. Additionally, FRT detection is also performed on the individual line-line or phase-neutral voltages.

The AFG behavior during UVRT and OVRT are defined by the setup FRT mode via parameters [G325] for UVRT and [G327] for OVRT. The supported FRT modes are:

I(cont) Continued operation mode where the pre-fault P and Q control is maintained to the extent possible.

I(Q) Additional dynamic reactive current injection of both positive (I+) and negative (I-) sequence components according to EN 50549-2 (2019, section 4.7.4.2.1) with Q priority, i.e. the active current is limited in favor for reactive current if the AFG current limit is reached.

I(P) Additional dynamic reactive current injection of both positive (I+) and negative (I-) sequence components according to EN 50549-2 (2019, section 4.7.4.2.1) with P priority, i.e. the reactive current is limited if the AFG current limit is reached.

I(zero) Zero current mode where the output current is immediately reduced below 10% of the rated AFG current as long as the grid voltage is outside the static voltage range.
Note, that this mode corresponds to the operation state "momentary cessation" as defined in UL 1741 (Supplement SA) or alternatively to an active "gate blocking" operation state.

In order to avoid activation of the dynamic voltage support for small voltage variations, a configurable voltage insensitivity range (dead-band) can be defined via parameter [G323].

Additionally, configurable voltage thresholds for automatic activation of the zero current mode I(zero) for both OVRT and UVRT can be defined respectively in parameters [G326] and [G328].

The active and reactive current limits during voltage fault ride through (UVRT and OVRT) are individual and defined via parameters [G321] and [G322], respectively. For stable fault recovery, an additional active current limitation based on the actual grid voltage during the fault is needed as shown in Fig. 42. For a remaining grid voltage below 40% the active current limit is linearly reduced to 0 and instead shifted to a reactive current demand given in below equation up to the reactive current limit.

$$I_{Qref} = \sqrt{I_{PMAX}^2 - I_{Pref}^2}$$

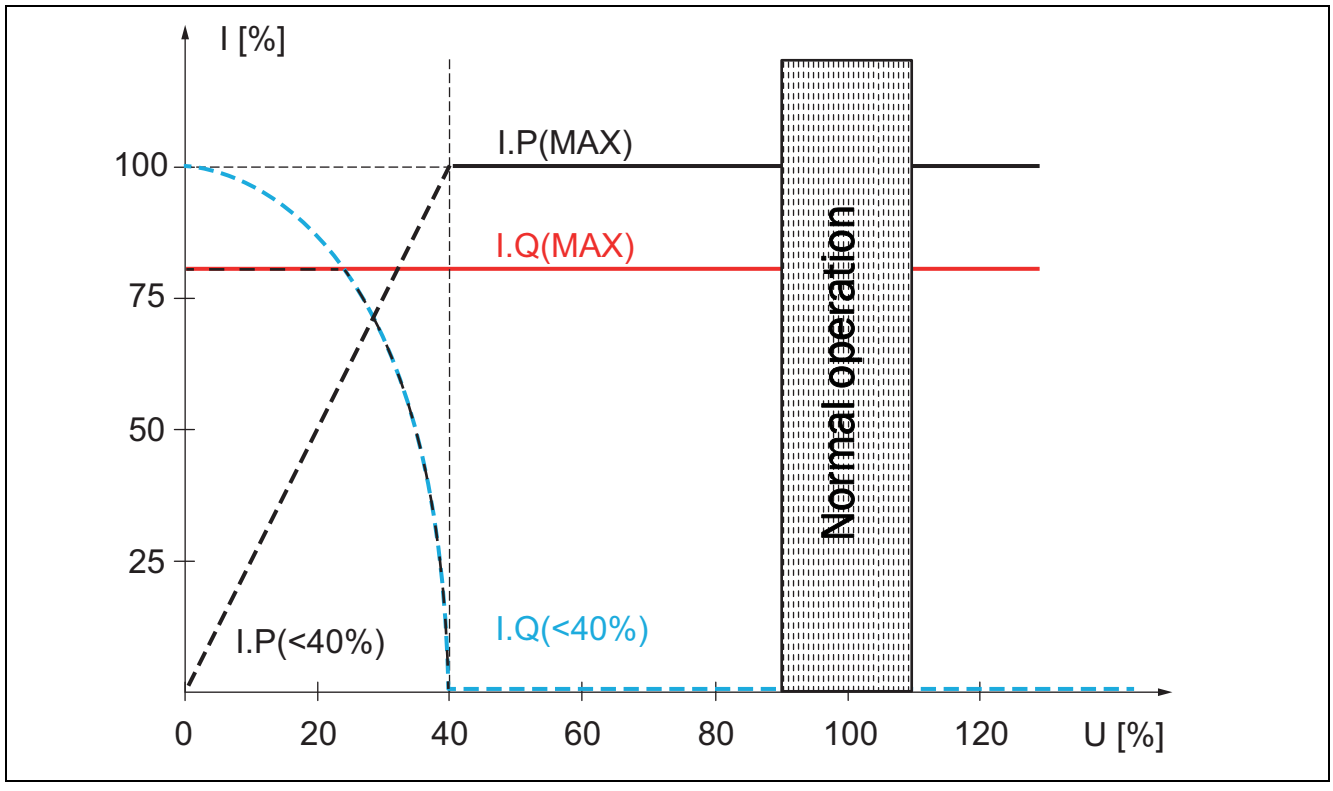


Fig. 42 Active (I_P) and reactive (I_Q) current limiting during UVRT/OVRT

The maximum time for dynamic grid support is defined in parameter [G324]. If the maximum time expires then the AFG unit resumes operation according to the FRT mode I(cont), i.e. continued operation mode.

The additional reactive current injection for modes $I_{(Q)}$ and $I_{(P)}$ can be configured via individual gain parameters [G329] and [G32A] for the positive- and negative sequence reactive current support as shown in Fig. 43.

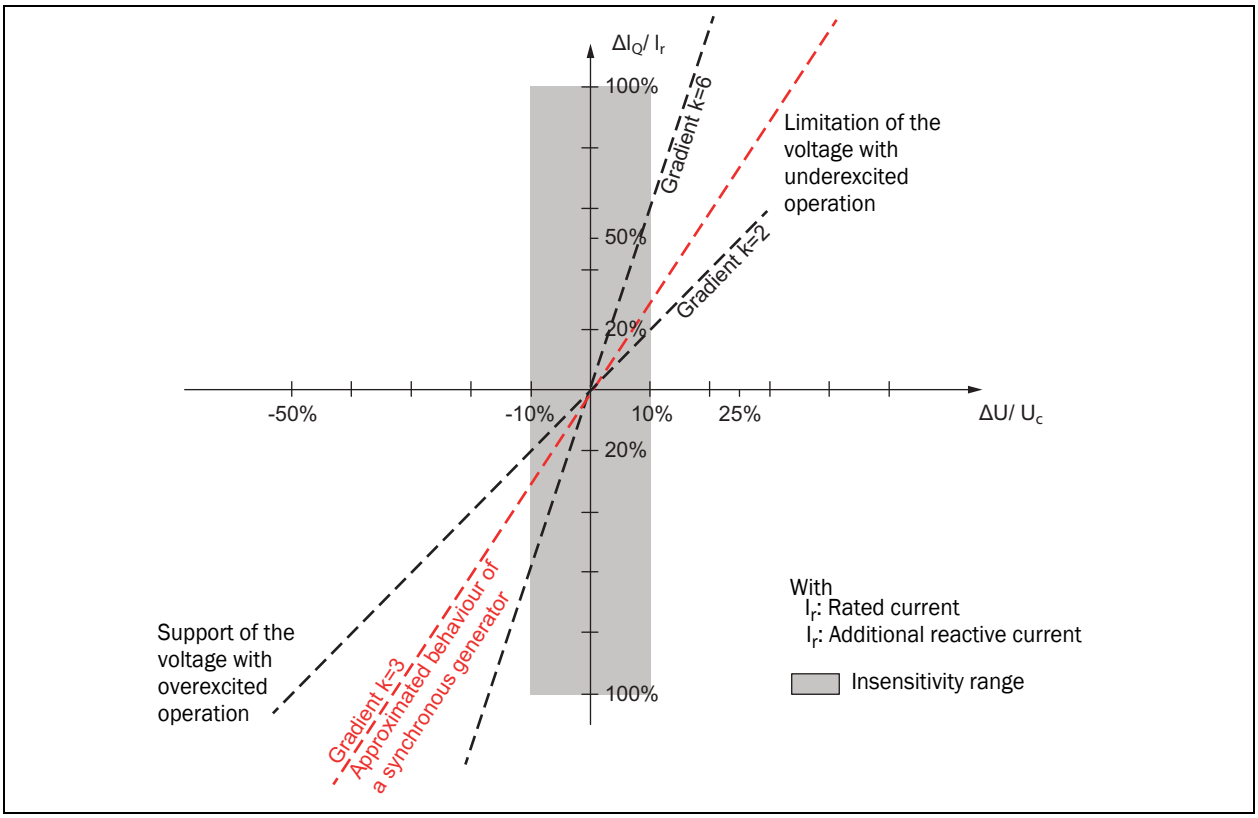


Fig. 43 FRT modes I(Q) and I(P) dynamic reactive current support for positive- and negative sequence according to EN 50549-2.Dedicated trip areas in the time-domain for both UVRT and OVRT are configurable via parameters [G32D]-[G32G] for UVRT and [G32H]-[G32K] for OVRT as shown in Fig. 44 (Source IEC 50549-2).

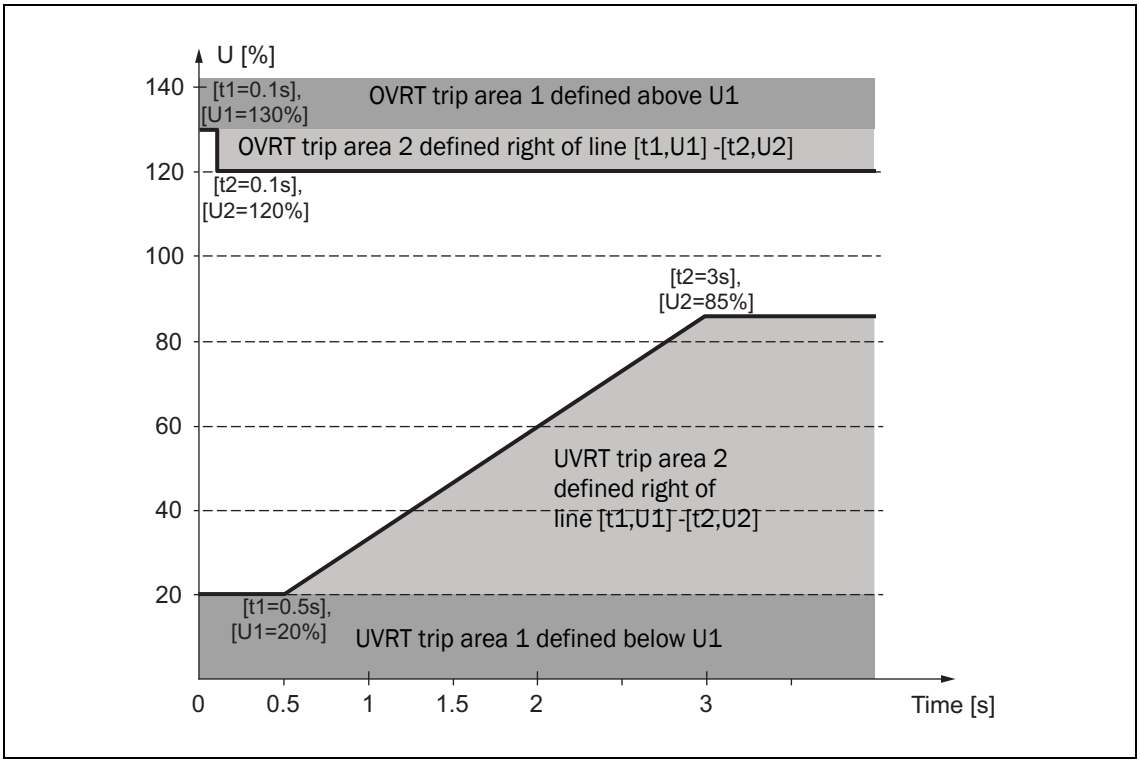


Fig. 44 UVRT and OVRT trip area description

7.17.3.1.4 Over frequency ride through (OFRT)

The AFG dynamic frequency support for OFRT is implemented according to the specifications for LFSM-O (Limited Frequency Sensitivity Mode - Overfrequency) in EN 50549-2 (2019, section 4.6.1), as shown in Fig. 45. The active power response is activated (if enabled via [G341]) when the grid frequency is greater than the defined start frequency (Fstart) [G342] for the intentional start delay time (tstart) [G343]. The amount of active power reduction is calculated based on the droop (D) [G344] and the pre-disturbance active power (Pref) according to below given equation.

$$\Delta P = \frac{1}{D[344]} \cdot \frac{F_{start}[342] - F}{F_{nom}[O12]} \cdot P_{ref}$$

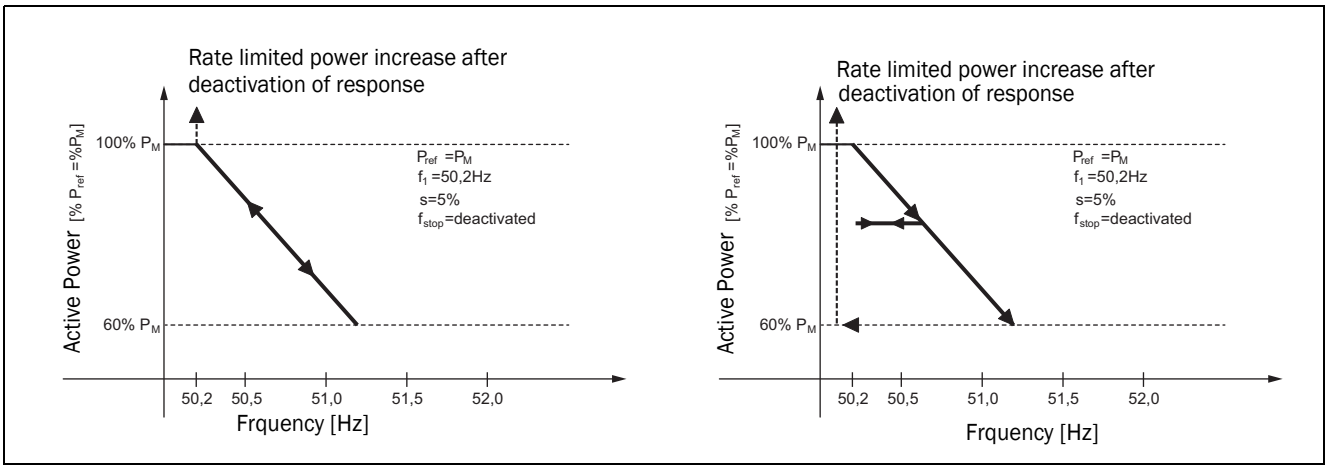


Fig. 45 Active power response during OFRT (source IEC 50549-2).

Left: Fig. 45 - Example of Active power frequency response to over frequency.

Right: Fig. 45 - Example of active power frequency response to over frequency with configured deactivation threshold.

If the deactivation threshold feature is enabled, then there should be no response according to the droop for decreasing frequency. Instead, the active power should remain constant until the frequency falls below the deactivation threshold (Fstop) [G345] including an additional deactivation delay time (tstop) [G346].

7.17.3.1.5 Under frequency ride through (UFRT)

Active response to frequency deviations typically sets requirement for increasing the AC output power during low frequency conditions. Therefore, active response during UFRT needs to be handled by the plant energy management control system.

7.17.3.2 Anti - Islanding detection (AID)

Two different methods for detecting the anti-islanding are implemented in AFG. These are:

- Passive anti-islanding detection (AID) method
- Active anti-islanding detection (AID) method

7.17.3.2.1 Passive AID method

This method detects islanding based on sudden voltage phase jumps or frequency jumps. Passive AID can be turned on or off in menu [G331].

7.17.3.2.2 Active AID method

This method detects islanding based on active injection of detection signals. Active AID can be turned on or off in menu [G332].

NOTE: Contact local supplier or authorized Emotron service personal if further assistance is required with AID detection.

7.17.4 Brake resistor overload protection

The brake resistor overload protection is simply a short-term (surge) on-time filter which sums the on-time of the short active pulses and trips the AFG when the time value exceeds the maximum short-term surge load, i.e. time duration [G35] t(Rb)max, of the brake resistor. The filter is decremented with a time-constant corresponding to 5 minutes to avoid filling up the filter in case of consecutive disturbances with sufficient time duration between the disturbances.

7.17.5 Detection of open circuit

A detection feature for an open circuit condition, i.e. an open main circuit breaker, possibly triggered by relay protection on the primary side (medium voltage side) of the plant transformer is available. The open circuit detection is triggered in case large deviations between the internal current reference and the actual output current is detected. Open circuit is detected if the actual output current is below the current threshold [G361] while the internal current reference is above the threshold [G361] multiplied by two. An open circuit trip is generated after the open circuit trip time [G362] has elapsed.

7.17.6 Grid start validation

Grid start validation in AFR/AFG when enabled monitor and validate grid parameters (voltage and frequency) before starting the operation of AFR/AFG. Grid start validation process validates that the grid frequency and voltage are within the range specified in [G37x] menus.

7.18 Remote control functions

Operation of the Run/Stop/Enable/Reset functions

As default, all the run/stop/reset related commands are programmed for remote operation via the inputs on the terminal strip (terminals 1-22) on the control board. With the function “Run/Stp Ctrl” [215] and “Reset Control” [216], this can be selected for keyboard or serial communication control.

NOTE: The examples in this paragraph do not cover all possibilities. Only the most relevant combinations are given. The starting point is always the default setting (factory) of the AC drive.

7.18.1 Default settings of the Run/ Stop/Enable/Reset functions

The default settings are shown in Fig. 46. In this example the AFR/AFG drive is started and stopped with DigIn 2 and a reset after trip can be given with DigIn 8.

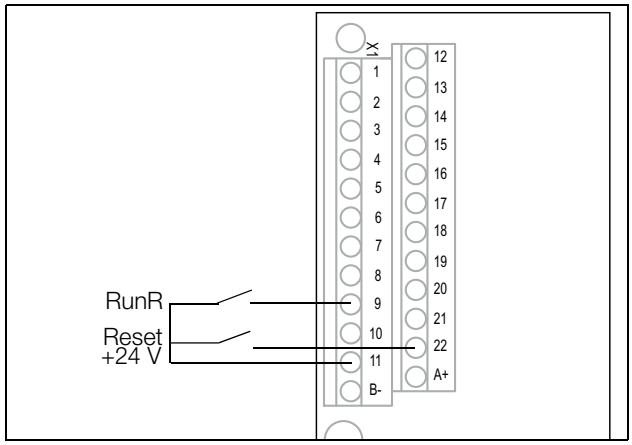


Fig. 46 Default setting Run/Reset commands

The inputs are default set for level-control. The rotation is determined by the setting of the digital inputs.

7.18.1.1 Enable and Stop functions

Both functions can be used separately or simultaneously. The choice of which function is to be used depends on the application and the control mode of the inputs (Level/Edge [21A]).

NOTE: In Edge mode, at least one digital input must be programmed to “stop”, because the Run commands are only able to start the AC drive.

7.18.1.1.1 Enable

Input must be active (HI) to allow any Run signal. If the input is made LOW, the output of the AC drive is immediately disabled and the AFR/AFG will stop immediately.

CAUTION!
If the Enable function is not programmed to a digital input, it is considered to be active internally.

7.18.1.1.2 Stop

If the input is low then the AFR/AFG drive will stop immediately. To run the AFR/AFG, input must be high.

7.18.1.2 Reset and Autoreset operation

If the AFR/AFG drive is in Stop Mode due to a trip condition, the AFR/AFG drive can be remotely reset by a pulse ("low" to "high" transition) on the Reset input, default on DigIn 8.
Depending on the selected control method, a restart takes place as follows:

7.18.1.2.1 Level-control

If the Run inputs remain in their position the AFR/AFG drive will start immediately after the Reset command is given.

7.18.1.2.2 Edge-control

After the Reset command is given a new Run command must be applied to start the AFR/AFG drive again.

Autoreset is enabled if the Reset input is continuously active. The Autoreset functions are programmed in menu "Autoreset [250]".

NOTE: If the control commands are programmed for Keyboard control or Com, Autoreset is not possible.

7.18.1.3 Run Inputs Level-controlled

The inputs are set as default for level-control. This means that an input is activated by making the input continuously "High". This method is commonly used if, for example, PLCs are used to operate the AFR/AFG drive.

CAUTION!
Level-controlled inputs DO NOT comply with the Machine Directive, if the inputs are directly used to start and stop the machine.

The examples given in this and the following paragraphs follow the input selection shown in Fig. 47.

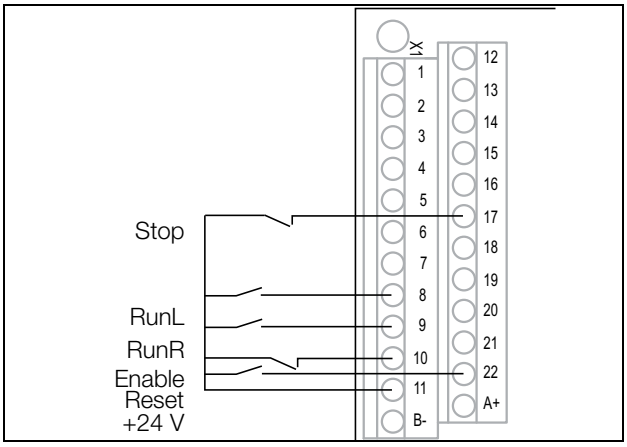


Fig. 47 Example of wiring for Run/Stop/Enable/Reset inputs

The Enable input must be continuously active in order to accept any run-right or run-left command. If both RunR and RunL inputs are active, then the AFR/AFG drive stops. Fig. 48 gives an example of a possible sequence.

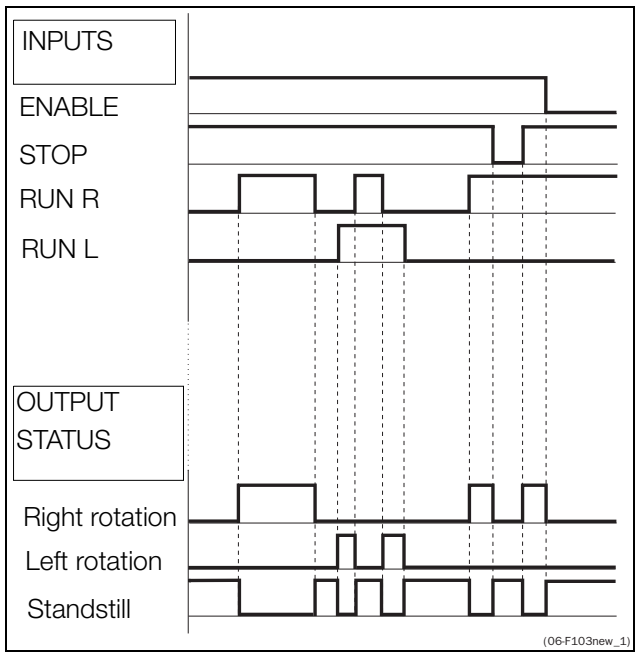


Fig. 48 Input and output status for level-control

7.18.1.4 Run Inputs Edge-controlled

Menu "[21A] Level/Edge" must be set to Edge to activate edge control. This means that an input is activated by a "low" to "high" transition or vice versa.

NOTE: Edge-controlled inputs comply with the Machine Directive (see Chapter 8. page 55), if the inputs are directly used for starting and stopping the machine.

See Fig. 47. The Enable and Stop input must be active continuously in order to accept any run-right or run-left command. The last edge (RunR or RunL) is valid. Fig. 49 gives an example of a possible sequence.

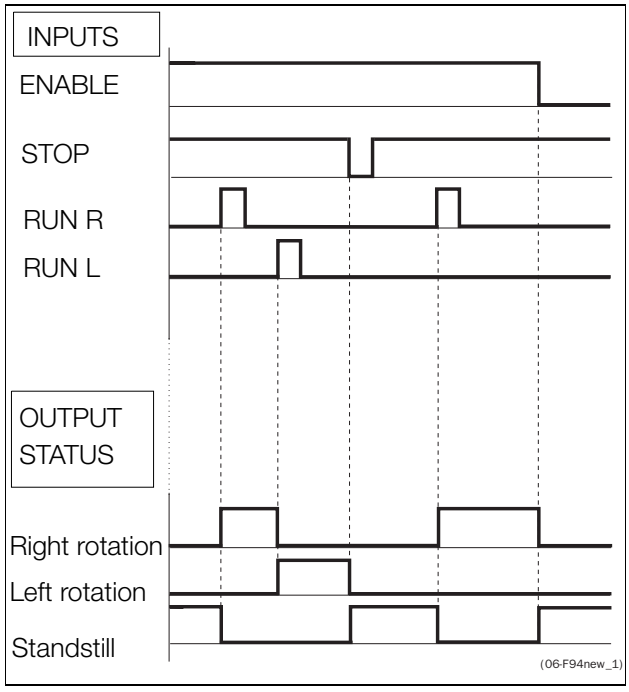


Fig. 49 Input and output status for edge-control

8. EMC and Machine Directive

8.1 EMC standards

The active front end and variable speed drive complies with the following EMC standards:

Generic EMC standards i.e. EN(IEC) 61000-6-2 and 61000-6-4

EN(IEC)61800-3:2004 Adjustable speed electronic power drive systems, part 3, EMC product standards:

In addition to that, AFG complies with low frequency electromagnetic immunity and emission requirements for dispersed generation systems in LV network i.e. IEC/TR 61000-3-15.

Standard:Category C3, for systems of rated supply voltage< 1000 VAC, intended for use in the second environment.

Optional: Category C2, for systems of rated supply voltage <1.000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by experienced person with the necessary skills in installing and/or commissioning variable speed drives including their EMC aspects.

8.2 Stop categories and emergency stop

The following information is important if emergency stop circuits are used or needed in the installation where a variable speed drive is used. EN 60204-1 defines 3 stop categories:

Category 0: Uncontrolled STOP:

Stopping by switching off the supply voltage. A mechanical stop must be activated. This STOP may not be implemented with the help of a variable speed drive or its input/output signals.

Category 1: Controlled STOP:

Stopping until the motor has come to rest, after which the mains supply is switched off. This STOP may not be implemented with the help of a variable speed drive or its input/output signals.

Category 2: Controlled STOP:

Stopping while the supply voltage is still present. This STOP can be implemented with each of the variable speed drives STOP command.

WARNING!
EN 60204-1 specifies that every machine must be provided with a category 0 stop. If the application prevents this from being implemented, this must be explicitly stated. Furthermore, every machine must be provided with an Emergency Stop function. This emergency stop must ensure that the voltage at the machine contacts, which could be dangerous, is removed as quickly as possible, without resulting in any other danger. In such an Emergency Stop situation, a category 0 or 1 stop may be used. The choice will be decided on the basis of the possible risks to the machine.

NOTE:
With option Safe Torque Off (STO), a stop according EN-IEC 62061:2005 SIL 2 & EN-ISO 13849-1:2006, can be achieved. See Instruction manual for Emotron VFX/FDU 2.1.

9. Operation via the Control Panel

This chapter describes how to use the control panel.

9.1 Control panels

In case of FDUL/VFXR/FDUG/VFXG deliveries, there are two control panels, one main panel in the Cabinet door controlling the complete Emotron FDUL/VFXR/FDUG/VFXG and one internal AFR/AFG panel designated for service engineers.
In case of AFR/AFG deliveries, there is only one panel that controls the AFR/AFG.

There are two different types of control panels. One with 4-line LCD display and one with a 2-line LCD display. In chapter 9.4 page 62 and chapter 9.3 page 58 are the panels described.

9.1.1 Main control panel for Emotron FDUL/VFXR/FDUG/VFXG

The Emotron FDUL/VFXR/FDUG/VFXG is equipped with one main control panel on the cabinet door see Fig. 50. When we further in this chapter describe how to use the control panel this is the one we are referring to.

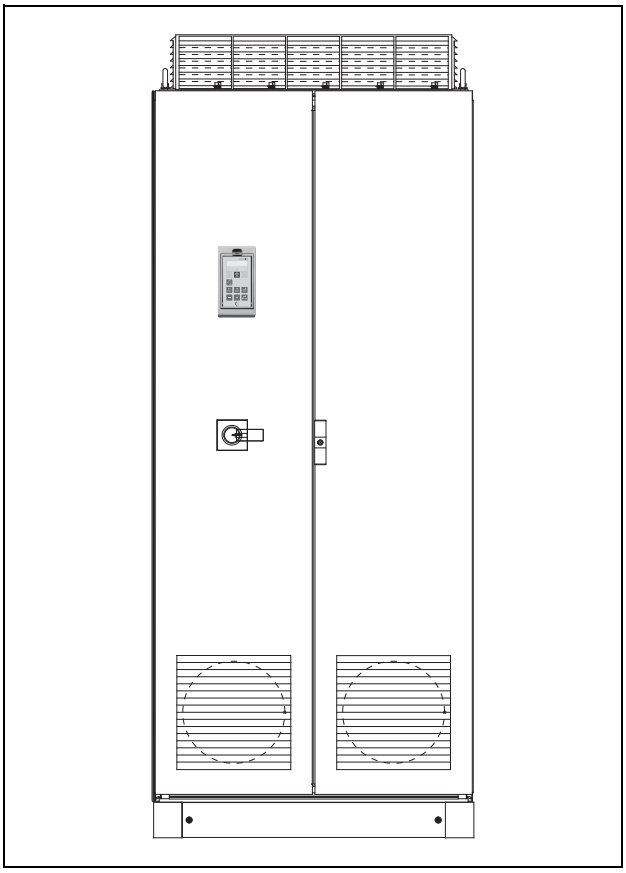


Fig. 50 VXFR with control panel in front door.

9.1.2 Control panel for AFR/AFG

Inside the cabinet door you will find a second control panel for the AFR/AFG unit, see Fig. 51. In this display you can observe status, trips and set parameters. Normally you do not need to do any changes in this panel. This panel is designated for use by service engineers.

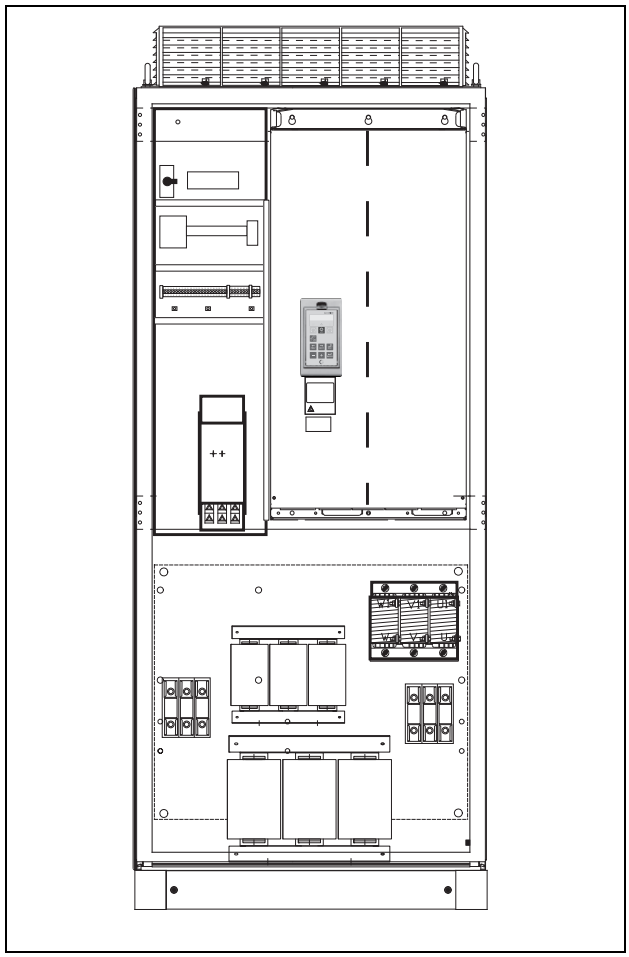


Fig. 51 Open the cabinet door to expose the AFR/AFG control panel.

9.2 General

The control panel in the front door displays the status of the Emotron FDUL/VFXR/FDUG/VFXG and is used to set all the user parameters. It is also possible to control the motor directly from the control panel. The control panel can be built-in or located externally via serial communication.

NOTE:
The VSI can run without the control panel being connected. However the settings must be such that all control signals are set for external use.

9.3 Control panel with 4-line display

This control panel with 4-line display is equipped with real time clock function. This means that actual date and time will be shown at e.g. a trip condition.

There is also an optional Control panel with Bluetooth communication available. See chapter 13.7 Control panel on page 158 for more information.

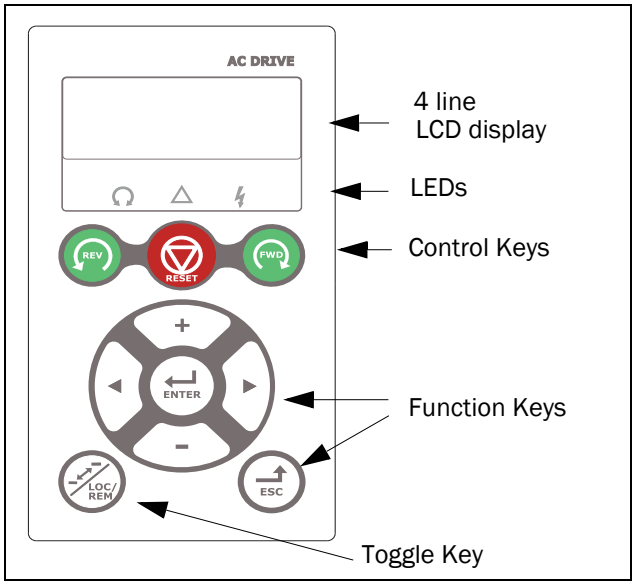


Fig. 52 Control panel with 4-line display, LEDs and Keys.

9.3.1 The display

The display is back lit and consists of 4 rows, each with space for 20 characters. The display is divided into following areas. The different areas in the display are described below:

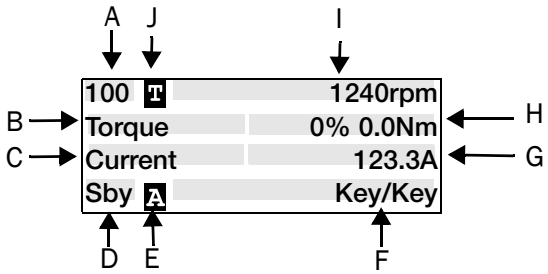


Fig. 53 The display.

Area A: Shows the actual menu number (3 or 4 digits).

Area B: Menu name or heading (Except in menus 100+ mode), 8 characters field.

Area C: Edit Cursor if editing or heading in menu [100], 8 characters field.

Area D*: Shows the status of the AC drive (3 digits). The following status indications are possible:

Digits	Description	Bit*
Stp	AFE/VSI is stopped	0
Run	AFE/VSI runs	1
Acc	Acceleration	2
Dec	Deceleration	3
Trp	Tripped	4
STO	Operating Safe Torque Off (STO), is flashing when activated.	5
VL	Operating at voltage limit	6
SL	Operating at speed limit	7
CL	Operating at current limit	8
TL	Operating at torque limit	9
OT	Operating at temperature limit	10
I^2t	Active I^2t protection	11
LV	Operating at low voltage	12
Sby	Operating from Standby power supply	13
LCL	Operating with low cooling liquid level	14
Slp	Sleep mode	15
SPS	Spin start active	16

*) The status shown in Area D on the control panel can be read via a fieldbus or serial communication, e.g. using Modbus address No. 30053.

It is also possible to read all status indications, not just the highest prioritized one, via a fieldbus or serial communication, e.g. using Modbus address No. 30180 and 30182. This information is also shown in EmoSoftCom PC-tool (optional), see menu “Area D status [72B]” of VSI instruction.

Area E: Shows active parameter set: A, B, C, or D [241].

Area F: Active control source.

Area G: Parameter value, shows the setting or selection in the active menu, 12 characters field.
This area is empty at the 1st level and 2nd level menu. This area also shows warnings and alarm messages. In some situations this area could indicate “+++” or ” - - -” see further information in the Instruction manual.

Area H: Signal values shown in menu [100], 12 characters field.

Area I: Preferred read-out value (chosen in menu [110])

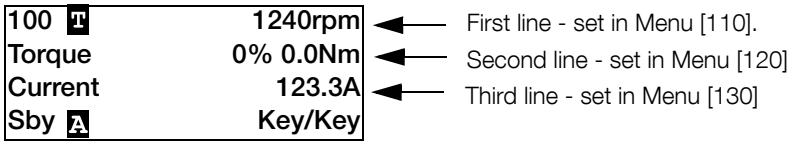
Area J Shows if the menu is in the toggle loop and/or the AC drive is set for Local operation.
T = in Toggle loop
L T = in Local operation and Toggle loop
L = Local operation

NOTE:
In area B and area C only 8 characters are available, this means that some texts will be shortened.

Menu [100] Preferred view

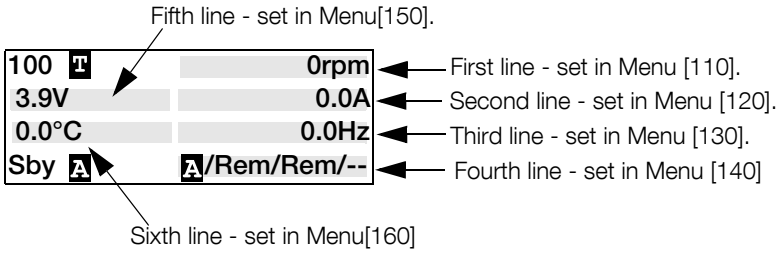
This menu is displayed at every power-up. During operation, the menu [100] will automatically be displayed when the keyboard is not operated for 5 minutes.

Menu "[100] Preferred View" displays the settings made in menu "[110], 1st line", "[120], 2nd line" and "[130], 3rd line".



Extended signal monitoring

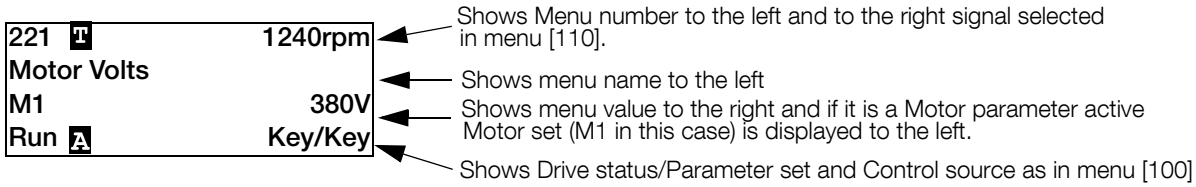
If you hold the ESC key when in menu [100] following window will appear, as long as the key is pressed.
Here First, Second and Third line are shown as selected in menu [100].
Then additional information will be displayed, selected in the menus [140], [150] and [160] according to below.



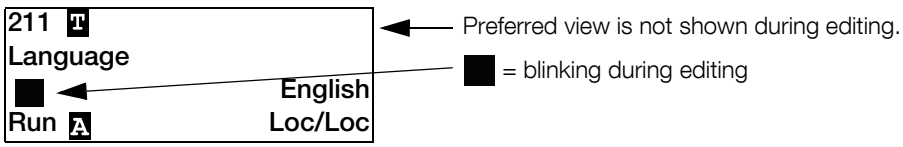
Use menu "[170] View mode" to select active type of menu [100] presentation, select if "Normal 100" or "Always 100+" Extended signal monitoring" shall be shown at power-up. A third choice is menu "Normal100wo" = menu [100] without explaining text at second and third line.

9.3.2 Editing mode

All other menus (read and read/write menus) are used in following way.



During editing, preferred view will not be displayed and the cursor will appear blinking to the left. See also below.



9.3.3 Fault logger

As real-time clock is available, line 2 will show trip/warning message and line three will show date and time when the trip condition occurred.

810 T	1240rpm
Ext trip	
2017-01-25	12:34.40
Run A	Rem/Rem

9.3.4 Real Time clock

In this 4 line Control panel (PPU) there is a built in Real time clock. This means that actual date and time will be shown at e.g. a trip condition. There is a built-in capacitor to be able to keep the clock running if the power disappear.

In case of loss of power, the backup time for the Real time clock function is at least 60 days.

Actual date and time will be set from factory. Date and time is shown and can be set in following menus.

Clock [930]

This menu group displays actual time and date, read only.

Time and date are factory set to CET (Central European mean time). Adjust if required in following sub-menus.

930 T	1240rpm
Clock	
2017-01-23	12:34.40
Run A	Key/Key

Time [931]

Actual time, displayed as hh:mm:ss. Adjustable setting.

931 T	1240rpm
Time	
	12:34.40
Run A	Key/Key

Unit	hh:mm:ss (hours: minutes: seconds)

Date [932]

Actual date, displayed as YYYY-MM-DD. Adjustable setting.

932 T	1240rpm
Date	
	2017-01-23
Run A	Key/Key

Unit:	YYYY-MM-DD (year-month-day)

Weekday [933]

Display of actual weekday, read only.

933 T	1240rpm
Weekday	
	Monday
Run A	Key/Key

9.3.5 LED indicators

The symbols on the control panel have the following functions:

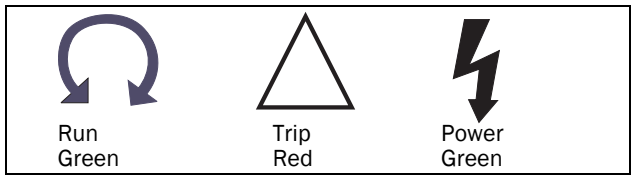


Fig. 54 LED indications

Table 15 LED indication

Symbol	Function		
	ON	FLASHING	OFF
POWER (green)	Power on	----------	Power off
TRIP (red)	Tripped	Warning/Limit	No trip
RUN (green)	Running	AC drive speed increase/ decrease (VSI only)	AFR/AFG/VSI stopped

NOTE: If the control panel is built in, the back light of the display has the same function as the Power LED in Table 15 (Blank panel LEDs).

9.3.6 Control keys

The control keys are used to give the Run, Stop or Reset commands directly. As default these keys are disabled, set for remote control. Activate the control keys by selecting Keyboard in the menus Ref Control [214] and Reset Ctrl [216].

If the Enable function is programmed on one of the digital inputs, this input must be active to allow Run/Stop commands from the control panel.

Table 16 Control keys

	RUN L:	gives a start with left rotation
RESET	STOP/RESET:	stops or resets
	RUN R:	gives a start with right rotation

NOTE:
It is not possible to simultaneously activate the Run/ Stop commands from the keyboard and remotely from the terminal strip (terminals 1-22).

9.3.7 The Toggle and Loc/Rem Key

This key has two functions: Toggle and switching between Loc/Rem function.

Press one second to use the toggle function

Press and hold the toggle key for more than five seconds to switch between Local and Remote function, depending on the settings in [2171] and [2172].

When editing values, the toggle key can be used to change the sign of the value, see section 9.6, page 63.

Toggle function

Using the toggle function makes it possible to easily step through selected menus in a loop. The toggle loop can contain a maximum of ten menus. As default the toggle loop contains the menus needed for Quick Setup. You can use the toggle loop to create a quick-menu for the parameters that are most importance to your specific application.

NOTE:
Do not keep the Toggle key pressed for more than five seconds without pressing either the +, - or Esc key, as this may activate the Loc/Rem function of this key instead. See menu [217].

Add a menu to the toggle loop

1. Go to the menu you want to add to the loop.
2. Press the Toggle key and keep it pressed while pressing the + key.

Delete a menu from the toggle loop

1. Go to the menu you want to delete using the toggle key.
2. Press the Toggle key and keep it pressed while pressing the - key.

Delete all menus from the toggle loop

1. Press the Toggle key and keep it pressed while pressing the Esc key.
2. Confirm with Enter. The menu Preferred view [100] is displayed.

Default toggle loop

Fig. 55 shows the default toggle loop. This loop contains the necessary menus that need to be set before starting. Press Toggle to enter menu [211] then use the Next key to enter the sub menus [212] to [21A] and enter the parameters. When you press the Toggle key again, menu [221] is displayed.

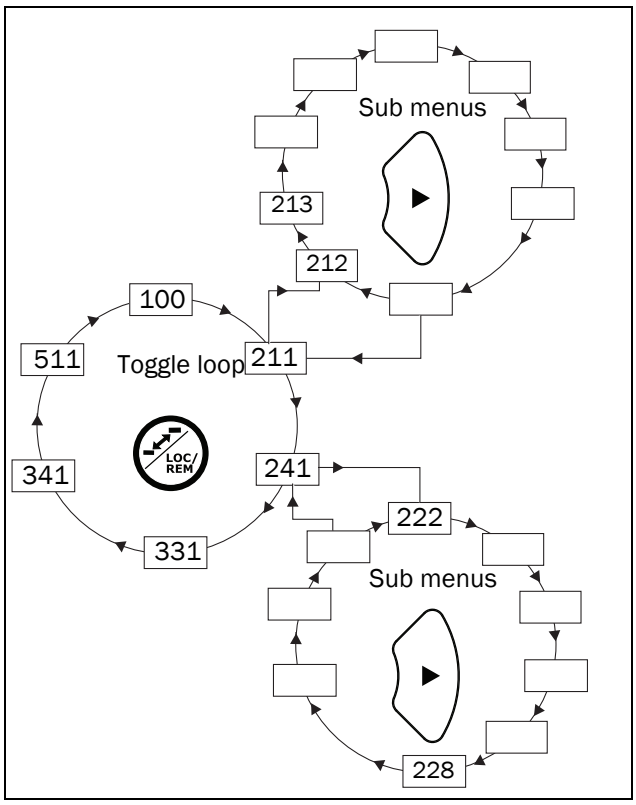


Fig. 55 Toggle loop example.

Indication of menus in toggle loop

Menus included in the toggle loop are indicated with a **T** in area B in the display.

Loc/Rem function

The Loc/Rem function of this key is disabled as default. Enable the function in menu [2171] and/or [2172].

With the function Loc/Rem you can change between local and remote control of the VSI from the control panel. The function Loc/Rem can also be changed via the DigIn, see menu Digital inputs [520]

Change control mode

1. Press the Loc/Rem key for five seconds, until Local? or Remote? is displayed.
2. Confirm with Enter.
3. Cancel with Esc.

Local mode

Local mode is used for temporary operation. When switched to LOCAL operation, the VSI is controlled via the defined Local operation mode, i.e. [2171] and [2172]. The actual status of the VSI will not change, e.g. Run/Stop conditions and the actual speed will remain exactly the same. When the VSI is set to Local operation, the display will show **L** in area B in the display.

The VSI will be started and stopped using the keys on the control panel. The reference signal can be controlled using the + and - keys on the keyboard, when in the menu [310].

Remote mode

When the VSI is switched to REMOTE operation, the VSI will be controlled according to selected control methods in the menu's Reference Control [214], Run/Stop Control [215] and Reset Control [216]. The actual operation status of the VSI will reflect the status and settings of the programmed control selections, e.g. Start/Stop status and settings of the programmed control selections.

To monitor the actual Local or Remote status of the VSI control, a "Loc/Rem" function is available on the Digital Outputs or Relays. When the VSI is set to Local, the signal on the DigOut or Relay will be active high, in Remote the signal will be inactive low. See menu Digital Outputs [540] and Relays [550].

9.3.8 Function keys

The function keys operate the menus and are also used for programming and read-outs of all the menu settings.

Table 17 Function keys

ENTER	ENTER key:	- step to a lower menu level - confirm a changed setting
ESC	ESCAPE key:	- step to a higher menu level - ignore a changed setting, without confirming
◄	PREVIOUS key:	- step to a previous menu within the same level - go to more significant digit in edit mode
►	NEXT key:	- step to a next menu within the same level - go to less significant digit in edit mode
-	- key:	- decrease a value - change a selection
+	+ key:	- increase a value - change a selection
LOC/ REM	TOGGLE and LOC/REM key:	- Toggle between menus in the toggle loop - Switching between local and remote control - Change the sign of a value

9.4 The menu structure

The menu structure consists of 4 levels:

Main Menu 1st level	The first character in the menu number.
2nd level	The second character in the menu number.
3rd level	The third character in the menu number.
4th level	The fourth character in the menu number.

This structure is consequently independent of the number of menus per level.

For instance, a menu can have one selectable menu ([O51] Freq Type, or it can have 7 selectable menus ([O30] Udc Control).

NOTE:
If there are more than 10 menus within one level, the numbering continues in alphabetic order.

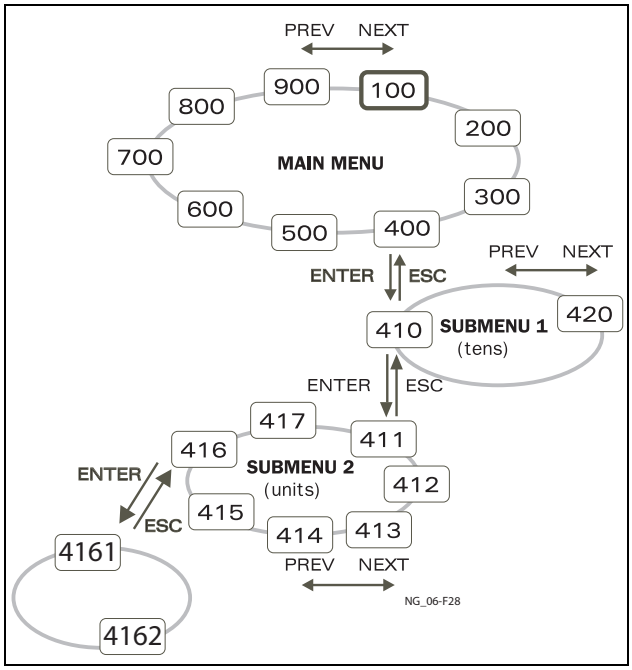


Fig. 56 Menu structure (general principle)

9.4.1 The main menu for AFR/AFG

This section gives you a short description of the functions in the Main menu for AFR/AFG.
For Emotron VFX and FDU refer to the standard instruction manual.

100 Preferred View

Displayed at power-up. It displays the actual process value as default. Programmable for many other read-outs.

200 Main Setup

Main settings to get the AFR/AFG operable. The supply data settings are the most important. Also option utility and settings.

300 Process and Application Parameters

Settings more relevant to the application such as Reactive power, Reference etc.

400 Monitor/Protection

Settings related to the monitors and protections.

500 Inputs/Outputs and Virtual Connections

All settings for inputs and outputs are entered here.

600 Logical Functions and Timers

All settings for conditional signal are entered here.

700 View Operation and Status

Viewing all the operational data like frequency, load, power, current, etc.

800 View Trip Log

Viewing the last 10 trips in the trip memory.

900 Service Information and AFR/AFG Data

Electronic type label for viewing the software version and AFR/AFG type.

000 AFE Option

Main setup for AFR/AFG dedicated features.

G00 Grid Code parameters

All settings for grid code requirements are entered here.

9.5 Programming during operation

Most of the parameters can be changed during operation without stopping the AFR/AFG or VSI. Parameters that can not be changed are marked with a lock symbol in the display.

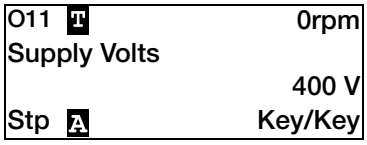
NOTE:
If you try to change a function during operation that only can be changed when the AFR/AFG is stopped, the message "Stop First" is displayed.

9.6 Editing values in a menu

Most values in the second row in a menu can be changed in two different ways. Enumerated values like the baud rate can only be changed with alternative 1.

Alternative 1

When you press the + or - keys to change a value, the cursor is flashing to the left in the display and the value is increased or decreased when you press the appropriate key. If you keep the + or - keys pressed, the value will increase or decrease continuously. When you keep the key pressed the change speed will increase. The Toggle key is used to change the sign of the entered value. The sign of the value will also change when zero is passed. Press Enter to confirm the value.

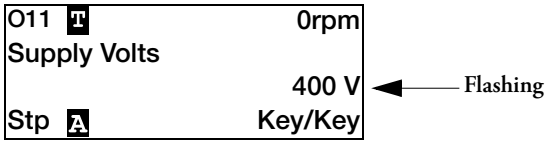


Alternative 2

Press the + or - key to enter edit mode. Then press the Prev or Next key to move the cursor to the right most position of the value that should be changed. The cursor will make the selected character blink. Move the cursor using the Prev or Next keys. When you press the + or - keys, the character at the cursor position will increase or decrease. This alternative is suitable when you want to make large changes.

To change the sign of the value, press the toggle key. This makes it possible to enter negative values.

Example: When you press Next the "400" will blink.



Press Enter to save the setting and Esc to leave the edit mode.

9.7 Copy current parameter to all sets

When a parameter is displayed, press the Enter key for 5 seconds. Now the text To all sets? is displayed. Press Enter to copy the setting for current parameter to all sets.

9.8 Programming example

This example shows how to program a change of Language from English (default) to Nederlands.

The flashing cursor indicates that a change has taken place but is not saved yet. If at this moment, the power fails, the change will not be saved.

Use the ESC, Prev, Next or the Toggle keys to proceed and to go to other menus.

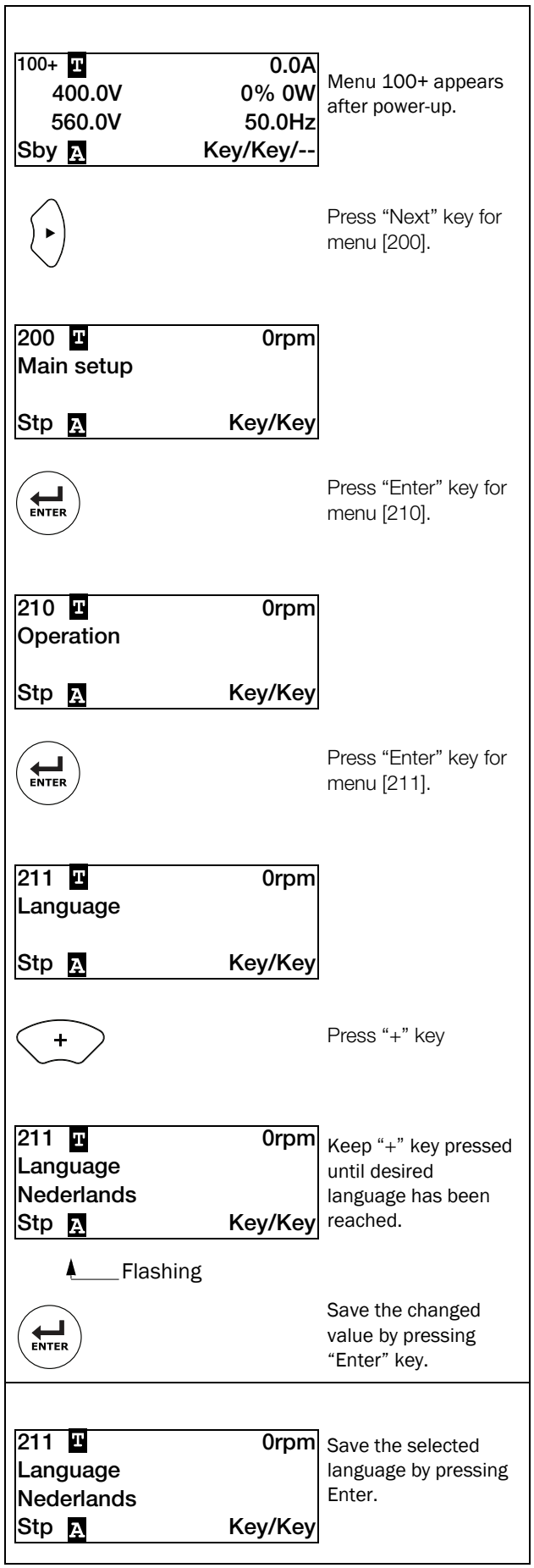


Fig. 57 Programming example

10. Serial communication

The AC drive provides possibility for different types of serial communication.

- Modbus RTU via RS232/485
- Fieldbuses as Profibus DP and DeviceNet
- Industrial Ethernet as Modbus/TCP, Profinet IO, EtherCAT and EtherNet/IP

10.1 Modbus RTU

Preferably use the isolated RS-485 interface for serial communication. This port is galvanically isolated.
The protocol used for data exchange is based on the Modbus RTU protocol, originally developed by Modicon.
The AC drive acts as a slave with selectable address in a master-slave configuration. The communication is half-duplex. It has a standard non return zero (NRZ) format.

The baud rate of the RS-485 interface is adjustable between 2400 to 115200.

The character frame format (always 11 bits) has:

- one start bit
- eight data bits
- two stop bits
- no parity

The AC drive has also an asynchronous serial communication interface, RS-232, behind the control panel.
Please note that this port is not galvanically isolated.

It is possible to temporarily connect a personal computer with for example the software EmoSoftCom (programming and monitoring software) to the RS232 connector on the control panel. This can be useful when copying parameters between AC drives etc. For permanent connection of a personal computer you have to use one of the communication option boards.

NOTE: This RS232 port is not isolated.

WARNING!
Correct and safe use of a RS232 connection depends on the ground pins of both ports being the same potential. Problems can occur when connecting two ports of e.g. machinery and computers where both ground pins are not the same potential. This may cause hazardous ground loops that can destroy the RS232 ports.

The RS232 connection behind the control panel is not galvanically isolated.

The RS232/485 option board from CG Drives & Automation is galvanically isolated.

Note that the control panel RS232 connection can safely be used in combination with commercial available isolated USB to RS232 converters.

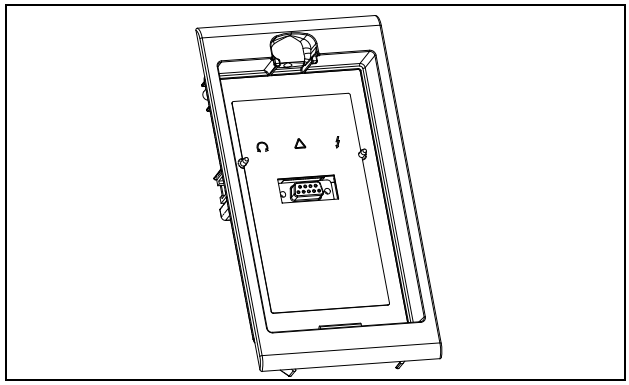


Fig. 58 RS232 connector behind the control panel

10.2 Parameter sets

Communication information for the different parameter sets.
The different parameter sets in the AC drive have the following DeviceNet instance numbers, Profibus slot/index numbers, Profinet IO index and EtherCAT index numbers:

Param. set	Modbus/ DeviceNet Instance number	Profibus Slot/Index	Profinet IO index	EtherCAT and CANopen index (hex)
A	43001–43899	168/160 to 172/38	19385 - 20283	4bb9 - 4f3b
B	44001–44899	172/140 to 176/18	20385 - 21283	4fa1 - 5323
C	45001–45899	176/120 to 179/253	21385 - 22283	5389 - 5706
D	46001–46899	180/100 to 183/233	22385 - 23283	5771 - 5af3

Parameter set A contains parameters 43001 to 43899. The parameter sets B, C and D contains the same type of information. For example parameter 43123 in parameter set A contain the same type of information as 44123 in parameter set B.

10.3 Start and stop commands

Set start and stop commands via serial communication.

Modbus/DeviceNet Instance number	Function
42901	Reset
42902	Run, active together with either RunR or RunL to perform start.
42903	RunR
42904	RunL

Note! Bipolar reference mode is activated if both RunR and RunL is active.

10.4 Reference signal

When menu “Reference Control [214]” is set to “Com” the following parameter data should be used:

Default	0
Range	-16384 to 16384
Corresponding to	-100% to 100% ref

Communication information

Modbus /DeviceNet Instance number	42905
Profibus slot /Index	168/64
EtherCAT index (hex)	4b59
Profinet IO index	19289
Fieldbus format	Int
Modbus format	Int

10.5 Description of the EInt formats

Eint is only used with Modbus-RTU and Modbus-TCP protocols.
A parameter with Eint format can be represented in two different formats (F). Either as a 15 bit unsigned integer format (F= 0) or a Emotron floating point format (F=1). The most significant bit (B15) indicates the format used. See detailed description below.
All parameters written to a register may be rounded to the number of significant digits used in the internal system.

The matrix below describes the contents of the 16-bit word for the two different EInt formats:

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
F=1	e3	e2	e1	e0	m10	m9	m8	m7	m6	m5	m4	m3	m2	m1	m0
F=0	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

If the format bit (B15) is 0, then all bits may be treated as a standard unsigned integer (UInt)

If the format bit is 1, then is the number interpreted as this:

Value = M * 10^E, where M=m10..m0 represents a two- complement signed mantissa and E= e3..e0 represents a two- complement signed exponent.

NOTE: Parameters with EInt format may return values both as 15 bit unsigned int (F=0) or in Emotron floating point (F=1).

Example, resolution

If you write the value 1004 to a register and this register has 3 significant digits, it will be stored as 1000.

In the Emotron floating point format (F=1), one 16-bit word is used to represent large (or very small numbers) with 3 significant digits.

If data is read or written as a fixed point (i.e. no decimals) number between 0-32767, the 15 bit Unsigned integer format (F=0) may be used.

Detailed description of Emotron floating point format

```
e3-e0 4-bit signed exponent. Gives a value
range:
-8..+7 (binary 1000 .. 0111)
m10-m0 11-bit signed mantissa.Gives a value
range:
-1024..+1023 (binary
10000000000..01111111111)
```

A signed number should be represented as a two complement binary number, like below:

Value Binary

```
-8 1000
-7 1001
..
-2 1110
-1 1111
0 0000
1 0001
2 0010
..
6 0110
7 0111
```

The value represented by the Emotron floating point format is m·10e.

To convert a value from the Emotron floating point format to a floating point value, use the formula above.

To convert a floating point value to the Emotron floating point format, see the C-code example below.

Example, floating point format

The number 1.23 would be represented by this in Emotron floating point format,

```
F EEEE MMMMMMMMMMM
1 1110 00001111011
F=1 -> floating point format used
E=-2
M=123
```

The value is then $123x10^{-2} = 1.23$

Example 15bit unsigned int format

The value 72.0 can be represented as the fixed point number 72. It is within the range 0-32767, which means that the 15-bit fixed point format may be used.

The value will then be represented as:

```
B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 B1 B0
0   0   0   0   0   0   0  0  0  1  0  0  1  0  0  0
```

Where bit 15 indicates that we are using the fixed point format (F=0).

Programming example:

```
typedef struct
{
  int m:11; // mantissa, -1024..1023
  int e: 4; // exponent -8..7
  unsigned int f: 1; // format, 1->special emoint format
}    eint16;
//---------------------------------------------------------------------------
unsigned short int float_to_eint16(float value)
{
  eint16 etmp;
  int dec=0;

  while (floor(value) != value && dec<16)
  {
     dec++; value*=10;
  }
  if (value>=0 && value<=32767 && dec==0)
     *(short int *)&etmp=(short int)value;
  else if (value>=-1000 && value<0 && dec==0)
  {
     etmp.e=0;
     etmp.f=1;
     etmp.m=(short int)value;
  }
  else
  {
     etmp.m=0;
     etmp.f=1;
     etmp.e=-dec;
     if (value>=0)
        etmp.m=1; // Set sign
     else
        etmp.m=-1; // Set sign
     value=fabs(value);
     while (value>1000)
     {
        etmp.e++; // increase exponent
        value=value/10;
     }
     value+=0.5; // round
     etmp.m=etmp.m*value; // make signed
  }
 return (*(unsigned short int *)&etmp);
}
//---------------------------------------------------------------------------
float eint16_to_float(unsigned short int value)
{
  float f;
  eint16 evalue;

  evalue=*(eint16 *)&value;
  if (evalue.f)
  {
     if (evalue.e>=0)
        f=(int)evalue.m*pow10(evalue.e);
     else
        f=(int)evalue.m/pow10(abs(evalue.e));
  }
  else
     f=value;

  return f;
}
//---------------------------------------------------------------------------
```

11. Functional description

This chapter describes the menus and parameters in the software. See chapter 9.3 Control panel with 4-line display page 58 in chapter Operation for detailed information about the Control panel.

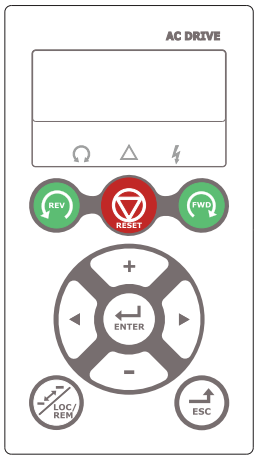


Fig. 59 LCD display

11.1 Menus

Following chapters describes the menus and parameters in the software. You will find a short description of each function and information about default values, ranges, etc. There are also tables containing communication information. You will find the parameter number for all available fieldbus options as well as the enumeration for the data.
On our home page in the download area, you could find a "Communication information" list and a list to note “Parameter set” information.

Regarding the functional description for VFXR/FDUL, see chapter “Functional description” in Emotron VFX/FDU 2.1 manuals,

NOTE: For communication information see Emotron VFX/FDU 2.1 manuals.

NOTE: Functions marked with the sign 🔒 cannot be changed during Run Mode.

11.1.1 Description of menu table layout

Following two kinds of tables are used in this chapter.

o32②	①	Udc ramp ③
Default:		④
⑤	⑥	⑦

o11 ②	①	Supply Volts ③
Default:		400 V ④
Range:		380 - 460 V
Resolution		1 V ⑦

1. Parameter cannot be changed during operation.
2. Parameter only for viewing.
3. Menu information as displayed on control panel. For explanation of display text and symbols, see Chapter 9. page 57.
4. Factory setting of parameter (also showed on display).
5. Available settings for the menu, listed selections.
6. Communication integer value for the selection. For use with communication bus interface (only if selection type parameters).
7. Description of selection alternative, setting or range (min - max value).

11.1.2 Resolution of settings

The resolution for all range settings described in this chapter is 3 significant digits. Table 18 shows the resolutions for 3 significant digits.

Table 18

3 Digit	Resolution
0.01-9.99	0.01
10.0-99.9	0.1
100-999	1
1000-9990	10
10000-99900	100

11.1.3 1st Line [110]

Sets the content of the first line in the menu "[100] Start Window".

110		1st Line
Default:		Current
Dependent on menu		
Process Val	0	Process value
El power	2	Electrical power
Process Ref	3	Process reference
React Power	4	Reactive power
Current	6	Current
Output volt	7	Output voltage
Frequency	8	Frequency
DC Voltage	9	DC voltage
IGBT Temp	10	IGBT temperature
Motor Temp *	11	Motor temperature
AFR Status	12	AFR status
Run Time	13	Run Time
Energy	14	Energy
Mains Time	15	Mains time
Unit Name	17	Unit name
Time	18	Time
Date	19	Date

* The "Motor temp" is only visible if you have the option PTC/PT100 card installed and a PT100 input is selected in menu[236].

** Can only be selected if Encoder option board is installed.

2nd Line [120]

Sets the content of the second line in the menu "[100] Start Window". Same selection as in menu [110].

120	2nd Line
Default:	El Power

3rd Line [130]

Sets the content of the third line in the menu "[100] Start Window". Same selection as in menu [110].

130	3rd Line
Default:	Frequency

4th Line [140]

Sets the content of the fourth line in the menu "[100] Start Window". Same selection as in menu [110].

140	4th Line
Default:	AFR Status

5th Line [150]

Sets the content of the fifth line in the menu "[100] Start Window". Same selection as in menu [110].

150	5th Line
Default:	DC Voltage

6th Line [160]

Sets the content of the sixth line in the menu "[100] Start Window". Same selection as in menu [110].

160	6th Line
Default:	Output volt

View mode [170]

Select how menu [100] shall be displayed.

170		View mode
Default:		Always 100+
Normal 100	0	Preferred view as set in menu 110, 120, 130
Always 100+	1	Extended signal monitoring as set in menus 110 - 160
Normal 100wo	2	As Normal 100 without text at second and third lines.

11.2 Main Setup [200]

The Main Setup menu contains the most important settings to get the AFE operational and set up for the application. It includes different sub menus concerning the control of the unit, protection, utilities and automatic resetting of faults. This menu will instantaneously be adapted to build in options and show the required settings.

11.2.1 Operation [210]

Selections concerning the AFE- control signals and serial communication are described in this submenu and is used to set the AFE up for the application.

Language [211]

Select the language used on the Display. Once the language is set, this selection will not be affected by the Load Default command.

211		Language
Default:		English
English	0	English selected
Svenska	1	Swedish selected
Nederlands	2	Dutch selected
Deutsch	3	German selected
Русский	6	Russian selected

Reference control [214]

To control the reactive power of the AFE needs a reference signal. This reference signal can be controlled by a remote source from the installation, the keyboard of the AFE, or by serial or fieldbus communication. Select the required reference control source for the application in this menu.

214		Ref control
Default:		Keyboard
Remote	0	The reference signal comes from the analogue inputs of the terminal strip (terminals 1-22).
Keyboard	1	Reference is set with the + and - keys on the Control Panel. Can only be done in menu “Set/View reference [310]”.
Com	2	The reference is set via the serial communication (RS 485, Fieldbus. or Wireless interfaces) See section 10.4, page 66. See Fieldbus or RS232/485 option manual for details.

NOTE:
If the reference is switched from Remote to Keyboard, the last remote reference value will be the default value for the control panel.

Run/Stop Control [215]

This function is used to select the source for run and stop commands.

215		Run/Stp Ctrl
Default:		Keybord
Remote	0	The start/stop signal comes from the digital inputs of the terminal strip (terminals 1-22).
Keyboard	1	Start and stop is set on the Control Panel.
Com	2	The start/stop is set via the serial communication (RS 485, Fieldbus.) See section 10.4, page 66. See Fieldbus or RS232/485 option manual for details.

Reset Control [216]

When the AFE is stopped due to a failure, a reset command is required to make it possible to restart the AFE. Use this function to select the source of the reset signal.

216	Reset Ctrl	
Default:		Remote+Keyb
Remote	0	The command comes from the inputs of the terminal strip (terminals 1-22).
Keyboard	1	The command comes from the command keys of the Control Panel.
Com	2	The command comes from the serial communication (RS 485, Fieldbus).
Remote + Keyb	3	The command comes from the inputs of the terminal strip (terminals 1-22) or the keyboard.
Com + Keyb	4	The command comes from the serial communication (RS485, Fieldbus) or the keyboard.
Rem+Keyb +Com	5	The command comes from the inputs of the terminal strip (terminals 1-22), the keyboard or the serial communication (RS485, Fieldbus).

Local/Remote key function [217]

The Toggle key on the keyboard, see chapter 9.3.7 page 61, has two functions and is activated in this menu. As default the key is just set to operate as a Toggle key that moves you easily through the menus in the toggle loop. The second function of the key allows you to easily swap between Local and normal operation (set up via [214] and [215]) of the AFE drive. Local mode can also be activated via a digital input. If both [2171] and [2172] is set to Standard, the function is disabled.

2171	LocRefCtrl	
Default:		Standard
Standard	0	Local reference control set via [214]
Remote	1	Local reference control via remote
Keyboard	2	Local reference control via keyboard
Com	3	Local reference control via communication

2172	LocRunCtrl	
Default:		Standard
Standard	0	Local Run/Stop control set via [215]
Remote	1	Local Run/Stop control via remote
Keyboard	2	Local Run/Stop control via keyboard
Com	3	Local Run/Stop control via communication

Lock Code? [218]

To prevent the keyboard being used or to change the setup of the AFE drive and/or process control, the keyboard can be locked with a password. This menu, “Lock Code [218]”, is used to lock and unlock the keyboard. Enter the password “291” to lock/unlock the keyboard operation. If the keyboard is not locked (default) the selection “Lock Code?” will appear. If the keyboard is already locked, the selection “Unlock Code?” will appear.

When the keyboard is locked, parameters can be viewed but not changed. The reference value can be changed and the AFE can be started, stopped and reversed if these functions are set to be controlled from the keyboard.

218	Lock code?
Default:	0
Range:	0–9999

Remote signal Level/Edge [21A]

In this menu you select the way to control the inputs for RunR, RunL and Reset that are operated via the digital inputs on the terminal strip. The inputs are default set for level-control, and will be active as long as the input is made and kept high. When edge-control is selected, the input will be activated by the low to high transition of the input. See chapter 7.17.4 page 52 for more information.

21A	Level / Edge	
Default:		Level
Level	0	The inputs are activated or deactivated by a continuous high or low signal. Is commonly used if, for example, a PLC is used to operate the AFE.
Edge	1	The inputs are activated by a transition; for Run and Reset from “low” to “high” and for Stop from "high" to "low".

CAUTION!
Level controlled inputs DO NOT comply with the Machine Directive if the inputs are directly used to start and stop the machine.

NOTE:
Edge controlled inputs can comply with the Machine Directive (see the chapter 8. page 55) if the inputs are directly used to start and stop the machine.

Mains supply voltage [21B]

WARNING!
This menu must be set according to the AFE product label and the supply voltage used. Wrong setting might damage the AFE or brake resistor.

In this menu the nominal mains supply voltage connected to the AFE can be selected. The setting will be valid for all parameter sets. The default setting, Not defined, is never selectable and is only visible until a new value is selected.

This menu specifies the AC supply voltage. The corresponding DC voltage is 1.34 times higher.

Once the supply voltage is set, this selection will not be affected by the Load Default command [243].

Brake chopper activation level is adjusted using the setting of [21B].

NOTE:
The setting is affected by the "Load from CP" command [245] and if loading parameter file via EmoSoftCom.

21B		Supply Volts
Default:		Not Defined
Not Defined	0	Inverter default value used. Only valid if this parameter is never set.
220-240 VAC	1	Only valid for AFR/AFG46
380-415 VAC	3	Only valid for AFR/AFG46/69
440-480 VAC	4	Only valid for AFR/AFG46/69
500-525 VAC	5	Only valid for AFR/AFG69
550-600 VAC	6	Only valid for AFR/AFG69
660-690 VAC	7	Only valid for AFR/AFG69

11.2.2 Parameter Set Handling [240]

Select Set [241]

Here you select the parameter set.

Note. The AFE unit only supports one parameter set.

241		Select Set
Default:		A
Selection:		A
A	0	Fixed selection to parameter set A.

The active set can be viewed in menu [721] AFR status.

Load Default Values Into Set [243]

With this function the factory setting can be selected for the parameter set. When loading the default settings, all changes made in the software are set to factory settings.

243		Default>Set
Default:		A
A	0	Only the selected parameter set will revert to its default settings.
Factory	5	All settings, except [211], [261] and [923], will revert to the default settings.

NOTE:
Trip log hour counter and other VIEW ONLY menus are not regarded as settings and will be unaffected.

NOTE:
If "Factory" is selected, the message "Sure?" is displayed. Press the + key to display "Yes" and then Enter to confirm.

Copy All Settings to Control Panel [244]

All the settings can be copied into the control panel. Start commands will be ignored during copying.

244		Copy to CP
Default:		No Copy
No Copy	0	Nothing will be copied
Copy	1	Copy all settings

NOTE: The actual value of menu [310] will not be copied into control panel memory set.

Load Settings from Control Panel [245]

This function can load all parameters from the control panel to the AFE unit. Parameter sets from the source AFE unit are copied to all parameter sets in the target AFE unit, only set A to set A for AFR.

Start commands will be ignored during loading.

245		Load from CP
Default:		No Copy
No Copy	0	Nothing will be loaded.
A	1	Data from parameter set A is loaded.

NOTE:
[244] and [245] applies only on parameter set A menus ranging from [100] to [900].
[244] and [245] does not act on AFE Option parameters [O00] and grid code parameters [G00].

11.2.3 Trip Autoreset/Trip Conditions [250]

The benefit of this feature is that occasional trips that do not affect the process will be automatically reset. Only when the failure keeps on coming back, recurring at defined times and therefore cannot be solved by the AFE, will the unit give an alarm to inform the operator that attention is required.

Also see § 12.2, page 150.

Autoreset example

In an application it is known that the main supply voltage sometimes disappears for a very short time, a so-called “dip”. That will cause the AFE to trip an “Undervoltage alarm”. Using the Autoreset function, this trip will be acknowledged automatically.

- Enable the Autoreset function by making the reset input continuously high.
- Activate the Autoreset function in the menu [251], Number of trips.
- Select in menu [259] Undervoltage the trip conditions that shall be allowed to be automatically reset by the Autoreset function, after the set delay time has expired.

Number of Trips [251]

Any number set above 0 activates the Autoreset. This means that after a trip, the AFE will restart automatically according to the number of attempts selected. No restart attempts will take place unless all conditions are normal.

If the Autoreset counter (not visible) contains more trips than the selected number of attempts, the Autoreset cycle will be interrupted. No Autoreset will then take place.

If there are no trips for more than 10 minutes, the Autoreset counter decreases by one.

If the maximum number of trips has been reached, the trip message hour counter (8x0 menu) is marked with an "A". Trip can be reset with a normal reset, but to re-activate the auto-reset functionality the auto-reset counter must be reset. This is done by de-activate the always high remote-reset input and then activate it again.

Example:

- Number of allowed autoreset attempts [251]= 5.
- Within 10 minutes 6 trips occur.
- At the 6th trip there is no autoreset, because the autoreset counter is set to allow only 5 attempts to autoreset a trip.
- To reset the autoreset counter, de-activate the always high remote-reset input and then activate it again.
- The autoreset counter is now zeroed.

251	No of Trips
Default:	0 (no Autoreset)
Range:	0–10 attempts

NOTE: An auto reset is delayed by the remaining ramp time.

DriveProtect [252]

Over temperature [2521]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2521 Over temp		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

NOTE: An auto reset is delayed by the remaining ramp time.

Over volt D [2522]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active**.**

2522 Over volt D		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

NOTE: An auto reset is delayed by the remaining ramp time.

Over volt G [2523]

Delay time starts counting when the fault is gone When the time delay has elapsed, the alarm will be reset if the function is active.

2523 Over volt G		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

Over volt [2524]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2524 Over volt		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

Under volt [2525]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active**.**

2525 Under volt		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

Over current F [2526]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2526 Over curr F		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

Power Fault [2527]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active**.**

2527 Power Fault		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

Liquid cooling low level [2528]

Delay time starts counting when the fault disappears. When the time delay has elapsed, the alarm will be reset if the function is active.

2528 LC Level		
Default:		Off
Off	0	Off
1-3600	1-3600	1-3600 s

MotorProtect [253]

PT100 [2535]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2535 PT100		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

PTC [2537]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2537 PTC		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

External Motor Temperature [253A]

Delay time starts counting when the fault disappears. When the time delay has elapsed, the alarm will be reset if the function is active.

253A Ext MotTemp		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

Comm & I/O [254]

Communication Error [2541]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2541 Com Error		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

AnIn<Offset [2543]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2543 AnIn<Offset		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

External [258]

External Trip 1 [2581]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2581 Ext Trip 1		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

External Trip 2 [2583]

Delay time starts counting when the fault is gone. When the time delay has elapsed, the alarm will be reset if the function is active.

2583 Ext Trip 2		
Default:		Off
Off	0	Off
1–3600	1–3600	1–3600 s

11.2.4 Serial Communication [260]

The integrated RS485 interface on terminal X1: A+ and B- will always be enabled regardless of setting in menu [261] Comm type. Further, it may be used in parallel to any Fieldbus option on X4 interface.

Menu [262] RS232/485 and its sub menus are used to configure the integrated RS485 interface.

This function is to define the communication parameters for serial communication. There are two types of options available for serial communication, RS232/485 (Modbus/RTU) and fieldbus modules (CANopen, Profibus, DeviceNet, Modbus/TCP, Profinet IO, EtherCAT and EtherNet/IP).
For more information see Chapter 10. page 65 and respective option manual.

Comm Type [261]

Select RS232/485 [262] or Fieldbus [263].

261 Com Type		
Default:		RS232/485
RS232/485	0	Integrated RS485 interface enabled. Fieldbus interface on X4 disabled (RESET).
Fieldbus	1	Fieldbus selected (CANopen, Profibus, DeviceNet, Modbus/TCP, Profinet IO, EtherCAT or EtherNet/IP). Integrated RS485 interface enabled (can be used in parallel to fieldbus option).

NOTE: Toggling the setting in this menu will perform a soft reset (re-boot) of the Fieldbus module.

RS232/485 [262]

Press Enter to set up the parameters for RS-232/485 (Modbus/RTU) communication.

262 RS232/485

Baud rate [2621]

Set the baud rate for the communication.

NOTE: This address is only used for the integrated/ isolated RS485 option.

2621 Baudrate		
Default:		9600
2400	0	Selected baud rate
4800	1	
9600	2	
19200	3	
38400	4	
57600	5	
115200	6	

Address [2622]

Enter the unit address for the AFE.

NOTE: This address is only used for the integrated/ isolated RS485 option.

2622 Address	
Default:	1
Selection:	1–247

Fieldbus [263]

Press Enter to set up the parameters for fieldbus communication.

263 Fieldbus

Address [2631]

Enter/view the unit/node address of the AFE Read and write access for CANopen, Profibus, DeviceNet. Read - only for EtherCAT.

2631 Address	
Default:	62
Range:	CANopen 1-127, Profibus 0–126, DeviceNet 0–63
Node address valid for CANopen (RW), Profibus(RW), DeviceNet (RW) and EtherCAT (RO).	

Process Data Mode [2632]

Enter the mode of process data (cyclic data). For further information, see the Fieldbus option manual.

NOTE: For CANopen module this menu is forced to "8".

2632 PrData Mode		
Default:		Basic
None	0	Control/status information is not used.
Basic	4	4 byte process data control/status information is used.
Extended	8	4 byte process data (same as Basic setting) + additional proprietary protocol for advanced users is used.

Read/Write [2633]

Select read/write to control the inverter over a Fieldbus network. For further information, see the Fieldbus option manual.

2633 Read/Write		
Default:		RW
RW	0	
Read	1	
Valid for process data. Select R (read only) for logging process without writing process data. Select RW in normal cases to control inverter.		

Additional Process Values [2634]

Define the number of additional process values sent in cyclic messages.

NOTE: For CANopen module this menu is forced to "Basic".

2634 AddPrValues	
Default:	0
Range:	0-8

CANBaudrate [2635]

Set the baud rate for CANopen Fieldbus.

NOTE: Used for CANopen module only

2635 CANBaudrate	
Default:	8
0	10 kbps
1	20 kbps
2	50 kbps
3	Reserve
4	100 kbps
5	125 kbps
6	250 kbps
7	500 kbps
8	1 Mbps
9	Auto *

* Under normal traffic conditions, i.e. with cyclic bus traffic above 2 Hz, the baudrate should be detected within 5 seconds.

NOTE: The automatic baud rate detection will NOT work if there is no traffic on the network.

Communication Fault [264]

Main menu for communication fault/warning settings. For further details please see the Fieldbus option manual.

Menus [2641] and [2642] are specifically used for Fieldbus option mounted on interface X4.

Menus [2643] and [2644] are specifically used for integrated RS485 interface on X1: A+ and B-.

Communication Fault Mode [2641]

Selects action if a Fieldbus fault is detected.

2641 ComFlt Mode		
Default:		Off
Off	0	No communication supervision.
Trip	1	Fieldbus selected: The AFE will trip if: 1. The internal communication between the control board and fieldbus option is lost for time set in parameter [2642]. 2. If a serious network error has occurred.
Warning	2	Fieldbus selected: The AFE will give a warning if: 1. The internal communication between the control board and fieldbus option is lost for time set in parameter [2642]. 2. If a serious network error has occurred.

NOTE: Menu [214] and/or [215] must be set to COM to activate the communication fault function.

Communication Fault Time [2642]

Defines the delay time for the Fieldbus trip/warning.

2642 ComFlt Time	
Default:	0.5 s
Range:	0.1-15 s

485 Fault Mode [2643]

Selects action for timeout on integrated RS485 interface on X1: A+ and B-.

2643 485Flt Mode		
Default:		Off
Off	0	No communication supervision.
Trip	1	The AFE will trip if there is no communication for time set in parameter [2644].
Warning	2	The AFE will give a warning if there is no communication for time set in parameter [2644].

NOTE: Menu [214] and/or [215] must be set to COM to activate the communication fault function.

485 Fault Time [2644]

Defines the delay time for the integrated RS485 trip/warning.

2644 485Flt Time	
Default:	0.5 s
Range:	0.1-15 s

Keybord Communication Fault Mode [2645]

When keyboard is removed in drive running condition and "[214] Ref Control" or "[215] Run/Stp Ctrl" is set to "Keyboard" the drive should come to stop.

2645 KbdComFMode		
Default:		Trip
Off	0	No supervison of keybord.
Trip	1	The drive will trip after time set in parameter [2646] if keyboard/control board is removed.
Warning	2	The drive will give a warning after time set in parameter [2646] if the keyboard/control board is removed.

Keyboard Communication Fault Time [2646]

Defines the delay time for detection of a removed control panel provided that 2645 is either trip or warning.

2646 KbdComFTime	
Default:	2 s
Range:	0.1 s - 15 s

Communication fault for control panel port

This feature enables communication fault for external controlling equipment connected to the CP port. Most importantly this enables detection if a wireless connection, via BLE or WiFi CP, is disconnected.

Fault is only enabled if all of following conditions are met:

- "[214] Ref Control" or "[215] Run/Stp Ctrl" is set to "Com".
- A device connected to the CP port has written to any of the communication command registers:
  - Run (2 or 42902)
  - RunR (3 or 42903)
  - RunL (4 or 42904)
  - Reference (42905)
- Communication command Run and one or both of RunR or RunL are set.
- Function enabled (Trip or Warning) in menu "[2647] CPportFMode"
- No communication on the control panel port for "[2648] CPportFTime" X seconds.

Control Panel port Fault Mode [2647]

2647 CPportFMode		
Default:		Trip
Off	0	No supervision of the control panel.
Trip	1	The drive will trip after time set in parameter [2648] if control panel is removed.
Warning	3	The drive will give a warning after time set in parameter [2648] if the control panel is removed.

Control Panel port Fault Time [2648]

2648 CPportFTime	
Default:	10.0 s
Range:	0.1 s - 15.0 s

Ethernet [265]

Settings for Ethernet module (Modbus/TCP, Profinet IO). For further information, see the Fieldbus option manual.

NOTE: The Ethernet module must be re-booted to activate the below settings. For example by toggling parameter [261]. Non-initialized settings indicated by flashing display text.

IP Address [2651]

2651 IP Address	
Default:	0.0.0.0

MAC Address [2652]

2652 MAC Address	
Default:	An unique number for the Ethernet module.

Subnet Mask [2653]

2653 Subnet Mask	
Default:	0.0.0.0

Gateway [2654]

2654 Gateway	
Default:	0.0.0.0

DHCP [2655]

2655 DHCP	
Default:	Off
Selection:	On/Off

Fieldbus Signals [266]

Defines mapping for additional process values. For further information, see the Fieldbus option manual.

FB S1/Wr1 - FB S8/Wr8 [2661]-[2668]

Used to create a block of parameters which can be written via communication.

2661 FB S1/Wr1	
Default:	0
Range:	0-65535

FB S9/Rd1 - FB S16/Rd8 [2669]-[266G]

Used to create a block of parameters which can be read via communication.

2669 FB S9/Rd1	
Default:	0
Range:	0-65535

NOTE: For Modbus all 16 fieldbus mappings can be used either as read or write. Configuration of register map is made menu [2661]-[266G] or Modbus range 42801-42816. Register read/write access is made in Modbus range 42821-42836.

FB Status [269]

Sub menus showing status of Fieldbus parameters. Please see the Fieldbus manual for detailed information.

269 FB Status

11.2.5 Wireless [270]

Parameters for configuring wireless communication links such as WiFi or Bluetooth Low Energy (BLE). Changing any of these parameters will trigger a reconfiguration action that could result in a slight delay of pressed buttons / menu change.

Wireless Mode [271]

Available options depend on capability of the connected control panel.

271		WirelessMode
Default		Off
Off	0	Wireless interfaces turned off
WiFi	1	WiFi interface enabled
BLE	2	Bluetooth Low Energy interface enabled

WiFi Options [272]

This menu is hidden unless menu“WirelessMode [271]” is set to WiFi.
After a sub-menu has been changed the response from the WiFi module can be observed in menu [272A] WiFi Status. If everything went well a "Config OK" is expected to be shown for 60 seconds.

WiFi Mode [2721]

Configures the 2.4 GHz WiFi interface of the control panel to either act as an AccessPoint (allowing clients to connect to the drive) or as station (i.e. connect to an already existing WiFi network as a client).

NOTE: Only one client can connect and communicate with the drive at same time.

2721		WiFi Mode
Default		AccessPoint
AccessPoint	0	Configure WiFi interface to act as an Access Point (AP) allowing client devices like mobile phones or tablets to connect to the network provided by the Drive. Remaining WiFi parameters [272X] will decide the properties of the provided WiFi network.
Station	1	Configure WiFi interface to connect to an existing WiFi network provided by an external Router/AP. Remaining WiFi parameters [272X] will be used to select the network to connect to and to provide the required credentials.

Channel [2722]

Sets the WiFi channel to operate on in AccessPoint mode. Menu hidden in Station mode (will adopt to the channel used by AP/Router connected to).

NOTE: Only channels 1-11 should be used in US.

2722	Channel
Default	5
0 - 13	2.4 GHz WiFi channels to be used in AccessPoint mode.

Encryption [2723]

Selects the encryption standard to be used for the transmitted WiFi data.

2723		Encryption
Default		WPA2
Open	0	No encryption of the wireless link
WEP	1	WEP encryption
WPA2	2	WPA-2 encryption

DHCP [2724]

Selects how IP properties are handled. Static implies user give address while DHCP implies that DHCP server on network assign an IP address. In case [2721] WiFi Mode is AccessPoint, DHCP is automatically selected.

2724		DHCP
Default		Static
Static	0	Static implies user set IP properties via menus [2727 - 2729].
DHCP	1	Server on network assign IP properties.

SSID [2725]

First 16 chars of network name to connect to if "[2721]WiFi Mode" = Station or SSID network name to broadcast if "[2721] WiFi Mode = AccessPoint.

2725	SSID
Default	Emotron_<5 random digits>

Password [2726]

Password to login to router/AP when "[2721] WiFi Mode" = Station or Password for clients to use if "[2721] WiFi Mode" = AccessPoint. In case [2723] Encryption is WPA2 minimum password length is 8 characters. In case of WEP only 5 or 13 character passwords are accepted.

Can't be read via field bus and not visible after entered.

2726	Password
Default	12345678

NOTE: Accepts only 32 - 126 ascii char in menus SSID [2725] and Password [2726] entry as IEEE standard speaks of 'printable ASCII characters' (in the range of 32 to 126).

IP Address [2727]

Shows static address to use if "[2724] DHCP" is set to Static. Shows assigned address if "[2724] DHCP" is set to DHCP. This is the IP address given to the Drive, use this address in client software to connect to the AFE.

2727	IP Address
Default	192.168.1.1

Subnet Mask [2728]

Shows static subnet mask to use if "[2724] DHCP" is set to Static. Shows assigned subnet mask if "[2724] DHCP" is set to DHCP.

2728	Subnet Mask
Default	255.255.255.0

WiFi Status [272A]

Status of WiFi module is shown in this menu "[272A] WiFi Status". Status is set directly from control panel (that host the WiFi module).

272A		WiFi Status
Default		OK
OK	0	No error
Mode error	1	Initialization failure of AP/Station mode
AP pwd err	2	AP password faulty
SSID error	3	SSID length error
SecPar error	4	Security parameters or SSID supplied is wrong
Sta Disconn	5	Disconnect from router/AP in station mode
NetConf err	6	Network configuration error (IP or DHCP)
Config OK	7	If no error, this is shown 60 seconds after configuration update, then it goes back to OK.

Bluetooth (BLE) options [273]

This menu is hidden if BLE not selected in menu “[271] WirelessMode”.

BluetoothID [2731]

Shows bluetooth device ID if connected control panel have bluetooth capability.

2731	BluetoothID
Default	0

NOTE: Default is 0 or if a BLE control panel is used an eight digit unique ID used in the broadcast name.

Paring key [2732]

Six digit numeric for the control panel BLE pairing with mobile or other BLE device.

2732	Paring Key
Default	123456

Security [274]

Possibility to limit access to control board (CB) registers from the wireless interfaces.

Security mode [2741]

Sets the security mode to be used.

2741 Sec. Mode		
Default:		Open
Open	0	All requests from wireless clients should be forwarded by the control panel to control board.
Password	1	Wireless client must supply a password before access to control board registers is granted. Once access is given it will last as long as the session.

Password [2742]

Eight (8) chars in four consecutive Modbus registers. Configuration of the password to be written by the client to open up wireless access. Four consecutive Modbus registers are used. Their Modbus addresses are 49550 to 49554.

This menu is only shown if menu “Security mode [2741]” is set to Password (1).

2742 Password	
Default:	“ “ (i.e. an empty string)

11.3 Process and Application Parameters [300]

These parameters are mainly adjusted to obtain optimum process or front end performance.

11.3.1 Reactive power Reference Value [310]

Set/view reference value for reactive power in % of AFR/ AFR unit nominal power.

NOTE:
Positive value - Over excited (Capacitive or leading).
Negative value - Under excited (Inductive or lagging).

View reference value

As default the menu [310] is in view operation. The value of the active reference signal is displayed.

Set reference value

If the function Reference Control [214] is set to: Ref Control = Keyboard, the reference value can be set in menu Set/View Reference [310] as a normal parameter or as a motor potentiometer with the + and - keys on the control panel.

310 Q Ref	
Default:	0%
Range	0 to +/- Qmax [041]

NOTE:
Write access to this parameter is only allowed when menu “Ref Control [214] is set to Keyboard. When Reference control is used, source “COM” is used, see Chapter 11.2.5 page 77.

NOTE:
To get any value in menu [310], Q max in menu [041] should be other than 0.

11.3.2 Preset References [360]

Motor Potentiometer [361]

Sets the properties of the motor potentiometer function. See the parameter "DigIn1 [521]" for the selection of the motor potentiometer function.

361 Motor Pot		
Default:		Non volatile
Volatile	0	After a stop, trip or power down, the AFE will start always from zero speed (or minimum speed, if selected).
Non volatile	1	Non Volatile. After a stop, trip or power down of the AFE, the reference value at the moment of the stop will be memorized. After a new start command the output speed will resume to this saved value.

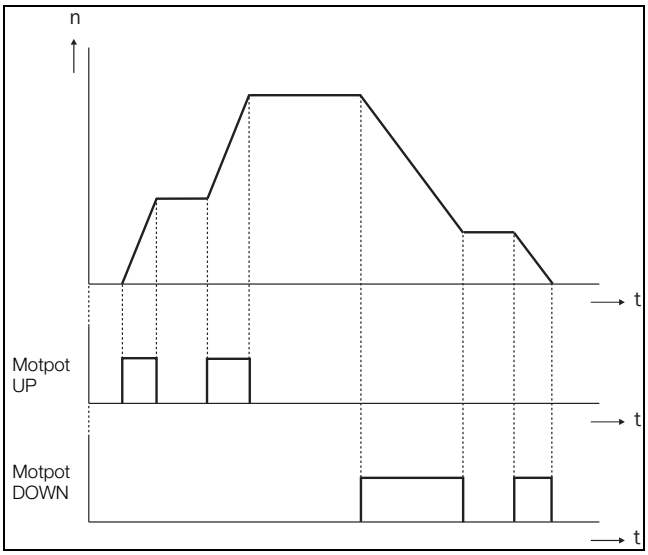


Fig. 60 MotPot function

Preset Ref 1 [362] to Preset Ref 7 [368]

Preset reference have priority over the analogue inputs. Preset references are activated by the digital inputs. The digital inputs must be set to the function Pres. Ref 1, Pres. Ref 2 or Pres. Ref 4.

Depending on the number of digital inputs used, up to 7 preset references can be activated per parameter set. Using all the parameter sets, up to 28 preset references are possible.

362 Preset Ref 1	
Default:	0%
Dependent on:	Max value depends on [O41]. Unit depends on mode selected in [G21]. Unit is % for Q-references and no unit for power factor references.

The same settings are valid for the menus [363] to [368].

The selection of the presets is as in Table 19.

Table 19

Preset Ctrl3	Preset Ctrl2	Preset Ctrl1	Output Speed
0	0	0	Analogue reference
0	0	1[1)]	Preset Ref 1
0	1[1)]	0	Preset Ref 2
0	1	1	Preset Ref 3
1[1)]	0	0	Preset Ref 4
1	0	1	Preset Ref 5
1	1	0	Preset Ref 6
1	1	1	Preset Ref 7

1)= selected if only one preset reference is active
1 = active input
0 = non active input

NOTE: If only Preset Ctrl3 is active, then the Preset Ref 4 can be selected. If Presets Ctrl2 and 3 are active, then the Preset Ref 2, 4 and 6 can be selected.

Keyboard reference mode [369]

This parameter sets how the reference value [310] is edited.

369		Key Ref Mode
Default:		MotPot
Normal	0	The reference value is edited as a normal parameter (the new reference value is activated when Enter is pressed after the value has been changed).
MotPot	1	The reference value is edited using the motor potentiometer function (the new reference value is activated directly when the key + or - is pressed).
MotPot+	2	This selection makes it possible to update the reference in "[310]" directly from the [100]-menu. Pressing +/- in the [100]-menu changes the menu to [310] and there you can continue to press +/- to update the reference. When no key has been pressed for a second the menu returns to [100] automatically.

11.4 Monitor/Protections [400]

Trip Text [430]

This menu group allow users to define their own trip/alarm messages.

ExtTrip 1Text [431]

In this menu user can define its own name for ExtTrip 1.

431	ExtTrip1Text
Default:	0

ExtTrip2Text [432]

In this menu user can define its own name for ExtTrip 2.

432	ExtTrip2Text
Default:	0

11.5 I/Os and Virtual Connections [500]

Main menu with all the settings of the standard inputs and outputs of the AFE.

11.5.1 Analogue Inputs [510]

Submenu with all settings for the analogue inputs.

AnIn1 Function [511]

Sets the function for Analogue input 1. Scale and range are defined by AnIn1 Advanced settings [513].

511 AnIn1 Fc		
Default:		Process Ref
Off	0	Input is not active
Max Torque	2	The input acts as an upper torque limit.
Process Val	3	The input value equals the actual process value (feedback) and is compared to the reference signal (set point) by the PID controller, or can be used to display and view the actual process value.
Process Ref	4	Reference value is set for control in process units, see Process Source [321] and Process Unit [322].
Ux	7	x-axis (cartesian coordinate) supply voltage measurement output signal from supply voltage measurement board (SVMB) to control board analogue input.
Uy	8	y-axis (cartesian coordinate) supply voltage measurement output signal from supply voltage measurement board (SVMB) to control board analogue input.
U(L1)	9	Supply phase L1 voltage measurement output signal from supply voltage measurement board (SVMB) to control board analogue input.
U(L2)	10	Supply phase L2 voltage measurement output signal from supply voltage measurement board (SVMB) to control board analogue input.
U(L3)	11	Supply phase L3 voltage measurement output signal from supply voltage measurement board (SVMB) to control board analogue input.

NOTE: When AnInX Func=Off, the connected signal will still be available for Comparators [610].

Adding analogue inputs

If more than one analogue input is set to the same function, the values of the inputs can be added together. In the following examples we assume that Process Source [321] is set to Speed.

Example 1: Add signals with different weight (fine tuning).

Signal on AnIn1 = 10 mA
Signal on AnIn2 = 5 mA

[511] AnIn1 Function = Process Ref.
[512] AnIn1 Setup = 4-20 mA
[5134] AnIn1 Function Min = Min (0 rpm)
[5136] AnIn1 Function Max = Max (1500 rpm)
[5138] AnIn1 Operation = Add+
[514] AnIn2 Function = Process Ref.
[515] AnIn2 Setup = 4-20 mA
[5164] AnIn2 Function Min = Min (0 rpm)
[5166] AnIn2 Function Max = User defined
[5167] AnIn2 Value Max = 300 rpm
[5168] AnIn2 Operation = Add+

Calculation:

AnIn1 = (10-4) / (20-4) x (1500-0) + 0 = 562.5 rpm

AnIn2 = (5-4) / (20-4) x (300-0) + 0 = 18.75 rpm

The actual process reference will be:
+562.5 + 18.75 = 581 rpm

Analogue Input Selection via Digital Inputs

When two different external Reference signals are used, e.g. 4-20mA signal from control centre and a 0-10 V locally mounted potentiometer, it is possible to switch between these two different analogue input signals via a Digital Input set to “AnIn Select”.

AnIn1 is 4-20 mA
AnIn2 is 0-10 V

DigIn3 is controlling the AnIn selection; HIGH is 4-20 mA, LOW is 0-10 V

“[511] AnIn1 Fc” = Process Ref;
set AnIn1 as reference signal input

“[512] AnIn1 Setup” = 4-20mA;
set AnIn1 for a current reference signal

“[513A] AnIn1 Enabl” = DigIn;
set AnIn1 to be active when DigIn3 is HIGH

“[514] AnIn2 Fc” = Process Ref;
set AnIn2 as reference signal input

“[515] AnIn2 Setup” = 0-10V;
set AnIn2 for a voltage reference signal

“[516A] AnIn2 Enabl” = !DigIn;
set AnIn2 to be active when DigIn3 is LOW

“[523] DigIn3=AnIn”;
set DIgIn3 as input fot selection of AI reference

Subtracting analogue inputs

Example 2: Subtract two signals

Signal on AnIn1 = 8 V
Signal on AnIn2 = 4 V

[511] AnIn1 Function = Process Ref.
[512] AnIn1 Setup = 0-10 V
[5134] AnIn1 Function Min = Min (0 rpm)
[5136] AnIn1 Function Max = Max (1500 rpm)
[5138] AnIn1 Operation = Add+
[514] AnIn2 Function = Process Ref.
[515] AnIn2 Setup = 0-10 V
[5164] AnIn2 Function Min = Min (0 rpm)
[5166] AnIn2 Function Max = Max (1500 rpm)
[5168] AnIn2 Operation = Sub-

Calculation:
AnIn1 = (8-0) / (10-0) x (1500-0) + 0 = 1200 rpm
AnIn2 = (4-0) / (10-0) x (1500-0) + 0 = 600 rpm

The actual process reference will be:
+1200 - 600 = 600 rpm

AnIn1 Setup [512]

The analogue input setup is used to configure the analogue input in accordance with the signal used that will be connected to the analogue input. With this selection the input can be determined as current (4-20 mA) or voltage (0-10 V) controlled input. Other selections are available for using a threshold (live zero), a bipolar input function, or a user defined input range. With a bipolar input reference signal, it is possible to control the motor in two directions. See fig. 61.

NOTE: The selection of voltage or current input is done with S1. When the switch is in voltage mode only the voltage menu items are selectable. With the switch in current mode only the current menu items are selectable.

512 AnIn1 Setup		
Default:		User Bipol V
Dependent on		Setting of switch S1
4–20mA	0	The current input has a fixed threshold (Live Zero) of 4 mA and controls the full range for the input signal. See Fig. 81.
0–20mA	1	Normal full current scale configuration of the input that controls the full range for the input signal. See Fig. 80.
User mA	2	The scale of the current controlled input, that controls the full range for the input signal. Can be defined by the advanced AnIn Min and AnIn Max menus.
User Bipol mA	3	Sets the input for a bipolar current input, where the scale controls the range for the input signal. Scale can be defined in advanced menu AnIn Bipol.
0–10V	4	Normal full voltage scale configuration of the input that controls the full range for the input signal. See Fig. 80.
2–10V	5	The voltage input has a fixed threshold (Live Zero) of 2 V and controls the full range for the input signal. See Fig. 81.
User V	6	The scale of the voltage controlled input, that controls the full range for the input signal. Can be defined by the advanced AnIn Min and AnIn Max menus.
User Bipol V	7	Sets the input for a bipolar voltage input, where the scale controls the range for the input signal. Scale can be defined in advanced menu AnIn Bipol.

NOTE: Always check the needed set up when the setting of S1 is changed; selection will not adapt automatically.

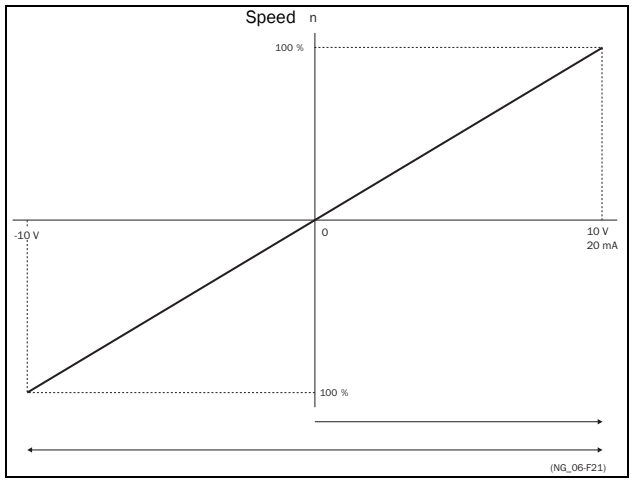


Fig. 61

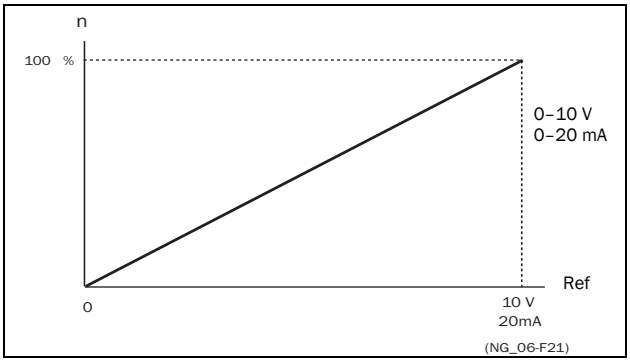


Fig. 62 Normal full-scale configuration

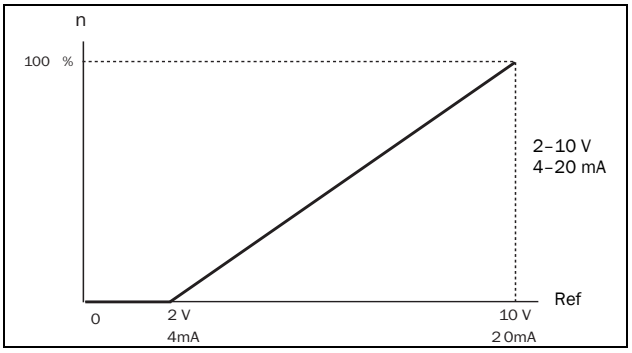


Fig. 63 2–10 V/4–20 mA (Live Zero)

AnIn1 Advanced [513]

NOTE: The different menus will automatically be set to either "mA" or "V", based on the selection in AnIn 1 Setup [512].

513 AnIn1 Advan

AnIn1 Min [5131]

Parameter to set the minimum value of the external reference signal. Only visible if [512] = User mA/V.

5131 AnIn1 Min	
Default:	0 V/4.00 mA
Range:	0.00–20.00 mA 0–10.00 V

AnIn1 Max [5132]

Parameter to set the maximum value of the external reference signal. Only visible if [512] = User mA/V.

5132 AnIn1 Max	
Default:	10.00 V/20.00 mA
Range:	0.00–20.00 mA 0–10.00 V

Special function: Inverted reference signal

If the AnIn minimum value is higher than the AnIn maximum value, the input will act as an inverted reference input, see fig. 64.

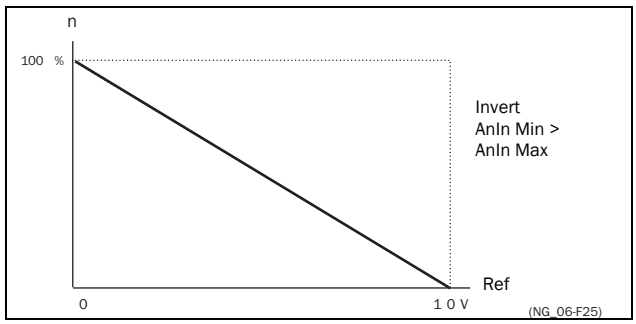


Fig. 64 Inverted reference

AnIn1 Bipol [5133]

This menu is only displayed if AnIn1 Setup is set to User Bipol mA or User Bipol V. The window will automatically show mA or V range according to selected function. The range is set by changing the positive maximum value; the negative value is automatically adapted accordingly. Only visible if [512] = User Bipol mA/V. The inputs RunR and RunL input need to be active, and "Rotation [219]", must be set to "R+L", to operate the bipolar function on the analogue input.

5133 AnIn1 Bipol	
Default:	10.00 V/20.00 mA
Range:	0.0–20.0 mA, 0.00–10.00 V

AnIn1 Function Min [5134]

With AnIn1 Function Min the physical minimum value is scaled to selected process unit. The default scaling is dependent of the selected function of AnIn1 [511].

5134 AnIn1 FcMin		
Default:		Min
Min	0	Min value
Max	1	Max value
User defined	2	Define user value in menu [5135]

Table 20 shows corresponding values for the min and max selections depending on the function of the analogue input [511].

Table 20

AnIn Function	Min	Max
Speed	Min Speed [341]	Max Speed [343]
Torque	0%	Max Torque [351]
Process Ref	Process Min [324]	Process Max [325]
Process Value	Process Min [324]	Process Max [325]

AnIn1 Function Value Min [5135]

With AnIn1 Function ValMin you define a user-defined value for the signal. Only visible when user-defined is selected in menu [5134].

5135 AnIn1 VaMin	
Default:	0.000
Range:	-10000.000 – 10000.000

AnIn1 Function Max [5136]

With AnIn1 Function Max the physical maximum value is scaled to selected process unit. The default scaling is dependent of the selected function of AnIn1 [511]. See table 20.

5136 AnIn1 FcMax		
Default:		Max
Min	0	Min value
Max	1	Max value
User defined	2	Define user value in menu [5137]

AnIn1 Function Value Max [5137]

With AnIn1 Function VaMax you define a user-defined value for the signal. Only visible when user-defined is selected in menu [5136].

5137 AnIn1 VaMax	
Default:	0.000
Range:	-10000.000 – 10000.000

NOTE: With AnIn Min, AnIn Max, AnIn Function Min and AnIn Function Max settings, loss of feedback signals (e.g. voltage drop due to long sensor wiring) can be compensated to ensure an accurate process control.

Example:
Process sensor is a sensor with the following specification:

Range: 0–3 bar
Output: 2–10 mA

Analogue input should be set up according to:
[512] AnIn1 Setup = User mA
[5131] AnIn1 Min = 2 mA
[5132] AnIn1 Max = 10 mA
[5134] AnIn1 Function Min = User-defined
[5135] AnIn1 VaMin = 0.000 bar
[5136] AnIn 1 Function Max = User-defined
[5137] AnIn1 VaMax = 3.000 bar

AnIn1 Operation [5138]

5138 AnIn1 Oper		
Default:		Add +
Add+	0	Analogue signal is added to selected function in menu [511].
Sub-	1	Analogue signal is subtracted from selected function in menu [511].

AnIn1 Filter [5139]

If the input signal is unstable (e.g. fluctuation reference value), the filter can be used to stabilize the signal. A change of the input signal will reach 63% on AnIn1 within the set AnIn1 Filter time. After 5 times the set time, AnIn1 will have reached 100% of the input change. See fig. 65.

5139 AnIn1 Filt	
Default:	0.1 s
Range:	0.001 – 10.0 s

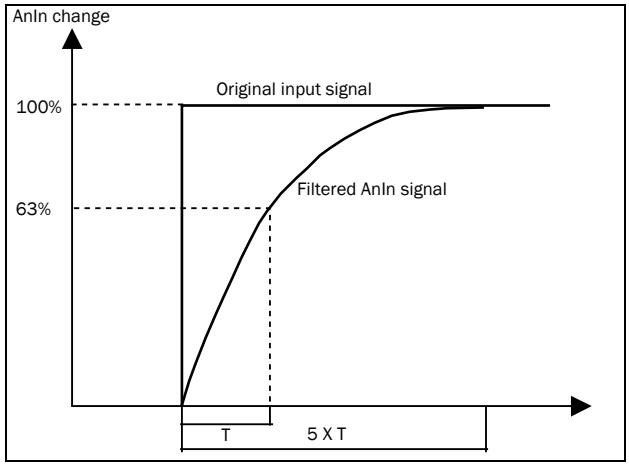


Fig. 65

AnIn1 Enable [513A]

Parameter for enable/disable analogue input selection via digital inputs (DigIn set to function AnIn Select).

513A AnIn1 Enabl		
Default:		On
On	0	AnIn1 is always active
!DigIn	1	AnIn1 is only active if the digital input is low.
DigIn	2	AnIn1 is only active if the digital input is high.

AnIn2 Function [514]

Parameter for setting the function of Analogue Input 2.

Same function as “AnIn1 Fc [511]”.

514 AnIn2 Fc	
Default:	AFR: Off AFG: U(L1)
Selection:	Same as in menu [511]

AnIn2 Setup [515]

Parameter for setting the function of Analogue Input 2.

Same functions as “AnIn1 Setup [512]”.

515 AnIn2 Setup	
Default:	User Bipol V
Dependent on	Setting of switch S2
Selection:	Same as in menu [512].

AnIn2 Advanced [516]

Same functions and submenus as under “AnIn1 Advan [513]”.

516 AnIn2 Advan

AnIn3 Function [517]

Parameter for setting the function of Analogue Input 3.

Same function as “AnIn1 Fc [511]”.

517 AnIn3 Fc	
Default:	AFR: Off AFG: U(L2)
Selection:	Same as in menu [511]

AnIn3 Setup [518]

Same functions as “AnIn1 Setup [512]”.

518 AnIn3 Setup	
Default:	User Bipol V
Dependent on	Setting of switch S3
Selection:	Same as in menu [512].

AnIn3 Advanced [519]

Same functions and submenus as under “AnIn1 Advan [513]”.

519 AnIn3 Advan

AnIn4 Function [51A]

Parameter for setting the function of Analogue Input 4.

Same function as “AnIn1 Fc [511].”

51A AnIn4 Fc	
Default:	AFR: Off AFG: U(L3)
Selection:	Same as in menu [511]

AnIn4 Set-up [51B]

Same functions as “AnIn1 Setup [512]”.

51B AnIn4 Setup	
Default:	User Bipol V
Dependent on	Setting of switch S4
Selection:	Same as in menu [512].

AnIn4 Advanced [51C]

Same functions and submenus as under “AnIn1 Advan[513]”.

51C AnIn4 Advan

AnIn Fault Mode [51D]

Response of AFE on AnIn fault can be configured in this menu.

51D AI Flt Mode		
Default:		Off
Off	0	Off
Trip	1	AFE generate trip/alarm if AnIn fault appears.
Warning	2	AFE generate warning if AnIn fault appears.

11.5.2 Digital Inputs [520]

Submenu with all the settings for the digital inputs.

NOTE: Additional inputs will become available when the I/O option boards are connected.

Digital Input 1 [521]

To select the function of the digital input.

On the standard control board there are eight digital inputs.

If the same function is programmed for more than one input that function will be activated according to "OR" logic if nothing else is stated.

521 DigIn 1		
Default:		RunL
Off	0	The input is not active.
Ext Trip 1	3	Be aware that if there is nothing connected to the input, the AFE will trip at "External trip 1" immediately. NOTE: The External Trip 1 is active low. NOTE: Activated according to "AND" logic.
Stop	4	Stop command according to the selected Stop mode in menu [33B]. NOTE: The Stop command is active low. NOTE: Activated according to "AND" logic.
Enable	5	Enable command. General start condition to run the AFE. If made low during running the output of the AFE is cut off immediately, causing the motor to coast to zero speed. NOTE: If none of the digital inputs are programmed to "Enable", the internal enable signal is active. NOTE: Activated according to "AND" logic.
RunR	6	Run Right command (positive speed). The output of the AFE will be a clockwise rotary field.
RunL	7	Run Left command (negative speed). The output of the AFE will be a counter-clockwise rotary field.
Ext Trip 2	8	Be aware that if there is nothing connected to the input, the AFE will trip at "External trip 2" immediately. NOTE: The External Trip 2 is active low. NOTE: Activated according to "AND" logic.
Reset	9	Reset command. To reset a Trip condition and to enable the Autoreset function.
Preset Ctrl1	10	To select the Preset Reference.
Preset Ctrl2	11	To select the Preset Reference.
Preset Ctrl3	12	To select the Preset Reference.
MotPot Up	13	Increases the internal reference value according to the set Acc MotPot time [333]. Has the same function as a "real" motor potentiometer, see fig. 60.
MotPot Down	14	Decreases the internal reference value according to the set Dec MotPot time [334]. See MotPot Up.
Ext Mot Temp	27	Be aware that if there is nothing connected to the input, the AFE will trip at "External Motor Temp" immediately. NOTE: The External Motor Temp is active low.
Loc/Rem	28	Activate local mode defined in [2171] and [2172].
LC Level	30	Liquid cooling low level signal. NOTE: The Liquid Cooling Level is active low.
Sleep	32	Possible to enter sleep mode through DigIn.
Timer 1	34	Timer 1 will be activated on the rising edge of this signal.
Timer 2	35	Timer 2 will be activated on the rising edge of this signal.
Timer 3	36	Timer 3 will be activated on the rising edge of this signal.
Timer 4	37	Timer 4 will be activated on the rising edge of this signal.

NOTE: Menus DigIn1 [521] and DigIn2 [522] are read only.

Digital Input 2 [522] to Digital Input 8 [528]

Same function as "DigIn 1[521]". Default function for DigIn 3 is Enable and for DigIn 8 is Reset. For DigIn 4 to 7 the default function is Off.

522 DigIn 2	
Default:	RunR
Selection:	Same as in menu DigIn 1 [521]

Additional digital inputs [529] to [52H]

529 B1 Digin 1	
Default:	Off
Selection:	Same as in menu DigIn 1 [521]

Additional digital inputs with I/O option board installed, "B1 DigIn 1 [529]" - "B3 DigIn 3 [52H]". B stands for board and 1 to 3 is the number of the board which is related to the position of the I/O option board on the option mounting plate. The functions and selections are the same as "DigIn 1 [521]".

11.5.3 Analogue Outputs [530]

Submenu with all settings for the analogue outputs. Selections can be made from application and AFE values, in order to visualize actual status. Analogue outputs can also be used as a mirror of the analogue input. Such a signal can be used as:

- a reference signal for the next AFE in a Master/Slave configuration (see fig. 66).
- a feedback acknowledgement of the received analogue reference value.

AnOut1 Function [531]

Sets the function for the Analogue Output 1. Scale and range are defined by AnOut1 Advanced settings [533].

531 AnOut1 Fc		
Default:		Speed
Process Val	0	Actual process value according to Process feedback signal.
El Power	2	Electrical Power
Process Ref	3	Actual process reference value.
React Power	4	Actual reactive power.
Frequency	5	Actual frequency.
Current	6	Actual current.
Output volt	8	Actual output voltage.
DC-voltage	9	Actual DC link voltage.
AnIn1	10	Mirror of received signal value on AnIn1.
AnIn2	11	Mirror of received signal value on AnIn2.
AnIn3	12	Mirror of received signal value on AnIn3.
AnIn4	13	Mirror of received signal value on AnIn4.
Torque Ref	15	Actual torque reference value (=0 in V/Hz mode)
AnMux1	16	Result of configured AnMux1 logical block, see [621].
AnMux2	17	Result of configured AnMux2 logical block, see [622].
IGBT Temp	18	Temperature of drive IGBT, see [71A].

NOTE: When selections AnIn1, AnIn2 .... AnIn4 is selected, the setup of the AnOut (menu [532] or [535]) has to be set to 0-10V or 0-20mA. When the AnOut Setup is set to e.g. 4-20mA, the mirroring is not working correct.

NOTE: Output and DC voltage are presented as a precentage of 1000 V (when selected on AnOut function.)

AnOut 1 Setup [532]

Preset scaling and offset of the output configuration.

532 AnOut1 Setup		
Default:		4-20mA
4–20mA	0	The current output has a fixed threshold (Live Zero) of 4 mA and controls the full range for the output signal. See fig. 63.
0–20mA	1	Normal full current scale configuration of the output that controls the full range for the output signal. See fig. 62.
User mA	2	The scale of the current controlled output that controls the full range for the output signal. Can be defined by the advanced AnOut Min and AnOut Max menus.
User Bipol mA	3	Sets the output for a bipolar current output, where the scale controls the range for the output signal. Scale can be defined in advanced menu AnOut Bipol.
0-10V	4	Normal full voltage scale configuration of the output that controls the full range for the output signal. See fig. 62.
2–10V	5	The voltage output has a fixed threshold (Live Zero) of 2 V and controls the full range for the output signal. See fig. 63.
User V	6	The scale of the voltage controlled output that controls the full range for the output signal. Can be defined by the advanced AnOut Min and AnOut Max menus.
User Bipol V	7	Sets the output for a bipolar voltage output, where the scale controls the range for the output signal. Scale can be defined in advanced menu AnOut Bipol.

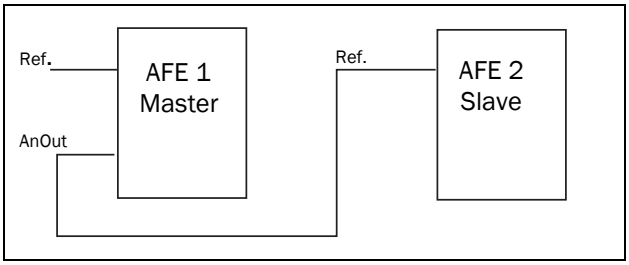


Fig. 66

AnOut1 Advanced [533]

With the functions in the AnOut1 Advanced menu, the output can be completely defined according to the application needs. The menus will automatically be adapted to “mA” or “V”, according to the selection in “AnOut1 Setup [532]”.

533	AnOut 1 Advan

AnOut1 Min [5331]

This parameter is automatically displayed if User mA or User V is selected in menu “AnOut 1 Setup [532]”. The menu will automatically adapt to current or voltage setting according to the selected setup. Only visible if [532] = User mA/V.

5331	AnOut 1 Min
Default:	4.00 mA
Range:	0.00 – 20.00 mA, 0 – 10.00 V

AnOut1 Max [5332]

This parameter is automatically displayed if User mA or User V is selected in menu “AnOut1 Setup [532]”. The menu will automatically adapt to current or voltage setting a ccording to the selected setup. Only visible if [532] = User mA/V.

5332	AnOut 1 Max
Default:	20.00 mA
Range:	0.00–20.00 mA, 0–10.00 V

AnOut1 Bipol [5333]

Automatically displayed if User Bipol mA or User Bipol V is selected in menu AnOut1 Setup. The menu will automatically show mA or V range according to the selected function. The range is set by changing the positive maximum value; the negative value is automatically adapted accordingly. Only visible if [512] = User Bipol mA/V.

5333	AnOut1Bipol
Default:	20.00 mA
Range:	-10.00–10.00 V, -20.0–20.0 mA

AnOut1 Function Min [5334]

With AnOut1 Function Min the physical minimum value is scaled to selected presentation. The default scaling is dependent of the selected function of “AnOut1 [531]”.

5334	AnOut1FCMin	
Default:		Min
Min	0	Min value
Max	1	Max value
User defined	2	Define user value in menu [5335]

Table 21 shows corresponding values for the min and max selections depending on the function of the analogue output [531].

Table 21

AnOut Function	Min Value	Max Value
Process Value	Process Min [324]	Process Max [325]
El Power	0%	Rated apparent Power
Process Ref	Process Min [324]	Process Max [325]
React Power	0%	Rated apparent power
Frequency	0 Hz	Supply Frequency [012]
Current	0 A	Supply Current [013]
Output Voltage	0 V	1000 V
DC voltage	0 V	1000 V
AnIn1	AnIn1 Function Min	AnIn1 Function Max
AnIn2	AnIn2 Function Min	AnIn2 Function Max
AnIn3	AnIn3 Function Min	AnIn3 Function Max
AnIn4	AnIn4 Function Min	AnIn4 Function Max

Example

Set the AnOut function for Frequency to 0Hz, set AnOut functionMin [5334] to “User-defined” and AnOut1 VaMin [5335] = 0.0. This results in an anlogue output signal from 0/4 mA to 20mA: 0 Hz to Fsupply.
This principle is valid for all Min to Max settings.

AnOut1 Function Value Min [5335]

With AnOut1 Function VaMin you define a user-defined value for the signal. Only visible when user-defined is selected in menu [5334].

5335	AnOut1VaMin
Default:	0.000
Range:	-10000.000–10000.000

AnOut1 Function Max [5336]

With AnOut1 Function Max the physical minimum value is scaled to selected presentation. The default scaling is dependent on the selected function of AnOut1 [531]. See Table 21.

5336 AnOut1FCMax		
Default:		Max
Min	0	Min value
Max	1	Max value
User defined	2	Define user value in menu [5337]

NOTE: It is possible to set AnOut1 up as an inverted output signal by setting AnOut1 Min > AnOut1 Max. See fig. 64, page 88.

AnOut1 Function Value Max [5337]

With AnOut1 Function VaMax you define a user-defined value for the signal. Only visible when user-defined is selected in menu [5334].

5337 AnOut1VaMax	
Default:	0.000
Range:	-10000.000–10000.000

AnOut2 Function [534]

Sets the function for the Analogue Output 2.

534 AnOut2 Fc	
Default:	El Power
Selection:	Same as in menu [531]

AnOut2 Setup [535]

Preset scaling and offset of the output configuration for analogue output 2.

535 AnOut2 Setup	
Default:	4-20mA
Selection:	Same as in menu [532]

AnOut2 Advanced [536]

Same functions and submenus as under AnOut1 Advanced [533].

536 AnOut2 Advan

11.5.4 Digital Outputs [540]

Submenu with all the settings for the digital outputs.

Digital Out 1 [541]

Sets the function for the digital output 1.

NOTE: The definitions described here are valid for the active output condition.

541 DigOut 1		
Default:		NOT2
Off	0	Output is not active and constantly low.
On	1	Output is made constantly high, i.e. for checking circuits and trouble shooting.
Run	2	Running. The AFE output is active = produces current for the motor.
Stop	3	The AFE output is not active.
At Process	6	The output = Reference.
No Trip	8	No Trip condition active.
Trip	9	A Trip condition is active.
AutoRst Trip	10	Autoreset trip condition active.
Limit	11	A Limit condition is active.
Warning	12	A Warning condition is active.
Ready	13	The AFE is ready for operation. This means that the AFE is powered up and healthy.
T= T_{lim}	14	The torque is limited by the torque limit function.
I>I_{nom}	15	The output current is higher than the AFE nominal current [013].
AnIn<Offset	17	One of the AnIn input signals is lower than 75% of the threshold level.
GCP Trip	18	Grid Code Protections (GCP) trip condition is active.
GCP Trigg	19	Grid Code Protections (GCP) trigged (condition for tripping met).
GCP Trip>	20	Grid Code Protections (GCP) over-trips condition is active.
GCP Trigg>	21	Grid Code Protections (GCP) over-trips condition trigged (condition for CGP tripping met).
GCP Trip<	22	Grid Code Protections (GCP) under-trips condition is active.
GCP Trigg<	23	Grid Code Protections (GCP) under-trips condition trigged (condition for GCP tripping met).
CA1	24	Analogue comparator 1 output.
CA2	25	Analogue comparator 2 output.

CA3	26	Analogue comparator 3 output.
CA4	27	Analogue comparator 4 output.
L1	28	Logic 1 expression output
L2	29	Logic 2 expression output
L3	30	Logic 3 expression output
L4	31	Logic 4 expression output
F1	32	Flip flop 1 output
F2	33	Flip flop 2 output
F3	34	Flip flop 3 output
F4	35	Flip flop 4 output
Operation	36	Run command is active or AFE running. The signal can be used to control the mains contactor if the AFE is equipped with Standby supply option.
T1Q	37	Timer 1 output
T2Q	38	Timer 2 output.
T3Q	39	Timer 3 output
T4Q	40	Timer 4 output
Loc/Rem	57	Local/Rem mode indication Local = 1, Remote = 0
Standby	58	Standby supply option is active
PTC Trip	59	Trip when function is active
PT100 Trip	60	Trip when function is active
Overvolt	61	Overvoltage due to high main voltage
Overvolt G	62	Overvoltage due to generation mode
Overvolt D	63	Overvoltage due to deceleration
I^2t	66	I^2t limit protection active
V-Limit	67	Overvoltage limit function active
C-Limit	68	Overcurrent limit function active
Overtemp	69	Over temperature warning
Low voltage	70	Low voltage warning
DigIn 1	71	Digital input 1
DigIn 2	72	Digital input 2
DigIn 3	73	Digital input 3
DigIn 4	74	Digital input 4
DigIn 5	75	Digital input 5
DigIn 6	76	Digital input 6
DigIn 7	77	Digital input 7
DigIn 8	78	Digital input 8
ManRst Trip	79	Active trip that needs to be manually reset
Com Error	80	Serial communication lost
External Fan	81	The AFE requires external cooling. Internal fans are active.
LC Pump	82	Activate liquid cooling pump
LC HE Fan	83	Activate liquid cooling heat exchanger fan
LC Level	84	Liquid cooling low level signal active
Com Active	87	Fieldbus communication active.
Option	90	Failure occurred in built-in option board.
NOT1	91	NOT gate 1 output
NOT2	92	NOT gate 2 output
NOT3	93	NOT gate 3 output
NOT4	94	NOT gate 4 output
NOT5	95	NOT gate 5 output
NOT6	96	NOT gate 6 output
NOT7	97	NOT gate 7 output
NOT8	98	NOT gate 8 output
CTR1	99	Counter 1 output
CTR2	100	Counter 2 output
CLK1	101	Clock logic 1output
CLK2	102	Clock logic 2 output
STO Active	107	STO is active
Charge Relay	111	Signal / Digital output for controlling charge contactor.
Main Relay	112	Signal / Digital output for controlling charge contactor.
Udc OK	113	AFR/AFG is up and running.

Digital Out 2 [542]

NOTE: The definitions described here are valid for the active output condition.

Sets the function for the digital output 2.

542	DigOut2
Default:	L1
Selection:	Same as in menu DigOut 1 [541].

11.5.5 Relays [550]

NOTE: Relay 1 is dedicated to Charge relay (K2). Relay 3 is dedicated for Main contactor (K1).

Submenu with all the settings for the relay outputs. The relay mode selection makes it possible to establish a "fail safe" relay operation by using the normal closed contact to function as the normal open contact.

NOTE: Additional relays will become available when I/O option boards are connected. Maximum 3 boards with 3 relays each.

Relay 1 [551]

Sets the function for the relay output 1. Same function as digital output 1 [541] can be selected.

551	Relay 1
Default:	Charge relay

NOTE: Menu Relay 1 [551] is read only.

Relay 2 [552]

NOTE: The definitions described here are valid for the active output condition.

Sets the function for the relay output 2.

552	Relay 2
Default:	NOT2
Selection:	Same as in menu DigOut 1 [541].

Relay 3 [553]

Sets the function for the relay output 3.

553	Relay 3
Default:	Main Relay

NOTE: Menu Relay 3 [553] is read only.

Board Relay [554] to [55C]

These additional relays are only visible if an I/O option board is fitted in slot 1, 2, or 3. The outputs are named B1 Relay 1–3, B2 Relay 1–3 and B3 Relay 1–3. B stands for board and 1–3 is the number of the board which is related to the position of the I/O option board on the option mounting plate. See menu DigOut 1 [541].

NOTE: Visible only if optional board is detected or if any input/output is activated.

Relay Advanced [55D]

This function makes it possible to ensure that the relay will also be closed when the AFE is malfunctioning or powered down.

Example

A process always requires a certain minimum flow. To control the required number of pumps by the relay mode NC, the e.g. the pumps can be controlled normally by the pump control, but are also activated when the AFE is tripped or powered down.

55D	Relay Advan

Relay 1 Mode [55D1]

55D1	Relay1 Mode	
Default:		N.O
N.O	0	The normal open contact of the relay will be activated when the function is active.
N.C	1	The normally closed contact of the relay will act as a normal open contact. The contact will be opened when function is not active and closed when function is active.

Relay Modes [55D2] to [55DC]

Same function as for "Relay 1 Mode [55D1]".

11.5.6 Virtual Connections [560]

Functions to enable eight internal connections of comparator, timer and digital signals, without occupying physical digital in/outputs. Virtual connections are used to wireless connection of a digital output function to a digital input function. Available signals and control functions can be used to create your own specific functions.

Example of start delay

The motor will start in RunR 10 seconds after DigIn1 gets high. DigIn1 has a time delay of 10 s.

Menu	Parameter	Setting
[521]	DigIn1	Timer 1
[561]	VIO 1 Dest	RunR
[562]	VIO 1 Source	T1Q
[641]	Timer1 Trig	DigIn 1
[642]	Timer1 Mode	Delay
[643]	Timer1 Delay	0:00:10

NOTE: When a digital input and a virtual destination are set to the same function, this function will act as an OR logic function.

Virtual Connection 1 Destination [561]

With this function the destination of the virtual connection is established. When a function can be controlled by several sources, e.g. VC destination or Digital Input, the function will be controlled in conformity with "OR logic". See DigIn for descriptions of the different selections.

561	VIO 1 Dest
Default:	Off
Selection:	Same selections as for Digital Input 1, menu [521].

Virtual Connection 1 Source [562]

With this function the source of the virtual connection is defined. See DigOut 1 for description of the different selections.

562	VIO 1 Source
Default:	Off
Selection:	Same as for menu [541].

Virtual Connections 2-8 [563] to [56G]

Same function as virtual connection 1 [561] and [562].

11.6 Logical Functions and Timers [600]

With the Comparators, Logic Functions and Timers, conditional signals can be programmed for control or signalling features. This gives you the ability to compare different signals and values in order to generate monitoring/ controlling features.

11.6.1 Comparators [610]

The comparators available make it possible to monitor different internal signals and values, and visualize via digital relay outputs, when a specific value or status is reached or established.

Analogue comparators [611] - [614]

There are 4 analogue comparators that compare any available analogue value (including the analogue reference inputs) with two adjustable levels. The two levels available are Level HI and Level LO. There are two analogue comparator types selectable, an analogue comparator with hysteresis and an analogue window comparator.
The analogue hysteresis type comparator uses the two available levels to create a hysteresis for the comparator between setting and resetting the output. This function gives a clear difference in switching levels, which lets the process adapt until a certain action is started. With such a hysteresis, even an unstable analogue signal can be monitored without getting a nervous comparator output signal. Another feature is the possibility to get a fixed indication that a certain level has been passed. The comparator can latch by setting Level LO to a higher value than Level HI.

The analogue window comparator uses the two available levels to define the window in which the analogue value should be within for setting the comparator output.
The input analogue value of the comparator can also be selected as bipolar, i.e. treated as signed value or unipolar, i.e. treated as absolute value.

Refer to fig. 71, page 102 where these functions are illustrated.

Analogue Comparator 1 Setup [611]

Analogue comparator 1, parameter group.

Analogue Comparator 1 Value [6111]

Selection of the analogue value for Analogue Comparator 1 (CA1).

Analogue comparator 1 compares the selectable analogue value in menu [6111] with the constant Level HI in menu [6112] and constant Level LO in menu [6113]. If Bipolar type[6115] input signal is selected then the comparison is made with sign otherwise if unipolar selected then comparison is made with absolute values.

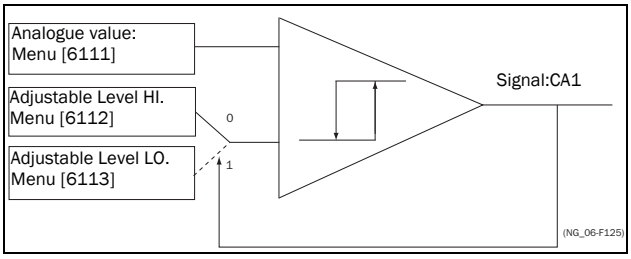


Fig. 67 Analogue comparator type Hysteresiss

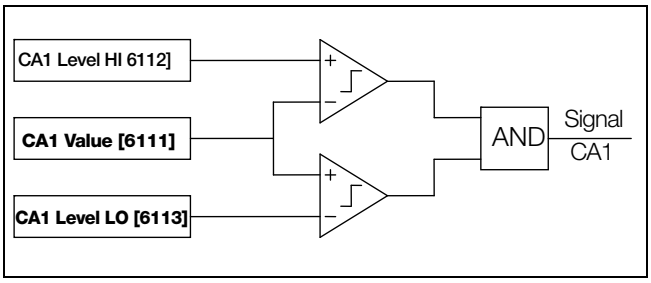


Fig. 68 Analogue comparator type "Window"

The output signal can be programmed as a virtual connection source and to the digital or relay outputs.

6111 CA1 Value		
Default:		Current
Process Val	0	Set by Process settings [321] and [322]
El Power	2	%
React Power	3	kVA
Current	5	A
Output volt	6	V
Frequency	7	Hz
DC Voltage	8	V
IGBT Temp	9	°C
PT100_1	10	°C
PT100_2	11	°C
PT100_3	12	°C
Energy	13	kWh
Run Time	14	h
Mains Time	15	h
AnIn1	16	%
AnIn2	17	%
AnIn3	18	%
AnIn4	19	%
Process Ref	20	Set by Process settings [321] and [322]
Process Err	21	
PT100_4	22	°C
PT100_5	23	°C
PT100_6	24	°C
AnMux1	25	%
AnMux2	26	%

Example

Create automatic RUN/STOP signal via the analogue reference signal. Analogue current reference signal, 4-20 mA, is connected to Analogue Input 1. “AnIn1 Setup”, menu [512] = 4-20 mA and the threshold is 4 mA. Full scale (100%) input signal on “AnIn 1” = 20 mA. When the reference signal on “AnIn1” increases 80% of the threshold (4 mA x 0.8 = 3.2 mA), the AFE will be set in RUN mode. When the signal on “AnIn1” goes below 60% of the threshold (4 mA x 0.6 = 2.4 mA) the AFE is set to STOP mode. The output of CA1 is used as a virtual connection source that controls the virtual connection destination RUN.

Menu	Function	Setting
511	AnIn1 Function	Process reference
512	AnIn1 Set-up	4-20 mA, threshold is 4 mA
341	Min Speed	0
343	Max Speed	1500
6111	CA1 Value	AnIn1
6112	CA1 Level HI	16% (3.2mA/20mA x 100%)
6113	CA1 Level LO	12% (2.4mA/20mA x 100%)
6114	CA1 Type	Hysteresis
561	VIO 1 Dest	RunR
562	VIO 1 Source	CA1
215	Run/Stp Ctrl	Remote

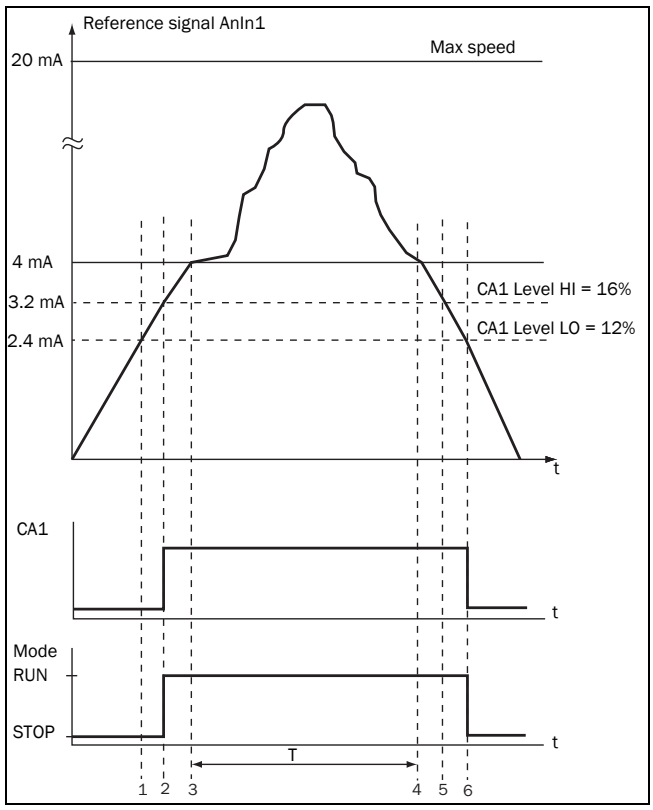


Fig. 69

No.	Description
1	The reference signal passes the Level LO value from below (positive edge), the comparator CA1 output stays low, mode=RUN.
2	The reference signal passes the Level HI value from below (positive edge), the comparator CA1 output is set high, mode=RUN.
3	The reference signal passes the threshold level of 4 mA, the motor speed will now follow the reference signal.
T	During this period the motor speed will follow the reference signal.
4	The reference signal reaches the threshold level, motor speed is 0 rpm, mode = RUN.
5	The reference signal passes the Level HI value from above (negative edge), the comparator CA1 output stays high, mode =RUN.
6	The reference signal passes the Level LO value from above (negative edge), the comparator CA1 output=STOP.

Analogue Comparator 1, Level High [6112]

Sets the analogue comparator high level, with range according to the selected value in menu [6111].

6112 CA1 LevelHI	
Default:	30.0 A
Range:	See min/max in table below.

Min/Max setting range for menu [6112]

Mode	Min	Max	Decimals
Process Val	Set by Process settings [321] and [322]		3
El Power, %	0	Max torque	0
React Power, kW	0	AFE S_nx4	0
Current, A	0	AFE I_nx4	1
Output volt, V	0	1000	1
Frequency, Hz	0	400	1
DC voltage, V	0	1250	1
IGBT temp, °C	0	100	1
PT 100_1_2_3, °C	-100	300	1
PT 100_4_5_6, °C	-100	300	1
Energy, kWh	0	1000000	0
Run time, h	0	65535	0
Mains time, h	0	65535	0
AnIn 1-4%	0	100	0
AnMux 1-2	0	100	0
Process Ref	Set by Process settings [321] and [322]		3
Process Err	Set by Process settings [321] and [322]		3

NOTE: If Bipolar selected [6115] then Min value is equal to -Max in the table.

Example

This example describes, both for hysteresis and window type comparator, the normal use of the constant level high and low.

Menu	Function	Setting
561	VC1 Dest	Timer 1
562	VC1 Source	CA1
6111	CA1 Value	Current
6112	CA1 Level HI	30.0 A
6113	CA1 Level LO	20.0 A
6114	CA1 Type	Hysteresis

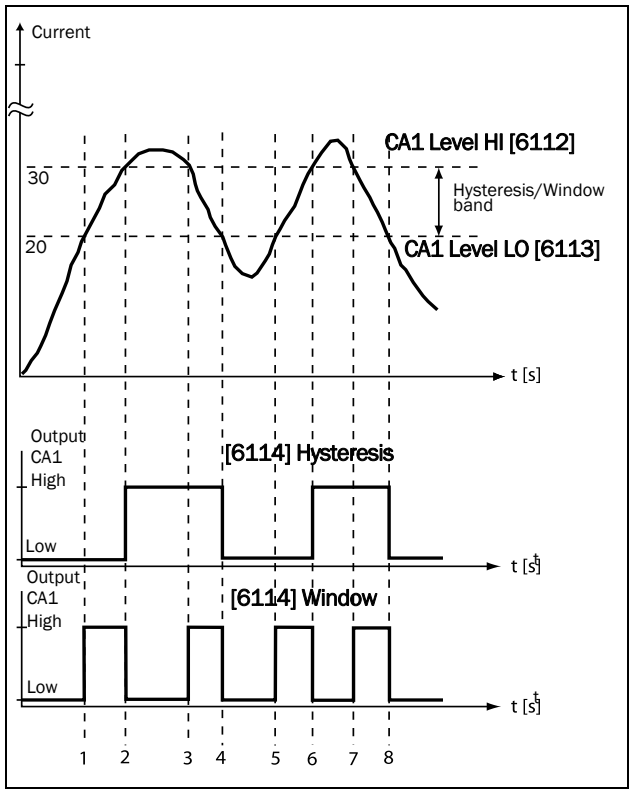


Fig. 70

Table 22 Comments to fig. 70 regarding Hysteresis selection.

No.	Description	Hysteresis
1	The reference signal passes the Level LO value from below (positive edge), the comparator CA1 does not change, output stays low.	—
2	The reference signal passes the Level HI value from below (positive edge), the comparator CA1 output is set high.	↑
3	The reference signal passes the Level HI value from above (negative edge), the comparator CA1 does not change, output stays high.	—
4	The reference signal passes the Level LO value from above (negative edge), the comparator CA1 is reset, output is set low.	↓
5	The reference signal passes the Level LO value from below (positive edge), the comparator CA1 does not change, output stays low.	—
6	The reference signal passes the Level HI value from below (positive edge), the comparator CA1 output is set high.	↑
7	The reference signal passes the Level HI value from above (negative edge), the comparator CA1 does not change, output stays high.	—
8	The reference signal passes the Level LO value from above (negative edge), the comparator CA1 is reset, output is set low.	↓

Table 23 Comments to fig. 70 regarding Window selection.

No.	Description	Window
1	The reference signal passes the Level LO value from below (signal inside Window band), the comparator CA1 output is set high.	↑
2	The reference signal passes the Level LO value from above (signal outside Window band), the comparator CA1 is reset, output is set low.	↓
3	The reference signal passes the Level HI value from above (signal inside Window band), the comparator CA1 output is set high.	↑
4	The reference signal passes the Level LO value from above (signal outside Window band), the comparator CA1 is reset, output is set low.	↓
5	The reference signal passes the Level LO value from below (signal inside Window band), the comparator CA1 output is set high.	↑
6	The reference signal passes the Level HI value from below (signal outside Window band),the comparator CA1 is reset, output is set low.	↓
7	The reference signal passes the Level HI value from above (signal inside Window band), the comparator CA1 output is set high.	↑
8	The reference signal passes the Level LO value from above (signal outside Window band), the comparator CA1 is reset, output is set low.	↓

Analogue Comparator 1, Level Low [6113]

Sets the analogue comparator low level, with unit and range according to the selected value in menu [6111].

6113	CA1 LevelLO
Default:	20.0 A
Range:	Range as [6112].

Analogue Comparator 1, Type [6114]

Selects the analogue comparator type, i.e. Hysteresis or Window type. See fig. 71 and fig. 72.

6114	CA1 Type	
Default:		Hysteresis
Hysteresis	0	Hysteresis type comparator
Window	1	Window type comparator

Analogue Comparator 1, Polarity [6115]

Selects how the selected value in [6111] should be handled prior to the analogue comparator , i.e. as absolute value or handled with sign. See fig. 71

6115	CA1 Polar	
Default:		Unipolar
Unipolar	0	Absolute value of [6111] used
Bipolar	1	Signed value of [6111] used

Example

See fig. 71 and fig. 72 for different principle functionality of comparator features 6114 and 6115.

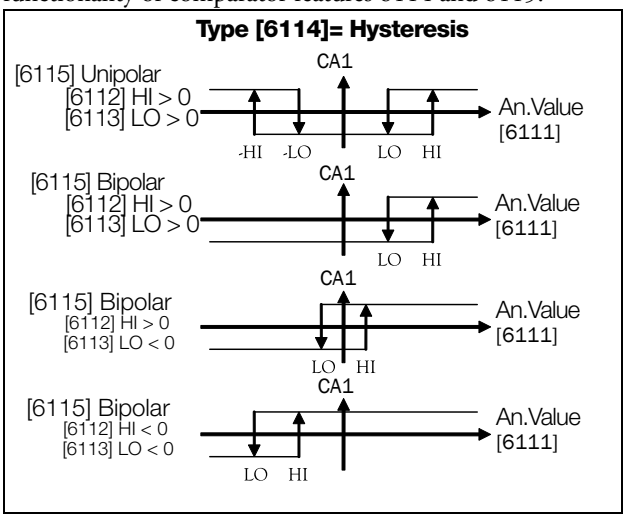


Fig. 71 Principle functionality of comparator features for "Type [6114] = Hysteresis "and "Polar [6115]".

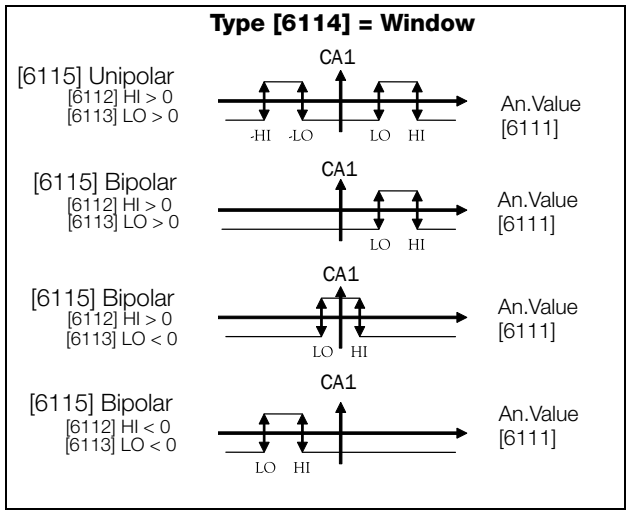


Fig. 72 Principle functionality of comparator features for "Type [6114] =Window " and "Polar [6115]".

NOTE: When "Unipolar" is selected, absolute value of signal is used.

NOTE: When "Bipolar" is selected in [6115] then:
1. Functionality is not symmetrical .
2. Ranges for high/low are bipolar

Analogue Comparator 1 Set Delay [6116]

The output signal for the analogue comparator 1 is delayed with the set value in this menu. See fig. 73.

6116	CA1 Set Dly
Default:	0 s
Range:	0 - 36000 s

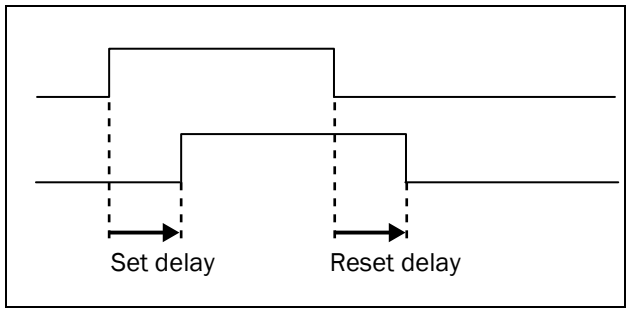


Fig. 73 Set/reset delay for output signal.

Analogue Comparator 1 Reset Delay [6117]

The reset of the output signal for the analogue comparator 1 is delayed with the set time in this menu. See fig. 73.

6117	CA1 Res Dly
Default:	0 s
Range:	0 - 36000 s

Analogue Comparator 1 Timer Value [6118]

The actual timer value for analogue comparator 1 is viewed in this menu.

6118	CA1 Tmr Val
Default:	0 s
Range:	0 - 36000 s

Setup Analogue Comparators 2-4 [612] - [614]

Refer to the descriptions for Analogue Comparator 1. See Chapter 15. page 169 regarding defaults.

11.6.2 Analogue Multiplexer [620]

The Analog Mux compares two configurable analogue input signals (InA and InB) and generates a virtual analogue output. Output behavior depends on the configured operator. Output can be used as source for analogue output or input value to analogue comparators.

Since both input and output is limited to range -100% to 100% some operations might overflow. Result is always limited within the range. Consequently some operators have a "divided by 2" variant to always produce overflow safe variants (result is always within the range).

AnMux1 [621]

AnMux InA [6211]

First input to the AnMux1. Select one of AnIn1 - 4. Input numbered as [6111], i.e. AnIn1 = 16 and default is AnIn1.

6211	AnMux InA
Default:	AnIn 1
Selections:	Same as in menu CA1 Value [6111].

AnMux InB [6212]

Second input to AnMux1. Select one of AnIn1 - 4. Input numbered as [6111], i.e. AnIn1 = 16 and default is AnIn2.

6212	AnMux InB
Default:	AnIn 2
Selections:	Same as in menu CA1 Value [6112].

Operator [6213]

Operator of the Analogue Mux 1. The names shown on the control panel will be changed according to the following.

6213	Operator	
Default:		Off
Off	0	No output
MIN(A,B)	1	Minimal value of InA and InB
MAX(A,B)	2	Max value of InA and InB
A+B	3	Sum of InA and InB
(A+B)/2	4	Sum of InA and InB that is overflow safe
A-B	5	Difference of InA and InB
(A-B)/2	6	Difference of InA and InB that is overflow safe
B-A	7	Difference of InB and InA
(B-A)/2	8	Difference of InB and InA that is overflow safe
ABS(A-B)	9	Absolute value of difference of InA and InB.
ABS(A-B)/2	10	Absolute value of difference of InA and InB that is overflow safe

AnMux2 [622]

The same function as in Analog Mux1[621].

AnMux InA [6221]

The function is the same as in Analogue Mux InA value [6211].

6221	AnMux InA
Default:	AnIn 1
Selections:	Same as in menu CA1 Value [6111].

AnMux InB [6222]

The function is the same as in Analogue Mux InB value [6212].

6222	AnMux InB
Default:	AnIn 2
Selections:	Same as in menu CA1 Value [6112].

Operator [6223]

The function is the same as in Operator [6213].

6223	Operator
Default:	Off
Selections:	Same as in menu Operator [6113].

11.6.3 Not Gate [630]

Output of the NOT gate is the inverted signal of the selected input. NOT gates are used when some other function (logic expression, digital out, virtual IO) needs the inverted signal.

NOT1 Input [631]

631	NOT1 Input
Default:	T2Q
Selection:	Same as in menu DigOut 1 [541].

NOT2 Input [632] - NOT8 Input [638]

Refer to the descriptions for NOT1 Input [631]. For default values see chapter 15. page 169.

11.6.4 Logic output [640]

Logic Output 1 [641]

By means of an expression editor, the input signals can be logically combined into the logics function to create a logic output signal.

The expression editor has the following features:

- All available digital output signals can be used as input to the logic block.
- The following logical operators are available:
  "+" : OR operator
  "&" : AND operator
  "^" : EXOR operator
  "." : This close the expression

Expressions according to the following truth table can be made (see also the example below):

Input		Result		
A	B	& (AND)	+ (OR)	^(EXOR)
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

The output signal can be programmed to the relay outputs or used as a virtual connection source [560].

The logic expression must be programmed by means of the menus [6411] to [641B], and its actual appearance can be viewed in menu [641], with example below:

```
641          0rpm
Logic 1
      ((0&1)&0)&1
Sby  A     Rem/Rem
```

Menu [641] shows the actual values of the four selected input signals set in menus [6412], [6414], [6416] and [6418].

Logic 1 Expression [6411]

Selection of execution order of the logic expression for the Logic 1 function:

6411 L1 Expr		
Default:		((1.2).3).4
((1.2).3).4	0	Default execution order, see explanation below.
(1.2).(3.4)	1	Alternative execution order, see explanation below.

- Parentheses ( ) show the order in which the Logic 1 Inputs are combined, according to [6211].
- 1, 2, 3, and 4, represent the Logic 1 Input signals selected in menu [6412], [6414], [6416], and [6418].
- The dots stand for the Logic 1 Operators (&, +, or ^), whose values are selected in menus [6413], [6415], and [6417].

To build the Logic 1 expression using the default selection in menu [6211], the execution order is as follows:

1. Input 1 is combined with Input 2 using Operator 1.
2. Input 3 is combined with the expression (1.2), using Operator 2.
3. Input 4 is combined with the result of (1.2).3, using Operator 3.

The alternative execution order leads to:

1. Input 1 is combined with Input 2 using Operator 1.
2. Input 3 is combined with Input 4 using Operator 3.
3. Expression (1.2) is combined with expression (3.4), using Operator 2.

Example

Input 1 [6412]

Input 2 = F1, menu [6414]

Input 3 = T1Q, menu [6416]

Input 4 = NOT1, menu [631]

In case NOT1 is configured to CA2 the output of the NOT1 gate will be the inverse of CA2 i.e. !CA2.

Operator 1 = & (AND), set in menu [6413]

Operator 2 = + (OR), menu [6415]

Operator 3 = & (AND), menu [6417]

The following expression is created, using the menus above:

CA1&F1+T1Q&NOT1

With the default setting for L1 Expression this is representing:

((CA1&F1)+T1Q)&NOT1

Let's use the following values on the input signals as an example:

CA1=1 (active/high)

F1= 1 (active/high)

T1Q = 1 (active/high)

NOT1 = 0 (inactive/low)

With the respective values inserted the resulting logic expression is:

```
641          0rpm
Logic 1
      ((1&1)+1)&0
Sby  A     Rem/Rem
```

which is equal to 0.

With the alternative execution order for the L1 Expression this is representing:

(CA1&F1)+(T1Q&NOT1)

With the above values inserted the resulting logic expression now becomes:

```
641          0rpm
Logic 1
      (1&1)+(1&0)
Sby  A     Rem/Rem
```

which is equal to 1.

Logic 1 Input 1 [6412]

In this menu the first input for the Logic 1 function is selected. The same selections are valid for [6414] L1 Input 2, [6416] L1 Input 3, and [6418] L1 Input 4.
Seechapter 15. page 169.

6412 L1 Input 1	
Default:	Trip
Selection:	Same as in menu DigOut 1 [541].

Logic 1 Operator 1 [6413]

In this menu the first operator for the Logic 1 function is selected.

6413 L1 Op 1		
Default:		&
.	0	When . (dot) is selected, the Logic 1 expression is finished (when two or three expressions are tied together).
&	1	&=AND
+	2	+=OR
^	3	^=EXOR

Logic 1 Input 2 [6414]

In this menu the second input for the Logic 1 function is selected.

6414 L1 Input 2	
Default:	NOT1
Selection:	Same as in menu DigOut 1 [541].

Logic 1 Operator 2 [6415]

In this menu the second operator for the Logic 1 function is selected.

6415 L1 Op 2	
Default:	&
Selection	Same as in menu L1 Op 1 [6413].

Logic 1 Input 3 [6416]

In this menu the third input for the Logic 1 function is selected.

6416 L1 Input 3	
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Logic 1 Operator 3 [6417]

In this menu the third operator for the Logic 1 function is selected.

6417 L1 Op 3	
Default:	.
Selection:	Same as in menu L1 Op 1 [6413].

Logic 1 Input 4 [6418]

In this menu the fourth input for the Logic 1 function is selected.

6418	L1 Input 4
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Logic 1 Set Delay [6419]

The activation of the output signal for the Logic 1 function is delayed with the set value in this menu. Compare to Fig. 73, page 102.

6419	L1 Set Dly
Default:	0.0 s
Range:	0 - 36000.0 s

Logic 1 Reset Delay [641A]

The reset of the output signal for the Logic 1 function is delayed with the set value in this menu. Compare to Fig. 73, page 102.

641A	L1 Res Dly
Default:	0.0 s
Range:	0 - 36000.0 s

Logic 1 Timer Value [641B]

The actual timer value for logic 1 is viewed in this menu.

641B	L1 Tmr Val
Default:	0.0 s
Range:	0 - 36000.0 s

Logic 2 - 4 [642] - [644]

Refer to the descriptions for Logic 1. For default values see chapter 15. page 169.

11.6.5 Timers [650]

The Timer functions can be used as a delay timer or as an interval with separate "on" and "off" times (alternate mode), or as a way to prolong a signal (on-time mode). The selected trigger signal starts the timer function, and the signal is converted according to the mode settings, resulting in the timer output signal (T1Q - T4Q). In "Delay" mode, the output signal T1Q becomes high if the set delay time is expired. See fig. 74.

In "Delay" mode, the activation of the timer output signal will be delayed in comparison to the trigger signal. The timer output signal is activated (high) when the set delay time has expired. See fig. 74. The timer output signal will however follow the trigger signal when this is deactivated (low) again.

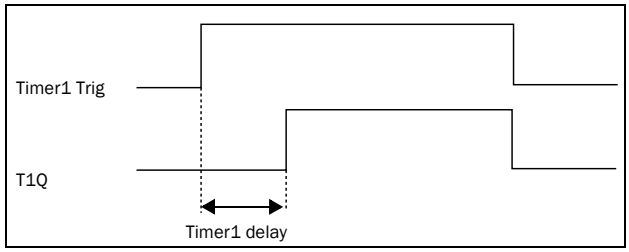


Fig. 74 Delay timer mode.

In alternate mode, the output signal T1Q will switch automatically from high to low etc. according to the set interval times "Timer1 T1" and "Timer 1 T2". See fig. 75.

The output signal can be programmed to the digital or relay outputs used in logic functions [600] or as a virtual connection source [560].

NOTE: The actual timers are common for all parameter sets. If the actual set is changed, the timer functionality [641] to [645] will change according set settings but the timer value will stay unchanged. So initialization of the timer might differ for a set change compared to normal triggering of a timer.

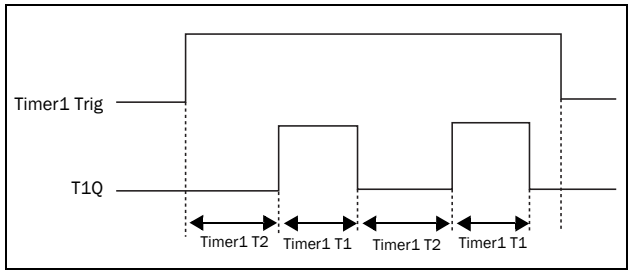


Fig. 75 Alternative timer mode

The function of the “On-time” mode is to extend an activated (high) timer output signal in comparison to the trigger signal. See Fig. 76.

- Output goes high when in signal goes high (positive edge trigged)
- Output stays high for configured time.
- If new positive edge is detected during configured on-time the elapsed time is reset.
- In case the in signal stays high longer than configured time output is kept high as long as in signal is active.

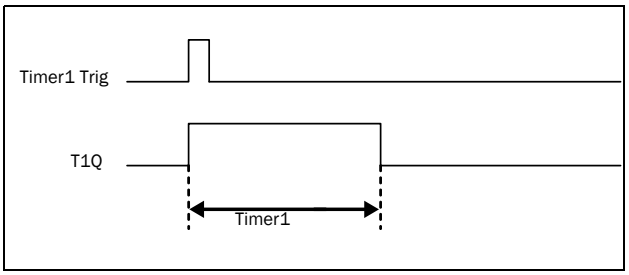


Fig. 76 On-time timer mode.

The timer output signals (T1Q - T4Q) can be programmed to the relay outputs used in logic functions [620], or be used as a virtual connection source [560].

NOTE: The actual timers are common for all parameter sets. If the actual parameter set is changed, the timer functionality will change according to the settings, but the timer value will stay unchanged. So initialisation of the timer might differ for a set change compared to normal triggering of a timer.

Timer 1 [651]

Parameter group for Timer 1.

Timer 1 Trig [6511]

Selection of the Timer input trigger signal

Timer 1 can be activated by a high signal on a DigIn that is set to Timer 1 or via a virtual destination [560].

6511 Timer1 Trig	
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Timer 1 Mode [6512]

Selection of mode of operation for Timer 1.

6512 Timer1 Mode		
Default:		Off
Off	0	Timer is disabled
Delay	1	Output signal will be delayed in comparison to the trigger signal.
Alternate	2	Timer output will automatically keep on switching according to the independently programmable on and off times as long as it is triggered.
On-time	3	Timer output will extend the trigger signal according to configured on-time.

Timer 1 Delay [6513]

This menu is only visible when timer mode is set to delay.

This menu can only be edited as in alternative 2, see section 9.6 page 63.

Timer 1 delay sets the time that will be used by the first timer after it is activated.

6513 Timer1Delay	
Default:	0.0 s
Range:	0 - 36000.0 s

Timer 1 T1 [6514]

This menu is only visible when timer mode is set to Alternate or On-time.

Timer 1 T1 sets the on time in both modes.

6514 Timer1 T1	
Default:	0.0 s
Range:	0 - 36000.0 s

Timer 1 T2 [6515]

Timer 1 T2 sets the off time in the alternate mode.

6515 Timer1 T2	
Default:	0.0 s
Range:	0 - 36000.0 s

NOTE: “Timer 1 T1 [6514]” and “Timer 1 T2 [6515]” are only visible when Timer Mode is set to Alternate.

Timer 1 Actual Value [6516]

Timer 1 Value shows actual value of the timer.

6516	Timer1Value
Default:	0.0 s
Range:	0 - 36000.0 s

Timer 2 - Timer 4 [652] - [654]

Refer to the description for Timer 1 [651].

11.6.6 Flip flops [660]

The flip-flop function is a memory circuit that can be used to store data concerning state. The output from a flip-flop is dependent not only on its current input, but also on its state at the moment this is received (hence previous input status also matters).

The set/reset flip-flop circuit has two input signals, SET and RESET, that control the state of an output signal, OUT. When none of the input signals are active (i.e. both are =0), the flip-flop will keep its current value. Changes of the flip-flop state always occur on the rising edge of one of its inputs.

When only one of the input signals becomes active (=1), this will directly decide the status of the output signal. Consequently if SET becomes active and RESET is inactive, the SET command is given to the output signal, OUT. This will result in a signal change from inactive to active (=1), if not already in an active state.

Conversely, if SET is inactive and RESET becomes active, the RESET command is given to the output signal, OUT, causing this to be deactivated (=0).

When both of the inputs signals becomes active the resulting operation depends on the configured Flip-flop priority mode as explained below.

Flip-flop priority mode

When both input signals becomes active simultaneously, i.e. both SET and RESET are =1, a priority function decides which signal will influence the output signal. There are three different priority settings available for the flip-flop function, selected in the menu for "Flip-flop Mode". Examples of the different priority settings are presented in fig. 77.

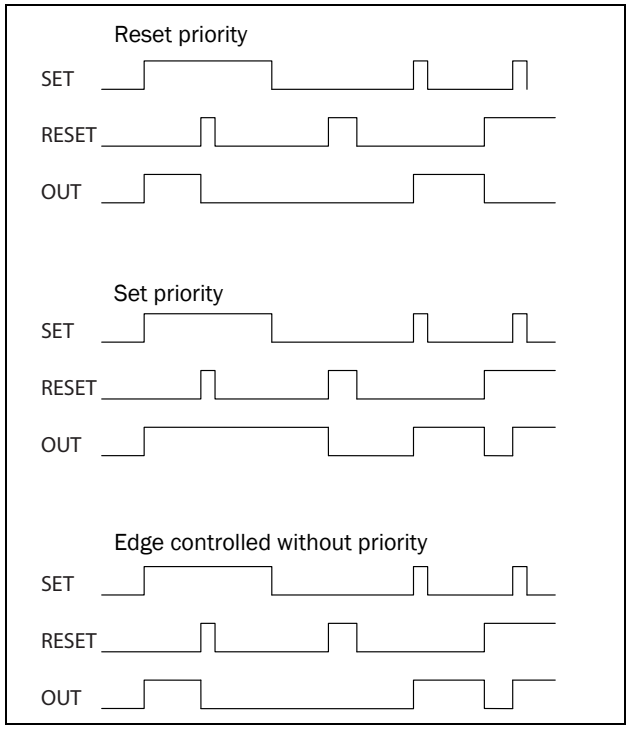


Fig. 77 Programmable flip-flop modes.

Reset priority

"Reset priority" means that if both input signals becomes active, it will be the RESET command that is obeyed, causing the output signal to become inactive (=0) on the rising edge of RESET, as can be seen in fig. 77 If RESET comes first OUT remain inactive when later SET signal becomes active. If SET comes first OUT will turn inactive upon the rising edge of RESET.

Set priority

For "Set priority" the determining input signal is SET. Should both input signals become active, this is resulting in an activated (=1) output signal on the rising edge of SET, as can be seen in fig. 77. If SET comes first OUT will remain active when later RESET signal becomes active. If RESET comes first OUT will turn active upon the rising edge of SET.

Edge controlled without priority

The third setting is “Edge controlled”, for which no input signal has priority over the other. The output signal follows any of the two input signals (still providing they are at a positive edge). The most recent registered activity decides the output. See table 24.
Should both inputs become activated simultaneously, there will not be any change; the output signal will just keep its earlier status.

NOTE: The input signals are updated in intervals of 8 milliseconds, therefore the signal changes are considered simultaneous if the difference is less than 8 ms.

Table 24 Truth table for Edge control without priority.

SET	RESET	OUT
0	0	- (no change)
↗1	0/1	1 (set)
0/1	↗1	0 (reset)
↗1	↗1	No change

Flip flop 1 [661]

Function for SR flip-flop 1.

Flip flop 1 mode [6611]

Priority setting of input signals for flip-flop 1.

6611 F1 mode		
Default:		Reset
Reset	0	Reset priority.
Set	1	Set priority.
Edge	2	Edge controlled without priority.

Flip flop 1 set [6612]

Selection of SET input signal for flip-flop 1.

6612 F1 set	
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Flip flop 1 reset [6613]

Selection of RESET input signals for flip-flop 1.

6613 F1 reset	
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Flip flop 1 set delay [6614]

The SET input signal for flip-flop 1 is delayed with the set value in this menu.

6614 F1 set Dly	
Default:	0.0 s
Selection:	0 - 36000.0 s

Flip flop 1 reset delay [6615]

The RESET input signal for flip-flop 1 is delayed with the set value in this menu.

6615 F1 res Dly	
Default:	0.0 s
Selection:	0 - 36000.0 s

Flip flop 1 timer value [6616]

This menu shows the actual value of the flip flop 1 timer.

6616	F1 Tmr Val
Default:	0.0 s
Selection:	0 - 36000.0 s

Flip flop 2 - 4 [662] - [664]

Refer to the description for Flip Flop 1[661].

11.6.7 Counters [670]

Counter functions for counting pulses and signalling on digital output when counter reaches specified high and low limit levels.

The counter is counting up on positive flanks on the triggered signal, the counter is cleared as long as the Reset signal is active.

The counter can be automatically decremented with specified decrement time, if no new trigger signal has occurred within the decrement time.

The counter value is clamped to the high limit value and the digital output function (C1Q or C2Q) is active when counter value equals high limit value.

See fig. 78 for more information of the counters.

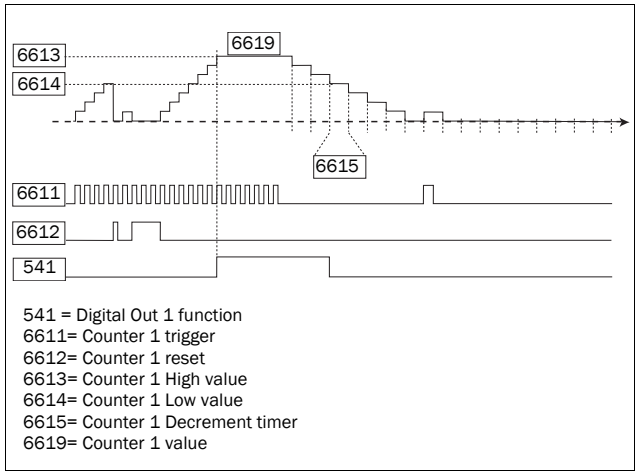


Fig. 78 Counters, operating principle.

Counter1 [671]

Counter 1 parameter group.

Counter 1 Trigger [6711]

Selection of the digital output signal used as trigger signal for counter 1. Counter 1 is incremented by 1 on every positive flank on the trigger signal.

NOTE: Maximum counting frequency is 8 Hz.

6711	C1 Trig
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Counter 1 Reset [6712]

Selection of the digital signal used as reset signal for counter 1. Counter 1 is cleared to 0 and held to 0 as long as reset input is active (high).

NOTE: Reset input has top priority.

6712	C1 Reset
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Counter 1 High value [6713]

Sets counter 1 high limit value. Counter 1 value is clamped to selected high limit value and the counter 1 output (C1Q) is active (high) when the counter value equals the high value.

NOTE: Value 0 means that counter output is always true (high).

6713	C1 High Val
Default:	0
Range:	0 - 10000

Counter 1 Low value [6714]

Sets counter 1 low limit value. Counter 1 output (C1Q) is de-activated (low) when the counter value is equal or smaller than the low value.

NOTE: Counter high value has priority so if high and low values are equal then the counter output is de-activated when the value is smaller than the low value.

6714	C1 Low Val
Default:	0
Range:	0 - 10000

Counter 1 Decrement timer [6715]

Sets counter 1 automatic decrement timer value. The counter 1 is decremented by 1 after elapsed decrement time and if no new trigger has happened within the decrement time. The decrement timer is reset to 0 at every counter 1 trig pulse.

6715	C1 DecTimer	
Default:		Off
Off	0	Off
1 - 3600	1 - 3600	1 - 3600 s

Counter 1 Value [6719]

Parameter shows the actual value of counter 1.

NOTE: Counter 1 value is common for all parameter sets.

NOTE: The value is volatile and lost at power down.

6719	C1 Value
Default:	0
Range:	0 - 10000

Counter2 [672]

Refer to description for Counter 1 [671].

Counter 2 Trigger [6721]

Function is identical to Counter 1 Trigger [6711].

6721	C2 Trig
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Counter 2 Reset [6722]

Function is identical to Counter 1 Reset [6712].

6722	C2 Reset
Default:	Off
Selection:	Same as in menu DigOut 1 [541].

Counter 2 High value [6723]

Function is identical to Counter 1 High value [6713].

6723	C2 High Val
Default:	0
Range:	0 - 10000

Counter 2 Low value [6724]

Function is identical to Counter 1 Low value [6714].

6724	C2 Low Val
Default:	0
Range:	0 - 10000

Counter 2 Decrement timer [6725]

Function is identical to Counter 1 Decrement timer [6715].

6725 C2 DecTimer		
Default:		Off
Off	0	Off
1 - 3600	1 - 3600	1 - 3600 s

Counter 2 Value [6729]

Parameter shows the actual value of counter 2.

NOTE: Counter 2 value is common for all parameter sets.

NOTE: The value is volatile and lost at power down.

6729 C2 Value	
Default:	0
Range:	0 - 10000

11.6.8 Clock Logic [680]

Group 670 if only available if the drive is equipped with a 4-line type Control panel (incl. RTC).
There are two Clock functions, Clock 1 and Clock 2. Each clock with separate settings for Time on, Time Off, Date on, Date Off and Weekday. These clocks can be used for activating/deactivating desired functions via Relay, digital output or Virtual I/O (For example creating start and stop commands).

Clock 1 [681]

The time, date and weekday for clock 1 are set in these submenus.

681 Clock 1

Clock 1 Time On [6811]

Time when the clock 1 output signal (CLK1) is activated.

6811 Clk1TimeON	
Default:	00:00:00 (hh:mm:ss)
Range:	0:00:00–23:59:59

Clock 1 Time Off [6812]

Time when the clock 1output signal (CLK1) is deactivated.

6812 Clk1TimeOff	
Default:	00:00:00 (hh:mm:ss)
Range:	0:00:00–23:59:59

Clock 1 Date On [6813]

Date when the clock 1 output signal (CLK1) is activated.

6813 Clk1DateOn	
Default:	2000-00-00
Range:	yyyy-mm-dd (year-month-day)

Clock 1 Date Off [6814]

Date when the clock output signal (CLK1) is deactivated. Note that if “Clk1DateOff” is set to an earlier date than “Clk1DateOn”, the result will be that the clock is not deactivated at the set date.

6814 Clk1DateOff	
Default:	2000-00-00
Range:	yyyy-mm-dd (year-month-day)

Clock 1 Weekday [6815]

Weekdays when the clock function is active. Having entered the editing mode, select or unselect the desired weekdays with the cursor using the PREV and NEXT keys on the control panel. Confirm by pressing ENTER. Exit the editing mode and the activated weekdays will be viewed in the menu display. The deactivated weekdays are replaced by a dash mark "-" (e.g. "MTWTF - -").

6815	Clk1Weekday
Default:	MTWTFSS (all activated)
Range:	Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.

NOTE: Please make sure that the correct time and date settings are done for the real time clock, menu group [930] "Clock".

Example 1:
The output CLK1 shall be active Mondays to Fridays on working hours, e.g. 08:00-17:00. This signal is used to start e.g. a fan with virtual I/O.

Menu	Text	Setting
6811	Clk1TimeOn	08:00
6812	Clk1TimeOff	17:00
6813	Clk1DateOn	2017-02-01 (date in the past)
6814	Clk1DateOff	2099-12-31 (Date in the future)
6815	Clk1Weekday	MTWTF- -
561	VIO 1 Dest	Run FWD
562	VIO 1 Source	Clk1

Example 2:
The output CLK1 shall be active on weekends, all day.

Menu	Text	Setting
6811	Clk1TimeOn	0:00:00
6812	Clk1TimeOff	23:59:59
6813	Clk1DateOn	2017-02-01 (date in the past)
6814	Clk1DateOff	2099-12-31 (Date in the future)
6815	Clk1Weekday	- - - - - SS
561	VIO 1 Dest	Run FWD
562	VIO 1 Source	Clk1

Clock 2 [682]

Refer to the description for Clock 1 [681].

11.7 View Operation/Status [700]

Menu with parameters for viewing all actual operational data, such as speed, torque, power, etc.

11.7.1 Operation [710]

Reactive power value [711]

Displays the actual controlled reactive power value in % of nominal power.

NOTE:
Positive value - Capacitive or leading.
Negative value - Inductive or lagging.

711	Q Value
Unit	%
Resolution	1%

Displacement power factor [712]

Displays the calculated displacement power factor at AFR/ AFG terminals. Power factor calculation is given in section 7.14.

NOTE:
Positive value - Over excited power factor.
Negative value - Under excited power factor.

NOTE:
Sign in displacement power factor is just to differentiate between excited and under excited power factor.

712	Cosφ
Unit:	-1 to 1
Resolution:	0.001

Electrical Power [713]

Displays the electrical power in % of nominal power and in W.

NOTE:
Positive value - Generating.
Negative value - Motoring.

713	El Power
Unit:	W
Resolution:	1 W

Reactive power [714]

Displays the actual reactive power.

NOTE:
Positive value - Over excited or capacitive.
Negative value - Under excited or Inductive.

714	React Power
Unit:	VA
Resolution:	1 VA

Current [716]

Displays the actual output current.

716	Current
Unit:	A
Resolution:	0.1 A

Supply Voltage [717]

Displays the calculated supply voltage at point of AFE connection.

717	Supply Volt
Unit:	V
Resolution:	0.1 V

Frequency [718]

Displays the actual output frequency.

NOTE:
Positive value = Positive phase sequence, i.e. L1 - L2 - L3.
Negative value = Negative phase sequence, i.e. L3 - L2 - L1.

718	Frequency
Unit:	Hz
Resolution:	0.1 Hz

DC Link Voltage [719]

Displays the actual DC link voltage.

719	DC Voltage
Unit:	V
Resolution:	0.1 V

IBGT Temperature [71A]

Displays the actual IGBT temperature, measured. The signal is generated by a sensor in the IGBT module.

71A	IGBT Temp
Unit:	°C
Resolution:	0.1°C

PT100_1_2_3 Temperature [71B]

Displays the actual PT100 temperature, for PT100 board 1.

71B	PT100 1,2,3
Unit:	°C
Resolution:	1°C

PT100_4_5_6 Temperature [71C]

Displays the actual PT100 temperature, for PT100 board 2.

71C	PT100 4,5,6
Unit:	°C
Resolution:	1°C

11.7.2 Status [720]

AFR Status [721]

Indicates the overall status of the AFE.

```
721            0rpm
AFR/AFG Status
     1/222/333/44
Sby          Rem/Rem
```

Fig. 79 AFR status

Display position	Function	Status value
1	Parameter Set	A,B,C,D
222	Source of reference value	-Rem (remote) -Key (keyboard) -Com (Serial comm.) -Opt (option)
333	Source of Run/ Stop command	-Rem (remote) -Key (keyboard) -Com (Serial comm.) -Opt (option)
44	Limit functions	- - - -No limit active -VL (Voltage Limit) -SL (Speed Limit) -CL (Current Limit) -TL (Torque Limit)

Example: "A/Key/Rem/TL"

This means:

A: Parameter Set A is active.

Key: Reference value comes from the keyboard (CP).

Rem: Run/Stop commands come from terminals 1-22.

TL: Torque Limit active.

Description of communication format

Integer values and bits used

Bit	Integer representation
1 - 0	Active Parameter set, where 0=A, 1=B, 2=C, 3=D
4 - 2	Source of Reference control value, where 0=Rem, 1=Key, 2=Com, 3=Option
7 - 5	Source of Run/Stop/Reset command, where 0=Rem, 1=Key, 2=Com, 3=Option
13 - 8	Active limit functions, where 0=No limit, 1=VL, 2=SL, 3=CL, 4=TL
14	Inverter is in warning (A warning condition is active)
15	Inverter is tripped (A Trip condition is active)

Example:
Previous example "A/Key/Rem/TL"
is interpreted "0/1/0/4"
In bit format this is presented as

Bit	Interpretation	Integer representation	
0 LSB	0	A(0)	Parameter set
1	0		
2	1	Key (1)	Source of control
3	0		
4	0		
5	0	Rem (0)	Source of command
6	0		
7	0		
8	0	TL (4)	Limit functions
9	0		
10	1		
11	0		
12	0		
13	0		
14	0		Warning condition
15 MSB	0		Trip condition

In the example above it is assumed that we have no trip or warning condition (the alarm LED on the control panel is off).

Warning [722]

Display the actual or last warning condition. A warning occurs if the AFE is close to a trip condition but still in operation. During a warning condition the red trip LED will start to blink as long as the warning is active.

```
722            0rpm
Warning
  Brake  17:15:38
Sby                        Rem/Rem
```

The active warning message is displayed in menu [722]. If no warning is active the message "No Error" is displayed. The following warnings are possible:

Communication integer value	Warning message
0	No Error
2	PTC
5	Ext trip
8	Comm error
9	PT100
12	Ext Mot Temp
13	LC Level
15	Option
16	Over temp
17	Over curr F
18	Over volt D

Communication integer value	Warning message
19	Over volt G
20	Over volt
21	Over speed
22	Under voltage
23	Power fault
24	Desat
25	DClink error
26	Int error
27	Ovolt m cut
28	Over voltage
29	Start Denied

See also chapter 12. page 149.

Digital Input Status [723]

Indicates the status of the digital inputs. See fig. 80.

1 DigIn 1
2 DigIn 2
3 DigIn 3
4 DigIn 4
5 DigIn 5
6 DigIn 6
7 DigIn 7
8 DigIn 8

The positions one to eight (read from left to right) indicate the status of the associated input:

1 High

0 Low

The example in fig. 80 indicates that DigIn 1, DigIn 3 and DigIn 6 are active at this moment.

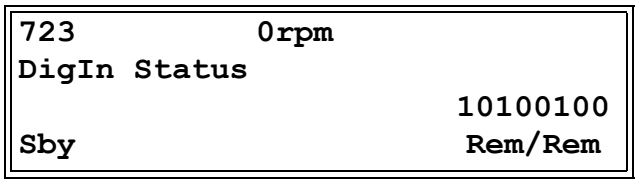


Fig. 80 Digital input status example

Digital Output Status [724]

Indicates the status of the digital outputs and relays. See fig. 81.

RE indicate the status of the relays on position:

1 Relay1
2 Relay2
3 Relay3

DO indicate the status of the digital outputs on position:

1 DigOut1
2 DigOut2

The status of the associated output is shown.

1 High
0 Low

The example in fig. 81 indicates that DigOut1 is active and Digital Out 2 is not active. Relay 1 is active, relay 2 and 3 are not active.

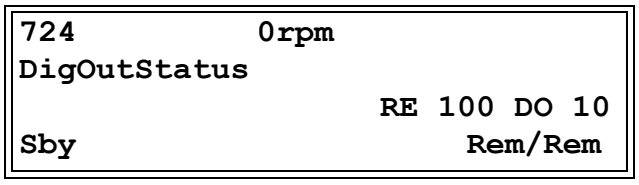


Fig. 81 Digital output status example

Analogue Input Status [725]

Indicates the status of the analogue inputs 1 and 2.

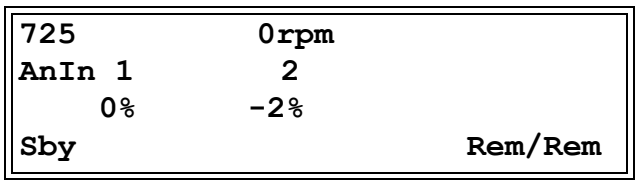


Fig. 82 Analogue input status

The first row indicates the analogue inputs.

1 AnIn 1
2 AnIn 2

Reading downwards from the first row to the second row the status of the belonging input is shown in %:

-100% AnIn1 has a negative 100% input value
65% AnIn2 has a 65% input value

So the example in fig. 82 indicates that both the Analogue inputs are active.

NOTE: The shown percentages are absolute values based on the full range/scale of the in- or output; so related to either 0–10 V or 0–20 mA.

Analogue Input Status [726]

Indicates the status of the analogue inputs 3 and 4.

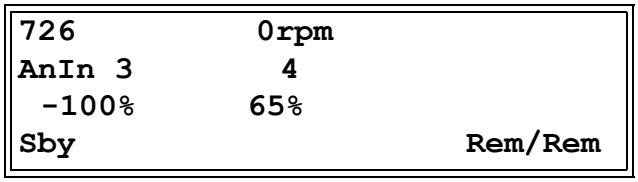


Fig. 83 Analogue input status

Analogue Output Status [727]

Indicates the status of the analogue outputs. fig. 84. E.g. if 4-20 mA output is used, the value 20% equals to 4 mA.

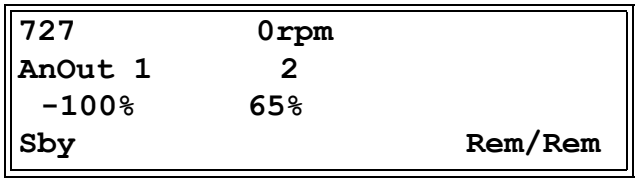


Fig. 84 Analogue output status

The first row indicates the Analogue outputs.

1 AnOut 1
2 AnOut 2

Reading downwards from the first row to the second row the status of the belonging output is shown in %:

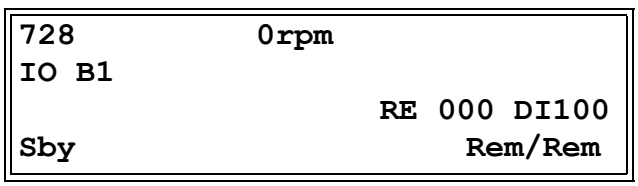
-100%AnOut1 has a negative 100% output value
65%AnOut2 has a 65% output value

The example in fig. 84 indicates that both the Analogue outputs are active.

NOTE: The shown percentages are absolute values based on the full range/scale of the in- or output; so related to either 0–10 V or 0–20 mA.

I/O board Status [728] - [72A]

Indicates the status for the additional I/O on option boards 1 (B1), 2 (B2) and 3 (B3).



Area D Stat [72B]

These menus are not visible in the control panel display. Only used in EmoSoftCom PC-tool (optional) and can be read via fieldbus or serial communication.

Area D LSB [72B1]

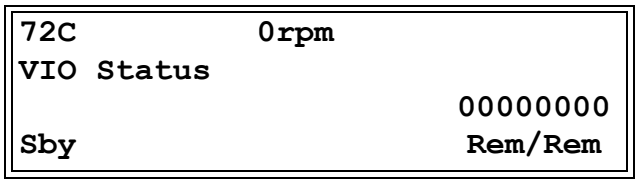
Status bits 0 to 15.
See chapter 9.3.1 page 58.

Area D MSB [72B2]

Status bits 16 and up.
See chapter 9.3.1 page 58.

VIO Status [72C]

Shows the values of the 8 Virtual IO´s in menu[560].



11.7.3 Stored values [730]

The shown values are the actual values built up over time. Values are stored at power down and updated again at power up.

Run Time [731]

Displays the total time that the AFE has been in the Run Mode.

731	Run Time
Unit:	hh:mm:ss (hours: minutes: seconds)
Range:	00: 00: 00–262143: 59: 59

Reset Run Time [7311]

Reset the run time counter. The stored information will be erased and a new registration period will start.

7311	Reset RunTm	
Default:		No
No	0	
Yes	1	

NOTE: After reset the setting automatically reverts to "No".

Mains time [732]

Displays the total time that the AFE has been connected to the mains supply. This timer cannot be reset.

732	Mains Time
Unit:	hh:mm:ss (hours: minutes: seconds)
Range:	00: 00: 00–262143: 59: 59

Energy [733]

Displays the total energy consumption since the last energy reset [7331] took place.

733	Energy
Unit:	Wh (shows Wh, kWh, MWh or GWh)
Range:	0.0–1GWh, Counter will restart at 0 after 1GWh

Reset Energy [7331]

Resets the energy counter. The stored information will be erased and a new registration period will start.

7331	Rst Energy	
Default:		No
No	0	
Yes	1	

NOTE: After reset the setting automatically goes back to "No".

11.8 View Trip Log [800]

Main menu with parameters for viewing all the logged trip data. In total the AFE saves the last nine trips in the trip memory. When a trip occurs the status menus are copied to the trip message log and here are nine trip message logs [810]–[890]. The trip memory refreshes on the FIFO principle (First In, First Out). When the tenth trip occurs the oldest trip will disappear. At every trip, the actual values of several parameter are stored and available for troubleshooting.

11.8.1 Trip message log with RTC [8x0]

Trip recorded with present Real Time Clock (RTC is mounted in 4-line control panel) are shown with actual time and date.

8x0	<Trip message>
Unit:	yy:mm:dd hh:mm:ss (year:month:day hours:minutes:seconds)
Range:	00: 00: 00–262143: 59: 59

11.8.2 Trip Message log without RTC [8x0]

Trip recorded with no present RTC are shown with the time of the "Run Time [731]" counter at trip occurrence.

After reset of occurred trip, the trip message will disappear and menu [100] will be indicated.

8x0	<Trip message>
Unit:	hh:mm:ss (hours:minutes:seconds)
Range:	00: 00: 00–262143: 59: 59

11.8.3 Trip message log [810]

When a trip occurs the menu will change to menu [810]. After resetting an alarm, the menu will change and show menu [100].

Below two examples of trip messages are shown.

Here the menu shows the date and the real time when the trip occurred.

```
810                              0rpm
Over temp
  2020-01-15                17:15:38
Sby                          Rem/Rem
```

Fig. 85

Here the menu shows the run time when the trip occurred.

```
810                              0rpm
Over temp
                           1396:13:00
Sby                          Rem/Rem
```

Fig. 86

Fig. 86 shows the third trip memory menu [810]: Over temperature trip occurred after 1396 hours and 13 minutes in Run time.

For Fieldbus integer value of trip message, see message table for Warning [722].

NOTE: Bits 0–5 used for trip message value. Bits 6–15 for internal use.

Trip message [811]-[81R]

The information from the status menus are copied to the trip message log when a trip occurs.

Trip menu	Copied from	Description
811	711	Q Value
812	712	Cos φ
813	713	El Power
814	714	Reactive Power
816	716	Current
817	717	Supply voltage
818	718	Frequency
819	719	DC voltage
81A	71A	IGBT Temperature
81B	71B	PT100 1, 2, 3
81C	721	AFR Status
81D	723	Digital input status
81E	724	Digital output status
81F	725	Analogue input status 1-2
81G	726	Analogue input status 3-4
81H	727	Analogue output status 1-2
81I	728	I/O status option board 1
81J	729	I/O status option board 2
81K	72A	I/O status option board 3
81L	731	Run Time
81M	732	Mains Time
81N	733	Energy
81O	310	Q reference
81P	72C	VIO Status
81Q	71C	PT100 4, 5, 6
81R	930	Clock

11.8.4 Trip Messages [820] - [890]

Same information as for menu [810].

All nine alarm lists contain the same type of data. For example DeviceNet parameter 31101 in alarm list 1 contains the same data information as 31151 in alarm list 2. See Menu List chapter 15. page 169.

11.8.5 Reset Trip Log [8A0]

Resets the content of the 9 trip memories.

8A0 Reset Trip L		
Default:		No
No	0	
Yes	1	

NOTE: After the reset the setting goes automatically back to "NO". The message "OK" is displayed for 2 sec.

11.9 System Data [900]

Main menu for viewing all the AFE system data.

11.9.1 AFR Data [920]

AFR Type [921]

Shows the AFE type according to the type number.
The options are indicated on the type plate of the AFE.

```
921
AFR/AFG2.1
    AFR/AFG46-175
Sby
```

Fig. 87 Example of AFR/AFG type.

Examples

AFR46-175 suited for 380-460 V mains supply and a rated input current of 175 A.

Software [922]

Shows the software version number of the AFE.

Fig. 88 gives an example of the version number.

```
922
Software
  V 5.04 - 97.10
Sby
```

Fig. 88 Example of software version

V 5.04= Software version

- 97.10 = option version, is only visible and valid for special software, type OEM adapted software.
  97 = (major) special software variant number
  10= (minor) revision of this special software

Table 25 Information for Modbus and Profibus number, software version

Bit	Example	Description
7–0	32	Minor version
13–8	5	Major version
15–14		release 00: V, release version 01: P, pre-release version 10: β, Beta version 11: α, Alpha version

Table 26 Information for Modbus and Profibus number, option version

Bit	Example	Description
7–0	07	Minor option version
15–8	03	Major option version

NOTE: It is important that the software version displayed in menu [922] is the same software version number as the software version number written on the title page of this instruction manual. If not, the functionality as described in this manual may differ from the functionality of the AFE.

Build Information [9221]

Software version created, date and time.

```
9221
Build Info
     200616145041
Sby
```

Default:	YYMMDDHHMMSS (YY=year, MM=month, DD=day, HH=hours, MM=minutes, SS=seconds)

Build ID [9222]

Software identification code.

```
9222
Build ID
          0E1B7F9E
Sby
```

Example:	0E1B7F9E

Unit name [923]

Option to enter a name of the unit for service use or customer identity. The function enables the user to define a name with max 12 characters. Use the Prev and Next key to move the cursor to the required position. Then use the + and - keys to scroll in the character list. Confirm the character by moving the cursor to the next position by pressing the Next key. See section User-defined Unit [323].

Example

Create user name USER 15.

1. When in the menu [923] press Next to move the cursor to the right most position.
2. Press the + key until the character U is displayed.
3. Press Next.
4. Then press the + key until S is displayed and confirm with Next.
5. Repeat until you have entered USER15.

```
923
Unit Name

Sby
```

Default:	0

When sending a unit name you send one character at a time starting at the right most position.

Hardware [924]

CB Key [9241]

Unique identifier of control board; 32 bit hex value.

```
9241
CB Key
          00DBDA8B
Sby
```

Example:	00DBDA8B

CtrlPanel [925]

This menu and sub menus will be hidden if an older control panel is connected.

Control panel software version [9251]

Shows the software version number of the control panel.

Fig. 88 gives an example of the version number.

```
9251
CP SW ver
            V 2.00
Sby
```

Fig. 89 Example of software version

V 2.00 = Software version

CP HW ver [9252]

Hardware version of connected control panel.

```
9252
CP HW ver
                 11
Sby
```

CP Build ID [9253]

32 bit hex value of build ID for control panel.

Fig. 90 gives an example of the version number.

```
9253
CP Build ID
          64A26CE5
Sby
```

Fig. 90 Example of control panel build ID.

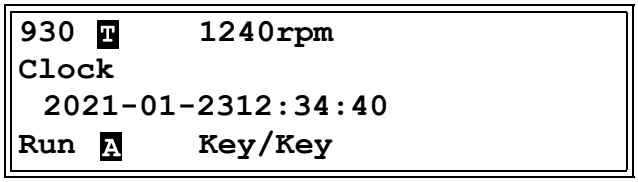
11.9.2 Real Time clock

In the 4-line Control panel there is a built-in Real time clock. This means that actual date and time will be shown at e.g. a trip condition. There is a built-in capacitor to be able to keep the clock running if the power disappear.
In case of loss of power, the backup time for the Real time clock function is at least 60 days.

Actual date and time will be set from factory. Date and time is shown and can be set in following menus.

Clock [930]

This menu group displays actual time and date, read only. Time and date are factory set to CET (Central European mean time). Adjust if required in following sub-menus.



Time [931]

Actual time, displayed as HH:MM:SS. Adjustable setting.

931	Time
Default:	00:00:00 (hh:mm:ss)

Date [932]

Actual date, displayed as YYYY-MM-DD. Adjustable setting.

932	Date
Default:	2000-00-00 (yy-mm-dd)

Weekday [933]

Display of actual weekday, read only.

933		Weekday
Default:		Monday
Monday	0	
Tuesday	1	
Wednesday	2	
Thursday	3	
Friday	4	
Saturday	5	
Sunday	6	

11.10 AFE Option [000]

Main menu for AFE dedicated settings.

11.10.1 Supply parameters [010]

Main menu for power supply parameters.

Supply Volts [011]

Nominal supply voltage.
This parameter is important for smooth start-up. During operation, AFE controller automatically monitors the grid voltage.

O11	Supply Volts
Default:	400 V
Range:	380 - 460 V 480-690 V

Supply Frequency [012]

Nominal supply frequency.
This parameter is important for smooth start-up.
During operation, AFE controller automatically monitors the grid frequency.

O12	Supply Freq
Default:	50 Hz
Range:	45 - 65 Hz

Supply Current [013]

Nominal supply current. Only used for mains supply synchronisation and overcurrent protection.

O13	Supply Curr
Default:	175 A
Range:	0 - AFR/AFG. Inom

Supply Sequence [014]

Nominal phase sequence of supply. Supply ID run [O15].

O14		Supply Seq
Default:		Pos
Pos	0	Positive phase sequence, i.e. L1-L2-L3
Neg	1	Negative phase sequence, i.e. L3-L2-L1

Supply IDrun [O15]

Identification run to measure and set up supply parameters.

O15		Supply IDrun
Default:		Off
Off	0	
On	1	Activate the supply ID-run

Supply Auto [O16]

Automatic activation of supply parameter identification after every power-up.

O16		Supply Auto
Default:		Off
Off	0	
On	1	Activate automatic ID-run

NOTE:
Select ID-Run method in [025].

11.10.2 Charge/Start parameters [O20]

Main menu for charge control and start/stop parameters.

Charge control [O21]

DC-link Charge relay control function.

O21		Charge ctrl
Default:		Supply - NC
Supply - NC	0	Charge at power supply via NC terminal on Relay 1.
Supply - NO	1	Charge at power supply via NO terminal on Relay 1.
Run - NO	2	Charge at run command via NO terminal on Relay 1.
Enable - NO	3	Charge at Enable command via NO terminal on Relay 1.
No Trip - NO	4	Charge at power supply via NO terminal on R1 provided that AFR/ AFG is not tripped.
Run!Trp - NO	5	Charge at run command via NO terminal on R1 provided that AFR/ AFG is not tripped.
Enb!Trp - NO	6	Charge at Enable command via NO terminal on R1 provided that AFR/ AFG is not tripped.

NOTE:
Normally open (NO) alternatives requires 24 V Standby supply option.

Start Mode [O22]

Start/Stop mode. If set to “Regen” AFR/AFG starts on regenerative demand.

O22		Run/Stp Mode
Default:		Standard
Standard	0	AFR/AFG active via Run command
Regen	1	AFR/AFG active only if regeneration required and valid run command.

NOTE:
Regeneration mode requires supply voltage measurement hardware option.

Regeneration stop delay time [023]

Regeneration stop delay time after AFR/AFG in motoring mode.

O23	Req Stp Time
Default:	1 s
Range:	0.00 - 10.0 s

NOTE:
Regeneration mode requires supply voltage measurement.

Start type [025]

This parameter selects the method to be used during synchronization (start) of AFR/AFG and ID-Run. Selecting Pulses method uses pulses for synchronization and ID-Run whereas selecting sensor uses information from supply voltage measurement board for synchronization and ID-Run.

O25		Start Type
Default:		Pulses
Pulses	0	Use pulses for sync and ID-Run
Sensor	1	Use SVMB for sync and ID-Run

NOTE:
Start type with sensor requires SVMB to be connected and setup correctly.

11.10.3 Udc controller parameters [030]

Main menu for DC-link voltage (Udc) parameters.

Udc reference [031]

DC-link voltage reference value.

O31	Udc ref
Default:	1.05*Upeak
Range:	Upeak to Umax

NOTE:
Actual DC - link voltage reference value is limited via actual supply voltage and [037 Udc margin].

Udc ramp time [032]

Udc ramp time, defined as time from 0 ->1000V.

O32	Udc ramp
Default:	1 s
Range:	0.0 - 10.0 s

Udc PI Gain controller [033]

Proportional gain of Udc PI controller.

O33	Udc PI Gain
Default:	5.0
Range:	0.0 - 10.0

Udc PI Time controller [034]

Integral time constant of Udc PI controller.

O34	Udc PI Time
Default:	0.2s
Range:	0.0 - 10.0s

Udc PI Max limit [035]

Udc PI controller max limit, i.e. active power limit.

O35	Udc PI Max
Default:	200%
Range:	0 - 400%

Udc PI Charge limit [036]

Udc PI controller max charge limit during synchronization, i.e. during Udc charging.

O36	Udc PI Charg
Default:	20%
Range:	0.0 - 20.0%

Udc margin [037]

Udc reference control margin from actual output voltage.

O37	Udc margin
Default:	5%
Range:	0.0 - 20.0%

NOTE:
Actual internal DC - link voltage reference value is limited via actual supply voltage and [037 Udc margin], i.e.

$$\sqrt{2} \times Uac \times (1 + [O37])$$

where Uac is the phase to phase RMS voltage.

Udc Droop [038]

DC-link voltage (Udc) droop controller share the electrical load equally between the AFR/AFG connected on the same DC-link.

O38	Udc Droop
Default:	0.0%
Range:	0.0% - 20.0%

11.10.4 Reactive power (Q) controller parameters [040]

Q Max limit [041]

Reactive power max. limit value, i.e. amount of unused capacity that is allowed for Q - compensation.

O41	Q Max
Default:	0%
Range:	0 to 100%

NOTE:
Reactive power limited internally by the amount of actual active power.

Q ramp time [042]

Q ramp time, defined as time from 0->100%.

O42	Q ramp
Default:	1s
Range:	0.0 - 10.0s

Q PI Gain [043]

Q PI controller P gain.

O43	Q PI Gain
Default:	0.10
Range:	0.00 - 1.00

Q PI Time [044]

Q PI controller I time.

O44	Q PI Time
Default:	0.1s
Range:	0.0 - 10.0s

Q Filter time [045]

Q filter time in dynamic/static feedback loop.

O45	Q Filter
Default:	1s
Range:	0.0 - 10.0s

11.10.5 Frequency controller parameters [050]

Frequency type [051]

Selects frequency observer type to handle variations in supply frequency.

O51		Freq Type
Default:		AFR: Observer AFG: Sensor
Observer	0	Use internal frequency observer (without sensor).
Fixed	1	Use fixed frequency
Sensor	2	Use grid frequency information from supply voltage measurement board

NOTE:
Frequency type with sensor requires SVMB to be connected and setup correctly.

11.10.6 View energy status [080]

Energy from Supply [081]

Energy from Supply (Total = Motoring - Generating).

O81	Energy Suppl
Unit:	Wh
Resolution:	1 Wh

Energy to Motor [082]

Energy delivered to Motor (Motoring mode).

O82	Energy Motor
Unit:	Wh
Resolution:	1 Wh

Energy to Supply [083]

Energy delivered to Supply (Generating mode).

O83	Energy Gen
Unit:	Wh
Resolution:	1 Wh

Reset energy [084]

Clear all energy Wh counters [O81] - [O83].

O84		Reset Energy
Default:		No
No	0	
Yes	1	Clear Wh counters.

11.10.7 View control status [O90]

Udc Reference and actual value [O91]

Internal Udc reference (after ramp) and actual value.

O91	Udc Ref Val
Unit:	%
Resolution:	0.1%

T Reference and actual value [O92]

Internal T reference (Udc PI output) and actual value.

O92	T Ref Val
Unit:	%
Resolution:	0.1%

Q Reference and actual value [O93]

Internal Q reference (after ramp) and actual value.

O93	Q Ref Val
Unit:	%
Resolution:	0.1%

Psi Reference and actual value [O94]

Internal Psi reference (Q PI output) and actual value.

O94	Psi Ref Val
Unit:	%
Resolution:	0.1%

11.11 Grid Code Functions [G00]

This menu contains settings related to grid monitoring, grid code voltage and frequency protection functions, grid code reactive power control modes and grid code dynamic support i.e. UVRT, OVRT, OFRT, anti-islanding and open circuit detection.

11.11.1 Grid Code Protection Functions [G10]

Settings related to grid code voltage and frequency protection functions.

Grid Code Voltage Protection [G11]

This sub menu provides settings related to voltage source, voltage trip levels, trip time, hysteresis, reset time etc.

Voltage Source for Grid Code Voltage Protections [G111]

Voltage source for all grid code voltage protections i.e. protection based on phase voltages or on line-line voltages. Selection Off here disable all grid code voltage protections.

G111		Source 3U
Default:		Off
Off	0	Grid code voltage protections are disabled.
3U (phase)	1	Phase voltages
3U (LL)	2	Line-Line voltages

1st Stage Grid Code Over Voltage Protection level [G112]

Trip level for first stage grid code over voltage protection.

G112	3U> Level
Default:	115.0%
Range:	100.0% - 200.0%

1st Stage Grid Code Over Voltage Protection Trip Time [G113]

Trip time for first stage grid code over voltage protection.

G113	3U> Time
Default:	1.50s
Range:	0 = Off 0.01s - 60.00s

2nd Stage Grid Code Over Voltage Protection level [G114]

Trip level for second stage grid code over voltage protection.

G114	3U>> Level
Default:	120.0%
Range:	100.0% - 200.0%

2nd Stage Grid Code Over Voltage Protection Trip Time [G115]

Trip time for second stage grid code over voltage protection.

G115	3U>> Time
Default:	0.20s
Range:	0=Off 0.01s - 60.00s

1st Stage Grid Code Under Voltage Protection level [G116]

Trip level for first stage grid code under voltage protection.

G116	3U< Level
Default:	85.0%
Range:	0.0% - 100.0%

1st Stage Grid Code Under Voltage Protection Trip Time [G117]

Trip time for first stage grid code under voltage protection.

G117	3U< Time
Default:	1.50s
Range:	0 = Off 0.01s - 60.00s

2nd Stage Grid Code Under Voltage Protection level [G118]

Trip level for second stage grid code under voltage protection.

G118	3U<< Level
Default:	80.0%
Range:	0.0% - 100.0%

2nd Stage Grid Code Under Voltage Protection Trip Time [G119]

Trip time for second stage grid code under voltage protection.

G119	3U<< Time
Default:	0.20s
Range:	0=Off 0.01s - 60.00s

Grid Code Voltage Protection Voltage Hysteresis [G11A]

This voltage hysteresis setting is common (applicable) to all grid code voltage protections.

G11A	U Hysteres
Default:	2.0%
Range:	0.0% - 100.0%

Grid Code Voltage Protection Reset Time [G11B]

This reset time setting is common (applicable) to all grid code voltage protections.

G11B	U Rst Time
Default:	1.00s
Range:	0=Off 0.00s - 60.00s

Grid Code Positive Sequence Over Voltage Protection level [G11C]

Trip level for grid code +ve sequence over voltage protection.

G11C	U+> Level
Default:	110.0%
Range:	100.0% - 200.0%

Grid Code Positive Sequence Over Voltage Protection Trip Time [G11D]

Trip time for grid code +ve sequence over voltage protection.

G11D	U+> Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code Positive Sequence Under Voltage Protection level [G11E]

Trip level for grid code +ve sequence under voltage protection.

G11E	U+< Level
Default:	85.0%
Range:	0.0% - 100.0%

Grid Code Positive Sequence Under Voltage Protection Trip Time [G11F]

Trip time for grid code +ve sequence under voltage protection.

G11F	U+< Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code Negative Sequence Over Voltage Protection level [G11G]

Trip level for grid code -ve sequence over voltage protection.

G11G	U-> Level
Default:	5.0%
Range:	0.0% - 100.0%

Grid Code Negative Sequence Over Voltage Protection Trip Time [G11H]

Trip time for grid code -ve sequence over voltage protection.

G11H	U-> Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code Zero Sequence Over Voltage Protection level [G11I]

Trip level for grid code zero sequence over voltage protection.

G11I	U0> Level
Default:	10.0%
Range:	0.0% - 100.0%

Grid Code Zero Sequence Over Voltage Protection Trip Time [G11J]

Trip time for grid code zero sequence over voltage protection.

G11J	U0> Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code 10-Minute Mean Over Voltage Protection level [G11K]

Trip level for grid code 10-minute mean over voltage protection.

G11K	Umean> Lvl
Default:	110.0%
Range:	100.0% - 200.0%

Grid Code 10-Minute Mean Over Voltage Protection Trip Time [G11L]

Trip time for grid code 10-minute mean over voltage protection.

G11L	Umean> Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code 10-Minute Mean Under Voltage Protection level [G11M]

Trip level for grid code 10-minute mean under voltage protection.

G11M	Umean< Lvl
Default:	90.0%
Range:	0.0% - 100.0%

Grid Code 10-Minute Mean Under Voltage Protection Trip Time [G11N]

Trip time for grid code 10-minute mean under voltage protection.

G11N	Umean< Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code Reactive Power Under Voltage Protection level [G110]

Trip level for grid code reactive power under voltage protection.

Using this protection, the generating plant (AFE/AFG) is disconnected from the network after trip time [G11P] elapse, if the measured network voltage is below trip level [G110] and if the generating plant (AFE) simultaneously extracts inductive reactive power from the network.

G11O	U(Q<0)< Lvl
Default:	85.0%
Range:	0.0% - 100.0%

Grid Code Reactive Power Under Voltage Protection Trip Time [G11P]

Trip time for grid code reactive power under voltage protection.

G11P	U(Q<0)< Time
Default:	Off
Range:	0=Off 0.01s - 60.00s

Grid Code Frequency Protection [G12]

This sub menu provide settings related to frequency trip levels, trip time, hysteresis and reset time etc.

Frequency Source For Grid Code Frequency Protections [G121]

Common frequency source for all grid code frequency protections. Selecting mean uses the mean of all phase frequencies. Selection Off disables all grid code frequency protections.

G121		Source F
Default:		Off
Off	0	Grid code frequency protections are disabled.
Mean	1	Mean of all phase frequencies.

1st Stage Grid Code Over Frequency Protection level [G122]

Trip level for first stage grid code over frequency protection.

G122	F> Level
Default:	102.0%
Range:	100.0% - 200.0%

1st Stage Grid Code Over Frequency Protection Trip Time [G123]

Trip time for first stage grid code over frequency protection.

G123	F> Time
Default:	1.50s
Range:	0 = Off 0.01s - 60.00s

2nd Stage Grid Code Over Frequency Protection level [G124]

Trip level for second stage grid code over frequency protection.

G124	F>> Level
Default:	105.0%
Range:	100.0% - 200.0%

2nd Stage Grid Code Over Frequency Protection Trip Time [G125]

Trip time for second stage grid code over frequency protection.

G125	F>> Time
Default:	0.20s
Range:	0 = Off 0.01s - 60.00s

1st Stage Grid Code Under Frequency Protection level [G126]

Trip level for first stage grid code under frequency protection.

G126	F< Level
Default:	98.0%
Range:	0.0% - 100.0%

1st Stage Grid Code Under Frequency Protection Trip Time [G127]

Trip time for first stage grid code under frequency protection.

G127	F< Time
Default:	1.50s
Range:	0 = Off 0.01s - 60.00s

2nd Stage Grid Code Under Frequency Protection level [G128]

Trip level for second stage grid code under frequency protection.

G128	F<< Level
Default:	95.0%
Range:	0.0% - 100.0%

2nd Stage Grid Code Under Frequency Protection Trip Time [G129]

Trip time for second stage grid code under frequency protection.

G129	F<< Time
Default:	0.20s
Range:	0 = Off 0.01s - 60.00s

Grid Code Frequency Protection Frequency Hysteresis [G12A]

This frequency hysteresis setting is common (applicable) to all grid code frequency protections.

G12A	F Hysteres
Default:	0.2%
Range:	0.0% - 100.0%

Grid Code Frequency Protection Reset Time [G12B]

This reset time setting is common (applicable) to all grid code frequency protections.

G12B	F Rst Time
Default:	1.00s
Range:	0=Off 0.00s - 60.00s

Grid Code ROCOF Protection [G13]

This sub menu provides settings related to Rate Of Change Of Frequency (ROCOF) protection. Trip level, trip time, hysteresis and reset time can be configured here.

Grid Code ROCOF Protection level [G131]

Trip level for rate of change of frequency (ROCOF) protection.

G131	ROCOF Level
Default:	2.00%/s
Range:	0.0%/s - 100.0%/s

Grid Code ROCOF Protection Trip Time [G132]

Trip time for rate of change of frequency (ROCOF) protection.

G132	ROCOF Time
Default:	2.00s
Range:	0 = Off 0.01s - 60.00s

Grid Code ROCOF Protection ROCOF Hysteresis [G133]

ROCOF hysteresis for grid code ROCOF protection.

G133	ROCOF Hyst
Default:	0.02%/s
Range:	0.0%/s - 100.0%/s

Grid Code ROCOF Protection Reset Time [G134]

Reset time settings for ROCOF protection.

G134	ROCOF Rst T
Default:	1.00s
Range:	0.00s - 60.00s

11.11.2 Grid Code Reactive Power (Q) Functions [G20]

Settings related to different grid code reactive power (Q) support modes.

Grid Code Reactive Power (Q) support mode [G21]

Select the required grid code reactive power (Q) support mode here.

G21		Q mode
Default:		Off
Off	0	Disables grid code reactive power support.
Q fix	1	Reactive power support via the set point (from Keyb, remote or comm).
Cosφ fix	2	Reactive power support via the set point (from Keyb, remote or comm).
Q(U)	3	Reactive power support as a function of grid/network voltage.
Cosφ(U)	4	Reactive power support as a function of grid/network voltage.
Q (P)	5	Reactive power support as a function of feed in power.
Cosφ(P)	6	Reactive power support as a function of feed in power.

Q control via the set point (Q fix) [G22]

This sub-menu provides the additional settings (over excited and under excited Q limits) when the reactive power (Q) reference is controlled via the set point i.e. Q reference is provided by the set point. Set point can be configured locally through keyboard [310], from remote (analogue input) or through serial communication. For details read section 7.17.2, page 43.

Maximum Reactive Power (Q) in Over Excitation [G221]

Sets the maximum limit of reactive power (Q) in over-excited mode.

G221	Q max oe
Default:	50%
Range:	0% - 100%

NOTE:
-ve sign in [G221] indicates the under excited mode and +ve sign indicates the over-excited mode.

NOTE:
Q_{ref} [310] is additionally also limited by Q_{max} [041] as shown in Fig. 37.

Maximum Reactive Power (Q) in Under Excitation [G222]

Sets the maximum limit of reactive power (Q) in under-excited mode.

G222	Q max ue
Default:	-50%
Range:	-100% - 0%

NOTE:
-ve Q value in [G222] indicates the under excited mode and +ve sign indicates the over-excited mode.

NOTE:
Q_{ref} [310] is additionally also limited by Q_{max} [041] as shown in Fig. 37.

Cosφ control via the set point (Cosφ fix) [G23]

This sub-menu provides the additional settings (over excited and under excited Cosφ limits) when the displacement power factor (Cosφ) reference is controlled via the set point i.e. Cosφ reference is provided by the set point. Set point can be configured locally through keyboard [310], from remote (analogue input) or through serial communication. Internally reactive power (Q) reference is calculated from the set displacement power factor (Cosφ). For details read section Reactive power (Q) support, section 7.17.2, page 43.

Minimum Displacement Power Factor (Cosφ) In Over Excitation [G231]

Sets the minimum limit of displacement power factor (Cosφ) in over-excited mode.

G231	Cosφ min oe
Default:	0.90
Range:	0.00 - 1.00

NOTE:
-ve Q sign in [G231] indicates the under excited mode and +ve sign indicates the over-excited mode.

NOTE:
Calculated Q_{ref} [310] is additionally also limited by Q_{max} [041] as shown in Fig. 37.

Minimum Displacement Power Factor (Cosφ) In Under Excitation [G232]

Sets the minimum limit of displacement power factor (Cosφ) in under-excited mode.

G232	Cosφ min ue
Default:	-0.90
Range:	-1.00 - 0

NOTE:
-ve Q value in [G232] indicates the under excited mode and +ve sign indicates the over-excited mode.

NOTE:
Calculated Q_{ref} [310] is additionally also limited by Q_{max} [041] as shown in Fig. 37.

Q control as a function of grid voltage Q(U) [G24]

AFR/AFG can support grid/network voltage in the event of grid/network voltage variations by providing or consuming the reactive power. For that, reactive power (Q) support can be configured as a function of grid/network measured voltage. Characteristics of reactive power (Q) support as a function of measured grid/network voltage can be configured using four configurable points. For details read section Reactive power (Q) support, section 7.17.2, page 43. In this menu, settings related Q-U characteristic curve can be configured.

Reactive Power (Q1) At Voltage Level (U1) [G241]

Desired reactive power support (Q1) at measured grid/ network voltage (U1) level.

G241	Q1
Default:	50%
Range:	-100% - 100%

NOTE:
-ve Q1 value in [G241] indicates the under excited mode and +ve sign indicates the over-excited mode.

Grid/Network Voltage (U1) level [G242]

Grid/Network voltage (U1) level at which specified Q1 is supplied.

G242	U1
Default:	85%
Range:	0% - 120%

Reactive Power (Q2) Voltage level (U2) [G243]

Desired reactive power support (Q2) at measured grid/ network voltage (U2) level.

G243	Q2
Default:	10%
Range:	-100% - 100%

NOTE:
-ve Q2 value in [G243] indicates the under excited mode and +ve sign indicates the over-excited mode.

Grid/Network Voltage (U2) level [G244]

Grid/Network voltage (U2) level at which specified Q2 is supplied.

G244	U2
Default:	95%
Range:	0% - 120%

Reactive Power (Q3) At Voltage level (U3) [G245]

Desired reactive power support (Q3) at measured grid/ network voltage (U3) level.

G245	Q3
Default:	-10%
Range:	-100% - 100%

NOTE:
-ve Q3 value in [G245] indicates the under excited mode and +ve sign indicates the over-excited mode.

Grid/Network Voltage (U3) level [G246]

Grid/Network voltage (U3) level at which specified Q3 is supplied.

G246	U3
Default:	105%
Range:	0% - 120%

Reactive Power (Q4) At Voltage level (U4) [G247]

Desired reactive power support (Q4) at measured grid/ network voltage (U4) level.

G247	Q4
Default:	-50%
Range:	-100% - 100%

NOTE:
-ve Q4 value in [G247] indicates the under excited mode and +ve sign indicates the over-excited mode.

Grid/Network Voltage (U4) level [G248]

Grid/Network voltage (U4) level at which specified Q4 is supplied.

G248	U4
Default:	110%
Range:	0% - 120%

Filter Time Constant On Grid/Network Voltage Measurement [G249]

Grid/Network voltage measurement used for Q(U) support has a first order filter. Time constant for that first order filter can be configured here. This is common time constant for all the voltage levels i.e. U1, U2, U3 and U4.

G249	Filt time
Default:	3.0s
Range:	0.0s - 60.0s

Minimum Allowed Displacement Power Factor in Q(U) mode [G24A]

Minimum allowed displacement power factor in Q(U) mode at AFR/AFG connection terminals. It limits the Q-reference in order to not allow the displacement power factor to go below the value specified in this menu.

G24A	Cosφ min
Default:	0.01
Range:	0.01s - 1.00s

Lock-In Active Power Level [G24B]

Q(U) mode is turned on if the actual active power of AFR/ AFG is higher than the value set in this menu.

G24B	P lock In
Default:	10%
Range:	0 = Off 1% - 100%

Lock-Out Active Power Level [G24C]

Q(U) mode is turned off if the actual active power of AFR/ AFG is lower than the value set in this menu.

G24C	P lock Out
Default:	0%
Range:	0% - 100%

NOTE:
Setting 0 (off) in [G24B] turns off the lock-in and lock out function for Q (U).

NOTE:
Hysteresis between lock-in and lock-out is available only if lock-in is higher than the lock-out value. In that cases, the difference between lock-in and lock-out acts as a hysteresis.

CosΦ control as a function of grid voltage Cosφ(U) [G25]

AFR/AFG can support grid/network voltage in the event of grid/network voltage variations by providing or consuming the reactive power. For that, displacement power factor (Cosφ) at the terminals of AFR/AFG can be configured as a function of grid/network measured voltage. Characteristics of displacement power factor (Cosφ) as a function of measured grid/network voltage can be configured using four configurable points. For details read section Reactive power (Q) support, section 7.17.2, page 43. In this menu, settings related Cosφ -U characteristic curve can be configured.

Displacement power factor (Cosφ1) At Voltage level (U1) [G251]

Desired displacement power factor (Cosφ1) at measured grid/network voltage (U1) level.

G251	Cosφ1
Default:	0.90
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ1 value in [G251] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Grid/Network Voltage (U1) level [G252]

Grid/Network voltage (U1) level at which specified Cosφ1 is maintained.

G252	U1
Default:	85%
Range:	0%- 120%

Displacement power factor (Cosφ2) At Voltage level (U2) [G253]

Desired displacement power factor (Cosφ2) at measured grid/network voltage (U2) level.

G253	Cosφ2
Default:	0.95
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ2 value in [G253] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Grid/Network Voltage (U2) level [G254]

Grid/Network voltage (U2) level at which specified Cosφ2 is maintained.

G254	U2
Default:	95%
Range:	0%- 120%

Displacement power factor (Cosφ3) At Voltage level (U3) [G255]

Desired displacement power factor (Cosφ3) at measured grid/network voltage (U3) level.

G255	Cosφ3
Default:	-0.95
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ3 value in [G255] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Grid/Network Voltage (U3) level [G256]

Grid/Network voltage (U3) level at which specified Cosφ3 is maintained.

G256	U3
Default:	105%
Range:	0%- 120%

Displacement power factor (Cosφ4) At Voltage level (U4) [G257]

Desired displacement power factor (Cosφ4) at measured grid/network voltage (U4) level.

G257	Cosφ4
Default:	-0.90
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ4 value in [G257] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Grid/Network Voltage (U4) level [G258]

Grid/Network voltage (U4) level at which specified Cosφ4 is maintained.

G258	U4
Default:	110%
Range:	0%- 120%

Filter Time Constant On Grid/Network Voltage Measurement [G259]

Grid/Network voltage measurement used for Cosφ (U) support has a first order filter. Time constant for that first order filter can be configured here. This is common time constant for all the voltage levels i.e. U1, U2, U3 and U4.

G259	Filt time
Default:	3.0s
Range:	0.0s - 60.0s

Lock-In Active Power Level [G25B]

Cosφ (U) mode is turned on if the actual active power of AFR/AFG is higher than the value set in this menu.

G25B	P lock IN
Default:	10%
Range:	0 = Off 1% - 100%

Lock-Out Acvtive Power Level [G25C]

Cosφ (U) mode is turned off if the actual active power of AFR/AFG is lower than the value set in this menu.

G25C	P lock Out
Default:	0%
Range:	0% - 100%

NOTE:
Setting 0 (off) in [G25B] turns off the lock-in and lock out function for Cosφ (U).

NOTE:
Hysteresis between lock-in and lock-out is available only if lock-in is higher than the lock-out value. In that cases, the difference between lock-in and lock-out acts as a hysteresis.

Q control as a function of feed in active power Q(P) [G26]

AFR/AFG reactive power support can also be configured as a function of feed in active power. Characteristics of the reactive power (Q) support as a function of feed in active power can be configured using four configurable points. For details read section Reactive power (Q) support, section 7.17.2, page 43. In this menu, settings related Q-P characteristic curve can be configured.

Reactive Power (Q1) At Active Power Level (P1) [G261]

Desired reactive power support (Q1) at calculated feed in active power (P1) level.

G261	Q1
Default:	10%
Range:	-100% - 100%

NOTE:
-ve Q1 value in [G261] indicates the under excited mode and +ve sign indicates the over-excited mode.

Feed In Active Power level (P1) [G262]

Feed in active power (P1) level at which specified Q1 is supplied.

G262	P1
Default:	25%
Range:	0% - 100%

Reactive Power (Q2) At Active Power Level (P2) [G263]

Desired reactive power support (Q2) at calculated feed in active power (P2) level.

G263	Q2
Default:	50%
Range:	-100% - 100%

NOTE:
-ve Q2 value in [G263] indicates the under excited mode and +ve sign indicates the over-excited mode.

Feed In Active Power Level (P2) [G264]

Feed in active power (P2) level at which specified Q2 is supplied.

G264	P2
Default:	50%
Range:	0% - 100%

Reactive Power (Q3) At Active Power Level (P3) [G265]

Desired reactive power support (Q3) at calculated feed in active power (P3) level.

G265	Q3
Default:	40%
Range:	-100% - 100%

NOTE:
-ve Q3 value in [G265] indicates the under excited mode and +ve sign indicates the over-excited mode.

Feed In Active Power Level (P3) [G266]

Feed in active power (P3) level at which specified Q3 is supplied.

G266	P3
Default:	75%
Range:	0% - 100%

Reactive Power (Q4) At Active Power Level (P4) [G267]

Desired reactive power support (Q4) at calculated feed in active power (P4) level.

G267	Q4
Default:	0%
Range:	-100% - 100%

NOTE:
-ve Q4 value in [G267] indicates the under excited mode and +ve sign indicates the over-excited mode.

Feed In Active Power level (P4) [G268]

Feed in active power (P4) level at which specified Q4 is supplied.

G268	P4
Default:	100%
Range:	0% - 100%

Filter Time Constant On Active Power Calculations [G269]

Calculated feed in active power (P) used for Q(P) support has a first order filter. Time constant for that first order filter can be configured here. This is common time constant for all the active power levels i.e. P1, P2, P3 and P4.

G269	Filt time
Default:	3.0s
Range:	0.0s - 60.0s

Cosφ control as a function of feed in active power Cosϕ (P) [G27]

Displacement power factor (Cosφ) at the terminals of AFE/ AFG can also be configured as a function of feed in active power. Characteristics of displacement power factor (Cosφ) as a function of feed in active power can be configured using four configurable points. For details read section Reactive power (Q) support, section 7.17.2, page 43. In this menu, settings related to Cosφ -P characteristic curve can be configured.

Displacement power factor (Cosϕ1) At Active Power Level (P1) [G271]

Desired displacement power factor (Cosϕ1) at calculated feed in active power (P1) level.

G271	Cosϕ1
Default:	0.90
Range:	-1.00 - 1.00

NOTE:
-ve Cosϕ1 value in [G271] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Feed In Active Power level (P1) [G272]

Feed in active power (P1) level at which specified Cosφ1 is maintained.

G272	P1
Default:	25%
Range:	0% - 100%

Displacement power factor (Cosφ2) At Active Power Level (P2) [G273]

Desired displacement power factor (Cosφ2) at calculated feed in active power (P2) level.

G273	Cosφ2
Default:	0.70
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ2 value in [G273] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Feed In Active Power level (P2) [G274]

Feed in active power (P2) level at which specified Cosφ2 is maintained.

G274	P2
Default:	50%
Range:	0% - 100%

Displacement power factor (Cosφ3) At Active Power Level (P3) [G275]

Desired displacement power factor (Cosφ3) at calculated feed in active power (P3) level.

G275	Cosφ3
Default:	0.88
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ3 value in [G275] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Feed In Active Power level (P3) [G276]

Feed in active power (P3) level at which specified Cosφ3 is maintained.

G276	P3
Default:	75%
Range:	0% - 100%

Displacement power factor (Cosφ4) At Active Power level (P4) [G277]

Desired displacement power factor (Cosφ4) at calculated feed in active power (P4) level.

G277	Cosφ4
Default:	1.00
Range:	-1.00 - 1.00

NOTE:
-ve Cosφ4 value in [G277] indicates the under excited (Q-absorbed) mode and +ve sign indicates the over-excited (Q-delivered) mode.

Feed In Active Power level (P4) [G278]

Feed in active power (P4) level at which specified Cosφ4 is maintained.

G278	P4
Default:	100%
Range:	0% - 100%

Filter Time Constant On Active Power Calculations [G279]

Calculated feed in active power (P) used for Cosφ(P) support has a first order filter. Time constant for that first order filter can be configured here. This is common time constant for all the active power levels i.e. P1, P2, P3 and P4.

G279	Filt time
Default:	3.0s
Range:	0.0s - 60.0s

Limiting Reactive Power (Q) [G28]

Settings related to active power threshold level, reactive power limit when active power is below threshold level and priority between active and reactive power are given in this sub-menu.

Active Power (P) Threshold Level [G281]

This is the active power threshold level below which reactive power (Q) is limited according to the limit set in [G282].

G281	P threshold
Default:	0%
Range:	0%: Functionality is OFF 1% - 100%

Reactive Power (Q) Limit Below Active Power (P) Threshold level [G282]

Reactive power limit when the active power is below the threshold level [G281] can be configured here.

G282	Q limit
Default:	10%
Range:	0% - 100%

Active (P) or Reactive (Q) Power Priority (P/Q) [G283]

AFR/AFG can be configured to prioritize active or reactive power depending upon the requirement. The priority setting defines the AFR/AFG behavior when kVA (or current) limit is reached. When AFR/AFG is configured with active power priority and the kVA (or current) limit is reached, reactive power is reduced to maintain the active power production. Similarly, when AFR/AFG is configured with reactive power priority and the kVA (or current) limit is reached, active power is reduced to maintain the reactive power production.

G283		Prio P/Q
Default:		P
P	0	Active power is prioritized.
Q	1	Reactive power is prioritized.

11.11.3 GC Disturbance [G30]

This menu contain settings related GC-FRT functions which includes UVRT, OVRT, UFRT, OFRT, AID. It also provide settings related to open circuit detection and brake resistor over-load protection. Other than that, normal operation range for AFR/AFG can also be define in this menu.

GC NormRange [G31]

Operating range (for supply voltage and frequency) for normal continues operation of AFR/AFG unit can be configured in this menu.

Umin [G311]

Menu for defining the minimum supply voltage required for continues normal operation of AFR/AFG.

G311	Umin
Default:	85.0%
Range:	0.0% - 100.0%

Umax [G312]

Menu for defining the maximum allowed supply voltage for continues normal operation of AFR/AFG.

G312	Umax
Default:	110.0%
Range:	100.0% - 140.0%

Fmin [G313]

Menu for defining the minimum supply frequency required for continues normal operation of AFR/AFG.

G313	Fmin
Default:	92.0%
Range:	85.0% - 100.0%

Fmax [G314]

Menu for defining the maximum allowed supply frequency for continues normal operation of AFR/AFG.

G314	Fmax
Default:	108.0%
Range:	100.0% - 115.0%

Umaxmax [G315]
Absolute maximum voltage that can be injected/supplied by the AFR/AFG.

G315	Umaxmax
Default:	125.0%
Range:	100.0% - 140.0%

Unorm [G316]
This menu defines the normalizing voltage for AFG unit.

G316	Unorm
Default:	400.0 V

NOTE:
All the voltage levels used for voltage protection in [G11], reactive power support in [G2x], grid dynamic support in [G3x] and grid start [G37x] are normalized against voltage defined in [G316].

GC dU (FRT) [G32]
This menu contain parameters related to dynamic voltage support during UVRT and OVRT.

NOTE:
BCC and brake resistor is required for UVRT and OVRT functionality if the energy source cannot be controlled.

dU Imax (P) [G321]
Maximum active current during FRT. Normalized to AFR/AFG nominal currents.

G321	dU Imax(P)
Default:	100%
Range:	0% - 120%

dU Imax (Q) [G322]
Maximum reactive current during FRT. Normalized to AFR/AFG nominal currents.

G322	dU Imax(Q)
Default:	100%
Range:	0% - 120%

dU Uband [G323]
Voltage insensitivity dead-band.
Voltage steps within the insensitivity dead-band does not activate dynamic voltage support.

G323	dU Uband
Default:	10.0%
Range:	0.0% - 20.0%

dU Timemax [G324]
Maximum duration of dynamic voltage support. After this time expires, AFR/AFG then continues the operation corresponding to dynamic support mode I(cont).

G324	dU Timemax
Default:	Off
Range:	0.01s - 300.00s

dU Mode UV [G325]
Dynamic voltage support mode during UVRT.

G325		dU Mode UV
Default:		I (cont)
I(cont)	0	Continued operation with pre-fault P, Q (to the extent possible).
I(Q)	1	Additional reactive current support with reactive power/current priority.
I(P)	2	Additional reactive current support with active power/current priority.
I(zero)	3	Zero current for momentary cessation.

dU Zero UV [G326]
Voltage threshold level below which zero current UVRT mode is activated (forced) irrespective of mode set in [G325]. Voltage threshold level is normalized to nominal grid voltage.

G326	dU Zero UV
Default:	15%
Range:	0% - 100%

dU Mode OV [G327]
Dynamic support mode during OVRT.

G327		dU Mode OV
Default:		I (cont)
I(cont)	0	Continued operation with pre-fault P, Q (to the extent possible).
I(Q)	1	Additional reactive current support with reactive power/current priority.
I(P)	2	Additional reactive current support with active power/current priority.
I(zero)	3	Zero current for momentary cessation.

dU Zero OV [G328]
Voltage threshold level above which zero current OVRT mode is activated (forced) irrespective of mode set in [G325]. Voltage threshold level is normalized to nominal grid voltage.

G328	dU Zero OV
Default:	120%
Range:	100% - 140%

dU K1 [G329]
Gain (K1) for positive sequence reactive current support during voltage disturbance according to EN 50549-2.

G329	dU K1
Default:	2.00
Range:	0.00 - 6.00

dU K2 [G32A]
Gain (K2) for negative sequence reactive current support during voltage disturbance according to EN 50549-2.

G32A	dU K2
Default:	0.00
Range:	0.00 - 6.00

Trip UV t1 [G32D]
UVRT trip-curve [1] time.
Selection t1=Off means that UVRT trip area [1] in Fig. 44 is inactivated.

G32D	Trip UV t1
Default:	0.25s
Range:	0.01s - 60.00s

Trip UV U1 [G32E]
UVRT trip-curve [1] voltage. In Fig. 44 UVRT trip area [1] is defined as the area below the horizontal line from [t(fault),U1] to [t1,U1].

G32E	Trip UV U1
Default:	0%
Range:	0% - 100%

Trip UV t2 [G32F]
UVRT trip-curve [2] time.
In Fig. 44, t2 = Off means that UVRT trip area [2] is inactivated.

G32F	Trip UV t2
Default:	3.00s
Range:	0.01s - 60.00s

Trip UV U2 [G32G]
UVRT trip-curve [2] voltage.
In Fig. 44, UVRT trip area [2] is defined as the area to the right of the linear line from [t1,U1] to [t2,U2] (and if selection t1=Off then area on the right of line from [t2,0] to [t2,U2]).

G32G	Trip UV U2
Default:	85%
Range:	0% - 100%

Trip OV t1 [G32H]
OVRT trip-curve [1] time.
Selection t1=Off means that OVRT trip area [1] in Fig. 44 is inactivated.

G32H	Trip OV t1
Default:	0.10s
Range:	0.01s - 60.00s

Trip OV U1 [G32I]
OVRT trip-curve [1] voltage.
In Fig. 44, OVRT trip area [1] is defined as the area above the horizontal line from [t(fault),U1] to [t1,U1].

G32I	Trip OV U1
Default:	130%
Range:	100% - 140%

Trip OV t2 [G32J]

OVRT trip-curve [2] time.
In Fig. 44, t2 = Off means that OVRT trip area [2] is inactivated.

G32J	Trip OV t2
Default:	0.10s
Range:	0.01s - 60.00s

Trip OV U2 [G32K]

OVRT trip-curve [2] voltage.
In Fig. 44, OVRT trip area [2] is defined as the area to the right of the linear line from [t1,U1] to [t2,U2] (and if selection t1=Off then area on the right of line from [t2,140%] to [t2,U2]).

G32K	Trip OV U2
Default:	120%
Range:	100% - 140%

GC AID [G33]

This menu contain parameters related to anti-islanding detection (AID) settings.

Passive AID [G331]

Enable/disable the passive AID method.

G331		Passive AID
Default:		Off
Off	0	Off
On	1	1° to 30°

Active AID [G332]

Enable/disable the active AID method.

G332		Active AID
Default:		Off
Off	0	Disable
Fast	1	Fast anti-islanding detection method.
Slow	2	Slow anti-islanding detection method.
Slow (>0.5s)	3	Slow anti-islanding detection method with minimum of 0.5s detection time.

NOTE:
Contact local supplier or authorized Emotron service personal if further assistance is required with AID detection.

GC dF (FRT) [G34]

This menu specifies the dynamic frequency support parameters during under frequency rider through (UFRT) and over frequency ride through (OFRT).

Active response to grid frequency reduction typically sets requirement for increasing the AC output power. Therefore, active response during UFRT needs to be handled by the plant energy management control system and not implemented in AFG.

NOTE:
BCC and brake resistor is required for OFRT functionality if the energy source cannot be controlled.

dOF Mode [G341]

Enable/disable the OFRT function according to LFSM-O (limited frequency sensitivity mode - over-frequency).

G341		dOF Mode
Default:		Off
Off	0	Disable
On (Pref)	1	P(dOF) acts on the actual AC output power at the instant when F reaches Fstart [G342].
On (Pnom)	2	P(dOF) acts on the nominal power of AFG when F reaches Fstart [G342] i.e. fixed droop.

dOF Fstart [G342]

Frequency at which OFRT function should activate (start) according to LFSM-O.
Normalized to nominal grid frequency.

G342	dOF Fstart
Default:	100.4%
Range:	100.0% - 110.0%

dOF tstart [G343]

Delay time before activation (start) of OFRT function according to LFSM-O.

G343	dOF tstart
Default:	0.0s
Range:	0.0s - 10.0s

dOF Droop [G344]

Droop (D) for LFSM-O (OFRT) function where ΔP=(1/D[G344])*(Fstart[G342]-F)/Fnom[O12]*P(dOF) where P(dOF) corresponds to the selection made in [G341] i.e. On(Pref) or On(Pnom) at the instant when F reaches Fstart[G342].

G344	dOF Droop
Default:	5.0%
Range:	2.0% - 12.0%

dOF Fstop [G345]

Deactivation threshold frequency for LFSM-O (OFRT) function.

NOTE:
The deactivation threshold frequency is disabled if Fstop [G345] ≥ Fstart [G342].

G345	dOF Fstop
Default:	110.0%
Range:	100.0% - 110.0%

dOF tstop [G346]

Deactivation delay time (if enabled) for LFSM-O (OFRT) function. Off means that the deactivation threshold is disabled.

G346	dOF tstop
Default:	Off
Range:	0=Off 0.1s - 600.0s

t (Rbrake) max [G35]

This menu specifies the thermal limitation of the brake resistor. It specifies the maximum short-term surge duration for the brake resistor.
Off means that the resistor protection is disabled.
An AFG trip is triggered when the resistor on-timer reaches t(Rb)max.
The resistor timer is decremented with a time constant of 5 minutes.

G35	t(Rbrake)max
Default:	Off
Range:	0=Off 0.1 - 60.0s

GC Open CB [G36]

This menu specifies the open-circuit detection parameters.

Open I< [G361]

Current detection level for open circuit.

G361	Open I<
Default:	20.0%
Range:	0.0% - 100.0%

Open Ttrip [G362]

Open circuit detection trip time.

G362	Open Ttrip
Default:	0.02s
Range:	0=Off 0.01s - 0.10s

GC Start [G37]

This menu specifies the settings related to the start behavior of AFR/AFG.

Umin Start [G371]

AFR/AFG start its operation only if grid voltage is higher than the voltage level set in this menu.

G371	Umin Start
Default:	90.0%

Umax Start [G372]

AFR/AFG start its operation only if grid voltage is lower than the voltage level set in this menu.

G372	Umax Start
Default:	110.0%

Fmin Start [G373

AFR/AFG start its operation only if grid frequency is higher than the frequency level set in this menu.

G373	Fmin Start
Default:	99.0%

Fmax Start [G374]

AFR/AFG start its operation only if grid frequency is lower than the frequency level set in this menu.

G374	Fmax Start
Default:	100.2%

Time Start [G375]

Before being able to start the operation of AFR/AFG, the grid parameters (voltage and frequency) must lie within the range defined in [G371], [G372], [G373] and [G374] for the time period set in this menu. Counter for time start is internally reset if any of the grid parameter goes out of the defined range.

G375	Time Start
Default:	60.0s

NOTE: AFR/AFG overlooks the settings in [G371], [G372], [G373] and [G374] if Off is selected in [G375]

P Start [G376]

This menu specifies the active power ramp when AFR/AFG start its operation. This ramp is only applicable at the start of operation. During normal running this ramp has no effect on active power.

G376	P Start
Default:	0.0%/min

11.11.4 Grid Monitor [G90]

These menus give the state of grid by presenting measured grid voltages, grid frequency etc. These menus are only read-out menus for reflecting the grid status. On power-up, if PLL's could not lock then the values in these menus start blinking in order to indicate the non-locked PLL's.

Phase Voltages [G91]

Amplitude of phase voltages i.e. U1, U2 and U3.

G91	U1	U2	U3
Unit:	V		
Resolution:	1V		

Line Voltages [G92]

Amplitude of line voltages i.e. U12, U23 and U31.

G92	U12	U23	U31
Unit:	V		
Resolution:	1V		

Symmetrical Voltages [G93]

Amplitude of symmetrical voltages i.e. U+, U- and U0.

G93	U+	U-	U0
Unit:	V		
Resolution:	1V		

Grid Frequency [G94]

G94	F
Unit:	Hz
Resolution:	0.01Hz

Rate Of Change Of Frequency [G95]

Shows the rate of change of grid frequency.

G95	dF/dt
Unit:	Hz/s
Resolution:	0.01 Hz/s

Mean Value Of Grid Voltage [G96]

Shows the 10-minute mean value of the grid voltage.

G96	U (10min)
Unit:	V
Resolution:	0.1V

Line currents [G97]

Shows the amplitude of line currents.

G97	I1 I2 I3
Unit:	%
Resolution:	1%

Symmetrical currents [G98]

Shows the amplitude of symmetrical currents.

G98	I+ I- I0
Unit:	%
Resolution:	1%

Displacement angle (phi) [G99]

Shows the angle between voltage and current.

G98	Phi+
Unit:	°
Resolution:	1°

PLL status [G9A]

Shows the status of phase locked loops.

G9A	PLL Status
Resolution:	16-bit Hex-number
Bit wise description:	Internal status bits of the grid monitoring PLLs Bit 0 (LSB): PLL Locked status (1->locked) Bit 1: Reserved for future use. Bit 2: Reserved for future use. Bit 3: Reserved for future use. Bit 5-4: Phase sequence status (1->Pos, 2->Neg) Bit 7-6: Reserved for future use Bit 15-8: Used for FRT status (see FRT spec) *Bit 9-8: UVRT status (1->active, 2-> recovery) *Bit 11-10: OVRT status (1->active, 2-> recovery) *Bit 13-12: AAID status (1->active) *Bit 14: Open-circuit status (1->active) *Bit 15: OFRT status (1->active)

12. Troubleshooting, Diagnoses and Maintenance

12.1 Trips, warnings and limits

In order to protect the AFR/AFG or VSI the principal operating variables are continuously monitored by the system. If one of these variables exceeds the safety limit an error/warning message is displayed. In order to avoid any possibly dangerous situations, the inverter sets itself into a stop Mode called Trip and the cause of the trip is shown in the display.

"Trip"

- The AFR/AFG/VSI stops immediately.
- The Trip relay or output is active (if selected).
- The Trip LED is on.
- The accompanying trip message is displayed.
- The "TRP" status indication is displayed (area D of the display).

Apart from the TRIP indicators there are two more indicators to show that the inverter is in an "abnormal" situation.

"Warning"

- The AFR/AFG/VSI is close to a trip limit.
- The Warning relay or output is active (if selected).
- The Trip LED is flashing.
- The accompanying warning message is displayed in window [722] Warning.
- One of the warning indications is displayed (area F of the display).

"Limits"

- The AFR/AFG/VSI is limiting torque and/or frequency to avoid a trip.
- The Limit relay or output is active (if selected).
- The Trip LED is flashing.
- One of the Limit status indications is displayed (area D of the display).

Table 27 List of trips and warnings

Trip/Warning messages	Selections	Trip (Normal/ Soft)	Warning indicators (Area D)
Ext trip	Via DigIn	Normal/Soft	
Comm error	Trip/Off/Warn	Normal/Soft	
Over temp	On	Normal	OT
Over curr F	On	Normal	
Over volt G	On	Normal	
Over volt	On	Normal	
Under voltage	On	Normal	LV

Table 27 List of trips and warnings

LC Level	Trip/Off/Warn Via DigIn	Normal/Soft	LCL
Desat ### *	On	Normal	
DClink error	On	Normal	
Power Fault	On	Normal	
PF #### *	On	Normal	
Ovolt m cut	On	Normal	
Supply error	On	Normal	
Sup Chk Err	On	Normal	
Sync error	On	Normal	
AutoID error	On	Normal	
Sup F Err	On	Normal	
Sup U Err	On	Normal	
Sensor Err	On	Normal	
GCP 3U>	On/Off	Normal	
GCP 3U>>	On/Off	Normal	
GCP 3U<	On/Off	Normal	
GCP 3U<<	On/Off	Normal	
CGP U+>	On/Off	Normal	
CGP U+<	On/Off	Normal	
CGP U->	On/Off	Normal	
CGP U0>	On/Off	Normal	
CGP Umean>	On/Off	Normal	
CGP Umean<	On/Off	Normal	
GCP U(Q<0)<	On/Off	Normal	
GCP F>	On/Off	Normal	
GCP F>>	On/Off	Normal	
GCP F<	On/Off	Normal	
GCP F<<	On/Off	Normal	
GCP ROCOF	On/Off	Normal	
GC starting	Off/Warn		
High Freq I	On/Off/Warn		
UVRT	On/Off	Normal	
OVRT	On/Off	Normal	
Passive AID	On/Off	Normal	
Active AID	On/Off	Normal	
Resistor Err	On/Off	Normal	
Open CB	On/Off	Normal	
Rect I Error	Off/Warn		
PLL Not Lock	Off/Warn		

* Refer to Table 28 regarding which Desat or Power Fault is triggered.

NOTE: For VSI refer to the Instruction manual for Emotron FDU/VFX.

12.2 Trip conditions, causes and remedial action

The table later on in this section must be seen as a basic aid to find the cause of a system failure and to how to solve any problems that arise. An AC drive is mostly just a small part of a complete AC drive system. Sometimes it is difficult to determine the cause of the failure, although the motor inverter gives a certain trip message it is not always easy to find the right cause of the failure. Good knowledge of the complete drive system is therefore necessary. Contact your supplier if you have any questions.

The AFR/AFG/VSI is designed in such a way that it tries to avoid trips by limiting torque, overvolt etc.

Failures occurring during commissioning or shortly after commissioning are most likely to be caused by incorrect settings or even bad connections.

Failures or problems occurring after a reasonable period of failure-free operation can be caused by changes in the system or in its environment (e.g. wear).

Failures that occur regularly for no obvious reasons are generally caused by Electro-Magnetic Interference. Be sure that the installation fulfils the demands for installation stipulated in the EMC directives. See chapter 8. page 55.

Sometimes the so-called "Trial and error" method is a quicker way to determine the cause of the failure. This can be done at any level, from changing settings and functions to disconnecting single control cables or replacing entire drives.

The Trip Log can be useful for determining whether certain trips occur at certain moments. The Trip Log also records the time of the trip in relation to the run time counter.

WARNING!
If it is necessary to open the AFR/AFG or VSI or any part of the system (motor cable housing, conduits, electrical panels, cabinets, etc.) to inspect or take measure-ments as suggested in this instruction manual, it is absolutely necessary to read and follow the safety instructions in the manual.

12.2.1 Technically qualified personnel

Installation, commissioning, demounting, making measurements, etc., of or at the motor inverter may only be carried out by personnel technically qualified for the task.

12.2.2 Opening the FDUL/VFXR/ FDUG/VFXG

WARNING!
Always switch the mains voltage off if it is necessary to open the AFR/AFG or VSI and wait at least 7 minutes to allow the capacitors to discharge.

WARNING!
In case of malfunctioning always check the DC-link voltage, or wait one hour after the mains voltage has been switched off, before dismantling the AFR/AFG or VSI for repair.

The connections for the control signals and the switches are isolated from the mains voltage. Always take adequate precautions before opening the AFR/AFG or VSI.

12.2.3 Precautions to take with a connected motor

If work must be carried out on a connected motor or on the driven machine, the mains voltage must always first be disconnected from the AFR/AFG and VSI. Wait at least 5 minutes before continuing.

12.2.4 Autoreset Trip

If the maximum number of Trips during Autoreset has been reached, the trip message hour counter is marked with an "A".

Fig. 91 Autoreset trip

Fig. 91 shows the 3rd trip memory menu [830]: Overvoltage G trip after the maximum Autoreset attempts took place after 345 hours, 45 minutes and 12 seconds of run time.

Table 28 Trip condition, their possible causes and remedial action

Trip condition	Possible Cause	Remedy
Ext trip	External input (DigIn 1-8) active: - active low function on the input.	- Check the equipment that initiates the external input - Check the programming of the digital inputs DigIn 1-8
Comm error	Error on serial communication (option)	- Check cables and connection of the serial communication. - Check all settings with regard to the serial communication - Restart the equipment including the VSI
Over temp	Heatsink temperature too high: - Too high ambient temperature of the VSI - Insufficient cooling - Too high current - Blocked or stuffed fans	- Check the cooling of the VSI cabinet. - Check the functionality of the built-in fans. The fans must switch on automatically if the heatsink temperature gets too high. At power up the fans are briefly switched on. - Check VSI and motor rating - Clean fans
Over curr F	Current exceeds the peak VSI current: - Too high load - Excessive load change - Soft short-circuit between phases or phase to earth - Poor or loose cable connections	- Check the main supply voltage. - Check on bad line cable connections - Check on bad earth cable connection - Check on water or moisture in the motor housing and cable connections.
Over volt G(enerator)	Too high DC Link voltage	- Check the main supply voltage - Try to take away the interference cause or use other main supply lines.
Over volt (Mains)	Too high DC Link voltage, due to too high mains voltage	- Check the main supply voltage - Try to take away the interference cause or use other main supply lines.
O(ver) volt M(ains) cut		
Under voltage	Too low DC Link voltage: - Too low or no supply voltage - Mains voltage dip due to starting other major power consuming machines on the same line.	- Make sure all three phases are properly connected and that the terminal screws are tightened. - Check that the DC supply voltage is within the limits of the VSI. - Try to use other mains supply lines if dip is caused by other machinery
Desat	Failure in output stage, desaturation of IGBTs	- Check on bad line cable connections - Check on bad earth cable connections - Check on water and moisture in the cabinett and cable connections
Desat U+ *		
Desat U- *		
Desat V+ *		
Desat V- *		
Desat W+ *		
Desat W- *		
Desat BCC *		
DC link error	DC link voltage ripple exceeds maximum level	- Make sure all three phases are properly connected and that the terminal screws are tightened. - Check that the DC supply voltage is within the limits of the VSI. - Try to use other mains supply lines if dip is caused by other machinery.
Power Fault	One of the PF(Power Fault) trips below has occured, but could not be determined.	- Check the PF errors and try to determine the cause. The trip history can be helpful.
PF Fan Err *	Error in fan module	- Check for clogged air inlet filters in panel door and blocking material in fan module.
PF Curr Err	Error in current balancing: - between different modules. - between two phases within one module.	- Check LCL - filter - Check fuses and line connections
PF Overvolt *	Error in DC - link	- Check LCL - filter. - Check fuses and line connections.
PF Comm Err *	Internal communication error	Contact service

Table 28 Trip condition, their possible causes and remedial action

Trip condition	Possible Cause	Remedy
PF Int Temp *	Internal temperature too high	Check internal fans
PF Temp Err *	Malfunction in temperature sensor	Contact service
Supply error	No synchronisation current pulse detected	- Check mains supply voltage - Check LCL-filter and cables - Check Circuit breaker and main contactor
Sup Chk Err	Actual supply frequency or phase sequence does not correspond to the settings in respective menus [012] and [014].	- Check mains supply voltage - Check LCL-filter and cables - Check Circuit breaker and main contactor - Check wiring of the voltage sensor (if “Sync option” is used) - Re-do supply ID-Run.
Sync Error	Overcurrent during synchronisation to supply	- Check mains supply voltage - Check LCL-filter and cables - Check Circuit breaker and main contactor - Check supply parameters [011]-[014] - Check if DC-link is not already loaded (check if any load drawing current from DC-link).
AutoID Error	Failure during ID run -Supply could not be identified	- Check corresponding Digital Input signal is high if enable signal is set in DigIn setting menu [520].
Sup U Err	Too much deviation in supply voltage.	- Check mains supply voltage - Check wiring of synchronization option board (voltage measurement board) if used. - Check if supply/grid voltage fluctuating too much.
Sup F Err	Too much deviation in supply voltage.	- Check mains supply voltage - Check wiring of synchronization option board (voltage measurement board) if used. - Check if supply/grid voltage fluctuating too much.
Sensor Err	Supply voltage measurement board is not configured/connected properly.	- Check and verify all the required settings for supply voltage measurement board. - Check the wiring connections required for supply voltage measurement board.
GCP 3U>	Monitored grid voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP 3U>>	Monitored grid voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP 3U<	Monitored grid voltage is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP 3U<<	Monitored grid voltage is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.

Table 28 Trip condition, their possible causes and remedial action

Trip condition	Possible Cause	Remedy
GCP U+>	Monitored positive sequence grid voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP U+<	Monitored positive sequence grid voltage is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP U->	Monitored negative sequence grid voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP U0>	Monitored zero sequence grid voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP Umean>	Monitored 10-minute mean voltage is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP Umean<	Monitored 10-minute mean voltage is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP U(Q<0)<	Monitored grid voltage is lower than the corresponding trip level setting plus the AFR/AFG consuming reactive power from the grid/network at the same time.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP F>	Monitored grid frequency is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP F>>	Monitored grid frequency is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP F<	Monitored grid frequency is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
GCP F<<	Monitored grid frequency is lower than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.

Table 28 Trip condition, their possible causes and remedial action

Trip condition	Possible Cause	Remedy
GCP ROCOF	Monitored rate of change of grid frequency is higher than the corresponding trip level setting.	- Check if the trip level settings are realistic. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid. - Check if supply/grid is stable
UVRT	UVRT trip, i.e. trip area (1 or 2) has been reached.	- Check the mains grid supply is within the acceptable operation range of AFR/AFG. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
OVRT	OVRT trip, i.e. trip area (1 or 2) has been reached.	- Check the mains grid supply is within the acceptable operation range of AFR/AFG. - Check the mains supply wiring. - Check the connection wiring of supply voltage measurement board. - Check the drive nominal settings are according to the connected supply/grid.
Passive AID	AID trip from passive detection.	- Check the mains cable connection of AFR/AFG to grid is proper. - Check the mains grid supply is within the acceptable operation range of AFR/AFG.
Active AID	AID trip from active detection.	- Check the mains cable connection of AFR/AFG to grid is proper. - Check the mains grid supply is within the acceptable operation range of AFR/AFG.
Resistor Err	Brake resistor protection trip.	- Contact authorized service team.
Open CB	Open circuit detected.	- An open main circuit breaker, possibly triggered by relay protection on the primary side (medium voltage side) of the plant transformer. Check if the main circuit breaker is opened.
Rect I Error	AFR/AFG cannot be started as the DC-link is already loaded. This protection is active when supply voltage measurement board is not used.	- Check if there is a load connected to the DC-link of AFR/AFG.
PLL Not Lock	AFR/AFG is waiting for the PLL to be locked (PLL not ready yet).	- Check setup (AnIn settings) for SVMB is correct. - Check supply (power) wires are connected properly to SVMB. - Check the supply sequence to AFR/AFG and to SVMB is same. - Wait for the PLL to be locked.
CG Starting	Grid voltage or frequency out of limit.	- Check the grid voltage and frequency. - Check the voltage measurement board is installed correctly. - Check the normalizing voltage in [G316] is set correctly.
High Freq I	High frequencies detected in the current.	- Check the LCL filter. - Check other installations on the grid sharing same transformer

* = 2...6 Module number if parallel power units (size 300–1500 A)

NOTE:
For VSI refer to the Instruction manual for Emotron FDU/VFX.

12.3 Maintenance

The AC drive is designed to require minimum of servicing and maintenance. There are however some things which must be checked regularly in order to optimise product life time.

- Keep the AC drive unit clean and cooling efficient (clean air inlets, heatsink profile, parts, components, etc)
- There is an internal fan that should be inspected and cleaned from dust if necessary.
- If AC drives are built into cabinets, also check and clean the dust filters of the cabinets regularly.
- Check external wiring, connections and control signals.
- Check tightening of all terminal screws regularly, especially important are power and motor cable connections

Preventive maintenance can optimise the product life time and secure trouble free operation without interruptions.

For more information on maintenance, please contact your CG Drives & Automation service partner.

Precautions to take with a connected motor

NOTE:
Refer to motor manufacturers instruction manual for motor maintenance requirements.

If work must be carried out on a connected motor or on the driven machine, the mains voltage must always first be disconnected from the drive unit.

If your drive is connected to a PMSM (Permanent magnet motor) it is most important that you also disconnect the motor before performing any maintenance on the drive unit.

WARNING!
Do not work on a drive when a rotating PMSM- permanent magnet motor is connected to it.
A rotating PMSM motor energizes the drive including its power terminals.

13. Options

13.1 Supply voltage measurement board (SVMB)

Part number	Description
01-5178-00	Supply voltage measurement board ver.1
01-5178-50	Supply voltage measurement board ver.1 with coated board.
01-6681-00	Supply voltage measurement board ver.2
01-6681-50	Supply voltage measurement board ver.2 with coated board.

The Voltage measurement board monitors the grid voltage and provides useful information to the frontend. This option can improve the starting of the active frontend and allows the AFR/VFXR/FDUL to withstand the momentary dips in the supply voltage. The voltage measurement board can also be useful for synchronizing the AFE to the grid during the case when VSI is loaded. Without this board there can be problems in synchronizing to the grid if VSI is heavily loaded.

SVMB ver.2 is mandatory for AFG (grid code) functionality.

13.2 Liquid cooling

AC drive modules in frame sizes E - O and F69 - T69 are available in a liquid cooled version. These units are designed for connection to a liquid cooling system, normally a heat exchanger of liquid-liquid or liquid-air type. Heat exchanger is not part of the liquid cooling option.
Drive units with parallel power modules (frame size G - T69) are delivered with a dividing unit for connection of the cooling liquid. The drive units are equipped with rubber hoses with leak-proof quick couplings.
The Liquid cooling option is described in a separate manual.

13.3 I/O Board

Part number	Description
01-3876-01	I/O option board 2.0

Each I/O option board 2.0 provides three extra relay outputs and three extra isolated digital inputs (24V). The I/O Board works in combination with the Pump/Fan Control, but can also be used as a separate option. Maximum 3 I/O boards possible. This option is described in a separate manual.

13.4 PTC/PT100

Part number	Description
01-3876-08	PTC/PT100 2.0 option board

The PTC/PT100 2.0 option board for connecting motor thermistors and max 3 PT100 elements to the AC drive is described in a separate manual.

13.5 Brake chopper

It is required to use brake resistor with AFR/AFG if AFR/AFG will be used for a limited regeneration. In this case part of the energy goes back to the grid and remaining part of the energy burns across the brake resistor. The brake resistor must be mounted outside the drive. The choice of the resistor depends on the application switch-on duration and duty-cycle. This option can not be after mounted..

WARNING!
The table gives the minimum values of the brake resistors. Do not use resistors lower than this value. The AC drive can trip or even be damaged due to high braking currents.

The following formula can be used to define the power of the connected brake resistor:

$$P_{resistor} = \frac{(\text{Brake level } V_{DC})^2}{R_{min}} \text{ x ED}$$

Where:

$P_{resistor}$ required power of brake resistor

Brake level V_{DC} is the DC brake voltage level (see Table 29)

Rmin minimum allowable brake resistor (see Table 30 and Table 31

ED effective braking period. Defined as:

$$ED = \frac{t_{br}}{120\ [s]}$$

t_{br} Active braking time at nominal braking power during a 2 minute operation cycle.

Maximum value of ED = 1, meaning continuous braking.

Table 29

Supply voltage (V_{AC}) (set in menu [21B]	Brake level (V_{DC})
220–240	380
380–415	660

Table 29

Supply voltage (V_{AC}) (set in menu [21B]	Brake level (V_{DC})
440–480	780
500–525	860
550–600	1000
660–690	1150

NOTE: This instruction manual provides help only if brake resistor is to be mounted on AFR/AFG unit. Please consult standard FDU/VFX instruction manual if brake resistor is to be connected on VSI side of FDUL/VFXR/ FDUG/VFXG.

Table 30 Brake resistor AFR/AFG46 V types

Type	Rmin [ohm] if supply 380–415 V_{AC}	Rmin [ohm] if supply 440–480 V_{AC}
-175	3.8	4.4
-250	2.7	3.1
-375	2 x 3.8	2 x 4.4
-500	2 x 2.7	2 x 3.1
-750	3 x 2.7	3 x 3.1
-1K0	4 x 2.7	4 x 3.1
-1K5	6 x 2.7	6 x 3.1

Table 31 Brake resistor AFR/AFG69 V types

Type	Rmin [ohm] if supply 500–525 V_{AC}	Rmin [ohm] if supply 550–600 V_{AC}	Rmin [ohm] if supply 660–690 V_{AC}
-175	4.9	5.7	6.5
-350	2 x 4.9	2 x 5.7	2 x 6.5
-525	3 x 4.9	3 x 5.7	3 x 6.5
-700	4 x 4.9	4 x 5.7	4 x 6.5
-1K05	6 x 4.9	6 x 5.7	6 x 6.5

NOTE: Although the AC drive will detect a failure in the brake electronics, the use of resistors with a thermal overload which will cut off the power at overload is strongly recommended.

The brake chopper option is built-in by the manufacturer and must be specified when the AC drive is ordered.

13.6 EmoSoftCom

EmoSoftCom is an optional software that runs on a personal computer. It can also be used to load parameter settings from the AC drive to the PC for backup and printing. Recording can be made in oscilloscope mode. Please contact CG Drives & Automation sales for further information.

13.7 Control panel

Control panel with a 4-line display.

Part number		Description
IP54	IP20/21	
01-6520-00	01-6521-00	4-line PPU (standard)
01-6520-10	01-6521-10	4-line PPU with Bluetooth (optional)

Fig. 92 Control panel with 4-line display.

The display is back lit and consists of 4 rows, each with space for 20 characters. The Control panel is equipped with real time clock function. This means that actual date and time will be shown at e.g. a trip condition.
There is also an optional Control panel with Bluetooth communication available for connection with cellphone or tablet.

13.8 External control panel kits (4-line)

13.8.1 Control panel kit, including blank panel

Part number	Description
01-6878-40	Control panel kit (size B)
01-6879-40	Control panel kit (size C)
01-6880-40	Control panel kit (size D and up)

Fig. 93 Control panel kit, including blank panel.

External control panel IP54 suitable for mounting on a cabinet door. This option is to be used in combination with an AC drive module ordered with a built-in control panel.

13.8.2 Control panel kit, including control panel

Part number	Description
01-6878-00	Standard PPU (size B)
01-6878-10	PPU with Bluetooth (size B)
01-6879-00	Standard PPU (size C)
01-6879-10	PPU with Bluetooth (size C)
01-6880-00	Standard PPU (size D and up)
01-6880-10	PPU with Bluetooth (size D and up)

Fig. 94 Control panel kit, including control panel.

External control panel IP54 suitable for mounting on a panel door. This option is to be used in combination with an AC drive module ordered with a blank control panel.

13.9 Communication options

Part number	Description	From CDUCDXCDUCDXF DUVFX software version (see menu [922])
01-3876-05	Profibus DP	4.0
01-3876-06	DeviceNet	4.0
01-3876-09	Modbus/TCP, Industrial Ethernet	4.11
01-3876-10	EtherCAT, Industrial Ethernet	4.32
01-3876-11	Profinet IO, one port Industrial Ethernet	4.32
01-3876-12	Profinet IO, two port Industrial Ethernet	4.32
01-3876-13	EtherNet/IP, two port industrial EtherNet	4.36
01-3876-16	CANopen	4.42

For communication with the AC drive there are several option boards for communication. There are different options for Fieldbus communication and one serial communication option with RS-232 or RS-485 interface which has galvanic isolation.

14. Technical Data

14.1 Electrical and mechanical specifications related to model

14.1.1 Emotron VFXR/FDUL

Table 32 VFXR/FDUL typical motor power at mains voltage 400 V and 460 V (refer also to the instruction manual for Emotron VFX/FDU)

VFXR/FDUL Model	Max output current Imax [A]*	Normal duty 120%, 1 min every 10 min			Heavy duty 150%, 1 min every 10 min			Frame	Dimensions Height=2,250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)	Weight kg (lbs)	AFR model
		Rated current Inom [A]	Power @400 V [kW]	Power @460 V [HP]	Rated current Inom [A]	Power @400 V [kW]	Power @460 V [HP]				
46-109	131	109	55	75	87	45	60	E46+E=G	800 (31.5)	380 (836)	AFR46-175
46-146	175	146	75	100	117	55	75	E46+E=G	800 (31.5)	400 (880)	AFR46-175
46-175	210	175	90	125	140	75	100	E46+E=G	900 (35.4)	480 (1056)	AFR46-175
46-210	252	210	110	150	168	90	125	F46+F=H	900 (35.4)	500 (1100)	AFR46-250
46-250	300	250	132	200	200	110	150	F46+F=H	900 (35.4)	500 (1100)	AFR46-250
46-300	360	300	160	250	240	132	200	F46+H=I	1300 (51.2)	700 (1540)	AFR46-250
46-375	450	375	200	300	300	160	250	G46 +G	1500 (59.1)	750 (1650)	AFR46-375
46-430	516	430	220	350	344	200	250	G46+H	1500 (59.1)	830 (1826)	AFR46-375
46-500	600	500	250	400	400	220	350	H46+H	1500 (59.1)	880 (1936)	AFR46-500
46-600	720	600	315	500	480	250	400	H46+I	1900 (74.8)	1040 (2288)	AFR46-500
46-650	780	650	355	550	520	315	400	I46+I	2200 (86.6)	1210 (2662)	AFR46-750
46-750	900	750	400	600	600	355	500	I46+I	2200 (86.6)	1210 (2662)	AFR46-750
46-860	1032	860	450	700	688	400	550	I46+J	2500 (98.4)	1370 (3014)	AFR46-750
46-1K0	1200	1000	560	800	800	450	650	J46+J	3000 (118.1)	1600 (3527)	AFR46-1K0
46-1K2	1440	1200	630	900	960	500	750	J46+KA	3300 (129.9)	1700 (3748)	AFR46-1K0
46-1K5	1800	1500	800	1250	1200	630	1000	K46+K	4500 (177.2)	2250 (4960)	AFR46-1K5
46-1K75	2100	1750	900	1500	1400	800	1200	K46+L	On request		AFR46-1K5

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

Table 33 VFXR/FDUL typical motor power at mains voltage 575 V and 690 V

VFXR/ FDUL Model	Max output current Imax [A]*	Normal duty 120%, 1 min every 10 min			Heavy duty 150%, 1 min every 10 min			Frame	Dimensions Height=2,250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)	Weight kg (lbs)	AFR model
		Rated current Inom [A]	Power @690 V [kW]	Power @575 V [HP]	Rated current Inom [A]	Power @690 V [kW]	Power @575 V [HP]				
69-109	131	109	110	100	87	90	75	F69+F69=H69	800 (31.5)	410 (902)	AFR69-175
69-146	175	146	132	125	117	110	100	F69+F69=H69	800 (31.5)	430 (946)	AFR69-175
69-185	222	185	160	150	148	132	125	F69+F69=H69	900 (35.4)	540 (1188)	AFR69-175
69-250	300	250	250	250	200	200	200	H69+H69	1,800 (70.9)	870 (1914)	AFR69-350
69-300	360	300	315	300	240	250	250	H69+H69	1,800 (70.9)	870 (1914)	AFR69-350
69-375	450	375	355	350	300	315	300	H69+H69	1,800 (70.9)	910 (2002)	AFR69-350
69-430	516	430	450	400	344	355	350	I69+I69	2,800 (110.2)	1350 (2970)	AFR69-525
69-560	672	560	560	600	448	450	400	I69+I69	2,800 (110.2)	1390 (3058)	AFR69-525
69-749	900	750	710	750	600	600	600	J69+J69	On request		AFR69-700
69-995	1200	1000	1000	1000	800	800	850	K69+KA69	On request		AFR69-1K05
69-1K12	1344	1120	1100	1200	896	900	950	K69+K69	On request		AFR69-1K05

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

14.1.2 Emotron VFXG/FDUG

Contact Emotron sales for further information.

14.1.3 Emotron AFR

Table 34 AFR46 Typical output DC power at mains voltage 400 V and 460V.

Model	Max input current Imax [A]*	Normal duty 120%, 1 min every 10 min			Frame	Dimensions Height=2,250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)	Weight kg (lbs)
		Rated input current Inom [A]	Output DC power @400 V AC [kW]	Output DC power @460 V AC [HP]			
AFR46-175	210	175	115	177	E46	600 (23.6)	290 (638)
AFR46-250	300	250	165	254	F46	800 (31.5)	400 (880)
AFR46-375	450	375	250	385	G46	1000 (39.4)	560 (1232)
AFR46-500	600	500	330	508	H46	1200 (47.2)	660 (1452)
AFR46-750	900	750	500	770	I46	1500 (59.1)	830 (1826)
AFR46-1K0	1200	1000	660	1017	J46	1800 (70.9)	1100 (2425)
AFR46-1K5	1800	1500	1000	1541	K46	2700 (106.3)	1600 (3527)

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

Table 35 AFR69 typical output DC power at mains voltage 575 V and 690 V.

Model	Max input current Imax [A]*	Normal duty 120%, 1 min every 10 min			Frame	Dimensions Height=2,250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)	Weight kg (lbs)
		Rated input current Inom [A]	Output DC power @690 V AC [kW]	Output DC power @575 V AC [HP]			
AFR69-175	210	175	200	223	F69	800 (31.5)	320 (704)
AFR69-350	420	350	400	446	H69	1,200 (47.2)	590 (1298)
AFR69-525	630	525	600	670	I69	1,700 (66.9)	860 (1892)
AFR69-700	840	700	800	893	J69	On request	
AFR69-1K05	1260	1050	1200	1340	K69	On request	

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

14.1.4 Emotron AFG

Table 36 AFG46 Typical output DC power at mains voltage 400V.

Model	Max input current Imax [A]* @400 V AC	Normal duty 120%, 1 min every 10 min		Frame (IP20 stacked)	Dimensions Height=2.250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)
		Rated input current Inom [A] @400 V AC	Output power @400 V AC @ 0.9 DPF [kW]**		
AFG46-109	131	109	68	E (single)	600 (23.6)
AFG46-175	210	175	110	E (single)	600 (23.6)
AFG46-250	300	250	156	F (single)	600 (23.6)
AFG46-350	420	350	220	G	800 (31.5)
AFG46-500	600	500	312	H	1000 (39.4)
AFG46-750	900	750	468	I	1200 (47.2)
AFG46-1K0	1200	1000	624	J	1800 (70.9)
AFG46-1K5	1800	1500	936	K	2400 (94.5)

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

**) Power given is at 0.9 displacement power factor. At unity power displacement factor, higher output power can be achieved accordingly.

**) For 460V AC supply, same output power available with reduced current capability.

Table 37 AFG69 Typical output power at mains voltage 690 V.

Model	Max input current Imax [A]* @690 V AC	Normal duty 120%, 1 min every 10 min		Frame (IP20 stacked)	Dimensions Height=2,250 mm (88.6 in) Depth=600 mm (23.6 in) Width mm (inches)
		Rated input current Inom [A] @690 V AC	Output power @690 V AC [kW] **		
AFG69-146	175	146	156	F69 (single)	600 (23.6)
AFG69-292	350	292	312	H69	1000 (39.4)
AFG69-438	525	438	468	I69	1200 (47.2)
AFG69-584	700	584	624	J69	1800 (70.9)
AFG69-876	1050	876	936	K69	2400 (94.5)

Assembled in IP54 cabinet including main switch + main contactor or motorized circuit breaker.

*) Available for a limited time and as long as drive temperature permits.

**) Power given is at 0.9 displacement power factor. At unity power displacement factor, higher output power can be achieved accordingly.

14.2 General electrical specifications

Table 38 General electrical specifications

General	
Mains voltage: VFXR46/FDUL46/VFXG46/FDUG46/AFR46/AFG46 VFXR69/FDUL69/VFXG69/FDUG69/AFR69/AFG69	380 - 460 V +10%/-15% 480 - 690 V +10%/-15%
Mains frequency:	48 to 52Hz and 58 to 62Hz
Input total power factor:	1.0
Output voltage VFXR/FDUL46, VFXG/FDUG46 and VFXR/FDUL69, VFXG/FDUG69	(0 - 1.2) * Mains supply voltage (V AC)
Output voltage AFR46/AFR69 and AFG46/AFG69	(1.0 - 1.2) * $\sqrt{2}$ * Mains supply voltage (V DC)
Switching frequency: VFXR/FDUL46, VFXG/FDUG46 and VFXR/FDUL69, VFXG/FDUG69	3 kHz (adjustable 1.5 - 6 kHz, FDUL only)
AFR46/AFR69	3 kHz
AFG46/AFG69	3150 *Main frequency/50
Efficiency at nominal load VFXR/FDUL46, VFXG/FDUG46 and VFXR/FDUL69, VFXG/FDUG69	97%
AFR46/AFR69 and AFG46/AFG69	98%
Harmonics to supply, THDI	< 5%
Control signal inputs: Analogue (differential)	
Analogue Voltage/current:	0-±10 V/0-20 mA via switch
Max. input voltage:	+30 V/30 mA
Input impedance:	20 kΩ (voltage) 250 Ω (current)
Resolution:	11 bits + sign
Hardware accuracy:	1% type + 1½ LSB fsd
Non-linearity	1½ LSB
Digital:	
Input voltage:	High: >9 V DC, Low: <4 V DC
Max. input voltage:	+30 V DC
Input impedance:	<3.3 V_{DC}: 4.7 kΩ ≥3.3 V_{DC}: 3.6 kΩ
Signal delay:	≤8 ms
Control signal outputs Analogue	
Output voltage/current:	0-10 V/0-20 mA via software setting
Max. output voltage:	+15 V @5 mA cont.
Short-circuit current (∞):	+15 mA (voltage), +140 mA (current)
Output impedance:	10 Ω (voltage)
Resolution:	10 bit
Maximum load impedance for current	500 Ω
Hardware accuracy:	1.9% type fsd (voltage), 2.4% type fsd (current)
Offset:	3 LSB
Non-linearity:	2 LSB
Digital	
Output voltage:	High: >20 V DC @50 mA, >23 V DC open Low: <1 V DC @50 mA
Shortcircuit current(∞):	100 mA max (together with +24 V DC)
Relays	
Contacts	0.1 – 2 A/U_{max} 250 VAC or 42 V_{DC}
RS-485 communication	
Differential voltage:	-7 V to 12 V
References	
+10 V DC -10 V DC +24 V DC	+10 V DC @10 mA Short-circuit current +30 mA max -10 V DC @10 mA +24 V DC Short-circuit current +100 mA max (together with Digital Outputs)

14.3 Operation at higher temperatures

All Emotron AFE units are made for operation at maximum of 40 °C (104 °F) ambient temperature. However it is possible to use the AFE units at higher temperatures with some loss in performance, using derating.
Derating of output current with - 2,5% per degree Celsius to max +5 °C or -1,39% per degree Fahrenheit to max 9 °F.
Max temp = 45 °C (113 °F).

14.4 Environmental conditions

Table 39 Operation

Parameter	Normal operation
Nominal ambient temperature	0°C–40°C (32 °F - 104 °F) See Chapter 14.3, for different conditions
Atmospheric pressure	86–106 kPa (12.5 - 15.4 PSI)
Relative humidity, non-condensing	0–90%
Contamination, according to IEC 60721-3-3	No electrically conductive dust allowed. Cooling air must be clean and free from corrosive materials. Chemical gases, class 3C2 (Coated boards 3C3). Solid particles, class 3S2.
Vibrations	According to IEC 60068-2-6, Sinusodial vibrations: 10<f<57 Hz, 0.075 mm (0.00295 ft) 57<f<150 Hz, 1g (0.035 oz)
Altitude	0–1,000 m (0 - 3280 ft) 460 V AFE units, with derating 1%/100 m (328 ft) of rated current up to 4,000 m (13123 ft). 690 V AFE units, with derating 1%/100 m (328 ft) of rated current up to 2,000 m (6562 ft). Coated boards required for 2000 - 4000 m (6562 - 23123 ft)

Table 40 Storage

Parameter	Storage condition
Temperature	-20 to +60 °C (-4 to +140 °F)
Atmospheric pressure	86–106 kPa (12.5 - 15.4 PSI)
Relative humidity according to IEC 60721-3-1	Class 1K4, max. 95% and non condensing and no formation of ice.

14.5 Control signals

Table 41

Terminal X1	Name:	Function (Default):	Signal:	Type:
1	+10 V	+10 VDC Supply voltage	+10 V DC, max 10 mA	output
2	AnIn1	Process reference	0 -10 V DC or 0/4–20 mA bipolar: -10 - +10 V DC or -20 - +20 mA	analogue input
3	AnIn2	AFR: Off AFG: U(L1)	0 -10 V DC or 0/4–20 mA bipolar: -10 - +10 V DC or -20 - +20 mA	analogue input
4	AnIn3	AFR: Off AFG: U(L2)	0 -10 V DC or 0/4–20 mA bipolar: -10 - +10 V DC or -20 - +20 mA	analogue input
5	AnIn4	AFR: Off AFG: U(L3)	0 -10V DC or 0/4–20 mA bipolar: -10 - +10 V DC or -20 - +20 mA	analogue input
6	-10 V	-10VDC Supply voltage	-10 V DC, max 10 mA	output
7	Common	Signal ground	0V	output
8	DigIn 1	RunL (Fixed)	0-8/24 V DC	digital input
9	DigIn 2	RunR (Fixed)	0-8/24 V DC	digital input
10	DigIn 3	Enable	0-8/24 V DC	digital input
11	+24 V	+24VDC Supply voltage	+24 V DC, 100 mA	output
12	Common	Signal ground	0 V	output
13	AnOut 1		0 ±10 V DC or 0/4– +20 mA	analogue output
14	AnOut 2	0 to max torque	0 ±10 V DC or 0/4– +20 mA	analogue output
15	Common	Signal ground	0 V	output
16	DigIn 4	Off	0-8/24 V DC	digital input
17	DigIn 5	Off	0-8/24 V DC	digital input
18	DigIn 6	Off	0-8/24 V DC	digital input
19	DigIn 7	Off	0-8/24 V DC	digital input
20	DigOut 1	LY, Active when AFE is not running or Dc-link voltage has not reached reference value.	24 V_{DC}, 100 mA	digital output
21	DigOut 2	LZ (trip pulse of 1s)	24 V_{DC}, 100 mA	digital output
22	DigIn 8	RESET	0-8/24 VDC	digital input
A+		RS-485 transmit and receive signals	Isolated differential signals -7V to 12V	Communication
B-				
Terminal X2				
31	N/C 1	Relay 1 output Dedicated for Charge Relay contactor K2.	potential free change over 0.1 – 2 A/U_{max} 250 V AC or 42 V DC	relay output
32	COM 1			
33	N/O 1			
41	N/C 2	Relay 2 Output LY, Active when AFE is not running or Dc-link voltage has not reached reference value.	potential free change over 0.1 – 2 A/U_{max} 250 V AC or 42 V DC	relay output
42	COM 2			
43	N/O 2			
Terminal X3				
51	COM 3	Relay 3 Output, Dedicated for Main Contactor K1	potential free change over 0.1 – 2 A/U_{max} 250 V AC or 42 V DC	relay output
52	N/O 3			

Table 41

Terminal X11			
+	24 VDC±10%	Input from 24 VDC ±10% double isolated transformer capable of supplying 1A continues current. Recommended fuse is 2A.	Input
-	0 V in		

15. Menu List

In the download area on our website, www.cgglobal.com or www.emotron.com, you find a communication information list and a list for noting parameter set information.

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
100	Start Window [100]								
110	1st Line	Current	43001	168/160	4BB9	19385	UInt	UInt	
120	2nd Line	El Power	43002	168/161	4BBA	19386	UInt	UInt	
130	3rd Line	Frequency	43003	168/162	4BBB	19387	UInt	UInt	
140	4th Line	AFR Status	43004	168/163	4BBC	19388	UInt	UInt	
150	5th Line	DC Voltage	43005	168/164	4BBD	19389	UInt	UInt	
160	6th Line	Output volt	43006	168/165	4BBE	19390	UInt	UInt	
170	View mode	Always 100+	43007	168/166	4BBF	19391	UInt	UInt	
200	Main Setup								
210	Operation								
211	Language	English	43011	168/170	4BC3	19395	UInt	UInt	
214	Ref control	Keyboard	43014	168/173	4BC6	19398	UInt	UInt	
215	Run/Stp Ctrl	Keyboard	43015	168/174	4BC7	19399	UInt	UInt	
216	Reset Ctrl	Remote+Keyb	43016	168/175	4BC8	19400	UInt	UInt	
217	Local/Rem								
2171	LocRefCtrl	Standard	43009	168/168	4BC1	19393	UInt	UInt	
2172	LocRunCtrl	Standard	43010	168/169	4BC2	19394	UInt	UInt	
218	Lock code?	0	43018	168/177	4BCA	19402	UInt, 1=1	UInt	
21A	Level/Edge	Level	43020	168/179	4BCC	19404	UInt	UInt	
21B	Supply Volts	Not Defined	43381	170/30	4D35	19765	UInt	UInt	
240	Set Handling								
241	Select Set	A	43022	168/181	4BCE	19406	UInt	UInt	
243	Default>Set	A	43023	168/182	4BCF	19407	UInt	UInt	
244	Copy to CP	No Copy	43024	168/183	4BD0	19408	UInt	UInt	
245	Load from CP	No Copy	43025	168/184	4BD1	19409	UInt	UInt	
250	Autoreset								
251	No of Trips	0	43071	168/230	4BFF	19455	UInt, 1=1	UInt	
252	DriveProtect								
2521	Over temp	Off	43072	168/231	4C00	19456	Long, 1=1s	EInt	
2522	Over volt D	Off	43075	168/234	4C03	19459	Long, 1=1s	EInt	
2523	Over volt G	Off	43076	168/235	4C04	19460	Long, 1=1s	EInt	
2524	Over volt	Off	43077	168/236	4C05	19461	Long, 1=1s	EInt	
2525	Under volt	Off	43088	168/247	4C10	19472	Long, 1=1s	EInt	
2526	Over curr F	Off	43082	168/241	4C0A	19466	Long, 1=1s	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
2527	Power Fault	Off	43087	168/246	4C0F	19471	Long, 1=1s	EInt	
2528	LC Level	Off	43099	169/3	4C1B	19483	Long, 1=1s	EInt	
253	MotorProtect								
2535	PT100	Off	43078	168/237	4C06	19462	Long, 1=1s	EInt	
2537	PTC	Off	43084	168/243	4C0C	19468	Long, 1=1s	EInt	
253A	Ext MotTemp	Off	43097	169/1	4C19	19481	Long, 1=1s	EInt	
254	Comm & I/O								
2541	Com Error	Off	43089	168/248	4C11	19473	Long, 1=1s	EInt	
2543	AnIn<Offset	Off	43566	170/215	4DEE	19950	Long, 1=1s	EInt	
258	External								
2581	Ext Trip 1	Off	43080	168/239	4C08	19464	Long, 1=1s	EInt	
2583	Ext Trip 2	Off	43564	170/213	4DEC	19948	Long, 1=1s	EInt	
260	Serial Com								
261	Com Type	RS232/485	43031	168/190	4BD7	19415	UInt	UInt	
262	RS232/485								
2621	Baudrate	9600	43032	168/191	4BD8	19416	UInt	UInt	
2622	Address	1	43033	168/192	4BD9	19417	UInt, 1=1	UInt	
263	Fieldbus								
2631	Address	62	43034	168/193	4BDA	19418	UInt, 1=1	UInt	
2632	PrData Mode	Basic	43035	168/194	4BDB	19419	UInt	UInt	
2633	Read/Write	RW	43036	168/195	4BDC	19420	UInt	UInt	
2634	AddPrValues	0	43039	168/198	4BDF	19423	UInt, 1=1	UInt	
2635	CANBaudrate	8	43030	168/189	4BD6	19414	UInt, 1=1	UInt	
264	Com Fault								
2641	ComFlt Mode	Off	43037	168/196	4BDD	19421	UInt	UInt	
2642	ComFlt Time	0,5s	43038	168/197	4BDE	19422	Long, 1=0.1s	EInt	
2643	485Flt Mode	Off	42979	168/138	4BA3	19363	UInt	UInt	
2644	485Flt Time	0,5s	42980	168/139	4BA4	19364	Long, 1=0.1s	EInt	
2645	KbdComFMode	Trip	42981	168/140	4BA5	19365	UInt	UInt	
2646	KbdComFTime	2s	42982	168/141	4BA6	19366	UInt, 1=0.1s	UInt	
2647	CPportFMode	Trip	42983	168/142	4BA7	19367	UInt	UInt	
2648	CPportFTime	10.0s	42984	168/143	4BA8	19368	UInt, 1=0.1s	UInt	
265	Ethernet [265]								
2651	IP Address	0.0.0.0	42701	167/115	4A8D	19085	UInt, 1=1	UInt	
			42702	167/116	4A8E	19086	UInt, 1=1	UInt	
			42703	167/117	4A8F	19087	UInt, 1=1	UInt	
			42704	167/118	4A90	19088	UInt, 1=1	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
2652	MAC Address	000000000000	42705	167/119	4A91	19089	UInt, 1=1	UInt	
			42706	167/120	4A92	19090	UInt, 1=1	UInt	
			42707	167/121	4A93	19091	UInt, 1=1	UInt	
			42708	167/122	4A94	19092	UInt, 1=1	UInt	
			42709	167/123	4A95	19093	UInt, 1=1	UInt	
			42710	167/124	4A96	19094	UInt, 1=1	UInt	
2653	Subnet Mask	0.0.0.0	42711	167/125	4A97	19095	UInt, 1=1	UInt	
			42712	167/126	4A98	19096	UInt, 1=1	UInt	
			42713	167/127	4A99	19097	UInt, 1=1	UInt	
			42714	167/128	4A9A	19098	UInt, 1=1	UInt	
2654	Gateway	0.0.0.0	42715	167/129	4A9B	19099	UInt, 1=1	UInt	
			42716	167/130	4A9C	19100	UInt, 1=1	UInt	
			42717	167/131	4A9D	19101	UInt, 1=1	UInt	
			42718	167/132	4A9E	19102	UInt, 1=1	UInt	
2655	DHCP	Off	42719	167/133	4A9F	19103	UInt	UInt	
266	FB Signal								
2661	FB Signal 1/ Wr1	0	42801	167/215	4AF1	19185	UInt, 1=1	UInt	
2662	FB Signal 2/ Wr2	0	42802	167/216	4AF2	19186	UInt, 1=1	UInt	
2663	FB Signal 3/ Wr3	0	42803	167/217	4AF3	19187	UInt, 1=1	UInt	
2664	FB Signal 4/ Wr4	0	42804	167/218	4AF4	19188	UInt, 1=1	UInt	
2665	FB Signal 5/ Wr5	0	42805	167/219	4AF5	19189	UInt, 1=1	UInt	
2666	FB Signal 6/ Wr6	0	42806	167/220	4AF6	19190	UInt, 1=1	UInt	
2667	FB Signal 7/ Wr7	0	42807	167/221	4AF7	19191	UInt, 1=1	UInt	
2668	FB Signal 8/ Wr8	0	42808	167/222	4AF8	19192	UInt, 1=1	UInt	
2669	FB Signal 9/ Rd1	0	42809	167/223	4AF9	19193	UInt, 1=1	UInt	
266A	FB Signal10/ Rd2	0	42810	167/224	4AFA	19194	UInt, 1=1	UInt	
266B	FB Signal11/ Rd3	0	42811	167/225	4AFB	19195	UInt, 1=1	UInt	
266C	FB Signal12/ Rd4	0	42812	167/226	4AFC	19196	UInt, 1=1	UInt	
266D	FB Signal13/ Rd5	0	42813	167/227	4AFD	19197	UInt, 1=1	UInt	
266E	FB Signal14/ Rd6	0	42814	167/228	4AFE	19198	UInt, 1=1	UInt	
266F	FB Signal15/ Rd7	0	42815	167/229	4AFF	19199	UInt, 1=1	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
266G	FB Signal16/ Rd8	0	42816	167/230	4B00	19200	UInt, 1=1	UInt	
269	FB Status								
270	Wireless								
271	WirelessMode	Off	40200	157/164	40C8	16584	UInt	UInt	
272	WiFi Options								
2721	WiFi Mode	AccessPoint	40201	157/165	40C9	16585	UInt	UInt	
2722	Channel	5	40202	157/166	40CA	16586	UInt, 1=1	UInt	
2723	Encryption	WPA-2	40203	157/167	40CB	16587	UInt	UInt	
2724	DHCP	Static	40204	157/168	40CC	16588	UInt	UInt	
2725	SSID	Emotron_<5 random digits>	40215	157/179	40D7	16699	UInt	UInt	
2726	Password	12345678	40235	157/199	40EB	16619	UInt	UInt	
2727	IP Address	192.168.1.1	40255	157/219	40FF	16639	UInt, 1=1	UInt	
			40256	157/220	4100	16640	UInt, 1=1	UInt	
			40257	157/221	4101	16641	UInt, 1=1	UInt	
			40258	157/222	4102	16642	UInt, 1=1	UInt	
2728	Subnet Mask	255.255.255.0	40259	157/223	4103	16643	UInt, 1=1	UInt	
			40260	157/224	4104	16644	UInt, 1=1	UInt	
			40261	157/225	4105	16645	UInt, 1=1	UInt	
			40262	157/226	4106	16646	UInt, 1=1	UInt	
272A	WiFi Status	OK	30054	117/218	2036	54	UInt	UInt	
273	BLE options								
2731	BluetoothID	0	42620	167/34	4A3C	19004	UInt, 1=1	UInt	
2732	Paring Key	123456	40267	157/231	410B	16651	UInt, 1=1	UInt	
274	Security								
2741	Sec. Mode	Open	40273	157/237	4111	16657	UInt	UInt	
2742	Password	Empty string	40274	157/238	4112	16658	UInt	UInt	
300	Process								
310	Q Ref	0%	42991	168/150	4BAF	19375	Long, 1=0.001	EInt	
360	Preset Ref								
361	Motor Pot	Non volatile	43131	169/35	4C3B	19515	UInt	UInt	
362	Preset Ref 1	0%	43132	169/36	4C3C	19516	Long, 1=0.001	EInt	
363	Preset Ref 2	250	43133	169/37	4C3D	19517	Long, 1=0.001	EInt	
364	Preset Ref 3	500	43134	169/38	4C3E	19518	Long, 1=0.001	EInt	
365	Preset Ref 4	750	43135	169/39	4C3F	19519	Long, 1=0.001	EInt	
366	Preset Ref 5	1000	43136	169/40	4C40	19520	Long, 1=0.001	EInt	
367	Preset Ref 6	1250	43137	169/41	4C41	19521	Long, 1=0.001	EInt	
368	Preset Ref 7	1500	43138	169/42	4C42	19522	Long, 1=0.001	EInt	
369	Key Ref Mode	MotPot	43139	169/43	4C43	19523	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
400	Monitor/Prot								
430	Trip Text								
431	ExtTrip1Text	0	42313	165/237	4909	18697	UInt	UInt	
432	ExtTrip2Text	0	42321	165/245	4911	18705	UInt	UInt	
500	I/Os								
510	An Inputs								
511	AnIn1 Fc	Process Ref	43201	169/105	4C81	19585	UInt	UInt	
512	AnIn1 Setup	User Bipol V	43202	169/106	4C82	19586	UInt	UInt	
513	AnIn1 Advan								
5131	AnIn1 Min	4.00mA	43203	169/107	4C83	19587	Long, 1=0.01	EInt	
5132	AnIn1 Max	20.00mA	43204	169/108	4C84	19588	Long, 1=0.01	EInt	
5133	AnIn1 Bipol	20.00mA	43205	169/109	4C85	19589	Long, 1=0.01	EInt	
5134	AnIn1 FcMin	Min	43206	169/110	4C86	19590	UInt	UInt	
5135	AnIn1 VaMin	0.000	43541	170/190	4DD5	19925	Long, 1=0.001	EInt	
5136	AnIn1 FcMax	Max	43207	169/111	4C87	19591	UInt	UInt	
5137	AnIn1 VaMax	0.000	43551	170/200	4DDF	19935	Long, 1=0.001	EInt	
5138	AnIn1 Oper	Add +	43208	169/112	4C88	19592	UInt	UInt	
5139	AnIn1 Filt	0.001s	43209	169/113	4C89	19593	Long, 1=0.001s	EInt	
513A	AnIn1 Enabl	On	43210	169/114	4C8A	19594	UInt	UInt	
514	AnIn2 Fc	AFR: Off AFG: U(L1)	43211	169/115	4C8B	19595	UInt	UInt	
515	AnIn2 Setup	User Bipol V	43212	169/116	4C8C	19596	UInt	UInt	
516	AnIn2 Advan								
5161	AnIn2 Min	4.00mA	43213	169/117	4C8D	19597	Long, 1=0.01	EInt	
5162	AnIn2 Max	20.00mA	43214	169/118	4C8E	19598	Long, 1=0.01	EInt	
5163	AnIn2 Bipol	20.00mA	43215	169/119	4C8F	19599	Long, 1=0.01	EInt	
5164	AnIn2 FcMin	Min	43216	169/120	4C90	19600	UInt	UInt	
5165	AnIn2 VaMin	0.000	43542	170/191	4DD6	19926	Long, 1=0.001	EInt	
5166	AnIn2 FcMax	Max	43217	169/121	4C91	19601	UInt	UInt	
5167	AnIn2 VaMax	0	43552	170/201	4DE0	19936	Long, 1=0.001	EInt	
5168	AnIn2 Oper	Add +	43218	169/122	4C92	19602	UInt	UInt	
5169	AnIn2 Filt	0.001s	43219	169/123	4C93	19603	Long, 1=0.001s	EInt	
516A	AnIn2 Enabl	On	43220	169/124	4C94	19604	UInt	UInt	
517	AnIn3 Fc	AFR: Off AFG: U(L2)	43221	169/125	4C95	19605	UInt	UInt	
518	AnIn3 Setup	User Bipol V	43222	169/126	4C96	19606	UInt	UInt	
519	AnIn3 Advan								
5191	AnIn3 Min	4.00mA	43223	169/127	4C97	19607	Long, 1=0.01	EInt	
5192	AnIn3 Max	20.00mA	43224	169/128	4C98	19608	Long, 1=0.01	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
5193	AnIn3 Bipol	20.00mA	43225	169/129	4C99	19609	Long, 1=0.01	EInt	
5194	AnIn3 FcMin	Min	43226	169/130	4C9A	19610	UInt	UInt	
5195	AnIn3 VaMin	0	43543	170/192	4DD7	19927	Long, 1=0.001	EInt	
5196	AnIn3 FcMax	Max	43227	169/131	4C9B	19611	UInt	UInt	
5197	AnIn3 VaMax	0	43553	170/202	4DE1	19937	Long, 1=0.001	EInt	
5198	AnIn3 Oper	Add +	43228	169/132	4C9C	19612	UInt	UInt	
5199	AnIn3 Filt	0.001s	43229	169/133	4C9D	19613	Long, 1=0.001s	EInt	
519A	AnIn3 Enabl	On	43230	169/134	4C9E	19614	UInt	UInt	
51A	AnIn4 Fc	AFR: Off AFG: U(L3)	43231	169/135	4C9F	19615	UInt	UInt	
51B	AnIn4 Setup	User Bipol V	43232	169/136	4CA0	19616	UInt	UInt	
51C	AnIn4 Advan								
51C1	AnIn4 Min	4.00mA	43233	169/137	4CA1	19617	Long, 1=0.01	EInt	
51C2	AnIn4 Max	20.00mA	43234	169/138	4CA2	19618	Long, 1=0.01	EInt	
51C3	AnIn4 Bipol	20.00mA	43235	169/139	4CA3	19619	Long, 1=0.01	EInt	
51C4	AnIn4 FcMin	Min	43236	169/140	4CA4	19620	UInt	UInt	
51C5	AnIn4 VaMin	0	43544	170/193	4DD8	19928	Long, 1=0.001	EInt	
51C6	AnIn4 FcMax	Max	43237	169/141	4CA5	19621	UInt	UInt	
51C7	AnIn4 VaMax	0	43554	170/203	4DE2	19938	Long, 1=0.001	EInt	
51C8	AnIn4 Oper	Add +	43238	169/142	4CA6	19622	UInt	UInt	
51C9	AnIn4 Filt	0.001s	43239	169/143	4CA7	19623	Long, 1=0.001s	EInt	
51CA	AnIn4 Enabl	On	43240	169/144	4CA8	19624	UInt	UInt	
51D	AI Flt Mode	Off	42859	168/18	4B2B	19243	UInt	UInt	
520	Digital Inputs								
521	DigIn 1	RunL	43241	169/145	4CA9	19625	UInt	UInt	
522	DigIn 2	RunR	43242	169/146	4CAA	19626	UInt	UInt	
523	DigIn 3	Enable	43243	169/147	4CAB	19627	UInt	UInt	
524	DigIn 4	Off	43244	169/148	4CAC	19628	UInt	UInt	
525	DigIn 5	Off	43245	169/149	4CAD	19629	UInt	UInt	
526	DigIn 6	Off	43246	169/150	4CAE	19630	UInt	UInt	
527	DigIn 7	Off	43247	169/151	4CAF	19631	UInt	UInt	
528	DigIn 8	Reset	43248	169/152	4CB0	19632	UInt	UInt	
529	B1 DigIn 1	Off	43501	170/150	4DAD	19885	UInt	UInt	
52A	B1 DigIn 2	Off	43502	170/151	4DAE	19886	UInt	UInt	
52B	B1 DigIn 3	Off	43503	170/152	4DAF	19887	UInt	UInt	
52C	B2 DigIn 1	Off	43504	170/153	4DB0	19888	UInt	UInt	
52D	B2 DigIn 2	Off	43505	170/154	4DB1	19889	UInt	UInt	
52E	B2 DigIn 3	Off	43506	170/155	4DB2	19890	UInt	UInt	
52F	B3 DigIn 1	Off	43507	170/156	4DB3	19891	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
52G	B3 DigIn 2	Off	43508	170/157	4DB4	19892	UInt	UInt	
52H	B3 DigIn 3	Off	43509	170/158	4DB5	19893	UInt	UInt	
530	Analogue Outputs								
531	AnOut1 Fc	Current	43251	169/155	4CB3	19635	UInt	UInt	
532	AnOut1 Setup	4-20mA	43252	169/156	4CB4	19636	UInt	UInt	
533	AnOut 1 Advan								
5331	AnOut 1 Min	4mA	43253	169/157	4CB5	19637	Long, 1=0.01	EInt	
5332	AnOut 1 Max	20.00mA	43254	169/158	4CB6	19638	Long, 1=0.01	EInt	
5333	AnOut1Bipol	20.00mA	43255	169/159	4CB7	19639	Long, 1=0.01	EInt	
5334	AnOut1FCMin	Min	43256	169/160	4CB8	19640	UInt	UInt	
5335	AnOut1VaMin	0.000	43545	170/194	4DD9	19929	Long, 1=0.001	EInt	
5336	AnOut1FCMax	Max	43257	169/161	4CB9	19641	UInt	UInt	
5337	AnOut1VaMax	0.000	43555	170/204	4DE3	19939	Long, 1=0.001	EInt	
534	AnOut2 Fc	EI Power	43261	169/165	4CBD	19645	UInt	UInt	
535	AnOut2 Setup	4-20mA	43262	169/166	4CBE	19646	UInt	UInt	
536	AnOut2 Advan								
5361	AnOut2 Min	4mA	43263	169/167	4CBF	19647	Long, 1=0.01	EInt	
5362	AnOut2 Max	20.00mA	43264	169/168	4CC0	19648	Long, 1=0.01	EInt	
5363	AnOut2Bipol	20.00mA	43265	169/169	4CC1	19649	Long, 1=0.01	EInt	
5364	AnOut2FcMin	Min	43266	169/170	4CC2	19650	UInt	UInt	
5365	AnOut2VaMin	0.000	43546	170/195	4DDA	19930	Long, 1=0.001	EInt	
5366	AnOut2FcMax	Max	43267	169/171	4CC3	19651	UInt	UInt	
5367	AnOut2VaMax	0.000	43556	170/205	4DE4	19940	Long, 1=0.001	EInt	
540	Digital Outputs								
541	DigOut 1	NOT2	43271	169/175	4CC7	19655	UInt	UInt	
542	DigOut 2	L1	43272	169/176	4CC8	19656	UInt	UInt	
550	Relays								
551	Relay 1	Charge relay	43273	169/177	4CC9	19657	UInt	UInt	
552	Relay 2	NOT2	43274	169/178	4CCA	19658	UInt	UInt	
553	Relay 3	Main Relay	43275	169/179	4CCB	19659	UInt	UInt	
554	B1 Relay 1	Off	43511	170/160	4DB7	19895	UInt	UInt	
555	B1 Relay 2	Off	43512	170/161	4DB8	19896	UInt	UInt	
556	B1 Relay 3	Off	43513	170/162	4DB9	19897	UInt	UInt	
557	B2 Relay 1	Off	43514	170/163	4DBA	19898	UInt	UInt	
558	B2 Relay 2	Off	43515	170/164	4DBB	19899	UInt	UInt	
559	B2 Relay 3	Off	43516	170/165	4DBC	19900	UInt	UInt	
55A	B3 Relay 1	Off	43517	170/166	4DBD	19901	UInt	UInt	
55B	B3 Relay 2	Off	43518	170/167	4DBE	19902	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
55C	B3 Relay 3	Off	43519	170/168	4DBF	19903	UInt	UInt	
55D	Relay Advan								
55D1	Relay1 Mode	N.O	43276	169/180	4CCC	19660	UInt	UInt	
55D2	Relay2 Mode	N.O	43277	169/181	4CCD	19661	UInt	UInt	
55D3	Relay3 Mode	N.O	43278	169/182	4CCE	19662	UInt	UInt	
55D4	B1R1 Mode	N.O	43521	170/170	4DC1	19905	UInt	UInt	
55D5	B1R2 Mode	N.O	43522	170/171	4DC2	19906	UInt	UInt	
55D6	B1R3 Mode	N.O	43523	170/172	4DC3	19907	UInt	UInt	
55D7	B2R1 Mode	N.O	43524	170/173	4DC4	19908	UInt	UInt	
55D8	B2R2 Mode	N.O	43525	170/174	4DC5	19909	UInt	UInt	
55D9	B2R3 Mode	N.O	43526	170/175	4DC6	19910	UInt	UInt	
55DA	B3R1 Mode	N.O	43527	170/176	4DC7	19911	UInt	UInt	
55DB	B3R2 Mode	N.O	43528	170/177	4DC8	19912	UInt	UInt	
55DC	B3R3 Mode	N.O	43529	170/178	4DC9	19913	UInt	UInt	
560	Virtual I/Os								
561	VIO 1 Dest	Off	43281	169/185	4CD1	19665	UInt	UInt	
562	VIO 1 Source	Off	43282	169/186	4CD2	19666	UInt	UInt	
563	VIO 2 Dest	Off	43283	169/187	4CD3	19667	UInt	UInt	
564	VIO 2 Source	Off	43284	169/188	4CD4	19668	UInt	UInt	
565	VIO 3 Dest	Off	43285	169/189	4CD5	19669	UInt	UInt	
566	VIO 3 Source	Off	43286	169/190	4CD6	19670	UInt	UInt	
567	VIO 4 Dest	Off	43287	169/191	4CD7	19671	UInt	UInt	
568	VIO 4 Source	Off	43288	169/192	4CD8	19672	UInt	UInt	
569	VIO 5 Dest	Off	43289	169/193	4CD9	19673	UInt	UInt	
56A	VIO 5 Source	Off	43290	169/194	4CDA	19674	UInt	UInt	
56B	VIO 6 Dest	RunR	43291	169/195	4CDB	19675	UInt	UInt	
56C	VIO 6 Source	DigIn 1	43292	169/196	4CDC	19676	UInt	UInt	
56D	VIO 7 Dest	RunL	43293	169/197	4CDD	19677	UInt	UInt	
56E	VIO 7 Source	DigIn 2	43294	169/198	4CDE	19678	UInt	UInt	
56F	VIO 8 Dest	Off	43295	169/199	4CDF	19679	UInt	UInt	
56G	VIO 8 Source	Operation	43296	169/200	4CE0	19680	UInt	UInt	
600	Logic&Timers								
610	Comparators								
611	CA1 Setup								
6111	CA1 Value	Current	43400	170/49	4D48	19784	UInt	UInt	
6112	CA1 LevelHI	30.0A	43401	170/50	4D49	19785	Long, 1=0.001	EInt	
6113	CA1 LevelLO	20.0A	43402	170/51	4D4A	19786	Long, 1=0.001	EInt	
6114	CA1 Type	Hysteresis	43403	170/52	4D4B	19787	UInt	UInt	
6115	CA1 Polar	Unipolar	43404	170/53	4D4C	19788	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
6116	CA1 Set Dly	0s	43405	170/54	4D4D	19789	Long, 1=1s	EInt	
6117	CA1 Res Dly	0s	43406	170/55	4D4E	19790	Long, 1=1s	EInt	
6118	CA1 Tmr Val	0s	43407	170/56	4D4F	19791	Long, 1=1s	EInt	
612	CA2 Setup								
6121	CA2 Value	El power	43408	170/57	4D50	19792	UInt	UInt	
6122	CA2 LevelHI	20%	43409	170/58	4D51	19793	Long, 1=0.001	EInt	
6123	CA2 LevelLO	10%	43410	170/59	4D52	19794	Long, 1=0.001	EInt	
6124	CA2 Type	Hysteresis	43411	170/60	4D53	19795	UInt	UInt	
6125	CA2 Polar	Unipolar	43412	170/61	4D54	19796	UInt	UInt	
6126	CA2 Set Dly	0s	43413	170/62	4D55	19797	Long, 1=1s	EInt	
6127	CA2 Res Dly	0s	43414	170/63	4D56	19798	Long, 1=1s	EInt	
6128	CA2 Tmr Val	0s	43415	170/64	4D57	19799	Long, 1=1s	EInt	
613	CA3 Setup								
6131	CA3 Value	Process Val	43416	170/65	4D58	19800	UInt	UInt	
6132	CA3 LevelHI	300	43417	170/66	4D59	19801	Long, 1=0.001	EInt	
6133	CA3 LevelLO	200	43418	170/67	4D5A	19802	Long, 1=0.001	EInt	
6134	CA3 Type	Hysteresis	43419	170/68	4D5B	19803	UInt	UInt	
6135	CA3 Polar	Unipolar	43420	170/69	4D5C	19804	UInt	UInt	
6136	CA3 Set Dly	0s	43421	170/70	4D5D	19805	Long, 1=1s	EInt	
6137	CA3 Res Dly	0s	43422	170/71	4D5E	19806	Long, 1=1s	EInt	
6138	CA3 Tmr Val	0s	43423	170/72	4D5F	19807	Long, 1=1s	EInt	
614	CA4 Setup								
6141	CA4 Value	Process Err	43424	170/73	4D60	19808	UInt	UInt	
6142	CA4 LevelHI	100	43425	170/74	4D61	19809	Long, 1=0.001	EInt	
6143	CA4 LevelLO	-100	43426	170/75	4D62	19810	Long, 1=0.001	EInt	
6144	CA4 Type	Window	43427	170/76	4D63	19811	UInt	UInt	
6145	CA4 Polar	Bipolar	43428	170/77	4D64	19812	UInt	UInt	
6146	CA4 Set Dly	0s	43429	170/78	4D65	19813	Long, 1=1s	EInt	
6147	CA4 Res Dly	0s	43430	170/79	4D66	19814	Long, 1=1s	EInt	
6148	CA4 Tmr Val	0s	43431	170/80	4D67	19815	Long, 1=1s	EInt	
620	Analog Mux								
621	AnMux1								
6211	AnMux InA	AnIn 1	43432	170/81	4D68	19816	UInt	UInt	
6212	AnMux InB	AnIn 2	43433	170/82	4D69	19817	UInt	UInt	
6213	Operator	Off	43434	170/83	4D6A	19818	UInt	UInt	
622	AnMux2								
6221	AnMux InA	AnIn 1	43435	170/84	4D6B	19819	UInt	UInt	
6222	AnMux InB	AnIn 2	43436	170/85	4D6C	19820	UInt	UInt	
6223	Operator	Off	43437	170/86	4D6D	19821	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
630	Not Gate								
631	NOT1 Input	T2Q	43438	170/87	4D6E	19822	UInt	UInt	
632	NOT2 Input	Udc OK	43439	170/88	4D6F	19823	UInt	UInt	
633	NOT3 Input	Off	43440	170/89	4D70	19824	UInt	UInt	
634	NOT4 Input	Off	43441	170/90	4D71	19825	UInt	UInt	
635	NOT5 Input	Off	43442	170/91	4D72	19826	UInt	UInt	
636	NOT6 Input	Off	43443	170/92	4D73	19827	UInt	UInt	
637	NOT7 Input	Off	43444	170/93	4D74	19828	UInt	UInt	
638	NOT8 Input	Off	43445	170/94	4D75	19829	UInt	UInt	
640	Logics								
641	Logic 1								
6411	L1 Expr	((1.2).3).4	43450	170/99	4D7A	19834	UInt	UInt	
6412	L1 Input 1	Trip	43451	170/100	4D7B	19835	UInt	UInt	
6413	L1 Op 1	&	43452	170/101	4D7C	19836	UInt	UInt	
6414	L1 Input 2	NOT1	43453	170/102	4D7D	19837	UInt	UInt	
6415	L1 Op 2	&	43454	170/103	4D7E	19838	UInt	UInt	
6416	L1 Input 3	Off	43455	170/104	4D7F	19839	UInt	UInt	
6417	L1 Op 3	.	43456	170/105	4D80	19840	UInt	UInt	
6418	L1 Input 4	Off	43457	170/106	4D81	19841	UInt	UInt	
6419	L1 Set Dly	0.0s	43458	170/107	4D82	19842	Long, 1=1s	EInt	
641A	L1 Res Dly	0.0s	43459	170/108	4D83	19843	Long, 1=1s	EInt	
641B	L1 Tmr Val	0.0s	43460	170/109	4D84	19844	Long, 1=1s	EInt	
642	Logic 2								
6421	L2 Expr	((1.2).3).4	43461	170/110	4D85	19845	UInt	UInt	
6422	L2 Input 1	CA1	43462	170/111	4D86	19846	UInt	UInt	
6423	L2 Op 1	&	43463	170/112	4D87	19847	UInt	UInt	
6424	L2 Input 2	NOT1	43464	170/113	4D88	19848	UInt	UInt	
6425	L2 Op 2	&	43465	170/114	4D89	19849	UInt	UInt	
6426	L2 Input 3	Run	43466	170/115	4D8A	19850	UInt	UInt	
6427	L2 Op 3	.	43467	170/116	4D8B	19851	UInt	UInt	
6428	L2 Input 4	Off	43468	170/117	4D8C	19852	UInt	UInt	
6429	L2 Set Dly	0.0s	43469	170/118	4D8D	19853	Long, 1=1s	EInt	
642A	L2 Res Dly	0.0s	43470	170/119	4D8E	19854	Long, 1=1s	EInt	
642B	L2 Tmr Val	0.0s	43471	170/120	4D8F	19855	Long, 1=1s	EInt	
643	Logic 3								
6431	L3 Expr	((1.2).3).4	43472	170/121	4D90	19856	UInt	UInt	
6432	L3 Input 1	CA1	43473	170/122	4D91	19857	UInt	UInt	
6433	L3 Op 1	&	43474	170/123	4D92	19858	UInt	UInt	
6434	L3 Input 2	NOT1	43475	170/124	4D93	19859	UInt	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
6435	L3 Op 2	&	43476	170/125	4D94	19860	UInt	UInt	
6436	L3 Input 3	Run	43477	170/126	4D95	19861	UInt	UInt	
6437	L3 Op 3	.	43478	170/127	4D96	19862	UInt	UInt	
6438	L3 Input 4	Off	43479	170/128	4D97	19863	UInt	UInt	
6439	L3 Set Dly	0.0s	43480	170/129	4D98	19864	Long, 1=1s	EInt	
643A	L3 Res Dly	0.0s	43481	170/130	4D99	19865	Long, 1=1s	EInt	
643B	L3 Tmr Val	0.0s	43482	170/131	4D9A	19866	Long, 1=1s	EInt	
644	Logic 4								
6441	L4 Expr	((1.2).3).4	43483	170/132	4D9B	19867	UInt	UInt	
6442	L4 Input 1	CA1	43484	170/133	4D9C	19868	UInt	UInt	
6443	L4 Op 1	&	43485	170/134	4D9D	19869	UInt	UInt	
6444	L4 Input 2	NOT1	43486	170/135	4D9E	19870	UInt	UInt	
6445	L4 Op 2	&	43487	170/136	4D9F	19871	UInt	UInt	
6446	L4 Input 3	Run	43488	170/137	4DA0	19872	UInt	UInt	
6447	L4 Op 3	.	43489	170/138	4DA1	19873	UInt	UInt	
6448	L4 Input 4	Off	43490	170/139	4DA2	19874	UInt	UInt	
6449	L4 Set Dly	0.0s	43491	170/140	4DA3	19875	Long, 1=1s	EInt	
644A	L4 Res Dly	0.0s	43492	170/141	4DA4	19876	Long, 1=1s	EInt	
644B	L4 Tmr Val	0.0s	43493	170/142	4DA5	19877	Long, 1=1s	EInt	
650	Timers								
651	Timer 1								
6511	Timer1 Trig	Off	43600	170/249	4E10	19984	UInt	UInt	
6512	Timer1 Mode	Off	43601	170/250	4E11	19985	UInt	UInt	
6513	Timer1Delay	0.0s	43602	170/251	4E12	19986	Long, 1=1s	EInt	
6514	Timer1 T1	0.0s	43603	170/252	4E13	19987	Long, 1=1s	EInt	
6515	Timer1 T2	0.0s	43604	170/253	4E14	19988	Long, 1=1s	EInt	
6516	Timer1Value	0.0s	43605	170/254	4E15	19989	Long, 1=1s	EInt	
652	Timer2								
6521	Timer2 Trig	Trip	43606	171/0	4E16	19990	UInt	UInt	
6522	Timer2 Mode	Delay	43607	171/1	4E17	19991	UInt	UInt	
6523	Timer2Delay	1.0s	43608	171/2	4E18	19992	Long, 1=1s	EInt	
6524	Timer2 T1	1.0s	43609	171/3	4E19	19993	Long, 1=1s	EInt	
6525	Timer2 T2	0.0s	43610	171/4	4E1A	19994	Long, 1=1s	EInt	
6526	Timer2Value	0.0s	43611	171/5	4E1B	19995	Long, 1=1s	EInt	
653	Timer3								
6531	Timer3 Trig	Off	43612	171/6	4E1C	19996	UInt	UInt	
6532	Timer3 Mode	Off	43613	171/7	4E1D	19997	UInt	UInt	
6533	Timer3Delay	0.0s	43614	171/8	4E1E	19998	Long, 1=1s	EInt	
6534	Timer3 T1	0.0s	43615	171/9	4E1F	19999	Long, 1=1s	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
6535	Timer3 T2	0.0s	43616	171/10	4E20	20000	Long, 1=1s	EInt	
6536	Timer3Value	0.0s	43617	171/11	4E21	20001	Long, 1=1s	EInt	
654	Timer4								
6541	Timer4 Trig	Off	43618	171/12	4E22	20002	UInt	UInt	
6542	Timer4 Mode	Off	43619	171/13	4E23	20003	UInt	UInt	
6543	Timer4Delay	0.0s	43620	171/14	4E24	20004	Long, 1=1s	EInt	
6544	Timer4 T1	0.0s	43621	171/15	4E25	20005	Long, 1=1s	EInt	
6545	Timer4 T2	0.0s	43622	171/16	4E26	20006	Long, 1=1s	EInt	
6546	Timer4Value	0.0s	43623	171/17	4E27	20007	Long, 1=1s	EInt	
660	Flip flops								
661	Flip flop 1								
6611	F1 mode	Reset	43630	171/24	4E2E	20014	UInt	UInt	
6612	F1 set	Off	43631	171/25	4E2F	20015	UInt	UInt	
6613	F1 reset	Off	43632	171/26	4E30	20016	UInt	UInt	
6614	F1 Set Dly	0.0s	43633	171/27	4E31	20017	Long, 1=1s	EInt	
6615	F1 Res Dly	0.0s	43634	171/28	4E32	20018	Long, 1=1s	EInt	
6616	F1 Tmr Val	0.0s	43635	171/29	4E33	20019	Long, 1=1s	EInt	
662	Flip flop 2								
6621	F2 mode	Reset	43636	171/30	4E34	20020	UInt	UInt	
6622	F2 set	Off	43637	171/31	4E35	20021	UInt	UInt	
6623	F2 reset	Off	43638	171/32	4E36	20022	UInt	UInt	
6624	F2 Set Dly	0.0s	43639	171/33	4E37	20023	Long, 1=1s	EInt	
6625	F2 Res Dly	0.0s	43640	171/34	4E38	20024	Long, 1=1s	EInt	
6626	F2 Tmr Val	0.0s	43641	171/35	4E39	20025	Long, 1=1s	EInt	
663	Flip flop 3								
6631	F3 mode	Reset	43642	171/36	4E3A	20026	UInt	UInt	
6632	F3 set	Off	43643	171/37	4E3B	20027	UInt	UInt	
6633	F3 reset	Off	43645	171/39	4E3D	20029	Long	EInt	
6634	F3 Set Dly	0.0s	43645	171/39	4E3D	20029	Long, 1=1s	EInt	
6635	F3 Res Dly	0.0s	43646	171/40	4E3E	20030	Long, 1=1s	EInt	
6636	F3 Tmr Val	0.0s	43647	171/41	4E3F	20031	Long, 1=1s	EInt	
664	Flip flop 4								
6641	F4 mode	Reset	43648	171/42	4E40	20032	UInt	UInt	
6642	F4 set	Off	43649	171/43	4E41	20033	UInt	UInt	
6643	F4 reset	Off	43650	171/44	4E42	20034	UInt	UInt	
6644	F4 Set Dly	0.0s	43651	171/45	4E43	20035	Long, 1=1s	EInt	
6645	F4 Res Dly	0.0s	43652	171/46	4E44	20036	Long, 1=1s	EInt	
6646	F4 Tmr Val	0.0s	43653	171/47	4E45	20037	Long, 1=1s	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
670	Counters								
671	Counter1								
6711	C1 Trig	Off	43654	171/48	4E46	20038	UInt	UInt	
6712	C1 Reset	Off	43655	171/49	4E47	20039	UInt	UInt	
6713	C1 High Val	0	43656	171/50	4E48	20040	Long, 1=1	EInt	
6714	C1 Low Val	0	43657	171/51	4E49	20041	Long, 1=1	EInt	
6715	C1 DecTimer	Off	43658	171/52	4E4A	20042	Long, 1=1s	EInt	
6719	C1 Value	0	43659	171/53	4E4B	20043	UInt, 1=1	UInt	
672	Counter2								
6721	C2 Trig	Off	43660	171/54	4E4C	20044	UInt	UInt	
6722	C2 Reset	Off	43661	171/55	4E4D	20045	UInt	UInt	
6723	C2 High Val	0	43662	171/56	4E4E	20046	Long, 1=1	EInt	
6724	C2 Low Val	0	43663	171/57	4E4F	20047	Long, 1=1	EInt	
6725	C2 DecTimer	Off	43664	171/58	4E50	20048	Long, 1=1s	EInt	
6729	C2 Value	0	43665	171/59	4E51	20049	UInt, 1=1	UInt	
680	Clock logic								
681	Clock 1								
6811	Clk1TimeON	00:00:00	43670	171/64	4E56	20054	Long, 1=1h	EInt	
			43671	171/65	4E57	20055	Long, 1=1m	EInt	
			43672	171/66	4E58	20056	Long, 1=1s	EInt	
6812	Clk1TimeOff	00:00:00	43673	171/67	4E59	20057	Long, 1=1h	EInt	
			43674	171/68	4E5A	20058	Long, 1=1m	EInt	
			43675	171/69	4E5B	20059	Long, 1=1s	EInt	
6813	Clk1DateOn	2000-00-00	43676	171/70	4E5C	20060	Long, 1=1y	EInt	
			43677	171/71	4E5D	20061	Long, 1=1m	EInt	
			43678	171/72	4E5E	20062	Long, 1=1d	EInt	
6814	Clk1DateOff	2000-00-00	43679	171/73	4E5F	20063	Long, 1=1y	EInt	
			43680	171/74	4E60	20064	Long, 1=1m	EInt	
			43681	171/75	4E61	20065	Long, 1=1d	EInt	
6815	Clk1Weekday	MTWWTFSS	43682	171/76	4E62	20066	UInt, 1=1	UInt	
682	Clock 2								
6821	Clk2TimeON	00:00:00	43684	171/78	4E64	20068	Long, 1=1h	EInt	
			43685	171/79	4E65	20069	Long, 1=1m	EInt	
			43686	171/80	4E66	20070	Long, 1=1s	EInt	
6822	Clk2TimeOff	00:00:00	43687	171/81	4E67	20071	Long, 1=1h	EInt	
			43688	171/82	4E68	20072	Long, 1=1m	EInt	
			43689	171/83	4E69	20073	Long, 1=1s	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
6823	Clk2DateOn	2000-00-00	43690	171/84	4E6A	20074	Long, 1=1y	EInt	
			43691	171/85	4E6B	20075	Long, 1=1m	EInt	
			43692	171/86	4E6C	20076	Long, 1=1d	EInt	
6824	Clk2DateOff	2000-00-00	43693	171/87	4E6D	20077	Long, 1=1y	EInt	
			43694	171/88	4E6E	20078	Long, 1=1m	EInt	
			43695	171/89	4E6F	20079	Long, 1=1d	EInt	
6825	Clk2Weekday	MTWWTFSS	43696	171/90	4E70	20080	UInt, 1=1	UInt	
700	Oper/Status								
710	Operation								
711	Q Value		31001	121/145	23E9	1001	Long, 1=0.001	EInt	
712	Cos φ		31002	121/146	23EA	1002	Int, 1=1rpm	Int	
713	El Power		31003	121/147	23EB	1003	Long, 1=0.1Nm	EInt	
			31004	121/148	23EC	1004	Long, 1=1%	EInt	
714	React Power		31005	121/149	23ED	1005	Long, 1=1VA	EInt	
			31006	121/150	23EE	1006	Long, 1=1%	EInt	
716	Current		31007	121/151	23EF	1007	Long, 1=0.1A	EInt	
717	Supply Volt		31008	121/152	23F0	1008	Long, 1=0.1V	EInt	
718	Frequency		31009	121/153	23F1	1009	Long, 1=0.1Hz	EInt	
719	DC Voltage		31010	121/154	23F2	1010	Long, 1=0.1V	EInt	
71A	IGBT Temp		31011	121/155	23F3	1011	Long, 1=0.1°C	EInt	
71B	PT100 1,2,3		31012	121/156	23F4	1012	Long, 1=1°C	EInt	
			31013	121/157	23F5	1013	Long, 1=1°C	EInt	
			31014	121/158	23F6	1014	Long, 1=1°C	EInt	
71C	PT100 4,5,6		31097	121/241	2449	1097	Long, 1=1°C	EInt	
			31098	121/242	244A	1098	Long, 1=1°C	EInt	
			31099	121/243	244B	1099	Long, 1=1°C	EInt	
720	Status								
721	AFR Status		31015	121/159	23F7	1015	UInt	UInt	
722	Warning		31016	121/160	23F8	1016	UInt	UInt	
723	DigIn Status		31017	121/161	23F9	1017	UInt, 1=1	UInt	
724	DigOutStatus		31018	121/162	23FA	1018	UInt, 1=1	UInt	
725	AnIn 1 2		31019	121/163	23FB	1019	Long, 1=1%	EInt	
			31020	121/164	23FC	1020	Long, 1=1%	EInt	
726	AnIn 3 4		31021	121/165	23FD	1021	Long, 1=1%	EInt	
			31022	121/166	23FE	1022	Long, 1=1%	EInt	
727	AnOut 1 2		31023	121/167	23FF	1023	Long, 1=1%	EInt	
			31024	121/168	2400	1024	Long, 1=1%	EInt	
728	IO Status B1		31025	121/169	2401	1025	UInt, 1=1	UInt	
729	IO Status B2		31026	121/170	2402	1026	UInt, 1=1	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
72A	IO Status B3		31027	121/171	2403	1027	UInt, 1=1	UInt	
72B	Area D Stat								
72B1	Area D LSB		30180	118/89	20B4	180	UInt, 1=1	UInt	
72B2	Area D MSB		30182	118/91	20B6	182	UInt, 1=1	UInt	
72C	VIO Status		30181	118/90	20B5	181	UInt, 1=1	UInt	
730	Stored values								
731	Run Time		31028	121/172	2404	1028	Long, 1=1h	EInt	
			31029	121/173	2405	1029	Long, 1=1m	EInt	
			31030	121/174	2406	1030	Long, 1=1s	EInt	
7311	Reset RunTm	No	7	0/6	2007	7	UInt	UInt	
732	Mains Time		31031	121/175	2407	1031	Long, 1=1h	EInt	
			31032	121/176	2408	1032	Long, 1=1m	EInt	
			31033	121/177	2409	1033	Long, 1=1s	EInt	
733	Energy		31034	121/178	240A	1034	Long, 1=1Wh	EInt	
7331	Rst Energy	No	6	0/5	2006	6	UInt	UInt	
800	View TripLog								
810	TripMessage		31101	121/245	244D	1101	UInt, 1=1	UInt	
811	Q Value		31102	121/246	244E	1102	Long, 1=0.001	EInt	
812	Cos φ		31103	121/247	244F	1103	Int, 1=1rpm	Int	
813	El Power		31104	121/248	2450	1104	Long, 1=0.1W	EInt	
			31105	121/249	2451	1105	Long, 1=1%	EInt	
814	React Power		31106	121/250	2452	1106	Long, 1=1VA	EInt	
			31107	121/251	2453	1107	Long, 1=1%	EInt	
816	Current		31108	121/252	2454	1108	Long, 1=0.1A	EInt	
817	Supply volt		31109	121/253	2455	1109	Long, 1=0.1V	EInt	
818	Frequency		31110	121/254	2456	1110	Long, 1=0.1Hz	EInt	
819	DC Voltage		31111	122/0	2457	1111	Long, 1=0.1V	EInt	
81A	IGBT Temp		31112	122/1	2458	1112	Long, 1=0.1°C	EInt	
81B	PT100 1,2,3		31113	122/2	2459	1113	Long, 1=1°C	EInt	
			31114	122/3	245A	1114	Long, 1=1°C	EInt	
			31115	122/4	245B	1115	Long, 1=1°C	EInt	
81C	AFR Status		31116	122/5	245C	1116	UInt	UInt	
81D	DigIn Status		31117	122/6	245D	1117	UInt, 1=1	UInt	
81E	DigOutStatus		31118	122/7	245E	1118	UInt, 1=1	UInt	
81F	AnIn 1 2		31119	122/8	245F	1119	Long, 1=1%	EInt	
			31120	122/9	2460	1120	Long, 1=1%	EInt	
81G	AnIn 3 4		31121	122/10	2461	1121	Long, 1=1%	EInt	
			31122	122/11	2462	1122	Long, 1=1%	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
81H	AnOut1 2		31123	122/12	2463	1123	Long, 1=1%	EInt	
			31124	122/13	2464	1124	Long, 1=1%	EInt	
81I	IO Status B1		31125	122/14	2465	1125	UInt, 1=1	UInt	
81J	IO Status B2		31126	122/15	2466	1126	UInt, 1=1	UInt	
81K	IO Status B3		31127	122/16	2467	1127	UInt, 1=1	UInt	
81L	Run Time		31128	122/17	2468	1128	Long, 1=1h	EInt	
			31129	122/18	2469	1129	Long, 1=1m	EInt	
			31130	122/19	246A	1130	Long, 1=1s	EInt	
81M	Mains Time		31131	122/20	246B	1131	Long, 1=1h	EInt	
			31132	122/21	246C	1132	Long, 1=1m	EInt	
			31133	122/22	246D	1133	Long, 1=1s	EInt	
81N	Energy		31147	122/36	247B	1147	Long, 1=1Wh	EInt	
81O	Q Ref		31135	122/24	246F	1135	Long, 1=0.001	EInt	
81P	VIO Status		31136	122/25	2470	1136	UInt, 1=1	UInt	
81Q	PT100 4,5,6		31137	122/26	2471	1137	Long, 1=1°C	EInt	
			31138	122/27	2472	1138	Long, 1=1°C	EInt	
			31139	122/28	2473	1139	Long, 1=1°C	EInt	
81R	Clock		31144	122/33	2478	1144	UInt, 1=1h	UInt	
			31145	122/34	2479	1145	UInt, 1=1m	UInt	
			31146	122/35	247A	1146	UInt, 1=1s	UInt	
820	Trip Message (Log 2)		31151 to 31196	122/40 to 122/85	247F to 24AC	1151 to 1196			
830	Trip Message (Log 3)		31201 to 31246	122/90 to 122/135	24B1 to 24DE	1201 to 1246			
840	Trip Message (Log 4)		31251 to 31296	122/140 to 122/185	24E3 to 2510	1251 to 1296			
850	Trip Message (Log 5)		31301 to 31346	122/190 to 122/235	2515 to 2542	1301 to 1346			
860	Trip Message (Log 6)		31351 to 31396	122/240 to 123/30	2547 to 2574	1351 to 1396			
870	Trip Message (Log 7)		31401 to 31446	123/35 to 123/80	2579 to 25A6	1401 to 1446			
880	Trip Message (Log 8)		31451 to 31496	123/85 to 123/130	25AB to 25D8	1451 to 1496			
890	Trip Message (Log 9)		31501 to 31546	123/135 to 123/180	25DD to 260A	1501 to 1546			
8A0	Reset Trip L	No	8	0/7	2008	8	UInt	UInt	
900	System Data								
920	AFR Data								

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
921	AFR Type		31037	121/181	240D	1037	UInt, 1=1	UInt	
922	Software		31038	121/182	240E	1038	UInt	UInt	
			31039	121/183	240F	1039	UInt	UInt	
9221	Build Info		31040	121/184	2410	1040	UInt	UInt	
			31041	121/185	2411	1041	UInt	UInt	
			31042	121/186	2412	1042	UInt	UInt	
			31043	121/187	2413	1043	UInt	UInt	
			31044	121/188	2414	1044	UInt	UInt	
			31045	121/189	2415	1045	UInt	UInt	
9222	Build ID		30160	118/69	20A0	160	UInt	UInt	
923	Unit Name	0	42301	165/225	48FD	18685	UInt	UInt	
			42302	165/226	48FE	18686	UInt	UInt	
			42303	165/227	48FF	18687	UInt	UInt	
			42304	165/228	4900	18688	UInt	UInt	
			42305	165/229	4901	18689	UInt	UInt	
			42306	165/230	4902	18690	UInt	UInt	
			42307	165/231	4903	18691	UInt	UInt	
			42308	165/232	4904	18692	UInt	UInt	
			42309	165/233	4905	18693	UInt	UInt	
			42310	165/234	4906	18694	UInt	UInt	
			42311	165/235	4907	18695	UInt	UInt	
			42312	165/236	4908	18696	UInt	UInt	
924	Hardware								
9241	CB Key		39900	156/119	20D2	210	UInt	UInt	
925	CtrlPanel								
9251	CP SW ver		39901	156/120	46AD	9901	UInt	UInt	
9252	CP HW ver		39902	156/121	46AE	9902	UInt, 1=1	UInt	
9253	CP Build ID		30220	118/129	20DC	220	UInt	UInt	
930	Clock								
931	Time	00:00:00	42601	167/15	4A29	18985	Long, 1=1h	EInt	
			42602	167/16	4A2A	18986	Long, 1=1m	EInt	
			42603	167/17	4A2B	18987	Long, 1=1s	EInt	
932	Date	2000-00-00	42604	167/18	4A2C	18988	Long, 1=1y	EInt	
			42605	167/19	4A2D	18989	Long, 1=1m	EInt	
			42606	167/20	4A2E	18990	Long, 1=1d	EInt	
933	Weekday	Monday	42607	167/21	4A2F	18991	Long	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
000	AFE Option								
010	Supply								
011	Supply Volts	400V	48001	188/60			Long, 1=1	EInt	
012	Supply Freq	50Hz	48002	188/61			Long, 1=1	EInt	
013	Supply Curr	175A	48003	188/62			Long, 1=0.1	EInt	
014	Supply Seq	Pos	48004	188/63			UInt, 1=1	UInt	
015	Supply Idrun	Off	48005	188/64			UInt, 1=1	UInt	
016	Supply Auto	Off	48006	188/65			UInt, 1=1	UInt	
020	Start/Stop								
021	Charge Ctrl	Supply-NC	48011	188/70			UInt, 1=1	UInt	
022	Run/Stp Mode	Standard	48012	188/71			UInt, 1=1	UInt	
023	Reg Stp Time	1s	48013	188/72			Long, 1=0.01	EInt	
025	Start Type	Pulses	48015	188/74			UInt, 1=1	UInt	
030	Udc Control								
031	Udc ref	1.05*Upeak	48021	188/80			Long, 1=0.1	EInt	
032	Udc ramp	1s	48022	188/81			Long, 1=0.01	EInt	
033	Udc PI Gain	5.0	48023	188/82			Long, 1=0.1	EInt	
034	Udc PI Time	0.2s	48024	188/83			Long, 1=0.01	EInt	
035	Udc PI Max	200%	48025	188/84			Long, 1=1	EInt	
036	Udc PI Charg	20%	48026	188/85			Long, 1=1	EInt	
037	Udc Margin	5%	48027	188/86			Long, 1=0.1	EInt	
038	Udc Droop	0.0%	48028	188/87			Long, 1=0.1%	EInt	
040	Q Control								
041	Q max	0%	48031	188/90			Long, 1=1	EInt	
042	Q ramp	1s	48032	188/91					
043	Q PI Gain	0.10	48033	188/92			Long, 1=0.01	EInt	
044	Q PI Time	0.1s	48034	188/93			Long, 1=0.01	EInt	
045	Q Filter	1s	48035	188/94			Long, 1=0.01	EInt	
050	Freq Control								
051	Freq Type	AFR: Observer AFG: Sensor	48041	188/100			UInt, 1=1	UInt	
080	View Energy								
081	Energy Suppl		48034	121/178			Long, 1=1Wh	EInt	
082	Energy Motor	Wh	48071	188/130			Long, 1=1Wh	EInt	
083	Energy Gen	Wh	48075	188/134			Long, 1=1Wh	EInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
084	Reset Energy	No	48079	188/138			UInt, 1=1	UInt	
090	View Control								
091	UdcRef Val	0	48081	188/140			Long,, 1=0.1	EInt	
092	T Ref Val	0	48083	188/142			Long,, 1=0.1	EInt	
093	Q Ref Val	0	48085	188/144			Long,, 1=0.1	EInt	
094	PsiRef Val	0	48087	188/146			Long,, 1=0.1	UInt	
G00	GC Code								
G10	GC Protect								
G11	GCP Voltage								
G111	Source 3U	Off	48201	189/5			UInt, 1=1	UInt	
G112	3U> Level	115.%	48202	189/6			UInt, 1=0.1%	UInt	
G113	3U> Time	1.50s	48203	189/7			UInt, 1=0.01s	UInt	
G114	3U>> Level	120.0%	48204	189/8			UInt, 1=0.1%	UInt	
G115	3U>> Time	0.20s	48205	189/9			UInt, 1=0.01s	UInt	
G116	3U< Level	85.0%	48206	189/10			UInt, 1=0.1%	UInt	
G117	3U< Time	1.50s	48207	189/11			UInt, 1=0.01s	UInt	
G118	3U<< Level	80.0%	48208	189/12			UInt, 1=0.1%	UInt	
G119	3U<< Time	0.20s	48209	189/13			UInt, 1=0.01s	UInt	
G11A	U Hysteres	2.0%	48210	189/14			UInt, 1=0.1%	UInt	
G11B	U Rst Time	1.00s	48211	189/15			UInt, 1=0.01s	UInt	
G11C	U+> Level	110.0%	48212	189/16			UInt, 1=0.1%	UInt	
G11D	U+> Time	Off	48213	189/17			UInt, 1=0.01s	UInt	
G11E	U+< Level	85.0%	48214	189/18			UInt, 1=0.1%	UInt	
G11F	U+< Time	Off	48215	189/19			UInt, 1=0.01s	UInt	
G11G	U-> Level	5.0%	48216	189/20			UInt, 1=0.1%	UInt	
G11H	U-> Time	Off	48217	189/21			UInt, 1=0.01s	UInt	
G11I	U0> Level	10.0%	48218	189/22			UInt, 1=0.1%	UInt	
G11J	U0> Time	Off	48219	189/23			UInt, 1=0.01s	UInt	
G11K	Umean> Lvl	110.0%	48220	189/24			UInt, 1=0.1%	UInt	
G11L	Umean> Time	Off	48221	189/25			UInt, 1=0.01s	UInt	
G11M	Umean< Lvl	90.0%	48222	189/26			UInt, 1=0.1%	UInt	
G11N	Umean< Time	Off	48223	189/27			UInt, 1=0.01s	UInt	
G11O	U(Q<0)< Lvl	85.0%	48224	189/28			UInt, 1=0.1%	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
G11P	U(Q<0)< Time	Off	48225	189/29			UInt, 1=0.01s	UInt	
G12	GCP Freq								
G121	Source F	Off	48230	189/34			UInt, 1=1	UInt	
G122	F> Level	102.0.%	48231	189/35			UInt, 1=0.1%	UInt	
G123	F> Time	1.50s	48232	189/36			UInt, 1=0.01s	UInt	
G124	F>> Level	105.0%	48233	189/37			UInt, 1=0.1%	UInt	
G125	F>> Time	0.20s	48234	189/38			UInt, 1=0.01s	UInt	
G126	F< Level	98.0%	48235	189/39			UInt, 1=0.1%	UInt	
G127	F< Time	1.50s	48236	189/40			UInt, 1=0.01s	UInt	
G128	F<< Level	95.0%	48237	189/41			UInt, 1=0.1%	UInt	
G129	F<< Time	0.20s	48238	189/42			UInt, 1=0.01s	UInt	
G12A	F Hysteres	0.2%	48239	189/43			UInt, 1=0.1%	UInt	
G12B	F Rst Time	1.00s	48240	189/44			UInt, 1=0.01s	UInt	
G13	GCP ROCOF								
G131	ROCOF Level	2.00%/s	48245	189/49			UInt, 1=0.01%/s	UInt	
G132	ROCOF Time	2.00s	48246	189/50			UInt, 1=0.01s	UInt	
G133	ROCOF Hyst	0.02%/s	48247	189/51			UInt, 1=0.01%/s	UInt	
G134	ROCOF Rst T	1.00s	48248	189/52			UInt, 1=0.01s	UInt	
G20	GC Q ctrl								
G21	Q mode	Off	48251	189/55			UInt, 1=1	UInt	
G22	Q fix								
G221	Q max oe	50%	48255	189/59			Int, 1=1%	Int	
G222	Q max ue	-50%	48256	189/60			Int, 1=1%	Int	
G23	Cosφ fix								
G231	Cosφ min oe	0.90	48258	189/62			Int, 1=0.01	Int	
G232	Cosφ min ue	-0.90	48259	189/63			Int, 1=0.01	Int	
G24	Q (U)								
G241	Q1	50%	48261	189/65			Int, 1=1%	Int	
G242	U1	85%	48265	189/69			UInt, 1=1%	UInt	
G243	Q2	10%	48262	189/66			Int, 1=1%	Int	
G244	U2	95%	48266	189/70			UInt, 1=1%	UInt	
G245	Q3	-10%	48263	189/67			Int, 1=1%	Int	
G246	U3	105%	48267	189/71			UInt, 1=1%	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
G247	Q4	-50%	48264	189/68			Int, 1=1%	Int	
G248	U4	110%	48268	189/72			UInt, 1=1%	UInt	
G249	Filt time	3.0s	48269	189/73			UInt, 1=0.1s	UInt	
G24A	Cosφ min	0.01	48270	189/74			Int, 1=0.01	Int	
G24B	P lock In	10%	48301	189/105			UInt, 1=1%	UInt	
G24C	P lock out	0%	48302	189/106			UInt, 1=1%	UInt	
G25	Cosφ (U)								
G251	Cosφ1	0.9	48271	189/75			Int, 1=0.01	Int	
G252	U1	85%	48275	189/79			UInt, 1=1%	UInt	
G253	Cosφ2	0.95	48272	189/76			Int, 1=0.01	Int	
G254	U2	95%	48276	189/80			UInt, 1=1%	UInt	
G255	Cosφ3	-0.95	48273	189/77			Int, 1=0.01	Int	
G256	U3	105%	48277	189/81			UInt, 1=1%	UInt	
G257	Cosφ4	-0.90	48274	189/78			Int, 1=0.01	Int	
G258	U4	110%	48278	189/82			UInt, 1=1%	UInt	
G259	Filt time	3.0s	48279	189/83			UInt, 1=0.1s	UInt	
G25B	P lock In	10%	48306	189/110			UInt, 1=1%	UInt	
G25C	P lock out	0%	48307	189/111			UInt, 1=1%	UInt	
G26	Q (P)								
G261	Q1	10%	48281	189/85			Int, 1=1%	Int	
G262	P1	25%	48285	189/89			UInt, 1=1%	UInt	
G263	Q2	50%	48282	189/86			Int, 1=1%	Int	
G264	P2	50%	48286	189/90			UInt, 1=1%	UInt	
G265	Q3	40%	48283	189/87			Int, 1=1%	Int	
G266	P3	75%	48287	189/91			UInt, 1=1%	UInt	
G267	Q4	0%	48284	189/88			Int, 1=1%	Int	
G268	P4	100%	48288	189/92			UInt, 1=1%	UInt	
G269	Filt time	3.0s	48289	189/93			UInt, 1=0.1s	UInt	
G27	Cosφ (P)								
G271	Cosφ1	0.90	48291	189/95			Int, 1=0.01	Int	
G272	P1	25%	48295	189/99			UInt, 1=1%	UInt	
G273	Cosφ2	0.70	48292	189/96			Int, 1=0.01	Int	
G274	P2	50%	48296	189/100			UInt, 1=1%	UInt	
G275	Cosφ3	0.88	48293	189/97			Int, 1=0.01	Int	
G276	P3	75%	48297	189/101			UInt, 1=1%	UInt	
G277	Cosφ4	1.0	48294	189/98			Int, 1=0.01	Int	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
G278	P4	100%	48298	189/102			UInt, 1=1%	UInt	
G279	Filt time	3.0s	48299	189/103			UInt, 1=0.1s	UInt	
G28	Limits								
G281	P threshold	0%	48252	189/56			UInt, 1=1%	UInt	
G282	Q limit	10%	48253	189/57			UInt, 1=1%	UInt	
G283	Prio P/Q	P	48254	189/58			UInt, 1=1	UInt	
G30	GC Distrbnce								
G31	GC NormRange								
G311	Umin	85.0%	48321	189/125			UInt, 1=0.1%	UInt	
G312	Umax	110.0%	48322	189/126			UInt, 1=0.1%	UInt	
G313	Fmin	92.0%	48323	189/127			UInt, 1=0.1%	UInt	
G314	Fmax	108.0%	48324	189/128			UInt, 1=0.1%	UInt	
G315	Umaxmax	125.0%	48325	189/129			UInt, 1=0.1%	UInt	
G316	Unorm	400.0V	48326	189/130			UInt, 1=0.1V	UInt	
G32	GC dU (FRT)								
G321	dU Imax (P)	100%	48331	189/135			UInt, 1=1%	UInt	
G322	dU Imax (Q)	100%	48332	189/136			UInt, 1=1%	UInt	
G323	dU Uband	10.0%	48333	189/137			UInt, 1=0.1%	UInt	
G324	dU Timemax	Off	48334	189/138			UInt, 1=0.01s	UInt	
G325	dU Mode UV	I (cont)	48335	189/139			UInt, 1=1	UInt	
G326	dU Zero UV	15%	48336	189/140			UInt, 1=1%	UInt	
G327	dU Mode OV	I (cont)	48337	189/141			UInt, 1=1	UInt	
G328	dU Zero OV	120%	48338	189/142			UInt, 1=1%	UInt	
G329	dU k1	2.00	48339	189/143			UInt, 1=0.01	UInt	
G32A	dU k2	0.00	48340	189/144			UInt, 1=0.01	UInt	
G32D	Trip UV t1	0.25s	48343	189/147			UInt, 1=0.01s	UInt	
G32E	Trip UV U1	0%	48344	189/148			UInt, 1=1%	UInt	
G32F	Trip UV t2	3.00s	48345	189/149			UInt, 1=0.01s	UInt	
G32G	Trip UV U2	85%	48346	189/150			UInt, 1=1%	UInt	
G32H	Trip OV t1	0.10s	48347	189/151			UInt, 1=0.01s	UInt	
G32I	Trip OV U1	130%	48348	189/152			UInt, 1=1%	UInt	
G32J	Trip OV t2	0.10s	48349	189/153			UInt, 1=0.01s	UInt	
G32K	Trip OV U2	120%	48350	189/154			UInt, 1=1%	UInt	
G33	GC AID								
G331	Passive AID	Off	48351	189/155			UInt, 1=1	UInt	
G332	Active AID	Off	48352	189/156			UInt, 1=1	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
G34	GC dF (FRT)								
G341	dOF Mode	Off	48361	189/165			UInt, 1=1	UInt	
G342	dOF Fstart	100.4%	48362	189/166			UInt, 1=0.1%	UInt	
G343	dOF tstart	0.0s	48363	189/167			UInt, 1=0.1s	UInt	
G344	dOF Droop	5.0%	48364	189/168			UInt, 1=0.1%	UInt	
G345	dOF Fstop	110.0%	48365	189/169			UInt, 1=0.1%	UInt	
G346	dOF tstop	Off	48366	189/170			UInt, 1=0.1s	UInt	
G35	t (Rbrake) max	Off	48370	189/174			UInt, 1=0.1s	UInt	
G36	GC Open CB								
G361	Open I<	20.0%	48368	189/172			UInt, 1=0.1%	UInt	
G362	Open Ttrip	0.02s	48369	189/173			UInt, 1=0.01s	UInt	
G37	GC Start								
G371	Umin Start	90.0%	48371	189/175			UInt, 1=0.1%	UInt	
G372	Umax Start	110.0%	48372	189/176			UInt, 1=0.1%	UInt	
G373	Fmin Start	99.0%	48373	189/177			UInt, 1=0.1s	UInt	
G374	Fmax Start	100.2%	48374	189/178			UInt, 1=0.1%	UInt	
G375	Time Start	60.0s	48375	189/179			UInt, 1=0.1%	UInt	
G376	P Start	0.0%/min	48376	189/180			UInt, 1=0.1%/min	UInt	
G90	Grid Monitor								
G91	U1	0	48401	189/205			UInt, 1=1	UInt	
	U2	0	48402	189/206			UInt, 1=1	UInt	
	U3	0	48403	189/207			UInt, 1=1	UInt	
G92	U12	0	48404	189/208			UInt, 1=1	UInt	
	U23	0	48405	189/209			UInt, 1=1	UInt	
	U31	0	48406	189/210			UInt, 1=1	UInt	
G93	U+	0	48407	189/211			UInt, 1=1	UInt	
	U-	0	48408	189/212			UInt, 1=1	UInt	
	U0	0	48409	189/213			UInt, 1=1	UInt	
G94	F	0Hz	48410	189/214			Int, 1=0.01Hz	Int	
G95	dF/dt	oHz/s	48411	189/215			Int, 1=0.01Hz/s	Int	
G96	U (10min)	0V	48412	189/216			UInt, 1=0.1V	UInt	
G97	I1	0	48413	189/217			UInt, 1=1	UInt	
	I2	0	48414	189/218			UInt, 1=1	UInt	
	I3	0	48415	189/219			UInt, 1=1	UInt	
G98	I+	0	48416	189/220			UInt, 1=1	UInt	
	I-	0	48417	189/221			UInt, 1=1	UInt	
	I0	0	48418	189/222			UInt, 1=1	UInt	

Menu Parameters		Default settings	Modbus Instance/ Device Net No.	Profibus slot/index	EtherCAT index (HEX)	Profinet index	Fieldbus format	Modbus format	Notes
G99	Phi+	0°	48419	189/223			UInt, 1=1	UInt	
G9A	PLL Status		48420	189/224					

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CG Drives & Automation Sweden AB
Mörsaregatan 12
Box 222 25
SE-250 24 Helsingborg
Sweden
T +46 42 16 99 00
F +46 42 16 99 49
www.emotron.com/www.cgglobal.com

Instruction manual: 01-7690-01r0
2021-05-31