MAKING MODERN LIVING POSSIBLE

Operating Instructions

VLT® Active Front End AFE 302

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VLT®
THE REAL DRIVE

Contents

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1 Introduction

1.1 Purpose of the Manual

1.1.1 How to Read these Operating Instructions

Please read this manual carefully for proper use. Incorrect handling of the frequency converter may cause improper operation of the frequency converter or related equipment, shorten lifetime or cause other troubles.

These Operating Instructions will help getting started, installing, programming, and troubleshooting the AFE 302.

Chapter 1 Introduction, introduces the manual and informs about the approvals, symbols, and abbreviations used in this literature.

Chapter 2 Safety Instructions and General Warning, entails instructions on how to handle the AFE 302 correctly.

Chapter 3 Crane System Design, describes the crane system design associated with the frequency converters.

Chapter 4 How to Install, guides through the mechanical and technical installation.

Chapter 6 How to Programme, describes how to operate and programme the AFE 302 via the Local Control Panel (LCP).

1.2 Safety Symbols

The following symbols are used in this document:

⚠WARNING

Indicates a potentially hazardous situation which could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation which could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

1.3 Software Version

VLT® Active Front End AFE 302

Operating Instructions
Software version: 1.15

1.4 Approvals

Table 1.1 Compliance Marks: CE and C-Tick

1.5 Abbreviations

AFE	Active Front End
AC	Alternating current
AWG	American Wire Gage
A	Ampere/AMP
AMA	Automatic Motor Adaptation
I_{LIM}	Current limit
°C	Degrees Celsius
DC	Direct current
EMC	Electro Magnetic Compatibility
ETR	Electronic Thermal Relay
FC	Frequency Converter
g	Gram
Hz	Hertz
HF	High Frequency
ID	Identification
IGBT	Insulated Gate Biopolar Transistor
IP	International Protection
IT	Isolation Terra
kHz	Kilohertz
kW	Kilowatt
kWh	Kilowatt-hour
LCP	Local Control Panel
MW	Megawatt
m	Meter
uF	Microfarad
mH	Millihenry Inductance
mA	Milliampere
MCM	Thousand circular mils
ms	Millisecond
min	Minute
MCT	Motion Control Tool
MDCIC	Multi Drive Control Interface Card
NEMA	National Electrical Manufacturers Association
Nm	Newton Meters
$I_{M,N}$	Nominal motor current
$f_{M,N}$	Nominal motor frequency
$P_{M,N}$	Nominal motor power
$U_{M,N}$	Nominal motor voltage
par.	Parameter
PELV	Protective Extra Low Voltage
PCB	Printed Circuit Board
PLC	Programmable Logic Controller
PN	Part Number
I_{INV}	Rated Inverter Output Current
Regen	Regenerative terminals
RCD	Residual Current Device
RPM	Revolutions Per Minute
RMS	Root Mean Square
s	Second
SW	Software
SMPS	Switching Mode Power Supply

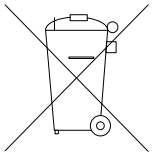
n_s	Synchronous Motor Speed
$I_{VLT,MAX}$	The maximum output current
$I_{VLT,N}$	The rated output current supplied by the frequency converter
T_{LIM}	Torque limit
THD	Total Harmonic Distortion
THDi	Total Harmonic Distortion in Current
THDu	Total Harmonic Distortion in Voltage
V	Volts

2 Safety Instructions and General Warning

2

2.1 Safety Regulations AFE 302

2.1.1 Disposal Instruction



Equipment containing electrical components may not be disposed with domestic waste. It must be separately collected with Electrical and Electronic waste according to local and currently valid legislation.

2.1.2 High Voltage Warning

⚠WARNING

The voltage of the AFE 302 is dangerous whenever the frequency converter is connected to mains. Incorrect installation or operation of the frequency converter may cause damage to the equipment, serious personal injury or death. The instructions in this manual must consequently be observed, as well as applicable local and national rules and safety regulations.

⚠WARNING

Installation in high altitudes
At altitudes above 2,000 m, contact Danfoss regarding PELV.

2.1.3 Safety Instructions

- Make sure that the AFE 302 is properly connected to earth.
- Protect users against supply voltage.
- Remember that the [Off] key on LCP is not a safety switch. Pressing the [Off] key does not disconnect the AFE 302 from the mains.

2.1.4 General Warnings

⚠WARNING

Touching the electrical parts may be fatal even after the equipment is disconnected from the mains.
Before carrying out the maintenance, the frequency converter must be disconnected from the mains. It will avoid the electrical shock hazard.
Check the discharge time on the nameplate for the exact waiting period. Otherwise wait at least 40 min.

⚠WARNING

When the AFE is on, the earth current from the AFE 302 frequency converter will exceed 3.5 mA. The earth cable must have a good contact to the earth terminal 95. The earth connection is done with the two separate cables. The size of each cable needs to be a half of the mains cable size in minimum.

2.1.5 Before Commencing Repair Work

1. Switch off the entire system.
2. Wait until the DC-link capacitor is discharged fully. See period of time on the warning label.
3. Disconnect DC bus terminals 88 and 89.
4. Disconnect the soft charge supply connector from the soft charge board.

⚠CAUTION

The source of the MDCIC connector (MK105) is the AC voltage from the front end of the LCL filter. Make sure to switch off the mains switch.

⚠CAUTION

The source of the fan voltage is from an external 400 V. Make sure to switch off the external fan voltage source switch.

2.1.6 System Description

NOTICE

The grounded Delta mains are not used.

An Active Front End (AFE) is sometimes called an active rectifier, in comparison with a passive rectifier such as the diode bridge. The AFE consists of LCL filter and the inverter unit.

The AFE main features are as follows:

- sinusoidal input current and low harmonic distortion in the mains
- unity power factor
- both rectifying and regenerating operation
- constant regulated DC voltage

Illustration 2.1 shows the AFE system example.

At start-up, the AFE must detect the mains frequency and phase to synchronize the operation.

During the normal operation, the AFE DC-link voltage is regulated to be constant. This means that the energy from the decelerated motor is passed on to the mains as regenerated electrical energy. A passive rectifier would require a braking resistor to consume the surplus energy as heat. The AFE is energy efficient for the application where the motor deceleration is frequent. Also the brake resistor space is saved.

The LCL filter allows the power flow. It also reduces the ripple current of the fundamental frequency, switching frequency, and their harmonics into the mains. A damping resistor Rd is connected in series with the filter capacitor Cf to stabilize the filter resonance.

The three inverter units are connected in parallel to achieve the required power level. One AFE controller regulates the three parallel-connected inverter units.

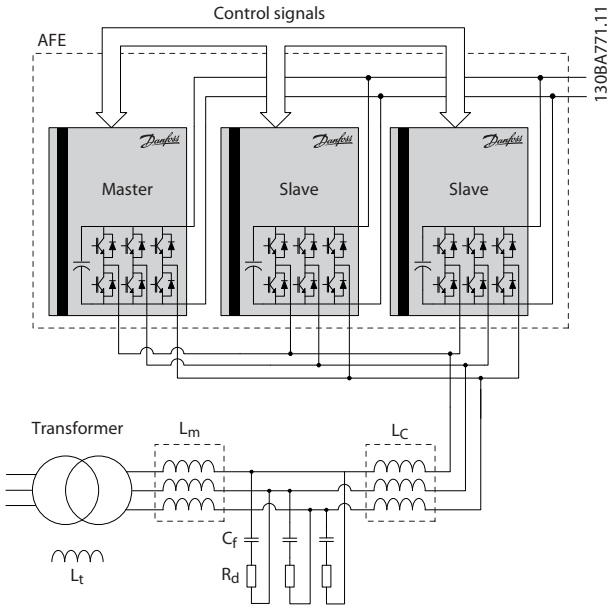


Illustration 2.1 Active Front End System Example

3 Crane System Design

3.1 Selection of Motor Voltage

The AFE system is designed to regulate a DC voltage of 630x1.08=680 V. 690 V motors are suitable for this system. When the motors are used in the field weakening region or with output filters, the motors with less than 650 V are used.

3.1.1 Selection of AFE & LCL Filter

- AFE systems are built up based on standard 690 V hardware.
- Standard AFE hardware runs on 630 V mains supply and DC-link voltage is 975 V.

3.1.2 Selection of AFE for Different Applications

- The frequency converter power size in the flux application must be one or two sizes higher than the application needed. Also, the frequency converter should not be higher than two to maintain a good resolution on current sensors.
- The AFE electrical rating should be selected based on the worst-case total power, including the overload percentage, rather than a mere sum of the motor power.
- Example:

  Hoist motors 500 kW @ 650 V - Hoist drives 800 kW

  Travel motors 8x50 kW @ 650 V - Travel drive 500 kW

  Trolley motors 4x55 kW @ 650 V - Trolley drive 400 kW

  AFE/LCL – 1,2 MW continuous, with a 175% overload for a maximum 1 min.

3.1.3 Selection of Output Filter (LC Filter)

- The output filter is needed because of the long motor cable configuration.
- Output filters should be sized based on the frequency converter's maximum output current.
- The dU/dt filters can be used up to 100 m to protect the motor. The sine-wave filters can be used with any cable length (maximum of 1,000 m).
- Above 150 m cable length it is recommended to use a sine-wave filter.
- The cable length is calculated as the sum of all parallel cables.
- Filters must be designed to switching frequency of the frequency converter. The resonance frequency, f0, of the filter should be:
  $10 \times fout\ max \le f0 \le \frac{fsw}{3}$
- The resonant frequency must meet the following equation, limited by the control frequency, f_{con}:
  $f0 < \frac{fcon}{6}$

Switching frequency [kHz]	Control frequency[1)] [kHz]
1.5	3
2	4
2.5	5
3	6
3.5	7
4	4
5	5
6	6
7	7

Table 3.1 Frequencies

1) The control frequency is an internal hardware frequency.

3.1.4 Selection of Switching Frequency

It is recommended that the switching frequency of AFE and motor drives shall be equal or an integer multiple of each other.

3.1.5 Selection of LCL Filter

The AFE system is designed in conjunction with the recommended Danfoss LCL filters in which the physical size, power rating and electrical parameters of the filters are optimized.
If non-Danfoss filters are used, system performance and stability may be degraded.

3.1.6 Crane Cable Concept

To reduce the high frequency noise on the mains line and to meet the EMC emission limits, the electromagnetic coupling should be avoided and the following rules have to be applied:

1. Use the shielded cable between the sine-wave filter and frequency converter.
2. Keep the unshielded cable away from the mains cable. The two cables should not be run in parallel.
3. If the installation requires to route the motor cables and mains cables in parallel, keep a distance of at least 45 cm between the two cables. Separate the cables by placing them in different cable trays or in different sections of a cable tray.
4. Use continuous cable trays and avoid "ladder-type" cable trays.
5. Route the motor cable along the metallic grounded conductors such as cable trays, rails from the building structure, pipes, etc.

3.1.7 Grounding Concept

- Do the common grounding between AFE and motor drives.
- The output filters and LCL should have low impedance grounding to the AFE and motor frequency drives.
- Ensure low impedance between entire crane construction and the cabinets and the transformer.
- Use only one connection to the transformer.

3.1.8 Cooling and Airflow

Cooling
The cooling air can be channeled through the air ducts at the top and bottom of the unit, through the back of the unit, or through the combination of the both methods.

Duct cooling
The duct cooling kit is used to install IP00/chassis D and E-frame frequency converters in the Rittal TS8 enclosure. See *Installation of Duct Cooling Kit in Rittal enclosures*, for further information.

Back cooling
The D and E frame frequency converters can be mounted in the Rittal cabinet where the cabinet backplate has cutout, through which the back-channel cooling is available.

NOTICE

The ideal cooling air is clean and dry. When the cooling air is from outside, the filter mats and long air inlet may be considered to prevent the dirty air problem. When the application environment is humid, consider the condensation of the frequency converter which may require the drain outlet.

NOTICE

The door fan(s) is required on the Rittal cabinet to remove the heat losses from the frequency converter and other components inside the enclosure. The total air flow required must be calculated and the appropriate fan can be selected. Rittal Therm software can calculate the cooling air flow volume. If the frequency converter is the only heat generating source in the enclosure, the minimum airflow required at an ambient temperature of 45 °C for the D3 and D4 frame sizes is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45 °C for the E2 frame size is 782 m^3/h (460 cfm).

Airflow
Table 3.2 shows the necessary airflow over the heat sink.

Enclosure protection	Frame size	Door fan(s)/Top fan airflow	Heatsink fan(s)
IP54/NEMA 12	F1, F2, F3 and F4	525 m^3/h (309 cfm)*	985 m^3/h (580 cfm)*
IP00/Chassis	D3 and D4	255 m^3/h (150 cfm)	765 m^3/h (450 cfm)
	E2 P400T7	255 m^3/h (150 cfm)	1105 m^3/h (650 cfm)
	E2 P500-P560T7	255 m^3/h (150 cfm)	1445 m^3/h (850 cfm)
* Airflow per fan. Frame size F contain multiple fans.			

Table 3.2 Heatsink Air Flow

NOTICE

The fan runs for the following reasons:

1. **AMA**
2. **DC Hold**
3. **Pre-Mag**
4. **The frequency converter current exceeds 60% of its nominal current rating.**
5. **The heat sink temperature exceeds its limit. The limit depends on the power size.**

When the fan is activated, it will run for a minimum of 10 min.

External ducts
If additional duct work is added externally to the Rittal cabinet the pressure drop in the ducting must be calculated. Use the charts below to derate the frequency converter according to the pressure drop.

3

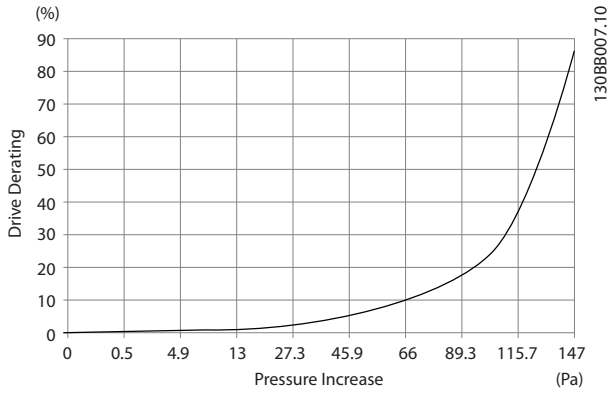


Illustration 3.1 D frame derating vs. pressure change
frequency converter air flow: 450 cfm (765 m³/h)

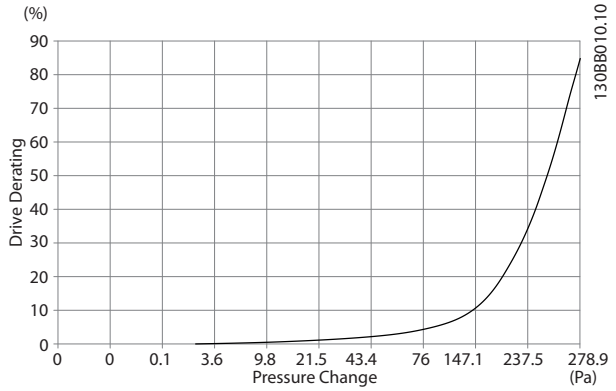


Illustration 3.2 E frame derating vs. pressure change (small fan), P355T7-P400T7
frequency converter air flow: 650 cfm (1105 m³/h)

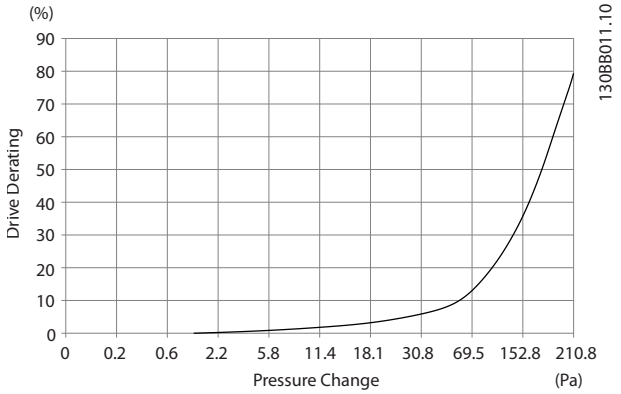


Illustration 3.3 E frame derating vs. pressure change (large fan), P500T7-P560T7
frequency converter air flow: 850 cfm (1445m³/h)

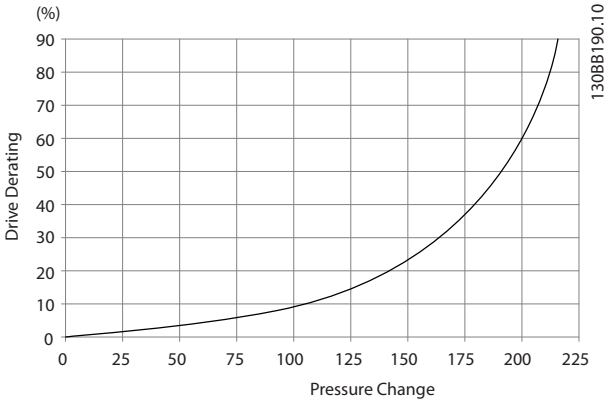


Illustration 3.4 F1, F2, F3, F4 frame derating vs. pressure change
frequency converter air flow: 580 cfm (985 m³/h)

3.1.9 Selection of Transformer

- The output of the HT-transformer must be specified for 630 V.
- It is recommended to use 2 separate transformers for 630 V and the 400 V and these transformers should be physically separated. The 400 V transformer must be close to or in the E-house to have a short ground cable.

NOTICE

Danfoss reviews/evaluates the LCL filter design for each application especially when the new transformer is used.

3.2 Assembling the Frequency Converter System

3.2.1 Tools Required

Operating Instructions for the FC Series.

Metric socket set	7–19 mm
Socket extensions	1/4" drive size, 4", 6" and 12"
Torx driver set	T8-T50
Torque wrench	0.675–19 Nm (6–168 in-lbs)
Needle nose pliers	
Magnetic sockets	
Ratchet	
Hex wrench set	
Screwdrivers	Standard and Phillips

Table 3.3 Tools Required

Additional Tools Recommended for Testing

Digital volt/ohmmeter (rated for 1200 V DC)
Voltmeter
Oscilloscope
Clamp-on style ammeter
Test cable PN 176F8766
Signal test board PN 176F8437
Power supply: 500-1000 V DC, 250 mA to supply external power to 4 power cards and the control card.
Power supply : 24 V DC, 2 A for external 24 V power supply.

Table 3.4 Additional Tools

3.2.2 General Tightening Torque Values

Table 3.5 tabulates the tightening torque values. The tightening toque values for the rectifier and IGBT modules are referred to in the instruction within the spare kits.

Shaft size	Driver size Torx/hex	Torque [in-lbs]	Torque [Nm]
M4	T-20/7 mm	10	1.0
M5	T-25/8 mm	20	2.3
M6	T-30/10 mm	35	4.0
M8	T-40/13 mm	85	10
M10	T-50/17 mm	170	19
M12	18 mm/19 mm	170	19

Table 3.5 Torque Values

3.2.3 Exploded Views

Number	Terminal and component description
1	Fan Voltage Supply (FVS)
2	Soft Charge Board (SC)
3	FVS Fuse (TB10)
4	SC Fuse (TB11)
5	Aux Fan Fuse
6	Fan Fuse
7	SMPS Fuse
8	Mains Terminals (R, S, T)
9	Aux Relay (TB12) 01 02 03 04 05 06
10	VSYNC (TB13) (Only for AFE Cabinet) 01-R, 02-S, 03-T
11	Control Card
12	MDCIC
13	Control Panel (Check the enlarged view)
14	DC Terminals (DC+ and DC-)
15	DC Bus Fuses

Table 3.6 Legend for *Illustration 3.6* to *Illustration 3.18*

The rated voltage and maximum current magnitudes for the AUX relay and VSYNC terminals are as follows:
AUX Relay: 240 V AC 2 A
VSYNC: 630 V 1 A

NOTICE

The control circuit including the control card terminal is PELV isolated and it is also isolated from the power circuit galvanically.

3

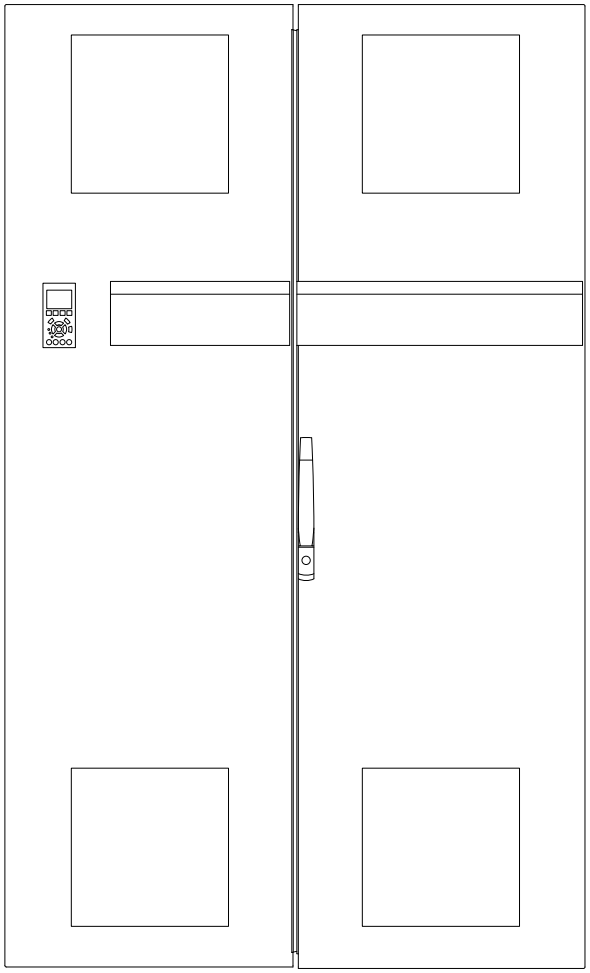


Illustration 3.5 Front Door View

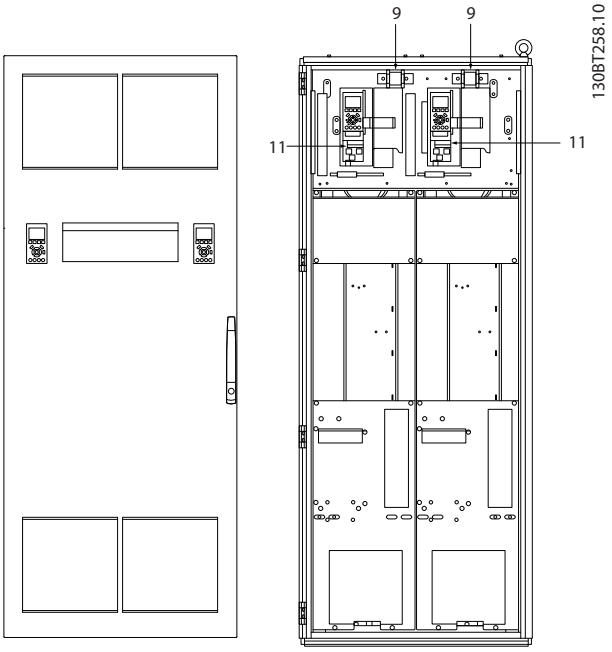


Illustration 3.7 Outside- and Inside View

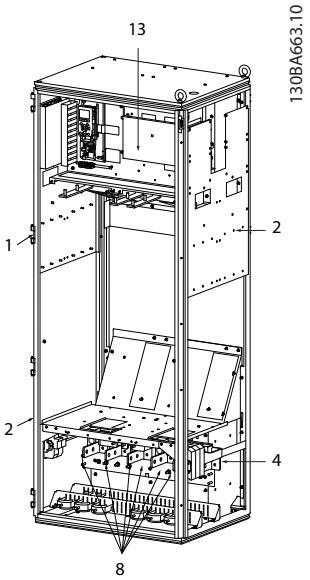


Illustration 3.8 800 mm Cabinet Skeleton View

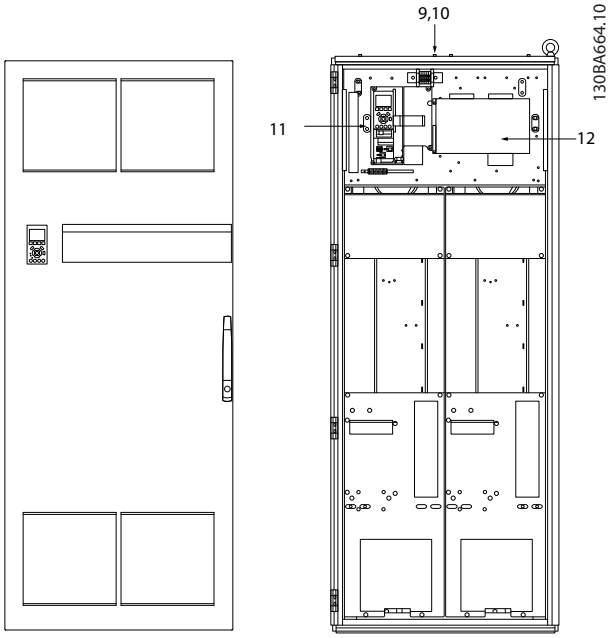


Illustration 3.6 800 mm Cabinet Front Door and its Inside Views (One Drive Case)

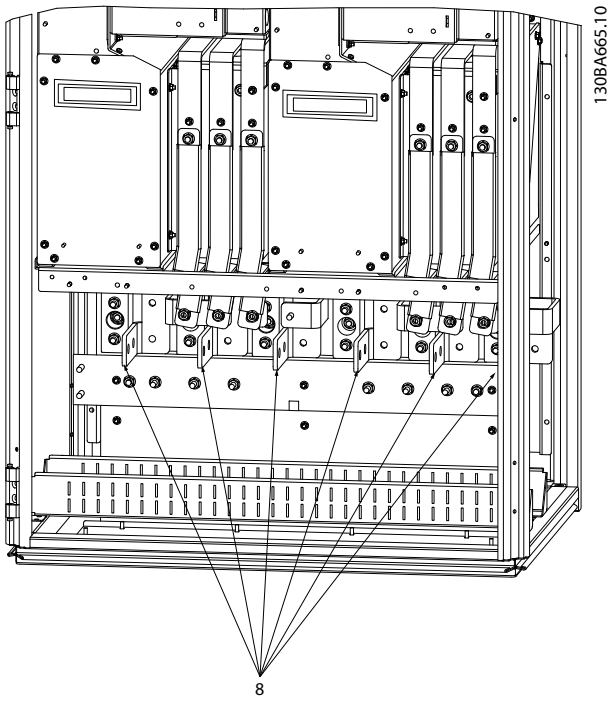


Illustration 3.9 800 mm Lower Front End View

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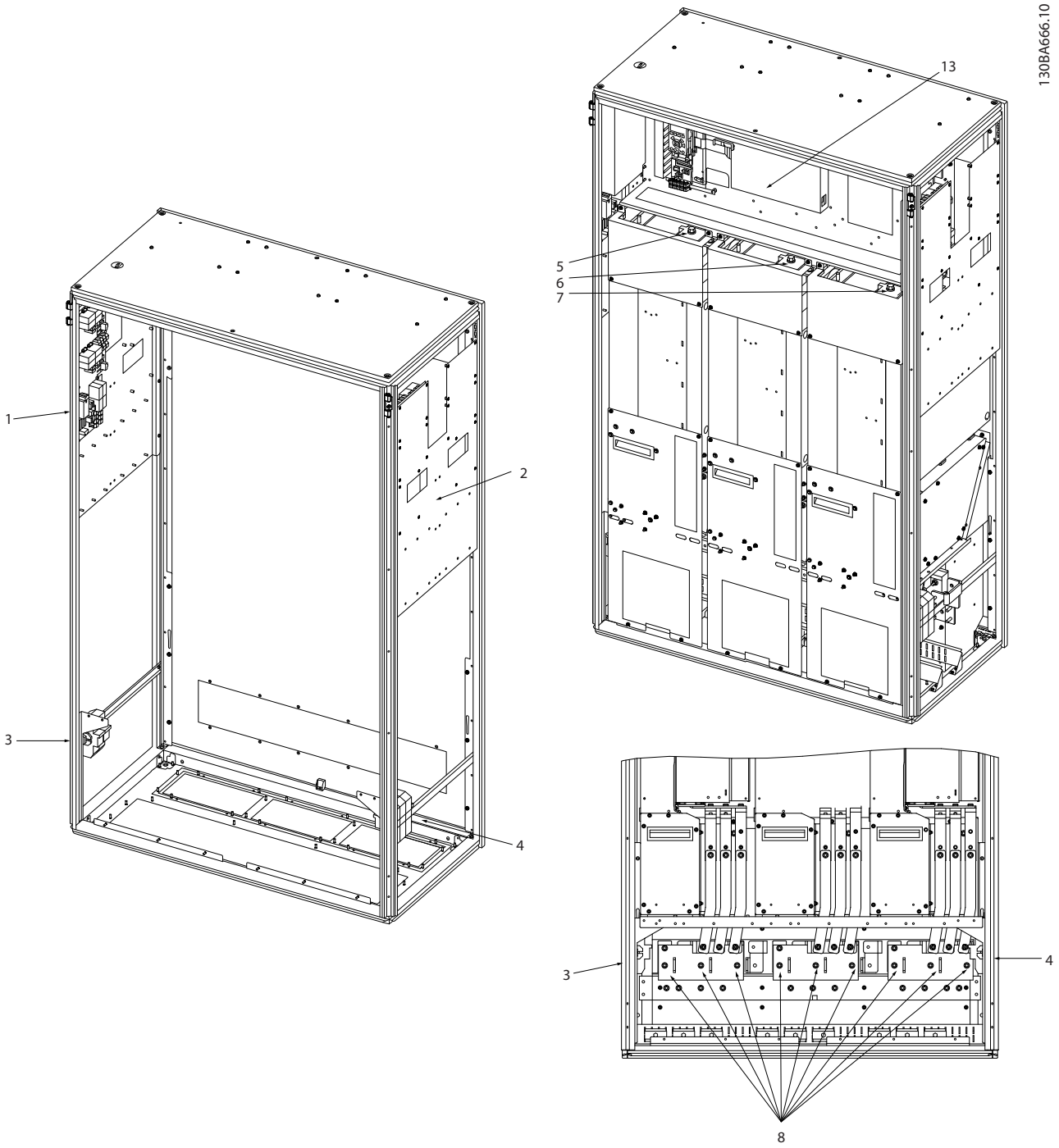

Illustration 3.10 1200 mm Cabinet Exploded View

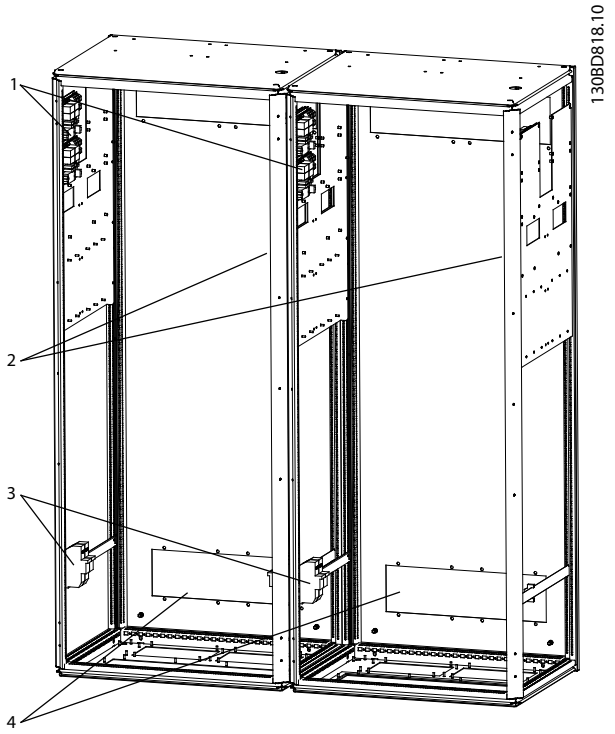

Illustration 3.11 1600 mm Cabinet Exploded View

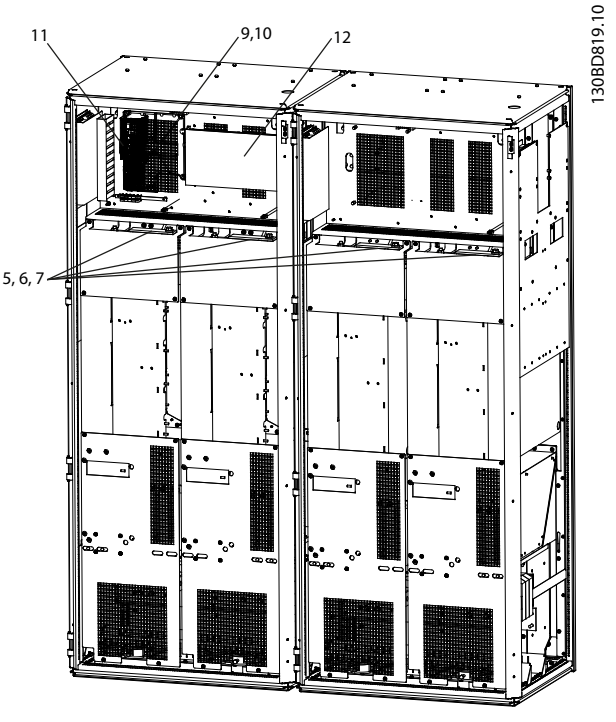

Illustration 3.12 1600 mm Cabinet Exploded View

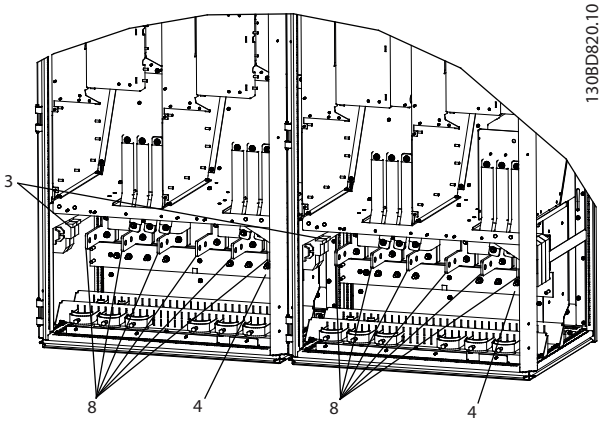

Illustration 3.13 1600 mm Cabinet Exploded View

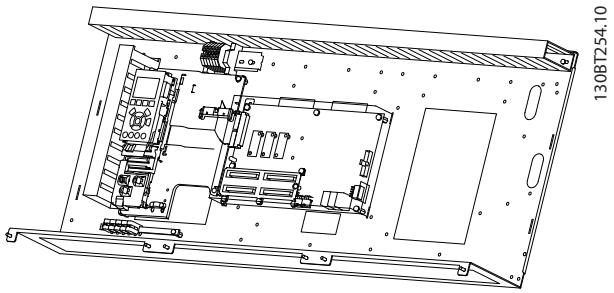

Illustration 3.14 One-drive Configuration Control Panel View

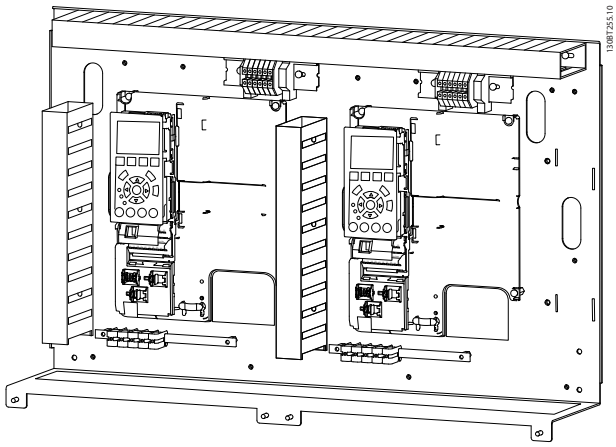

Illustration 3.15 Two Independent Drive Configuration Control Panel View

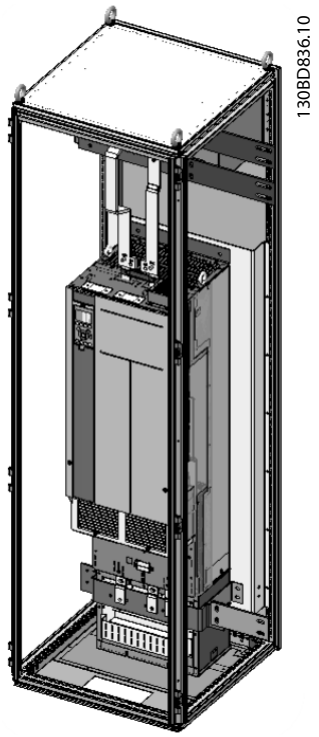

Illustration 3.16 600 mm Drive Cabinet

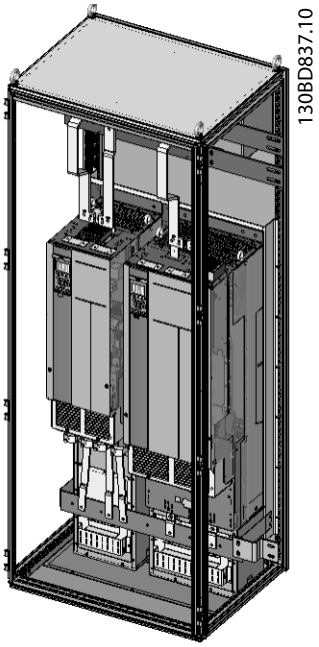

Illustration 3.17 800 mm Drive Cabinet

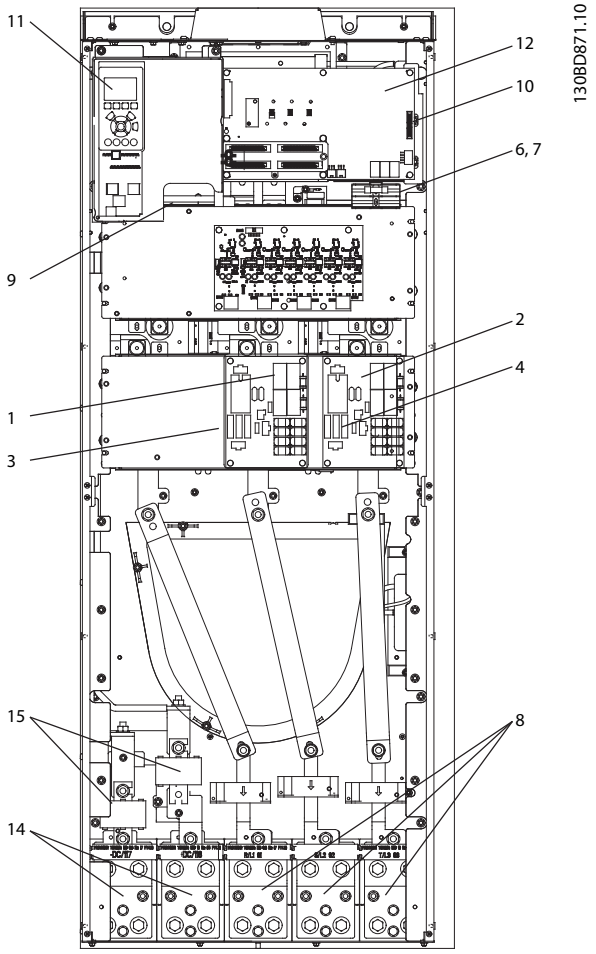

Illustration 3.18 AFE E-frame Drive Open View

3.2.4 MDCIC Connector Configuration

The MDCIC board has the four connectors. The ribbon cables from the power units will be connected from FK100 to FK103.

For one power unit configuration, the part 176F9091 which consists of the DC/DC converter and the ribbon cable is connected to FK101. It generates an isolated 5 V from an internal 24 V for the RS-485 communication.

FK100 (Master)	FK102 (Slave 2)
FK101 (Slave 1)	FK103 (Slave 3)

Table 3.7 MDCIC Port Layout

3.3 First Power Up/Commissioning Check List

The following measurement equipment are recommended:

- Voltage meter (1 kV AC/DC env. Cat III)
- Current clamp min. 2 kA
- Harmonic analyzer, only for commissioning

Check list

- Check fan voltage supply (3x400 V).
- Verify that system is not powered.
- Verify the system is grounded to earth.
  - all AFEs and frequency converters
  - all motors
  - all filters
  - the whole crane construction
  - HT transformer
- Check that there are no earth faults or short circuits at the motor cables and motors.
- Check that the DC discharge resistor is connected right and not shorted.
- Verify phase sequence and continuity for the voltage sensing on the AFE as described below.
  - Make sure that power is not applied.
  - Manually close input contactor between AFE and LCL filter.
  - Unplug the MK105 connector on the MDCIC.
  - Measure MK105 of MDCIC harness to the input phases.
  - Red wire of MK105 to phase R.
  - White wire of MK105 to phase S.
  - Black wire of MK105 to phase T.
  - All should be <0.2Ω.
- Open the input contactor between AFE and LCL filter.
- Verify that the mains voltage is 630 V RMS and balanced.
- Apply power to the LCL filter and verify that the rms current magnitude measured between the line and delta connection point is approximately same as the value using the following formula: $_{i=}\frac{630\times314\times C\times3}{\sqrt{3}}$, where C is the LCL filter capacitance, delta value.
- Leave the AFE main contactors open and disallow the AFE start signal in the PLC.
- Soft charge the system but do not enable the main contactor.
- Let the softcharge circuit active for about 5min.
- Check the voltage at the AFE Mains side when the AFE is powered up by softcharge. The voltage between all phases should be 0 V. Also the voltage between the phases L1/L2/L3 and earth should be 0 V. Please call Danfoss service if you can measure a voltage greater then 10 V here. Do not switch on the mains contactors if you measure a voltage more than 10 V here.
- Verify that the LCP readings for the DC-link voltage from all the AFE and inverter drives are within ±2% of the value measured with the voltage meter. The estimated DC-link voltage value at 630 V mains voltage with no load is as follows:
  $890\,VDC+5/-10\% = (Vmains\_LL\_RMS\times\sqrt{2}+5/-10\%$
  $=630\times1,414+5/-10\%)$
- Download all the AFE and frequency converter settings with MCT 10 Set-up Software.
  1. Capacitance value of the LC filter in the inverter drive must be star equivalent.
  2. Set the right LCL filter values in the AFE, the capacitance value of the LCL filter shall be entered as delta equivalent.
  3. Set the right mains values in the AFE.
  4. Parameter group *4-** Output Limits* AFE – use factory settings.
  5. Total system capacitance par. 7-60 must be programmed with a sum of the DC-link capacitance x 0,9.

6. Use parameter group *7-** Controllers* as follows:
    - Parameter *7-61 DC-Link Reference* is 975 V.
    - Parameter *7-62 DC-Link PI Proportional Gain* (Kp) is calculated internally based on the power size and DC capacitance in parameter *7-60 DC-Link Total Capacity*. Recommend to use the default value. The wrong setting could cause the unstable DC voltage regulation.
    - Parameter *7-63 DC-Link PI Integral Time* (Ti) is 5 ms in default.

- Switch Crane off.
- Program the PLC to the normal start-up sequence.
- Switch Crane on.
- The AFE starts, but not any of the inverters, and verify that the AFE and inverter LCP readings are 975 V DC and that they are within ±2% of a calibrated voltage meter.
- Check if all fans are running after closing the mains contactor.
- Start checking inverters and motors.
- Save all parameter settings with MCT 10 Set-up Software.
- For the crane commissioning, measure THDu and THDi of the 630 V and 400 V terminals and document the results in the commissioning certificate.
- Verify that the THD levels of the 400 V terminal are complied to EN 61000-3 or other country specified harmonic requirements.

3.4 E-House Design

3.4.1 Cables between AFE and LCL Filters

- The cables should be as short as possible.
- The connection must be made with shielded cables.

The synchronization voltage cable which is connected to the AFE-MDCIC board MK105 must be separated from all power cables. The distance needs to be at least 50 cm from other power cables.

3.4.2 Cables to the Damping Resistors

The cables should be as short as possible.

3.5 Test with the Real System Transformer and Motors

3.5.1 Re-program the Frequency Converter Parameters

- Set the mains voltage, mains frequency, the transformer values, LCL filter values, and DC capacitance.

3.6 On-site Final Test

3.6.1 Change Parameters to Actual

- Set actual cable length.
- Check encoder wiring and encoder direction.
- Optimize ramp time shapes.
- Save parameter settings in the LCPs.

3.6.2 Run with Full Load

- Check that AFE input voltage is stable. The voltage waveform does not need to be sinusoidal.
- Check that DC-link voltage is stable.

3.7 AFE Emergency and Restore Procedures

Chapter 3.7.1 Emergency Run when One Slave Unit is Damaged to *chapter 3.7.4 Restoration after Master Unit is Repaired* describe how to set up an emergency run and how to restore the drive for the case where one of the three units are damaged. *Chapter 3.7.5 Emergency Run When More Than One Unit is Damaged* describes the case where the multiple units are damaged.

3.7.1 Emergency Run when One Slave Unit is Damaged

NOTICE

The mains synchronization voltage is always connected to the MDCIC board. Make sure that the mains power switch is off before opening the frequency converter cabinet.

NOTICE

The power is reduced to two thirds of the original.

1. Switch Crane off.
2. Switch the circuit breaker in front of the damaged AFE power unit off.
3. Check the DC-link voltage with a voltage meter at the terminals before and after the DC fuses.

NOTICE

Do not touch until the DC voltage is below 10 V.

4. Disconnect the DC-link fuses of the damaged power unit and AC connection.
5. Disconnect the softcharge connector on the softcharge board of the damaged power unit.
6. Disconnect the ribbon cable, from the damaged AFE power unit, on the MDCIC card.
7. If the removed connector is at Inverter 2 position, move the ribbon cable at Inverter 3 position to Inverter 2.
8. Turn the key switch to *AFE emergency mode*.
9. Switch Cane on.
10. Check on the AFE LCP if it is in set-up 2. The set-up shift at the AFE is done with terminal 32 at AFE control card. Terminal 32 = 0 means set-up 1, Terminal 32 = 1 means set-up 2.
11. A warning 78 (power unit set-up) may come up at the AFE LCP.
12. Switch Crane off.
13. Wait at least 20 s. All LCPs must be completely off.
14. Switch Crane on.
15. The warning 78 disappears and the warning 77 (Reduced power mode) appears on LCP.
16. The AFE can run with two units with a reduced power.

3.7.2 Restoration after Slave Unit is Repaired

1. Switch Crane on but do not run any frequency converter.
2. Turn the key switch to *AFE normal mode*.
3. A warning 78 appears on AFE LCP.
4. Check on the AFE LCP if it is in set-up 1. The set-up shift at the AFE is done with terminal 32 at AFE control card. Terminal 32 = 0 means set-up 1, Terminal 32 = 1 means set-up 2.
5. Switch Crane off.
6. Check the DC-link voltage with a voltage meter at the terminals before and after the DC fuses.

NOTICE

Do not touch until the DC voltage is below 10 V.

7. Bring back the ribbon cables on the MDCIC card in the original set-up (AFE Master to Inverter 1, AFE Slave left to Inverter 2, AFE Slave right to Inverter 3).
8. Connect the softcharge connector on the softcharge board.
9. Connect the DC-link fuses and AC connection.
10. Switch on the circuit breaker in front of the AFE.
11. Switch Crane on.
12. The AFE runs now with all 3 power units.

3.7.3 Emergency Run when Master Unit is Damaged

NOTICE

The power is reduced to two thirds of the original.

1. Switch Crane off.
2. Switch the circuit breaker in front of the damaged AFE power unit off.
3. Check the DC-link voltage with a voltage meter at the terminals before and after the DC fuses.

NOTICE

Do not touch until the DC voltage is below 10 V.

4. Disconnect the DC-link fuses of the damaged power unit and AC connection.
5. Disconnect the softcharge connector on the softcharge board of the damaged power unit.
6. Disconnect the ribbon cable from the Inverter 1 position at the MDCIC.
7. Unplug the ribbon cable at Inverter 3 position on the MDCIC card and plug it at Inverter 1 position.
8. Plug this ribbon cable (what you plugged out from Inverter 3) on the connector Inverter 1. Now the right power unit will be the AFE Master.
9. Turn the key switch to *AFE emergency mode*.
10. Switch Crane on.
11. Check on the AFE LCP if it is in set-up 2.
12. A warning 78 may appear on AFE LCP.
13. Switch Crane off.
14. Wait at least 20 s. All LCPs must be completely off.
15. Switch Crane on.
16. The warning 78 disappears and the warning 77 appears on LCP.
17. The AFE can run with two units with a reduced power.

3

3.7.4 Restoration after Master Unit is Repaired

1. Switch Crane on but do not run any frequency converter/motor.
2. Turn the key switch to *AFE normal mode*.
3. A warning 78 appears on AFE.
4. Check on the AFE LCP if it is in set-up 1 (see attached file LCP.pdf). The set-up shift at the AFE is done with terminal 32 at AFE control card. Terminal 32 = 0 means set-up 1, Terminal 32 = 1 means set-up 2.
5. Switch Crane off.
6. Check the DC-link voltage with a voltage meter at the terminals before and after the DC fuses.

NOTICE

Do not touch until the DC voltage is below 10 V.

7. Bring back the ribbon cables on the MDCIC card in the original set-up (AFE Master to Inverter 1, AFE Slave left to Inverter 2, AFE Slave right to Inverter 3).
8. Connect the softcharge connector on the softcharge board.
9. Connect the DC-link fuses an AC connection.
10. Switch on the circuit breaker in front of the AFE.
11. Switch Crane on.
12. The AFE runs now with all 3 power units.

3.7.5 Emergency Run When More Than One Unit is Damaged

When multiple units are damaged, an emergency run with a minimum of one unit can be performed. The procedure of setting up the emergency run and restoring from the emergency run can be referred to in *chapter 3.7.1 Emergency Run when One Slave Unit is Damaged* to *chapter 3.7.4 Restoration after Master Unit is Repaired*.

The key procedure of an emergency run is as follows:

1. Disconnect AC and DC sides of the damaged units.
2. Change the connector position at MDCIC.
   - 2a The ribbon cables at the MDCIC are connected from FK100 (Master) following FK101, FK102, and FK103. You do not skip the terminal sequence.
   - 2b You can go down to one unit. When one master unit is used, the part (176F9091) needs to be connected at FK101 to have the RS-485 communication.
3. Power up.
   - 3a The warning message W78 (Power Unit Setup) appears on LCP.
   - 3b Change the number of the units in *parameter 14-59 Actual Number of Inverter Units*.
4. Power cycle.
   - 4a The warning message W77 (Reduced Power Mode) appears on LCP.
   - 4b The power is reduced to the original power multiplied by the number of active units over the original number of the units.

The following issues are considered:

1. In an emergency run, the door fan may not be in operation. It is recommended that the emergency configuration is only for a temporary usage.
2. An emergency run may cause the overcurrent alarm at start-up because the start-up current may be high for the number of units used. The switching frequency (*parameter 14-01 Switching Frequency*) may need to be increased from 1.5 kHz to 2 or 2.5 kHz.

3.8 Manual Shut Down Sequence

- Stop all motor drives.
- switch off the AFE start signal.
- Open the mains contactor
- Switch off the HT transformer if necessary
- In emergency, command the AFE to stop and open the AFE contactor, or pull the safe stop and open the AFE contactor.

3.9 Start-up Sequence

Illustration 3.19 shows the typical AFE start-up sequence flow chart. The flow chart describes the interaction among Auxiliary Hardware, AFE Frequency Converters, and Liebherr Control PLC. The arrowed lines indicate the flow of the actions. The Liebherr PLC expects to receive the “Control Ready” and “Ready” signals from the AFE frequency converter and it will send “Run” signal to AFE frequency converter. The waiting periods and the number of tries are tentative. The “Control Ready” signal is on when the power in Control Card is on. The meaning of the "Ready" signal in the AFE frequency converter is different from the one in the standard frequency converter. The “Ready” signal in the AFE frequency converter is on when the DC voltage is boosted to the level where the AFE regulation is enabled.

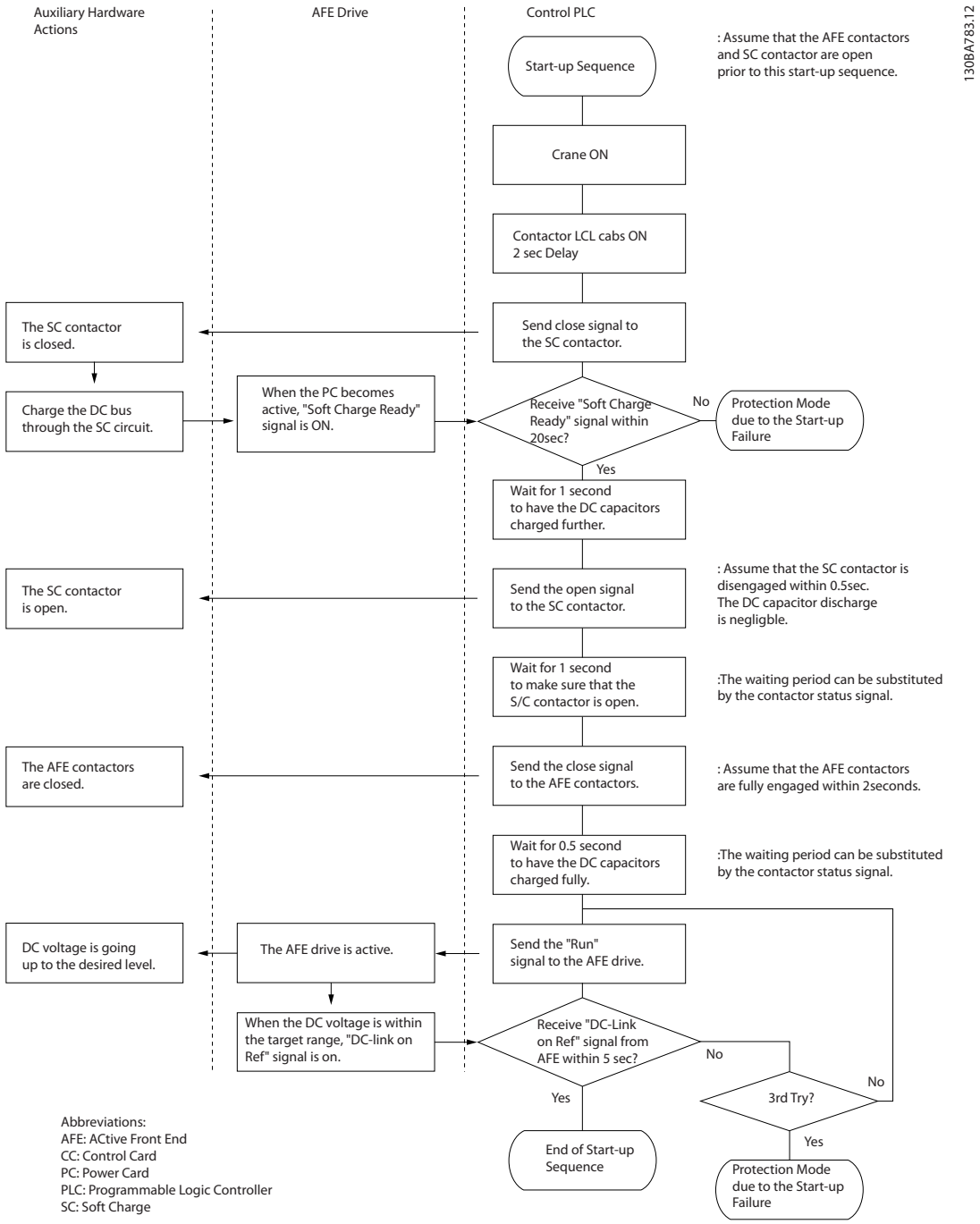

Illustration 3.19 Start-up Sequence Flow Chart

3

3.10 Shut-down Sequence

It is recommended to send a STOP signal to the AFE before shutting down the power.

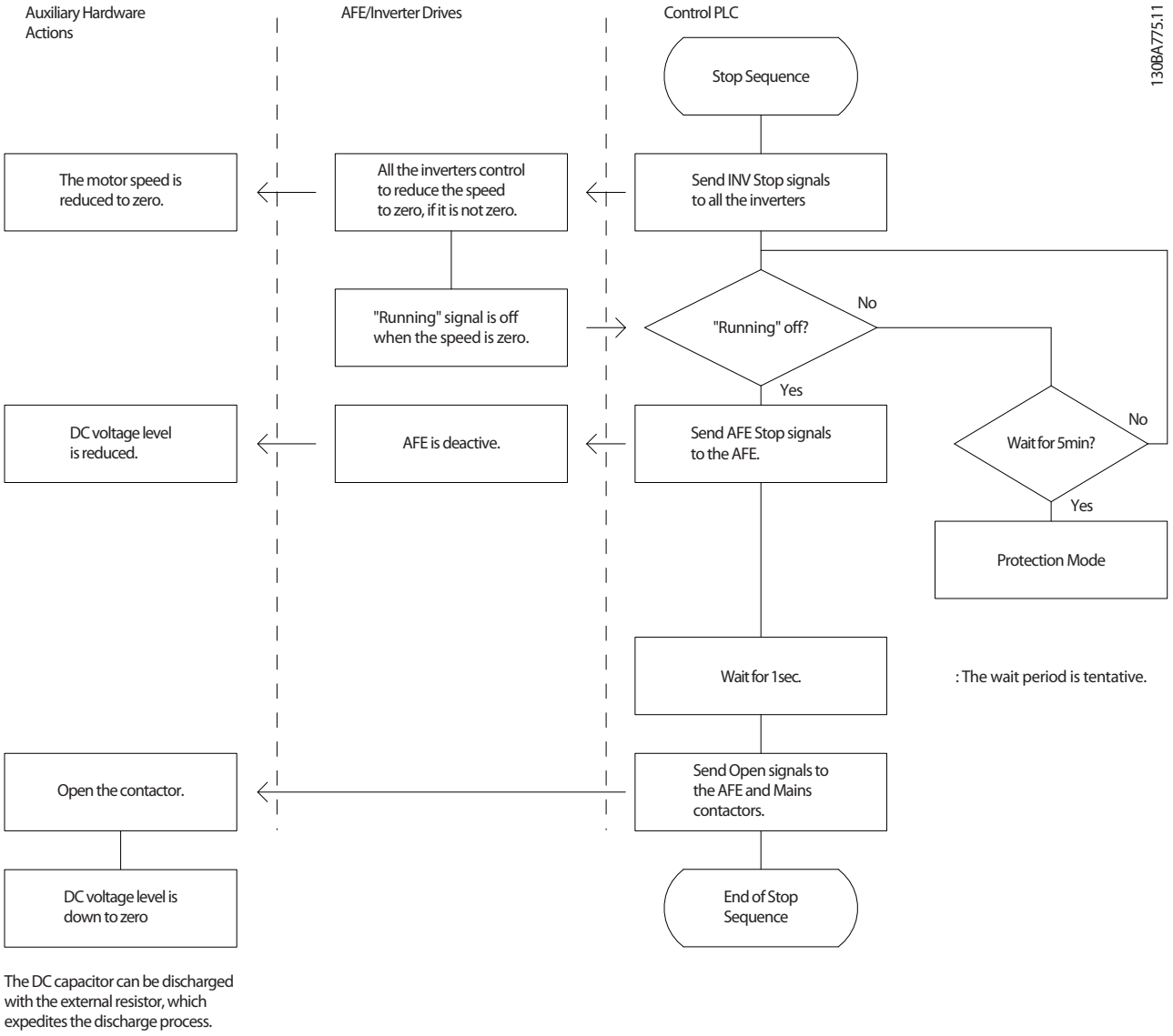

Illustration 3.20 Shut-down Sequence Flow Cart

4 How to Install

This chapter covers mechanical and electrical installations to and from power terminals and control card terminals.

4.1 Overall Typical Frequency Converter Configuration

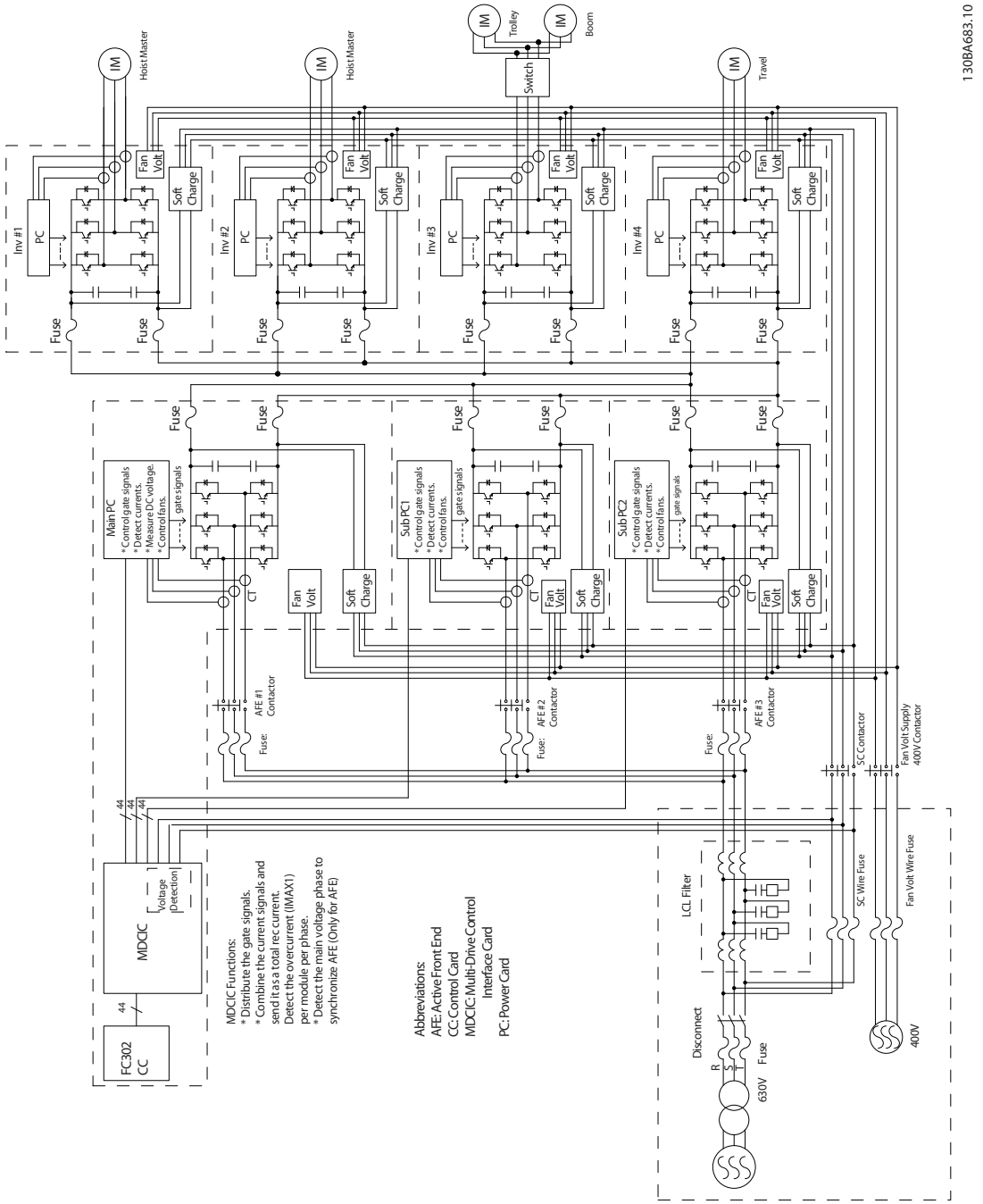

Illustration 4.1 Typical System Overview

The typical 1.2 MW LCL filter components are described below:

1. Lc choke 100 uH
2. Lm choke 29 uH
3. Capacitor 10x 40 uF in delta, 30 pieces
4. Resistors 90 mΩ 4000 W, 3 pieces

4

4.2 Pre-installation

4.2.1 Planning the Installation Site

Before performing the installation it is important to plan the installation of the frequency converter. Neglecting this may result in extra work during and after the installation. Select the best possible operation site by considering the followings:

- Ambient operating temperature
- Installation method
- Cooling method
- Position of the frequency converter
- Cable routing
- Power source supply configuration
- Motor current rating with respect to the frequency converter maximum current magnitude
- Fuse arrangement, either built-in fuses or the properly rated external fusees

4.2.2 Receiving the Frequency Converter

When receiving the frequency converters, please inspect the frequency converters for any damage which may occur during the transportation. When the damage is noticed, please contact the shipping company immediately to claim the damage and let Danfoss know the situation to work for the corrective action.

4.2.3 Transportation and Unpacking

Illustration 4.2 and *Illustration 4.3* show the front and side views of the frequency converter, shipping crate, respectively.

The unpacking procedure is as follows:

1. Remove clips from one long side panel (A) and all around the top.
2. Remove the long side panel (A).
3. Remove the top panel (B).
4. Remove clips from one short side panel (C).
5. Remove the short side panel (C)
6. Remove the rest of the clips.
7. Remove the final two panels.

NOTICE

The package includes the plinth at the bottom of the frequency converter. The plinth allows proper cooling of the frequency converter during the shipment.

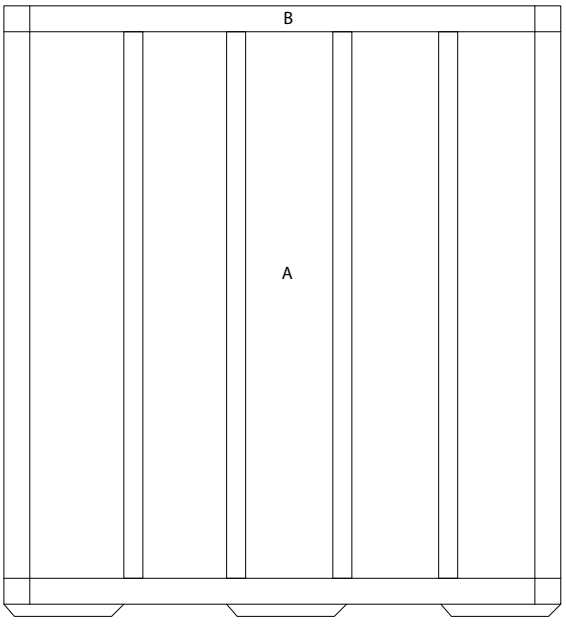

Illustration 4.2 Package Front View

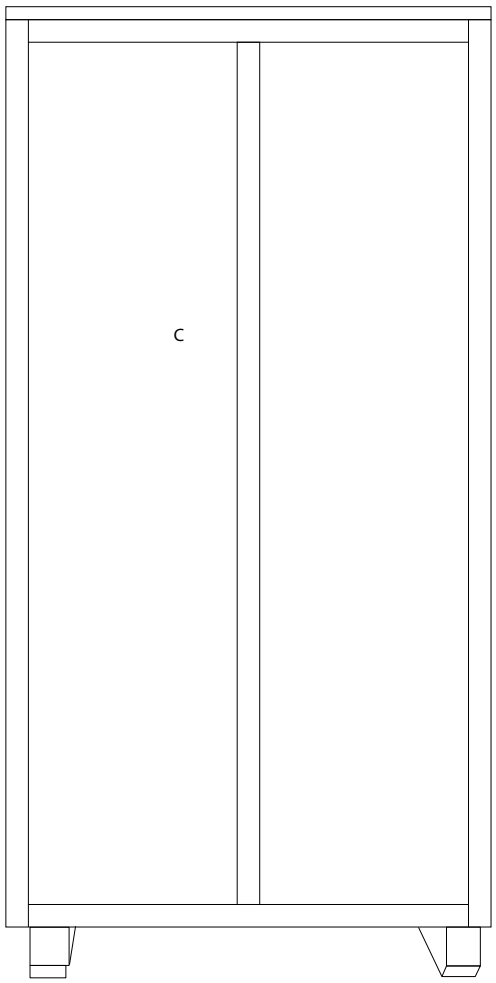

Illustration 4.3 Package Side View

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4.2.4 Lifting

Illustration 4.4 and *Illustration 4.5* show the main load carrying points (1 and 2 in the illustrations) of the F-frame cabinets. Lift the cabinets with all the lifting eyes and/or use a bar to avoid bending the lifting holes of the frequency converters. The same principle is applied for the AFE cabinets.

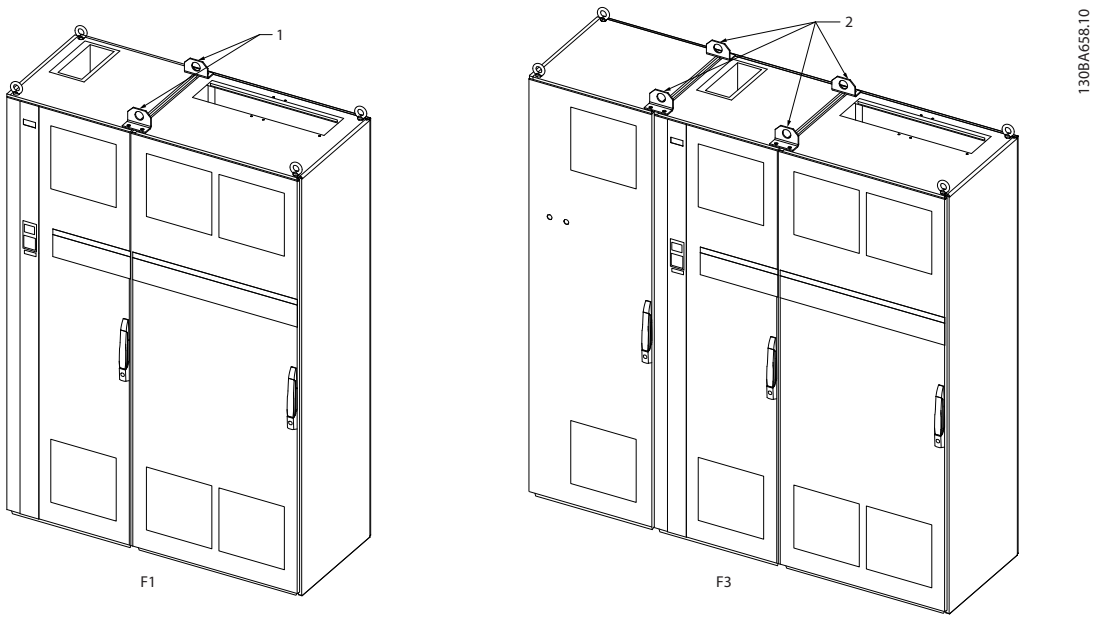

Illustration 4.4 Main Load Carrying Points

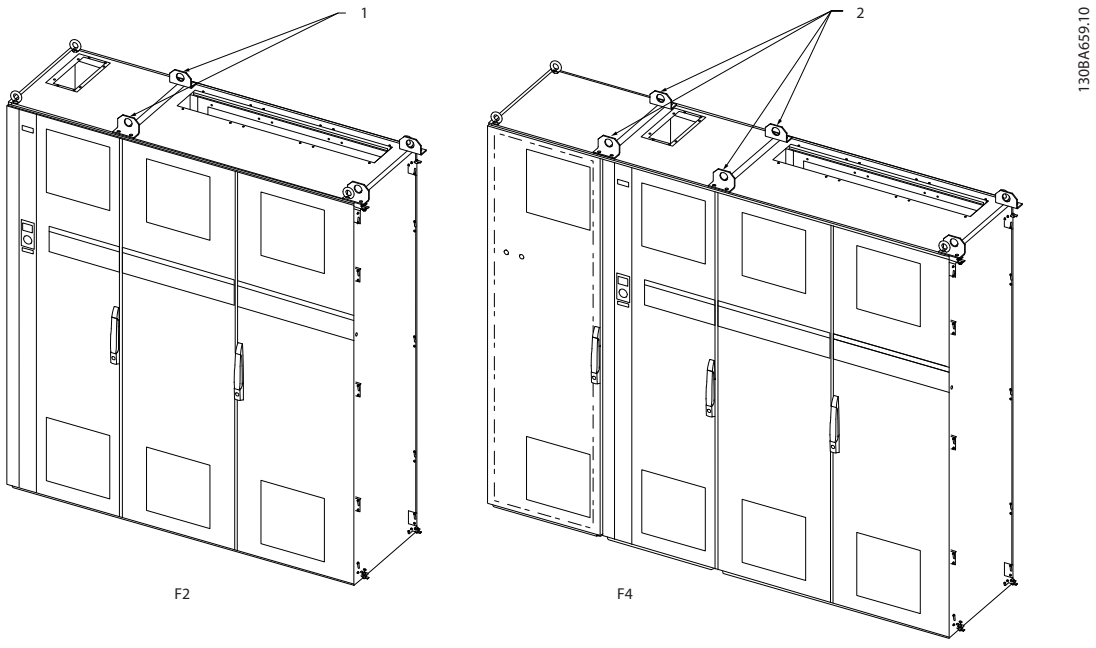

Illustration 4.5 Main Load Carrying Points

NOTICE

The lifting cable angle should be 60° or greater. The spreader bar is an acceptable way of lifting. A spreader bar is an acceptable way to lift the F Frame.

4.2.5 Mechanical Dimensions

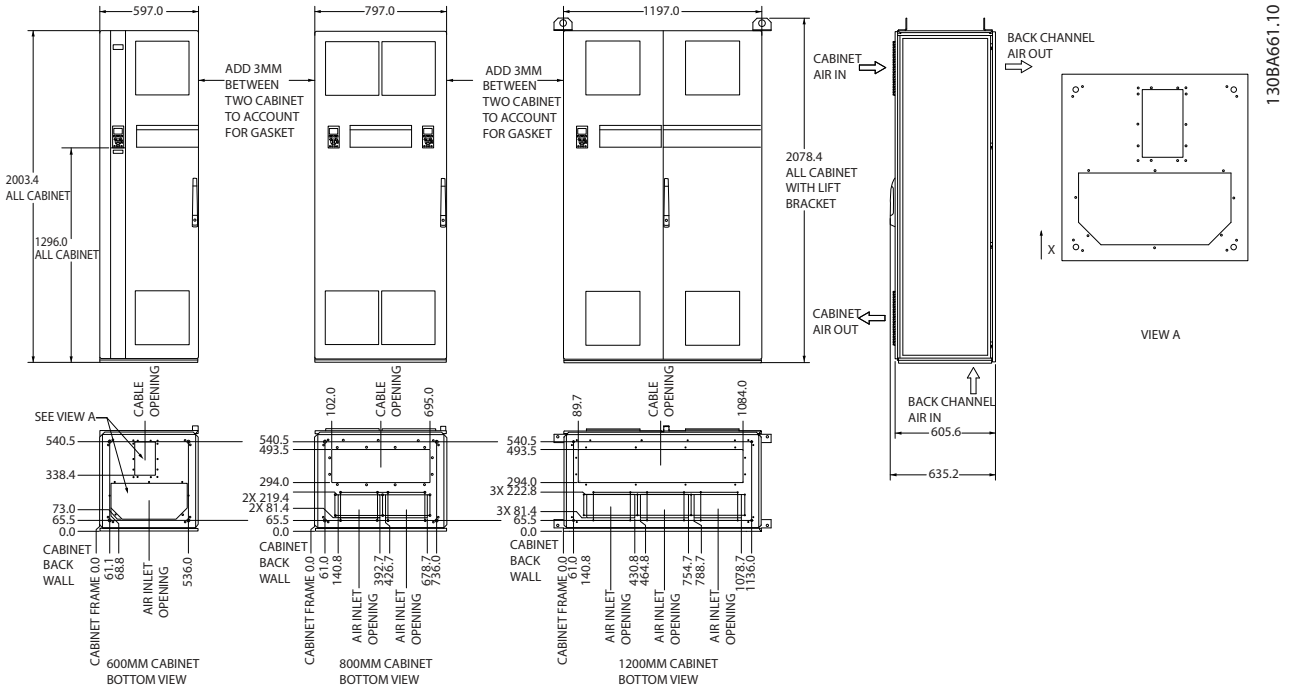

Illustration 4.6 Dimensions

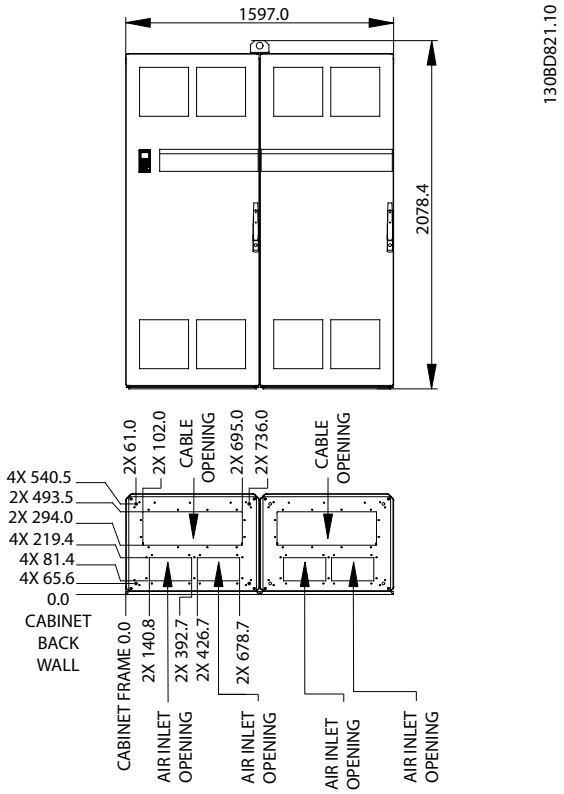

Illustration 4.7 Dimensions 1600 mm Cabinet

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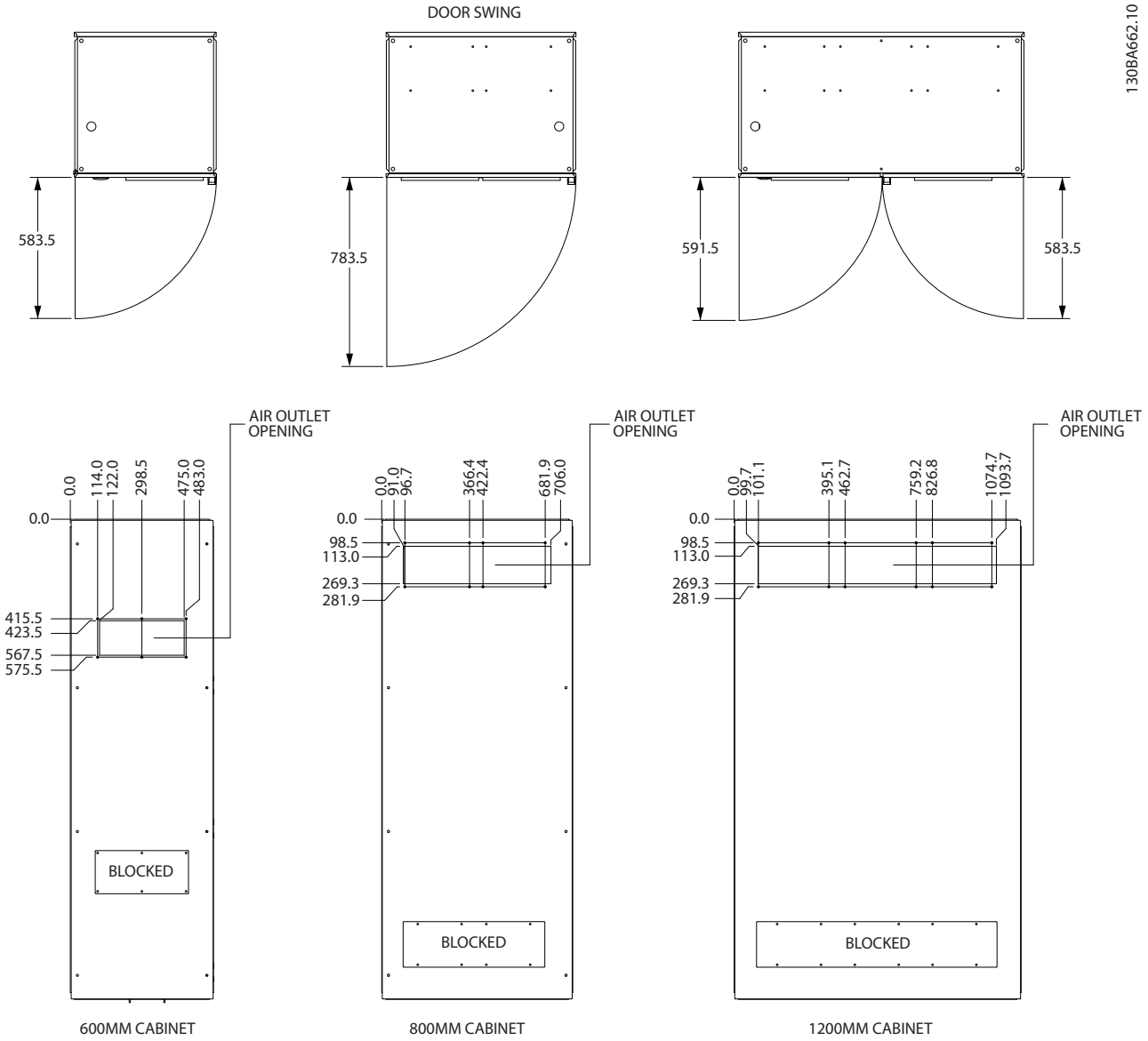

Illustration 4.8 Door Swing View and Back View

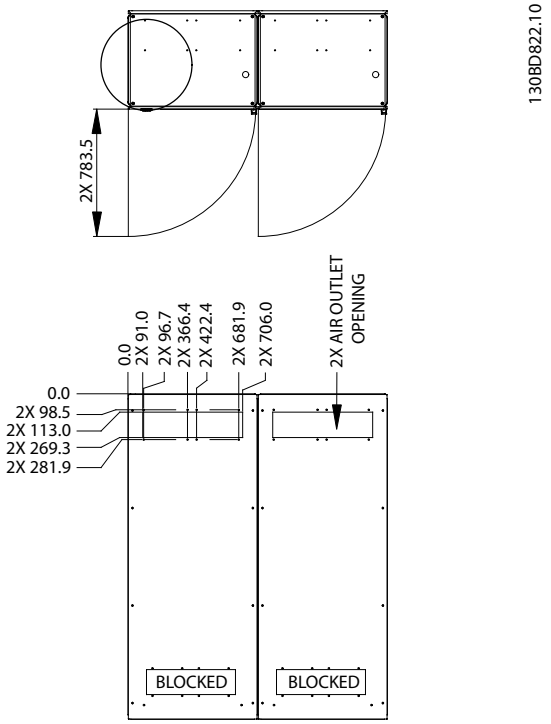

Illustration 4.9 1600 mm Cabinet Door Swing View

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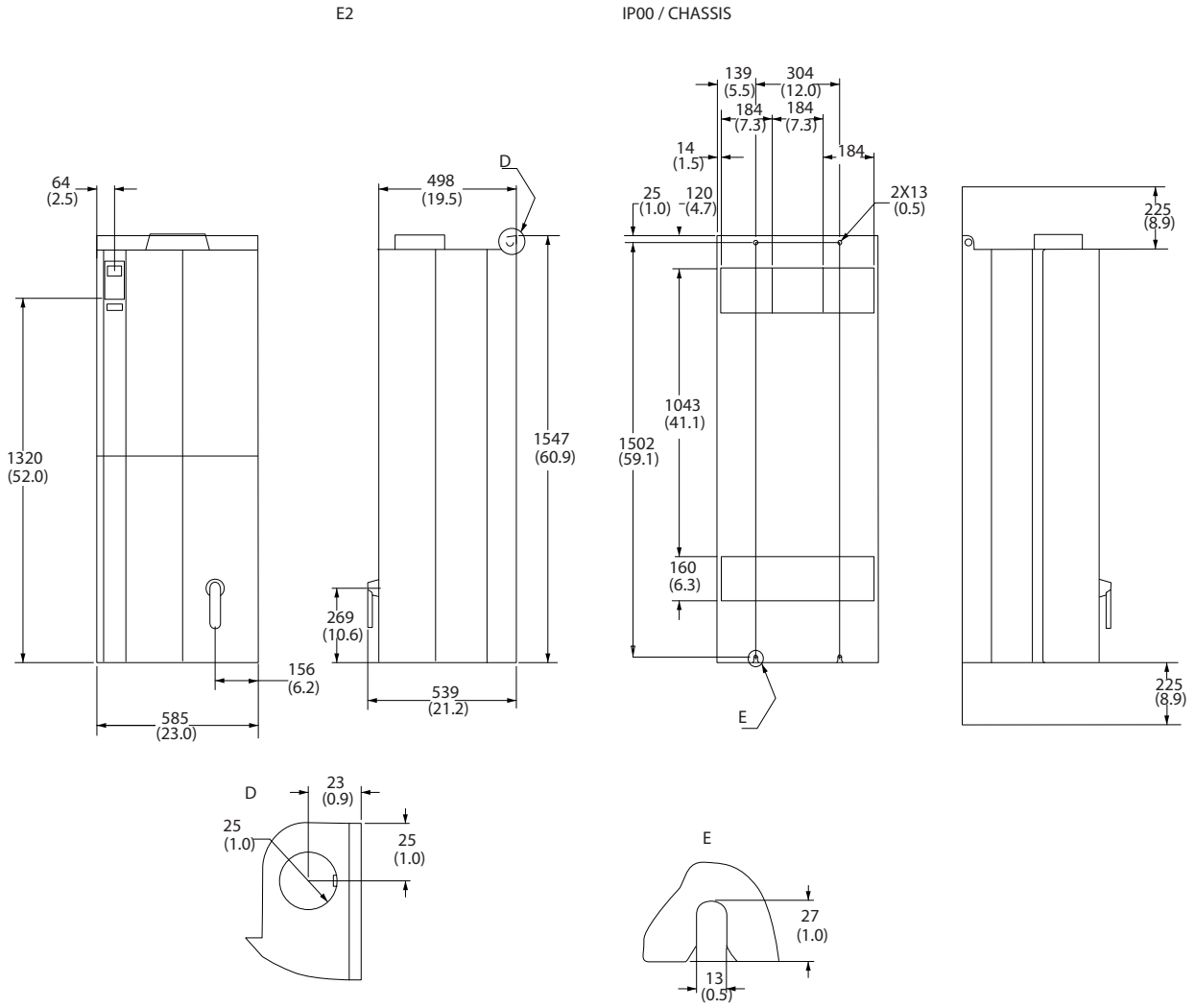


Illustration 4.10 Dimensions E-frame IP00 Drive

4.2.6 Weight Information

Crate length	Crate weight		Cabinet weight		Cabinet content weight		Total package weight		Package contents
[mm]	[kg]	[lbs]	[kg]	[lbs]	[kg]	[lbs]	[kg]	[lbs]	
600	120	252	57	126	159	351	336	729	Cabinet and D frame frequency converter
800	130	273	76	168	306	675	512	1116	Inverter modules Qty. 2
1200	160	336	115	253	459	1012	734	1601	Inverter modules Qty. 3
1200	160	336	115	253	318	701	593	1290	600 mm cabinet qty. 2, D vrame frequency converters qty. 2
1600	260	546	153	337	612	1349	1025	2232	2 x 800 mm cabinet with inverter modules qty. 2, 1600 mm cabinet with inverter modules qty. 4
2000	320	672	191	421	765	1687	1276	2780	1200 mm cabinet with inverter modules qty. 3, 800 mm cabinet with inverter modules qty. 2
2400	380	798	229	505	918	2024	1527	3327	2 x 1200 mm cabinet with inverter modules qty. 3, 1600 mm cabinet with inverter modules qty. 4 800 mm cabinet with inverter modules qty. 2
2800	440	924	267	590	1071	2361	1778	3875	1200 mm cabinet with inverter modules qty. 3, 2 x 800 mm cabinet with inverter modules qty. 2

Table 4.1 Weight Based on Shipping Package Crate Size

4.3 Mechanical Installation

The installation of the frequency converters must be prepared carefully. Review the mechanical drawings for the space requirement.

4.3.1 Tools Needed

To perform the mechanical installation the following tools are needed:

- Tape measure
- Wrench with metric sockets (7-19 mm)
- Extensions to wrench
- Lifting bar to lift the unit (rod or tube Ø 20 mm) able to lift minimum 400 kg.
- Crane or other lifting aid to place the frequency converter in position

4.3.2 General Considerations

Space
Ensure the proper space at the top and bottom of the frequency converter, allowing enough air circulation and cable accessibility.

Wire access
Ensure that the proper cable access space is present.

When the IP00 D or E frame frequency converters are mounted on the Rittal cabinet, the cables to the frequency converter must be secured to the back panel of the cabinet. For example, the cable clamps can be used.

4.3.3 Terminal Locations

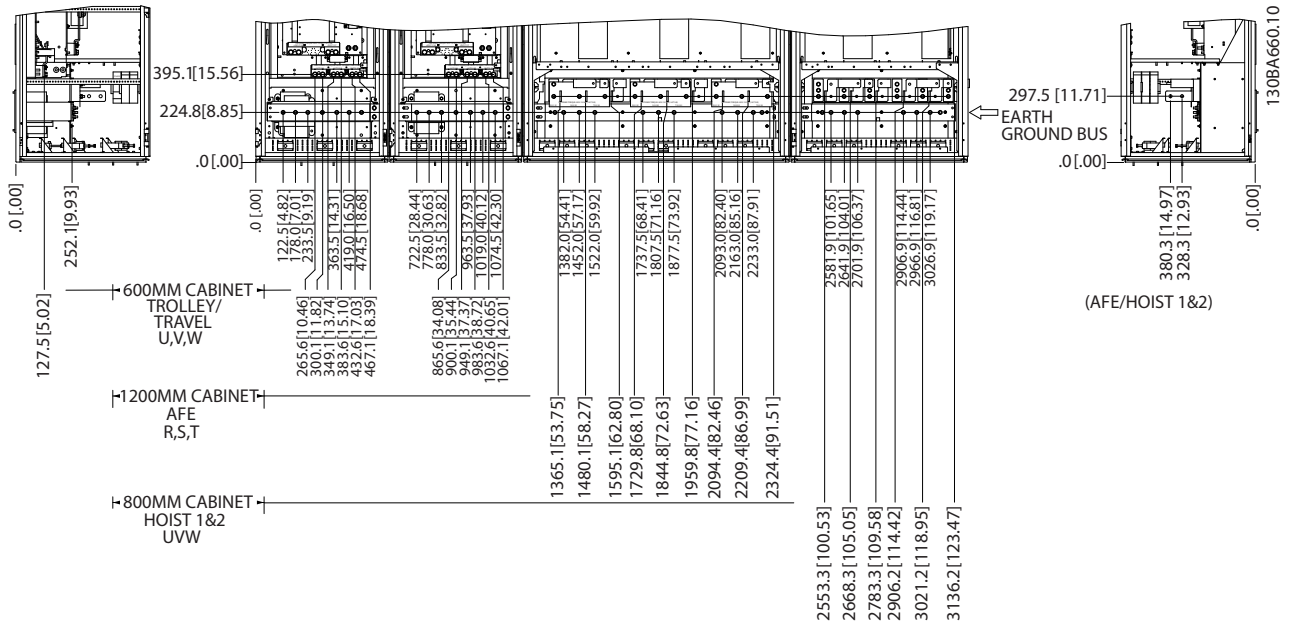


Illustration 4.11 Terminals for the Typical Crane System

4.3.4 Mains Torque

Table 4.2 tabulates the tightening torque values for the mains and DC bus terminals.

Enclosure	Terminal	Torque Value	Bolt size
E, F	Mains, DC bus	19 Nm (168 in-lbs)	M10

Table 4.2 Torque Values for Mains and DC Bus Terminals

4.3.5 Mains Connection

The mains cables must be connected at the terminals 91, 92 and 93. The ground cable is connected at the terminal 94.

Terminal No.	Function
91, 92, 93	Mains R/L1, S/L2, T/L3
94	Ground

Table 4.3 Mains Connection

Power (3x525-690 V AC)	Max. Cable Size (mm^2 (AWG))
P400-P560	4x240 (4x500 MCM)
P630-P800	8x150 (8x300 MCM)
P900-P1M2	12x150 (12x300 MCM)
P1M4-P1M6	16x150 (16x300 MCM)

Table 4.4 Mains Cable Size

NOTICE

Check the name plate to ensure that the mains voltage of the AFE matches the power supply of the crane.

Ensure that the power supply can supply the necessary current to the frequency converter.

Ensure that the fuses have the correct current and voltage rating.

4.3.6 Screened Cables

⚠WARNING

Danfoss recommends using screened cables between the LCL filter and the frequency converter. Unshielded cables can be used between transformer and LCL filter input side.

It is important that screened and armoured cables are connected in a proper way to ensure the high EMC immunity and low emissions.

The connection can be made using either cable glands or clamps

- EMC cable glands: Generally, available cable glands can be used to ensure an optimum EMC connection.
- EMC cable clamp: Clamps allowing easy connection are supplied with the frequency converter.

4.3.7 Fuses

It is recommended to use fuses and/or circuit breakers on the supply side as protection in case of component break-down inside the frequency converter (first fault).

NOTICE

This is mandatory to ensure compliance with IEC 60364 for CE or NEC 2009 for UL.

⚠WARNING

Protect personnel and property against the consequence of component break-down internally in the frequency converter.

Branch circuit protection
To protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines etc., must be protected against short-circuit and overcurrent according to national/international regulations.

NOTICE

The recommendations do not cover branch circuit protection for UL.

Short-circuit protection
Danfoss recommends using the fuses/circuit breakers mentioned below to protect service personnel and property in case of component break-down in the frequency converter.

Overcurrent protection
The frequency converter provides overload protection to limit threats to human life, property damage and to avoid fire hazard due to overheating of the cables in the installation. The frequency converter is equipped with an internal overcurrent protection (*parameter 4-18 Current Limit*) that can be used for upstream overload protection (UL-applications excluded). Moreover, fuses or circuit breakers can be used to provide the overcurrent protection in the installation. Overcurrent protection must always be carried out according to national regulations.

The following tables list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. Circuit breakers must be used, provided they meet the national/international regulations and they

limit the energy into the frequency converter to an equal or lower level than the compliant circuit breakers.
If fuses/circuit breakers according to recommendations are selected, possible damage on the frequency converter is mainly limited to damage inside the unit.

4.3.8 High Power Fuses

4

525-690 V, frame sizes D, E and F
The fuses below are suitable for use on a circuit capable of delivering the Short Circuit Current Rating (SCCR) of 100,000 Amps (symmetrical).

Size/Type	Bussmann PN*	Rating	Siba
P630-P900	170M7081	1600 A, 700 V	20 695 32.1600
P1M0	170M7082	2000 A, 700 V	20 695 32.2000
P1M2-P1M4	170M7083	2500 A, 700 V	20 695 32.2500
P1M6	170M7084	3000 A,700 V	

Table 4.5 Frame Size F, Line Fuses, 525-690 V

Size/Type	Bussmann PN*	Rating	Siba
P630-P1M6	170M8611	1100 A, 1000 V	20 781 32. 1000

Table 4.6 Frame Size F, Inverter Module DC Link Fuses, 525-690 V

**170M fuses from Bussmann use the -/80 visual indicator, -TN/80 Type T, -/110 or TN/110 Type T indicator fuses of the same size and amperage may be substituted for the external use.*

Supplementary fuses

Frame size	Bussmann PN*	Rating
D, E and F	KTK-4	4 A, 600 V

Table 4.7 SMPS Fuse

Size/Type	Bussmann PN*	LittelFuse	Rating
P37K-P400, 525-690 V	KTK-4		4 A, 600 V
P500-P1M6, 525-690 V		KLK-15	15 A, 600 V

Table 4.8 Fan Fuses

Bussmann PN	Rating
FWC-20A-10F	20 A, 600 V

Table 4.9 Fan Voltage/Softcharge Fuse

4.4 Electrical Installation

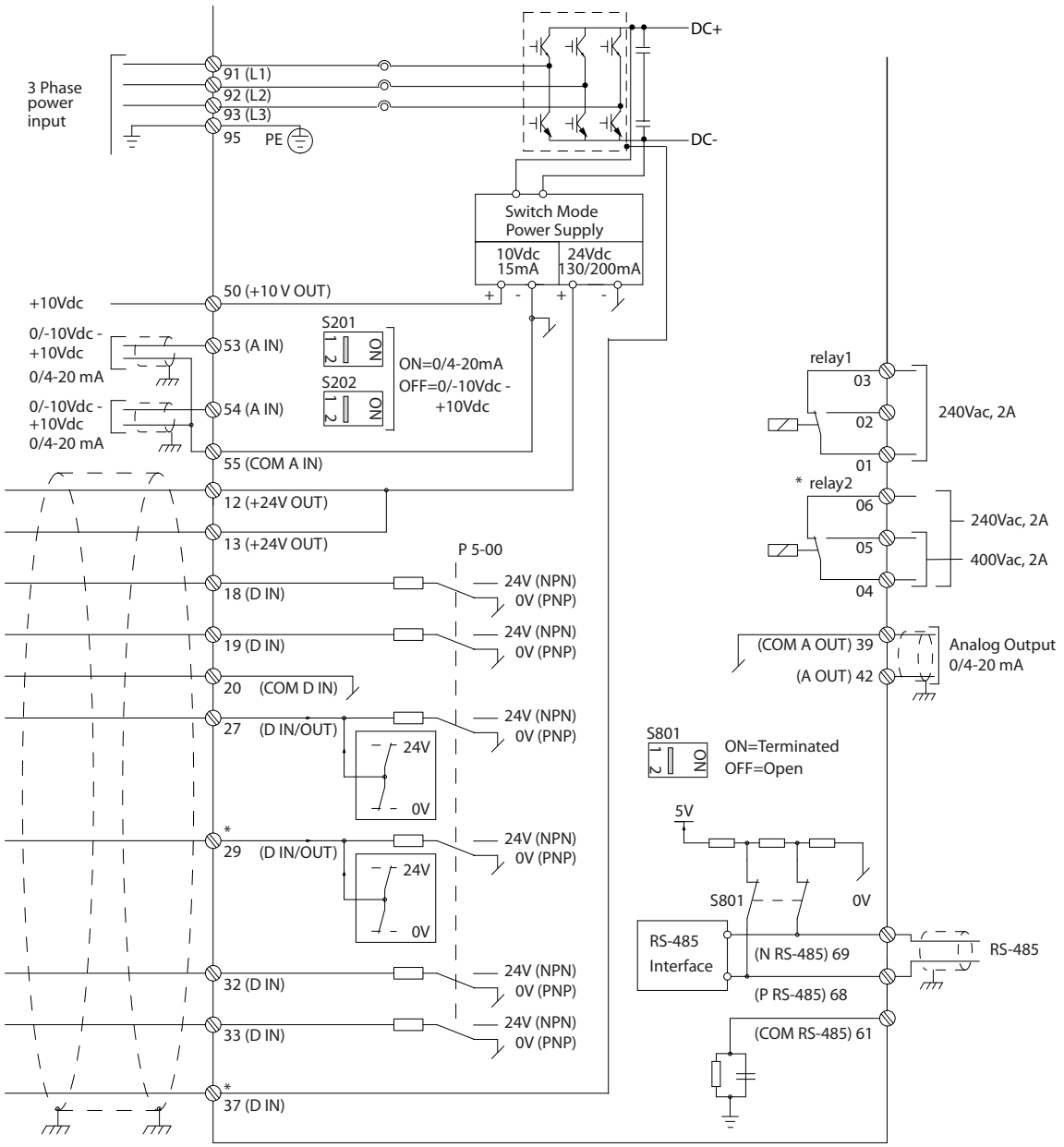


Illustration 4.12 Diagram showing all electrical terminals without options.

A = analog, D = digital

Terminal 37 is used for Safe Stop. For instructions on Safe Stop installation please refer to the *VLT® Frequency Converters - Safe Torque Off Operating Instructions*.

4.4.1 Control Wires

Connect the shields to ground in a proper way to ensure optimum electrical immunity.

Connect the wires as described in the Operating Instructions for the frequency converter. Remember to connect the shields in a proper way to ensure optimum electrical immunity.

4

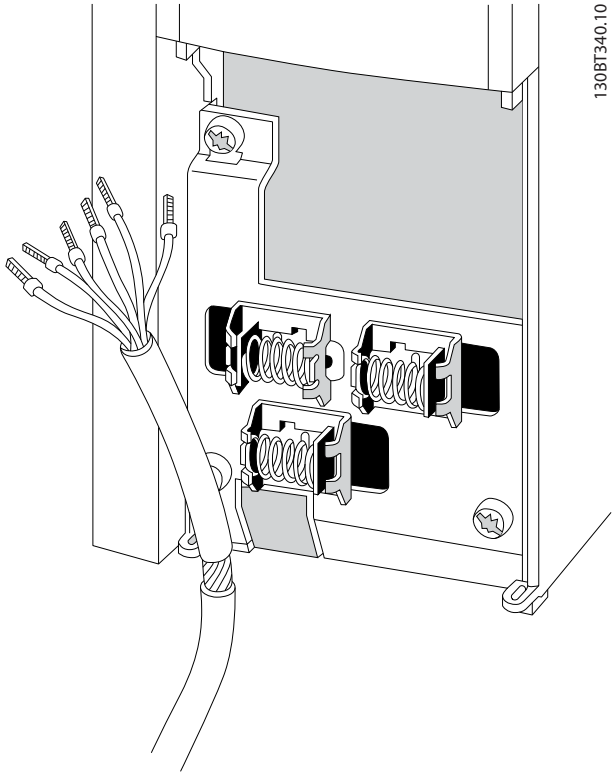


Illustration 4.13 Control Cable Installation

4.4.2 Power Connections

Cabling and fusing

NOTICE

Cables General
All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper (75°C) conductors are recommended.

The power cable connections are situated as shown below. The size of the cable cross section is determined according to the frequency converter's current rating and the local regulation requirement.

For protection of the frequency converter the correctly rated fuses must be used or the unit must be with built-in fuses. The recommended fuses can be seen in the tables in the fuses section. Always ensure that proper fusing is made according to the local regulation.

4.4.3 Grounding

The following basic issues need to be considered when installing a frequency converter to obtain electromagnetic compatibility (EMC):

- Safety grounding: The frequency converter could have a high leakage current. It must be grounded appropriately for safety reasons. Apply local safety regulations.
- High-frequency grounding: Keep the ground wire connections as short as possible.

Connect the frequency converters to the ground with the lowest possible conductor impedance. The lowest possible conductor impedance is obtained by keeping the conductor short and by using the large possible cross section conductors.
The metal cabinets of the different devices are mounted on the cabinet rear plate using the lowest possible HF impedance. This avoids having different HF voltages for the individual devices and avoids the risk of radio interference currents running in connection cables that may be used between the devices. The radio interference will have been reduced.
Use the fastening bolts of the devices as HF connection to the rear plate. It is necessary to remove insulating paint or similar from the fastening points.

4.4.4 Electrical Installation, Control Terminals

To connect the cable to the terminal:

1. Strip insulation of 9-10 mm
2. Insert a screwdriver[1)] in the square hole.
3. Insert the cable in the adjacent circular hole.
4. Remove the screwdriver. The cable is now mounted to the terminal.

To remove the cable from the terminal:

1. Insert a screw driver[1)] in the square hole.
2. Pull out the cable.

[1)] Max. 0.4 x 2.5 mm

Wiring to Control Terminals

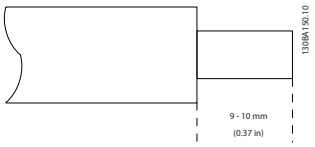


Illustration 4.14 Strip Isolation

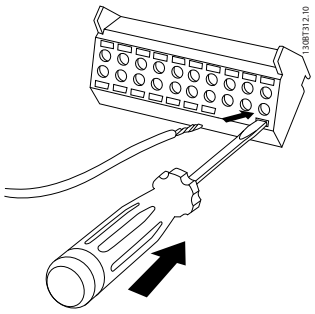


Illustration 4.15 Insert Screwdriver and Cable

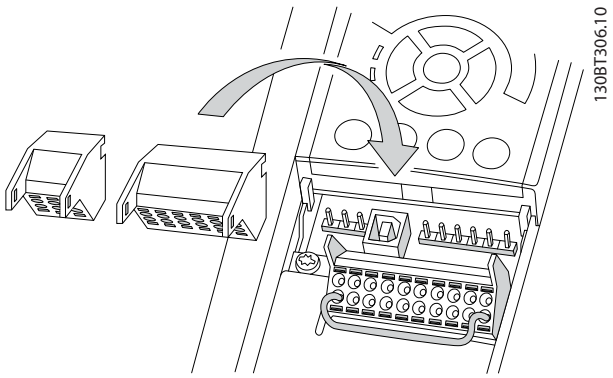


Illustration 4.16 Control Cable Terminals

5 Specifications

5.1 General Specifications

Mains supply (L1, L2, L3)	
Supply voltage	525-690 V -10/+5%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the frequency converters continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the drive's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the frequency converter's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
Max. imbalance temporary between mains phases	3.0% of rated supply voltage
True Power Factor (λ)	≥0.9 nominal at rated load
Displacement Power Factor (cos ϕ) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups)	maximum 1 time/2 min.
Environment according to EN60664-1	over-voltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100.000 RMS symmetrical Amperes, 500/600/690 V maximum.

Torque characteristics	
Overload torque (constant torque)	maximum 150% (typical)/175% (1.2 MW and above) for 60 s[1)]

1) Percentage relates to the nominal torque.

Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27[1)], 29, 32, 33,
Logic	PNP or NPN
Voltage level	0-24 V DC
Voltage level, logic'0' PNP	< 5 V DC
Voltage level, logic'1' PNP	> 10 V DC
Voltage level, logic '0' NPN[2)]	> 19 V DC
Voltage level, logic '1' NPN[2)]	< 14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0-110 kHz
(Duty cycle) Minimum pulse width	4.5 ms
Input resistance, R_i	approx.4 kΩ

Safe stop Terminal 37[3] (Terminal 37 is fixed PNP logic)	
Voltage level	0-24 V DC
Voltage level, logic'0' PNP	< 4 V DC
Voltage level, logic'1' PNP	>20 V DC
Nominal input current at 24 V	50 mA rms
Nominal input current at 20 V	60 mA rms
Input capacitance	400 nF

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

1) Terminals 27 and 29 can also be programmed as output.

2) Except safe stop input Terminal 37.

3) See for further information about terminal 37 and Safe Stop.

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 to +10 V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	100 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

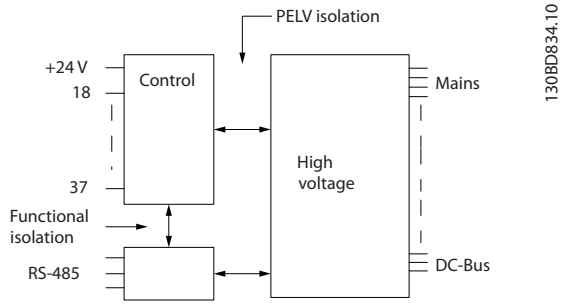


Illustration 5.1 PELV Isolation of Analog Inputs

5

Digital output	
Programmable digital/pulse outputs	2
Terminal number	27, 29[1)]
Voltage level at digital/frequency output	0-24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error: 0.1 % of full scale
Resolution of frequency outputs	12 bit

1) Terminal 27 and 29 can also be programmed as input.

The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 to 20 mA
Maximum load GND - analog output less than	500 Ω
Accuracy on analog output	Maximum error: 0.5% of full scale
Resolution on analog output	12 bit

The analog output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3V
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Control card, 10 V DC output	
Terminal number	±50
Output voltage	10.5 V ±0.5 V
Maximum load	15 mA

The 10 V DC supply is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, RS-485 serial communication	
Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Control card, USB serial communication	
USB standard	1.1 (Full speed)
USB plug	USB type B plug

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB ground connection is not galvanically isolated from protection earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

Relay outputs	
Programmable relay outputs	2
Relay 01 terminal number	1-3 (break), 1-2 (make)
Maximum terminal load (AC-1)[1] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (Inductive load @ cosφ0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (Inductive load)	24 V DC, 0.1 A
Relay 02 (FC 302 only) terminal number	4-6 (break), 4-5 (make)
Maximum terminal load (AC-1)[1] on 4-5 (NO) (Resistive load)	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4-5 (NO) (Inductive load @ cosφ0.4)	240 V AC, 0.2 A
Maximum. terminal load (DC-1)[1] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4-5 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4-6 (NC) (Inductive load @ cosφ0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4-6 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4-6 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

1) IEC 60947 part 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

Cable lengths and cross sections	
Maximum cross section to control terminals, flexible/ rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross section to control terminals	0.25 mm^2/24 AWG

Control card performance	
Scan interval	1 ms

Control characteristics	
Resolution of frequency	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms

Surroundings	
Enclosure, frame size D and E	IP 00/Chassis
Enclosure, frame size F	IP 54/Type 12
Vibration test	0.7 g
Max. relative humidity	5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43	class H_25
Ambient temperature (with SFAVM switching mode)	
- with derating	Max. 55 °C[1]
- at full continuous drive output current	Max. 45 °C[1]

1) For more information on derating, see special conditions in the Design Guide

Minimum ambient temperature during full-scale operation	0 °C
Minimum ambient temperature at reduced performance	-10 °C
Temperature during storage/transport	-25 to +65/70 °C
Maximum altitude above sea level without derating	1,000 m

Derating for high altitude, see special conditions in the Design Guide

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011
EMC standards, Immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

See section on special conditions in the Design Guide.

Protection and Features

- Temperature monitoring of the heatsink ensures that the frequency converter trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the values stated in the tables on the following pages (Guideline - these temperatures may vary for different power sizes, frame sizes, enclosure ratings etc.).
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the DC voltage ensures that the frequency converter trips if the DC circuit voltage is too low or too high.
- The frequency converter constantly checks for critical levels of internal temperature, load current, and the DC voltage. As a response to a critical level, the frequency converter can adjust the switching frequency and/ or change the switching pattern to ensure the performance of the frequency converter.

5

5.2 Mains Supply

5.2.1 Mains Supply 3x525-690 V AC

AFE 302	P400	P800	P1200	P1600
Typical Input at 550 V [kW]	315	710	1000	1400
Typical Input at 630 V [kW]	400	800	1200	1600
Enclosure	IP00 E1	IP54 F1	IP54 F2	IP54 F1*2
Continuous input current at 550 V [A]	429	889	1317	1652
Intermittent input current (60 s overload) at 550 V [A][1)]	644	1334	2305	2891
Typical DC voltage at 550 V [V]	850	850	850	850
Continuous output DC current at 550 V [A]	457	947	1403	1760
Continuous input current at 630 V [A]	410	850	1260	1580
Intermittent input current (60 s overload) at 630 V [A][1)]	615	1275	2205	2765
Typical DC voltage at 630 V [V]	975	975	975	975
Continuous output DC current at 630 V [A]	425	882	1307	1639
Max. Cable size, mains [mm^2 (AWG)]	4x240 (4x500 mcm)	8x150 (8x300 mcm)	12x150 (12x300mcm)	16x150 (16x300mcm)
Estimated power loss at 630 V [kW]	8	16	24	32
Weight IP00 for E and IP54 for F1 and F2	221	382	574	764
Weight Module [kg]	NA	102	102	102
Effieciency[2)]	0.98	0.98	0.98	0.98
Heatsink overtemp trip level [°C]	85	85	85	85
Power card ambient trip [°C]	68	68	68	68

Table 5.1 Mains Supply 3x525-690 V AC

1) The typical overload percentage is 150. The P1M2 to P1M6 overload percentage is 175.

2) The efficiency is estimated at the nominal load condition. It is expected to be within ±15%. If the switching frequency is increased, the power loss rises.

6 How to Programme

6.1 Parameter Selection

Parameters for AFE 302 are grouped into various parameter groups for easy selection of the correct parameters for optimized operation of the frequency converter.

0-** Operation and Display

- Basic Settings, set-up handling
- Display and Local Control Panel parameters for choosing readouts, setting up selections and copying functions

4-** Limits Warnings

5-** Digital inputs and outputs includes relay controls

6-** Analog In/Out

7-** Controllers

8-** Communications and Options

14-** Special functions

15-** AFE information

16-** Data Read-Out

40-** Mains/Filter

6.2 Parameters: 0-** Operation and Display

Parameters related to the basic functionality of the AFE. Parameters related to the function of the display and buttons.

6.2.1 0-0* Basic Settings

0-01 Language

Option:		Function:
		Defines the language to be used in the display.
[0] *	English	Part of Language packages 1 - 4

6.2.2 0-1* Set-up Operations

Define and control the individual parameter setups.

0-10 Active Set-up

Option:		Function:
		Select the set-up to control the frequency converter functions.
[0]	Factory setup	Cannot be changed. It contains the Danfoss data set, and can be used as a data source when returning the other set-ups to a known state.
[1] *	Set-up 1	*Set-up 1* [1] to *Set-up 4* [4] are the four separate parameter set-ups within which all parameters can be programmed.
[2]	Set-up 2	
[3]	Set-up 3	
[4]	Set-up 4	
[9]	Multi Set-up	Remote selection of set-ups using digital inputs and the serial communication port. This set-up uses the settings from *0-12 This Set-up Linked to*. Stop the frequency converter before making changes to open- and closed loop functions

Required to use emergency mode.

0-11 Edit Set-up

Option:		Function:
		Editing can either follow the active setup selection (*parameter 0-10 Active Set-up*), or be fixed at a setup number. This parameter is unique for LCP and buses.
[0]	Factory setup	
[1] *	Set-up 1	
[2]	Set-up 2	
[3]	Set-up 3	
[4]	Set-up 4	
[9]	Active Set-up	

0-12 This Set-up Linked to

Option:		Function:
		This parameter sets the AFE to automatically synchronise the values of the 'not changeable during operation' parameters between this set-up and the set-up selected in this parameter. Note: The values in this setup are overwritten.
[0] *	Not linked	
[1]	Set-up 1	
[2]	Set-up 2	
[3]	Set-up 3	
[4]	Set-up 4	

0-13 Readout: Linked Set-ups

Range:		Function:
0*	[0 - 255]	View a list of all the set-ups linked by means of *0-12 This Set-up Linked to*. The parameter has one index for each parameter set-up. The parameter value displayed for each index represents which set-ups are linked to that parameter set-up.

Index	LCP value
0	{0}
1	{1,2}
2	{1,2}
3	{3}
4	{4}

Table 6.2 Example: Set-up 1 and Set-up 2 are linked

0-14 Readout: Edit Set-ups / Channel

Range:		Function:
0*	[-2147483648 - 2147483647]	View the setting of *0-11 Edit Set-up* for each of the 4 different communication channels. When the number is displayed as a hex number, as it is in the LCP, each number represents one channel. Numbers 1-4 represent a set-up number; 'F' means factory setting; and 'A' means active set-up. The channels are, from right to left: LCP, FC-bus, USB, HPFB1-5. Example: The number AAAAAA21h means that the FC bus selected Set-up 2 in *0-11 Edit Set-up*, the LCP selected Set-up 1 and all others used the active set-up.

6.2.3 0-2* LCP Display

Parameters used to select what kind of information (e.g. power, current, frequency) should be displayed in the STATUS window.

0-20 Display Line 1.1 Small

Option:		Function:
		Select a variable for display in line 1, left position.
[0]	None	No display value selected.
[1501]	Running Hours	
[1502]	kWh Counter	
[1600]	Control Word	Present control word
[1603]	Status Word	Present status word.
[1630]	DC Link Voltage	Intermediate circuit voltage in the AFE.
[1634]	Heatsink Temp.	Present heat sink temperature of the AFE. The cut-out limit is 95 ±5°C; cutting back in occurs at 70 ±5°C.
[1635]	Inverter Thermal	Percentage load of the inverters.
[1636]	Inv. Nom. Current	Nominal current of the AFE.
[1637]	Inv. Max. Current	Maximum current of the AFE.
[1639]	Control Card Temp.	Temperature of the control card.
[1641]	Current	Value of measured current
[1642]	Voltage	Shows the actual mains voltage, when the AFE is running.
[1643]	Frequency	Returns the actual mains frequency, when the AFE is running.
[1644]	Power [kW]	Returns the calculated mains power in kW
[1645]	Power [hp]	Returns the calculated mains power in HP.
[1660]	Digital Input	Signal states form the 6 digital terminals (18, 19, 27, 29, 32 and 33). Input 18 corresponds to the bit at the far left. Signal low = 0; Signal high = 1.
[1665]	Analog Output 42 [mA]	Shows the value at output 42 in mA.
[1666]	Digital Output [bin]	Binary value of all digital outputs.
[1671]	Relay Output [bin	Shows all the relay settings.
[1680]	Fieldbus CTW 1	Control word (CTW) received from the Bus Master.
[1682]	Fieldbus REF 1	Main reference value sent with control word from the Bus Master.
[1684]	Comm. Option STW	Extended fieldbus communication option status word.
[1685]	FC Port CTW 1	Control word (CTW) received from the Bus Master.
[1686]	FC Port REF 1	Status word (STW) sent to the Bus Master.
[1690]	Alarm Word	One or more alarms in a Hex code.
[1691]	Alarm Word 2	One or more alarms in a Hex code.

0-20 Display Line 1.1 Small

Option:		Function:
[1692]	Warning Word	One or more warnings in a Hex code.
[1693]	Warning Word 2	One or more warnings in a Hex code.
[1694]	Ext. Status Word	One or more status conditions in a Hex code.

0-21 Display Line 1.2 Small

Option:		Function:
[1641] *	Mains Current [A]	Select a variable for display in line 1, middle position. The options are the same as listed for parameter group *0-2* LCP Display*.

0-22 Display Line 1.3 Small

Option:		Function:
[1644] *	Power [kW]	Select a variable for display in line 1, right position. The options are the same as listed for parameter group *0-2* LCP Display*.

0-23 Display Line 2 Large

Option:		Function:
[1643] *	Frequency [Hz]	Select a variable for display in line 2. The options are the same as those listed for parameter group *0-2* LCP Display*.

0-24 Display Line 3 Large

Option:		Function:
		Select a variable for display in line 2.
[1630] *	Counter [kWh]	
		The options are the same as those listed for *0-20 Display Line 1.1 Small*.

0-25 My Personal Menu

Range:		Function:
Size related*	[0 - 9999]	Define up to 50 parameters to appear in the *Q1 Personal Menu*, accessible via the [Quick Menu] key on the LCP. The parameters are displayed in the *Q1 Personal Menu* in the order they are programmed into this array parameter. Delete parameters by setting the value to '0000'. For example, this can be used to provide quick, simple access to just one or up to 50 parameters which require changing on a regular basis (e.g. for plant maintenance reasons) or by an OEM to enable simple commissioning of their equipment.

6

6.2.4 0-4* LCP Keypad

Enable, disable and password protect individual keys on the LCP.

0-40 [Hand on] Key on LCP

Option:		Function:
[0]	Disabled	Key disabled avoids accidental usage of the key.
[1] *	Enabled	[Hand On] key enabled
[2]	Password	Avoid unauthorised start in Hand mode. If *parameter 0-40 [Hand on] Key on LCP* is included in My Personal Menu, define the password in *0-65 Personal Menu Password*. Otherwise, define the password in *parameter 0-60 Main Menu Password*.

0-41 [Off] Key on LCP

Option:		Function:
[0]	Disabled	Avoids accidental stop of the AFE.
[1] *	Enabled	
[2]	Password	Avoids unauthorised stop. If *0-41 [Off] Key on LCP* is included in the Quick Menu, then define the password in *parameter 0-65 Quick Menu Password*.

0-42 [Auto on] Key on LCP

Option:		Function:
[0]	Disabled	avoid accidental start of the AFE in Auto mode.
[1] *	Enabled	
[2]	Password	Avoids unauthorised start in Auto mode. If *0-42 [Auto on] Key on LCP* is included in the Quick Menu, then define the password in *parameter 0-65 Quick Menu Password*.

0-43 [Reset] Key on LCP

Option:		Function:
[0]	Disabled	No effect when [Reset] is pressed. Avoids accidental alarm reset.
[1]	Enabled	
[2]	Password	Avoids unauthorised resetting. If *parameter 0-43 [Reset] Key on LCP* is included in the Quick Menu, then define the password in *parameter 0-65 Quick Menu Password*.
[7]	Enabled without OFF	Resets the AFE without setting it in *Off* mode.
[8]	Password without OFF	Resets the AFE without setting it in *Off* mode. A password is required when pressing [Reset] (see [2]).

6.2.5 0-5* Copy/Save

Copy parameters from and to the LCP. Use these parameters for saving and copying set-ups from one frequency converter to another.

0-50 LCP Copy

Option:		Function:
[0] *	No copy	
[1]	All to LCP	
[2]	All from LCP	
[3]	Size indep. from LCP	

0-51 Set-up Copy

Option:		Function:
[0] *	No copy	No function
[1]	Copy to set-up 1	
[2]	Copy to set-up 2	
[3]	Copy to set-up 3	
[4]	Copy to set-up 4	
[9]	Copy to all	

6.2.6 0-6* Password

0-60 Main Menu Password

Range:		Function:
100*	[-9999 - 9999]	Define the password for access to the Main Menu via the [Main Menu] key. If *0-61 Access to Main Menu w/o Password* is set to *[0] Full access*, this parameter is ignored.

0-61 Access to Main Menu w/o Password

Option:		Function:
[0] *	Full access	Disables password defined in *parameter 0-60 Main Menu Password*.
[1]	LCP: Read only	Prevent unauthorised editing of Main Menu parameters.
[2]	LCP: No access	Prevent unauthorised viewing and editing of Main Menu parameters.
[3]	Bus: Read only	Read-only functions for parameters on Fieldbus and/or FC standard bus.
[4]	Bus: No access	No access to parameters is allowed via Fieldbus and/or FC standard bus.
[5]	All: Read only	Read-only function for parameters on LCP, Fieldbus or FC standard bus.
[6]	All: No access	No access from LCP, Fieldbus or FC standard bus is allowed.

If *[0] Full access* is selected, *parameter 0-60 Main Menu Password*, *0-65 Personal Menu Password* and *0-66 Access to Personal Menu w/o Password* are ignored.

NOTICE

A more complex password protection is available for OEMs upon request.

0-65 Quick Menu Password		
Range:		**Function:**
200*	[-9999 - 9999]	Define the password for access to the Quick Menu via the [Quick Menu] key. If *parameter 0-66 Access to Quick Menu w/o Password* is set to *[0] Full access*, this parameter is ignored.

0-66 Access to Quick Menu w/o Password		
If *0-61 Access to Main Menu w/o Password* is set to *[0] Full access* then this parameter is ignored.		
Option:		**Function:**
[0] *	Full access	Disables the password defined in *parameter 0-65 Quick Menu Password*.
[1]	LCP: Read only	Prevents unauthorised editing of Quick Menu parameters.
[3]	Bus: Read only	Read only functions for Quick Menu parameters on Fieldbus and/or FC standard bus.
[5]	All: Read only	Read only function for Quick Menu parameters on LCP, Fieldbus or FC standard bus.

0-67 Bus Password Access		
Range:		**Function:**
0*	[0 - 9999]	Writing to this parameter enables users to unlock the frequency converter from bus/MCT 10 Set-up Software.

6.3 Parameters: 4-** Limits/Warnings

6.3.1 4-1* Limits

Use these parameters to adjust warning limits for power. Warnings are shown on the LCP, can be programmed as outputs, and can be read out via the serial bus in the Extended Status Word.

4-18 Current Limit

Range:		Function:
Size related*	[1.0 - 1000.0 %]	This is a true current limit function.

6.3.2 4-5* Adjustable Warnings

4-52 Warning Regen Limit

Range:		Function:
Size related*	[0-2*Nominal NO Power kW]	Enter the regen power limit. When the regenerative power exceeds this limit the display reads Regen Limit. The signal outputs can be programmed to produce a status signal on terminals 27 or 29 and on relay outputs 01 or 02.

4-53 Warning Power Limit

Range:		Function:
Size related*	[0-2*Nominal NO Power kW]	Enter the active power limit. When the active power exceeds this limit the display reads Power Limit. The signal outputs can be programmed to produce a status signal on terminals 27 or 29 and on relay outputs 01 or 02.

6.3.3 4-9* Output Limits

4-90 Output Frequency Deviation Function

Option:		Function:
		Select the time-out function. The time-out function activates when the output frequency exceeds the deviation limit set in parameter *4-91 Output Frequency Deviation Limit* for the time set in parameter *4-92 Output Frequency Deviation Timeout*
[0] *	Trip	Generate an alarm trip when a fault condition is encountered.
[1]	Warning	Generate a warning when a fault condition is encountered.
[2]	Disabled	Take no action on fault condition.

Select which reaction the AFE should take in case the frequency deviation set in parameter *4-91 Output Frequency Deviation Limit*.

4-91 Output Frequency Deviation Limit

Range:		Function:
20%*	[1 - 50%]	Selects the max deviation in procentage from the nominiel mains frequency set in parameter *40-01 Mains Frequency*

4-92 Output Frequency Deviation Timeout

Range:		Function:
0.001 s*	[0.000 - 60.000 s]	Selects the max time where the frequency deviation set in parameter *4-91 Output Frequency Deviation Limit* can be exceeded.

4-93 Output Voltage Deviation Function

Option:		Function:
		Select the time-out function. The time-out function activates when the output vontage exceeds the deviation limit set in parameter *4-91 Output Frequency Deviation Limit* for the time set in parameter *4-92 Output Frequency Deviation Timeout*.
[0] *	Trip	Generate an alarm trip when a fault condition is encountered.
[1]	Warning	Generate a warning when a fault condition is encountered.
[2]	Disabled	Take no action on fault condition.

Select which reaction the AFE should take in case the voltage deviation set in parameter *4-94 Output Voltage Deviation Limit* is exeeded.

4-94 Output Voltage Deviation Limit

Range:		Function:
20%*	[1 - 50%]	Selects the max deviation in procentage from the nominiel mains voltage set in parameter *40-00 Mains Voltage*.

4-95 Output Voltage Deviation Timeout

Range:		Function:
0.001 s*	[0.000 - 60.000 s]	Selects the max time where the voltage deviation set in parameter *4-94 Output Voltage Deviation Limit* can be exceeded.

6.4 Parameters: 5-** Digital In/Out

Parameters for configuring the I/O mode. NPN/PNP and setting up I/O to Input or Output.

5-00 Digital I/O Mode

Option:		Function:
		Digital inputs and programmed digital outputs are pre-programmable for operation either in PNP or NPN systems.
[0] *	PNP	No reaction to signals transmitted to the terminal.
[1]	NPN	Resets the frequency converter after a TRIP/ALARM. Not all alarms can be reset.

NOTICE

When changing this parameter, a power cycle must be carried out before the parameter change is active.

This parameter cannot be adjusted while the AFE is running.

5-01 Terminal 27 Mode

Option:		Function:
[0]	Input	Defines terminal 27 as a digital input.
[1] *	Output	Defines terminal 27 as a digital output.

This parameter cannot be adjusted while the AFE is running.

5-02 Terminal 29 Mode

Option:		Function:
[0]	Input	Defines terminal 29 as a digital input.
[1] *	Output	Defines terminal 29 as a digital output.

This parameter cannot be adjusted while the AFE is running.

6.4.1 5-1* Digital Inputs

Parameters for configuring the input functions for the input terminals.

NOTICE

For the parameters in group *5-1* Digital Inputs* it is possible to choose between the different possible functions related to the input on this terminal.

[0]	No operation	No reaction to signals transmitted to the terminal.
[1]	Reset	Resets AFE after a TRIP/ALARM. Not all alarms can be reset.
[8]	Start	(Default Digital input 18): Select start for a start/stop command. Logic '1' = start, logic '0' = stop.

5-10 Terminal 18 Digital Input

Option:		Function:
[0]	No operation	
[1]	Reset	
[8] *	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

5-11 Terminal 19 Digital Input

Option:		Function:
[0]	No operation	
[1] *	Reset	
[8]	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

5-12 Terminal 27 Digital Input

Option:		Function:
[0] *	No operation	
[1]	Reset	
[8]	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

5-13 Terminal 29 Digital Input

Option:		Function:
[0] *	No operation	
[1]	Reset	
[8]	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

5-14 Terminal 32 Digital Input

Option:		Function:
[0] *	No operation	
[1]	Reset	
[8]	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

5-15 Terminal 33 Digital Input

Option:		Function:
[0] *	No operation	
[1]	Reset	
[8]	Start	
[23] *	Set-up select bit 0	Select Set-up select bit 0 or Select Set-up select bit 1 to select one of the four set-ups. Set*parameter 0-10 Active Set-up* to Multi Set-up.
[24] *	Set-up select bit 1	(Default Digital input 32): Same as Set-up select bit 0 [23].

6.4.2 5-3* Digital Outputs

Parameters for configuring the output functions for the output terminals. The 2 solid-state digital outputs are common for terminals 27 and 29. Set the I/O function for terminal 27 in parameter *5-01 Terminal 27 Mode*, and set the I/O function for terminal 29 in *5-02 Terminal 29 Mode*. These parameters cannot be adjusted while the AFE is running.

5-30 Terminal 27 Digital Output

Option:		Function:
[0]	No operation	*Default for all digital outputs and relay outputs*
[1]	Control ready	The control board receives supply voltage.
[2]	Drive ready	The frequency converter is ready for operation and applies a supply signal on the control board.
[9]	Alarm	An alarm activates the output. There are no warnings.
[252]	Regen limit	Active when actual regenerative power is above the value set in parameter *4-52 Warning Regen Limit*
[253]	Power limit	Active when actual active power is above the value set in parameter *4-53 Warning Power Limit*.
[254]	Soft charge ready	DC bus charged
[255] *	DC-link on ref.	AFE running and motor operation allowed.

5-31 Terminal 29 Digital Output

Option:		Function:
[0] *	No operation	*Default for all digital outputs and relay outputs*
[1]	Control ready	The control board receives supply voltage.
[2]	Drive ready	The frequency converter is ready for operation and applies a supply signal on the control board.
[9]	Alarm	An alarm activates the output. There are no warnings.
[252]	Regen limit	Active when actual regenerative power is above the value set in parameter *4-52 Warning Regen Limit*
[253]	Power limit	Active when actual active power is above the value set in parameter *4-53 Warning Power Limit*.
[254]	Soft charge ready	DC bus charged
[255]	DC-link on ref.	AFE running and motor operation allowed.

In this parameter, the function for the terminal 29 digital output is selected.

6.4.3 5-4* Relays

Parameters for configuring the timing and the output functions for the relays

(Relay 1 [0], Relay 2 [1])

5-40 Function Relay

Option:		Function:
[0]	No operation	*Default for all digital outputs and relay outputs*
[1]	Control ready	The control board receives supply voltage.
[2]	Drive ready	The frequency converter is ready for operation and applies a supply signal on the control board.
[9]	Alarm	An alarm activates the output. There are no warnings.
[252]	Regen limit	Active when actual regenerative power is above the value set in parameter *4-52 Warning Regen Limit*
[253]	Power limit	Active when actual active power is above the value set in parameter *4-53 Warning Power Limit*.
[254] *	Soft charge ready	DC bus charged
[255]	DC-link on ref.	AFE running and motor operation allowed.

In this parameter, the function for the relay outputs is selected. The selection of each mechanical relay is realised in an array parameter.

5-41 On Delay, Relay

Range:		Function:
0.01 s*	[0.01 - 600.00 s]	This parameter makes it possible to delay the cut-in time of the relays. The selection of each mechanical relay is realised in an array parameter.

5-42 Off Delay, Relay

Range:		Function:
0.01 s*	[0.01 - 600.00 s]	This parameter makes it possible to delay the cut-out time of the relays. The selection of each mechanical relay is realised in an array parameter.

6.5 Parameters: 6-** Analog In/Out

6.5.1 6-5* Analog Output 1

Parameters for configuring analog output 1, i.e. Terminal 42. Analog outputs are current outputs: 0/4 to 20 mA. Common terminal (terminal 39) is the same terminal and has the same electrical potential for analog common and digital common connection. Resolution on the analog output is 12 bit.

6-50 Terminal 42 Output

Option:		Function:
[0] *	No operation	No signal is provided on the analog output.
[103]	Current	Signal represents the unit current. The inverter max. current (taken from parameter *16-37 Inv. Max. Current*) is equal to 20 mA.
[106]	Power	Signal represents the unit power. The unit nominal power (taken from parameter *15-41 Power Section*) is equal to 20 mA.
[133]	Current 4-20mA	Signal represents the unit current with 0 equal to 4 mA. The inverter max. current (taken from parameter *16-37 Inv. Max. Current*) is equal to 20 mA.
[136]	Power 4-20mA	Signal represents the unit power with 0 equal to 4 mA. The unit nominal power (taken from parameter *15-41 Power Section*) is equal to 20 mA.

6-51 Terminal 42 Output Min Scale

Range:		Function:
0 %*	[0 - 200 %]	Scale for the minimum output (0 or 4 mA) of the analogue signal at terminal 42. Set the value to be the **percentage** of the full range of the variable selected in *6-50 Terminal 42 Output*.

6-52 Terminal 42 Output Max Scale

Range:		Function:
100%*	[0.00 – 200%]	Scale the maximum output of the selected analog signal at terminal 42. Set the value to the maximum value of the current signal output. Scale the output to give a current lower than 20 mA at full scale; or 20 mA at an output below 100% of the maximum signal value. If 20 mA is the desired output current at a value between 0-100% of the full-scale output, programme the percentage value in the parameter, i.e. 50% = 20 mA. If a current between 4 and 20 mA is desired at maximum output (100%), calculate the percentage value as follows: $20\ mA / desired\ maximum\ current \times 100\%$ $i.e.\ 10mA: \frac{20\ mA}{10\ mA} \times 100\% = 200\%$

6-52 Terminal 42 Output Max Scale

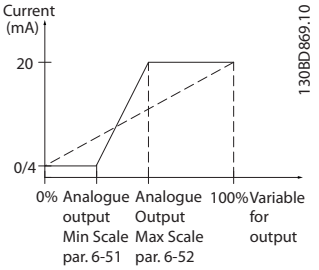
Range:		Function:
		

Illustration 6.1 Scale Output

6.6 Parameters: 7-** Controllers

6.6.1 7-6* DC-Link PI Ctrl.

7-60 DC-Link Total Capacity

Range:		Function:
70560.0 u(=) F*	[0.0 - 1000000.0 uF]	Set the capacitance equal to 90% of the capacitance of all the AFE and inverter drives connected in the common DC bus.
		Power size dependent.

FC 302 T7	Nameplate DC capacitance (mF)	90% DC capacitance (mF)
P400-P560	11.20	10.08
P630-P800	22.40	20.16
P900-P1M0	33.60	30.24
P1M4-P1M6	44.80	40.32

Table 6.3 Capacitance

7-61 DC-Link Reference

Range:		Function:
980 V*	[1.414*Nominal Voltage-1125 V]	Set the voltage reference for the DC-Link voltage controller.
		Line voltage dependent.

7-62 DC-Link PI Proportional Gain

Range:		Function:
67.214*	[0.000 = Off - 1000.000 N/A]	Set the wanted proportional gain of the DC-link voltage controller. Too large value may lead to oscillations.
		Power size dependent.

7-63 DC-Link PI Integral Time

Range:		Function:
5.0 ms*	[1.0 - 1.000.0 ms]	

6.7 Parameters: 8-** Communications and Options

6.7.1 8-0* General Settings

8-01 Control Site

Option:		Function:
[0] *	Digital and ctrl. word	Control by using both digital input and control word.
[1]	Digital only	Control by using digital inputs only.
[2]	Control word only	Control by using control word only.

The setting in this parameter overrides the settings in *8-50 Coasting Select* to *8-56 Preset Reference Select*.

8-02 Control Word Source

Option:		Function:
[0]	None	
[1] *	FC RS485	
[2]	FC USB	

8-03 Control Word Timeout Time

Range:		Function:
1 s*	[0.1 - 18000 s]	Enter the maximum time expected to pass between the reception of two consecutive telegrams. If this time is exceeded, it indicates that the telegram communication has stopped. The function selected in *8-04 Control Word Timeout Function*is then carried out. A valid control word triggers the time-out counter.

This parameter specifies which action should be performed, if a timeout of the control word occurs.

8-04 Control Word Timeout Function

Option:		Function:
[0] *	Off	
[2]	Stop	
[5]	Stop and trip	

8-06 Reset Control Word Timeout

Option:		Function:
[0] *	Do not reset	
[1]	Do reset	

6.7.2 8-1* Control Word Settings

Parameters for configuring the option control word profile.

This parameter selects the interpretation of the control word and status word. Valid selections are determined by installed option.

8-10 Control Word Settings

Option:		Function:
[0] *	FC AFE profile	

Bit	AFE Profile	
	Bit = 0	Bit = 1
0	-	-
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
6	Stop	Start
7	No Function	Reset
8	-	-
9	-	-
10	Data not valid	Data valid
11	-	-
12	-	-
13	-	-
14	-	-
15	-	-

Table 6.4 Bus Control Word

Bit	AFE Profile	
	Bit = 0	Bit = 1
0	Control not ready	Control ready
1	Unit not ready	Unit ready
2	Soft charge not ready	Soft charge ready
3	No trip	Trip
4	-	-
5	-	-
6	No TripLock	TripLock
7	No warning	Warning
8	DC-link not on reference	DC-link on reference
9	Local control	Remote control
10	Not ramping	Ramping
11	Not running	Running
12	-	-
13	No DC voltage warning	DC voltage warning
14	No current limit	Current limit
15	No Thermal warning	Thermal warning

Table 6.5 Bus Status Word

8-13 Configurable Status Word STW

Option:		Function:
		Bit 12 to 15 of the STW is configurable for various status signals.
[0]	No function	
[1] *	Profile default	
[2]	Alarm 68 only	
[3]	Trip except Alarm 68	
[16]	T37 DI status	

6.7.3 8-3* FC Port Settings

8-30 Protocol

Option:		Function:
[0] *	FC	Communication according to the FC Protocol as described in the *VLT AutomationDrive Design Guide, RS-485 Installation and Set-up*.
[1]	FC MC	Select the protocol for the FC (standard) port.

8-31 Address

Range:		Function:
Size related*	[1 - 255]	Enter the address for the FC (standard) port. Valid range: 1-126.

8-32 FC Port Baud Rate

Option:		Function:
[0]	2400 Baud	Baud rate selection for the FC (standard) port.
[1]	4800 Baud	
[2]	9600 Baud	
[3]	19200 Baud	
[4]	38400 Baud	
[5]	57600 Baud	
[6]	76800 Baud	
[7]	115200 Baud	

8-35 Minimum Response Delay

Range:		Function:
10 ms*	[1 - 10000 ms]	Specify the minimum delay time between receiving a request and transmitting a response. This is used for overcoming modem turnaround delays.

8-36 Max Response Delay

Range:		Function:
Size related*	[11 - 10001 ms]	Specify the maximum permissible delay time between transmitting a request and receiving a response. If a response from the frequency converter is exceeding the time setting, then it is discarded.

8-37 Max Inter-Char Delay

Range:		Function:
Size related*	[0.00 - 35.00 ms]	Specify the maximum permissible time interval between receipt of 2 bytes. This parameter activates time-out if transmission is interrupted. This parameter is active only when *8-30 Protocol* is set to *[1] FC MC* protocol.

Enables use of freely configurable telegrams or standard telegrams for the FC port.

8-40 Telegram Selection

Option:		Function:
[1] *	Standard Telegram 1	
[101]	PPO 1	
[102]	PPO 2	
[103]	PPO 3	
[104]	PPO 4	
[105]	PPO 5	
[106]	PPO 6	
[107]	PPO 7	
[108]	PPO 8	
[200]	Custom telegram 1	

6.7.4 8-5* Digital/Bus

Parameters for configuring the control word digital/bus merging.

NOTICE

These parameters are active only when *8-01 Control Site* is set to *[0] Digital and control word*.

8-53 Start Select		
Option:		**Function:**
		Allows a choice between controlling the Start function via the terminals (digital input) and/or via the bus. ***NOTICE*** **This parameter is only active if *8-01 Control Site* is set to *[0] Digital and control word*.**
[0]	Digital input	
[1]	Bus	
[2]	Logic AND	
[3] *	Logic OR	

6.8 Parameters: 14-** Special Functions

6.8.1 14-0* AFE Switching

14-01 Switching Frequency

Select the AFE switching frequency. Changing the switching frequency can help to reduce acoustic noise from the AFE. Default depend on power size.

Option:		Function:
[0]	1.0 kHz	
[1]	1.5 kHz	Default switching frequency for 355-1200 kW, 690V
[2]	2.0 kHz	Default switching frequency for 250-800 kW, 400V and 37-315 kW, 690V
[3]	2.5 kHz	
[4]	3.0 kHz	Default switching frequency for 18.5-37 kW, 200V and 37-200 kW, 400V
[5]	3.5 kHz	
[6]	4.0 kHz	Default switching frequency for 5.5 – 15 kW, 200V and 11-30 kW, 400V
[7]	5.0 kHz	Default switching frequency for 0.25 – 3,7 k W, 200V and 0.37-7.5 kW, 400V
[8]	6.0 kHz	
[9]	7.0 kHz	
[10]	8.0 kHz	
[11]	10.0 kHz	
[12]	12.0kHz	
[13]	14.0 kHz	
[14]	16.0kHz	

6.8.2 14-2* Trip Reset

Parameters for configuring auto reset handling, special trip handling and control card self test or initialisation.

14-20 Reset Mode

Select the reset function after tripping. Once reset, the frequency converter can be restarted.

Option:		Function:
[0] *	Manual reset	Select *Manual reset* [0], to perform a reset via [RESET] or via the digital inputs.
[1]	Automatic reset x 1	Select *Automatic reset x 1…x20* [1]-[12] to perform between one and twenty automatic resets after tripping.
[2]	Automatic reset x 2	
[3]	Automatic reset x 3	
[4]	Automatic reset x 4	

14-20 Reset Mode

Select the reset function after tripping. Once reset, the frequency converter can be restarted.

Option:		Function:
[5]	Automatic reset x 5	
[6]	Automatic reset x 6	
[7]	Automatic reset x 7	
[8]	Automatic reset x 8	
[9]	Automatic reset x 9	
[10]	Automatic reset x 10	
[11]	Automatic reset x 15	
[12]	Automatic reset x 20	
[13]	Infinite Automatic Reset	Select *Infinite Automatic Reset* [13] for continuous resetting after tripping.

NOTICE

The AFE may start without warning. If the specified number of AUTOMATIC RESETs is reached within 10min, the frequency converter enters Manual reset [0] mode. After the Manual reset is performed, the setting of *14-20 Reset Mode* reverts to the original selection. If the number of automatic resets is not reached within 10min, or when a Manual reset is performed, the internal AUTOMATIC RESET counter returns to zero.

NOTICE

Automatic reset will also be active for resetting safe stop function.

14-21 Automatic Restart Time

Range:		Function:
10s*	[0 - 600 s]	Enter the time interval from trip to start of the automatic reset function. This parameter is active when *14-20 Reset Mode* is set to *Automatic reset* [1] - [13].

NOTICE

Remember to set switches S201 (A53) and S202 (A54) as specified below when performing a control card test in *parameter 14-22 Operation Mode* [1]. Otherwise, the test fails.

14-22 Operation Mode

Option:		Function:
		Use this ameter to specify normal operation; to perform tests; or to initialise all parameters except *15-03 Power Up's*, *15-04 Over Temp's* and *15-05 Over Volt's*. This function is active only when the power is cycled to the frequency converter. Select *[0] Normal operation* for normal operation of the frequency converter with the motor in the selected application.

6

14-22 Operation Mode		
Option:		**Function:**
		Select *[1] Control card test* to test the analog and digital inputs and outputs and the +10 V control voltage. The test requires a test connector with internal connections. Use the following procedure for the control card test: 1. Select *[1] Control card test*. 2. Disconnect the mains supply and wait for the light in the display to go out. 3. Set switches S201 (A53) and S202 (A54) = 'ON'/I. 4. Insert the test plug (see *Illustration 6.2*). 5. Connect to mains supply. 6. Carry out various tests. 7. The results are displayed on the LCP and the frequency converter moves into an infinite loop. 8. *Parameter 14-22 Operation Mode* is automatically set to Normal operation. Carry out a power cycle to start up in Normal operation after a control card test. **If the test is OK** LCP read-out: Control Card OK. Disconnect the mains supply and remove the test plug. The green LED on the Control Card lights up. **If the test fails** LCP read-out: Control Card I/O failure. Replace the frequency converter or Control card. The red LED on the Control Card is turned on. Test plugs (connect the following terminals to each other): 18 - 27 - 32; 19 - 29 - 33; 42 - 53 - 54

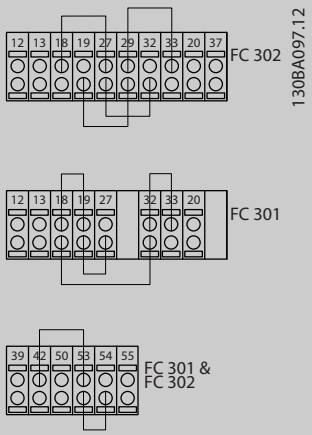


Illustration 6.2 Test Plugs

14-22 Operation Mode		
Option:		**Function:**
		Select *[2] Initialisation* to reset all parameter values to default settings, except for *15-03 Power Up's*, *15-04 Over Temp's*, and *15-05 Over Volt's*. The frequency converter resets during the next power-up. *Parameter 14-22 Operation Mode* also reverts to the default setting *[0] Normal operation*.
[0] *	Normal operation	
[1]	Control card test	
[2]	Initialisation	
[3]	Boot mode	

14-29 Service Code		
Range:		**Function:**
[000000]	000000 Hex - FFFFF	For internal service only.
0 N/A*	[-2147483647 - 2147483647 N/A]	Service use only

6.8.3 14-5* Environment

These parameters help the frequency converter to operate under special environmental conditions.

14-52 Fan Control		
Option:		**Function:**
[0] *	Auto	
[1]	On 50%	
[2]	On 75%	
[3]	On 100%	

14-53 Fan Monitor		
Option:		**Function:**
[0]	Disabled	
[1] *	Warning	
[2]	Trip	Select which reaction the frequency converter should take in case a fan fault is detected.

14-59 Actual Number of Inverter Units		
Range:		**Function:**
Size related*	[1 - 1]	Set the actual number of power units.

6.9 Parameters: 15-** AFE Information

6.9.1 15-0* Operating Data

15-00 Operating Hours

Range:		Function:
0h*	[0 - 2147483647 h]	View how many hours the AFE has run. The value is saved when the AFE is turned off.

15-01 Running Hours

Range:		Function:
0h*	[0 - 2147483647 h]	View how many hours the AFE has run. Reset the counter in *parameter 15-07 Reset Running Hours Counter*. The value is saved when the AFE is turned off.

15-02 kWh Counter

Range:		Function:
0kWh*	[0 - 2147483647 kWh]	Registering the power consumption of the system as a mean value over one hour. Reset the counter in *15-06 Reset kWh Counter*.

15-03 Power Up's

Range:		Function:
0*	[0 - 2147483647]	View the number of times the AFE has been powered up.

15-04 Over Temp's

Range:		Function:
0*	[0 - 65535]	View the number of frequency converter temperature faults which have occurred.

15-05 Over Volt's

Range:		Function:
0*	[0 - 65535]	View the number of AFE overvoltages which have occurred.

15-06 Reset kWh Counter

Option:		Function:
[0] *	Do not reset	No reset of the kWh counter is desired.
[1]	Reset counter	Press [OK] to reset the kWh counter to zero (see *15-02 kWh Counter*).

NOTICE

The reset is carried out by pressing [OK].

15-07 Reset Running Hours Counter

Option:		Function:
[0] *	Do not reset	
[1]	Reset counter	Select *[1] Reset* and press [OK] to reset the Running Hours counter to zero (see *15-01 Running Hours*). This parameter cannot be selected via the serial port, RS-485. Select *[0] Do not reset* if no reset of the Running Hours counter is desired.

6.9.2 15-2* Historic Log

View up to 50 logged data items via the array parameters in this parameter group. For all parameters in the group, [0] is the most recent data and [49] the oldest data. Data is logged every time an *event* occurs. *Events* in this context are defined as a change in one of the following areas:

1. Digital input
2. Digital outputs (not monitored in this SW release)
3. Warning word
4. Alarm word
5. Status word
6. Control word
7. Extended status word

Events are logged with value, and time stamp in msec. The time interval between two events depends on how often *events* occur (maximum once every scan time). Data logging is continuous but if an alarm occurs, the log is saved and the values can be viewed on the display. This feature is useful, for example when carrying out service following a trip. View the historic log contained in this parameter via the serial communication port or via the display.

15-20 Historic Log: Event

Array [50]

Range:		Function:
0*	[0 - 255]	View the event type of the logged events.

15-21 Historic Log: Value

Array [50]

Range:		Function:
0*	[0 - 2147483647]	View the value of the logged event. Interpret the event values according to this table:

Digtal input	Decimal value. See *16-60 Digital Input* for description after converting to binary value.

15-21 Historic Log: Value

Array [50]

Range:		Function:	
		Digital output (not monitored in this SW release)	Decimal value. See *parameter 16-66 Digital Output [bin]* for description after converting to binary value.
		Warning word	Decimal value. See *16-92 Warning Word* for description.
		Alarm word	Decimal value. See *16-90 Alarm Word* for description.
		Status word	Decimal value. See *16-03 Status Word* for description after converting to binary value.
		Control word	Decimal value. See *16-00 Control Word* for description.
		Extended status word	Decimal value. See *parameter 16-94 Ext. Status Word* for description.

15-22 Historic Log: Time

Array [50]

0*	[0 - 2147483647 s]	View the time at which the logged event occurred. Time is measured in ms since frequency converter start.

6.9.3 15-3* Alarm Log

Parameters in this group are array parameters, where up to 10 fault logs can be viewed. [0] is the most recent logged data, and [9] the oldest. Error codes, values, and time stamp can be viewed for all logged data.

15-30 Fault Log: Error Code

Array [10]

Range:		Function:
0*	[0 - 255]	View the error code and look up its meaning in .

15-31 Alarm Log: Value

Array [10]

Range:		Function:
0*	[-32767 - 32767]	View an extra description of the error. This parameter is mostly used in combination with *alarm 38 internal fault*.

15-32 Fault Log: Time

Array [10]

0*	[0 - 2147483647 s]	View the time when the logged event occurred. Time is measured in seconds from frequency converter start-up.

6.9.4 15-4* Drive Identification

Parameters containing read only information about the hardware and software configuration of the AFE.

15-40 AFE Type

Option:	Function:
	View the AFEtype. The read-out is identical to the FC 300 Series power field of the type code definition, characters 1-6.

15-41 Power Section

Option:	Function:
	View the AFE type. The read-out is identical to the FC 300 Series power field of the type code definition, characters 7-10.

15-42 Voltage

Option:	Function:
	View the AFE type. The read-out is identical to the FC 300 Series power field of the type code definition, characters 11-12.

15-43 Software Version

Range:		Function:
0*	[0 - 5]	View the combined SW version (or 'package version') consisting of power SW and control SW.

15-44 Ordered Typecode String

Option:	Function:
	View the type code string used for re-ordering the AFE in its original configuration.

15-45 Actual Typecode String

Range:		Function:
0*	[0 - 40]	View the actual type code string.

15-46 AFE Ordering No

Option:	Function:
	View the 8-digit ordering number used for re-ordering the AFE in its original configuration.

15-47 Power Card Ordering No

Range:		Function:
0*	[0 - 8]	View the power card ordering number.

15-48 LCP Id No		
Range:		**Function:**
0*	[0 - 20]	View the LCP ID number.

15-49 SW ID Control Card		
Range:		**Function:**
0*	[0 - 20]	View the control card software version number.

15-50 SW ID Power Card		
Range:		**Function:**
0*	[0 - 20]	View the power card software version number.

15-51 AFE Serial Number		
Option:		**Function:**
		View the AFE serial number.

15-53 Power Card Serial Number		
Range:		**Function:**
0*	[0 - 19]	View the power card serial number.

6.9.5 15-9* Parameter Info

15-92 Defined Parameters
Array [1000]

0*	[0 - 9999]	View a list of all defined parameters in the AFE. The list ends with 0.

15-93 Modified Parameters		
Array [1000]		
Range:		**Function:**
0*	[0 - 9999]	View a list of the parameters that have been changed from their default setting. The list ends with 0. Changes may not be visible until up to 30 s after implementation.

15-99 Parameter Metadata		
Array [30]		
Range:		**Function:**
0*	[0 - 9999]	This parameter contains data used by the MCT 10 Set-up Software.

6.10 Parameters: 16-** Data Read-outs

6.10.1 16-0* General Status

16-00 Control Word

Range:		Function:
0*	[0 - FFFF]	View the Control word sent from the AFE via the serial communication port in hex code.

16-03 Status Word

Range:		Function:
0*	[0 - FFFF]	View the Status word sent from the AFE via the serial communication port in hex code.

6

6.10.2 16-3* AFE Status

16-30 DC Link Voltage

Range:		Function:
0 V*	[0 - 10000 V]	View a measured value. The value is filtered with a 30 ms time constant.

16-34 Heatsink Temp.

Range:		Function:
0°C*	[0 - 255 °C]	View the AFE heatsink temperature. The cut-out limit is 90 ± 5°C, and the motor cuts back in at 60 ± 5°C.

16-35 Inverter Thermal

Range:		Function:
0 %*	[0 - 100 %]	View the percentage load.

16-36 Inv. Nom. Current

Range:		Function:
A*	[0.01 - 10000.00 A]	View the inverter nominal current.

16-37 Inv. Max. Current

Range:		Function:
A*	[0.01 - 10000.00 A]	View the inverter maximum current.

16-39 Control Card Temp.

Range:		Function:
0 °C*	[0 - 100 °C]	View the temperature on the control card, stated in °C

16-41 Current

Range:		Function:
0.00 A *	[0.00 - 1856.00 A]	Returns the value of measured current as a mean value IRMS.

16-42 Voltage

Range:		Function:
0.0V*	[0.0 - 6000.0V]	Shows the AFE output voltage when the AFE is running.

16-43 Frequency

Range:		Function:
0.0 Hz*	[0.0 - 6500.0 Hz]	Returns the actual AFE frequency, when the AFE is running.

16-44 Power [kW]

Range:		Function:
0.00 kW *	[0.00 - 1000.00 kW]	Returns the calculated AFE power on basis of the actual voltage and current.

16-45 Power [hp]

Range:		Function:
0.00 hp *	[0.00 - 1000.00 hp]	Returns the calculated AFE power on basis of the actual mains voltage and mains current.

16-49 Current Fault Source

Range:		Function:
0*	[0 - 8]	Value indicates source of current faults including short circuit, over current, and phase imbalance (from left): 1-4 Inverter 5-8 Rectifier 0 No fault recorded

6.10.3 16-6* Inputs and Outputs

16-60 Digital Input

Range:		Function:
0*	[0 - 1023]	View the signal states from the active digital inputs. Example: Input 18 corresponds to bit no. 5, '0' = no signal, '1' = connected signal. Bit 6 works in the opposite way, on = '0', off = '1' (safe stop input).

Bit 0	Digital input term. 33
Bit 1	Digital input term. 32
Bit 2	Digital input term. 29
Bit 3	Digital input term. 27
Bit 4	Digital input term. 19
Bit 5	Digital input term. 18
Bit 6	Digital input term. 37
Bit 10-63	Reserved for future terminals

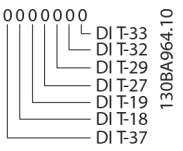


Illustration 6.3 Active Digital Inputs

16-65 Analog Output 42 [mA]		
Range:		**Function:**
0*	[0 - 30]	View the actual value at output 42 in mA. The value shown reflects the selection in *6-50 Terminal 42 Output*.

16-66 Digital Output [bin]		
Range:		**Function:**
0*	[0 - 15]	View the binary value of all digital outputs.

16-71 Relay Output [bin]		
Range:		**Function:**
0*	[0 - 511]	View the settings of all relays.

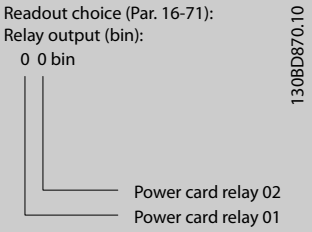


Illustration 6.5 Relay Settings

6.10.4 16-8* Fieldbus & FC Port

Parameters for reporting the BUS references and control words.

16-80 Fieldbus CTW 1		
Range:		**Function:**
0*	[0 - 65535]	View the 2-byte control word (CTW) received from the bus master. Interpretation of the control word depends on the fieldbus option installed and the control word profile selected in *8-10 Control Profile*. For more information, refer to the relevant fieldbus manual.

16-82 Fieldbus REF 1		
Range:		**Function:**
0*	[-200 - 200]	View the 2-byte word sent with the control word from the bus master to set the reference value. For more information, refer to the relevant fieldbus manual.

16-84 Comm. Option STW		
Range:		**Function:**
0*	[0 - 65535]	View the extended fieldbus comm. option status word. For more information, refer to the relevant fieldbus manual.

16-85 FC Port CTW 1		
Range:		**Function:**
0*	[0 - 65535]	View the 2-byte control word (CTW) received from the bus master. Interpretation of the control word depends on the fieldbus option installed and the control word profile selected in *8-10 Control Profile*.

16-86 FC Port REF 1		
Range:		**Function:**
0*	[-200 - 200]	View the 2-byte status word (STW) sent to the bus master. Interpretation of the status word depends on the fieldbus option installed and the control word profile selected in *8-10 Control Profile*.

6.10.5 16-9* Diagnosis Read-Outs

NOTICE

When using MCT 10 Set-up Software, the readout parameters can only be read online, i.e. as the actual status. This means that the status is not stored in the MCT 10 Set-up Software file.

16-90 Alarm Word		
Range:		**Function:**
0*	[0 - 4294967295]	View the alarm word sent via the serial communication port in hex code.

16-91 Alarm Word 2		
Range:		**Function:**
0*	[0 - 4294967295]	View the alarm word sent via the serial communication port in hex code.

16-92 Warning Word		
Range:		**Function:**
0*	[0 - 4294967295]	View the warning word sent via the serial communication port in hex code.

16-93 Warning Word 2		
Range:		**Function:**
0*	[0 - 4294967295]	View the warning word sent via the serial communication port in hex code.

16-94 Ext. Status Word		
Range:		**Function:**
0*	[0 - 4294967295]	Returns the extended warning word sent via the serial communication port in hex code.

6.11 Parameters: 40-** Mains / Filter

6.11.1 40-0* Mains Data

40-00 Mains Voltage

Range:		Function:
630 V*	[[525-690 V]]	Set the mains voltage line to line.

40-01 Mains Frequency

Option:		Function:
[0] *	50 Hz	Set the mains nominal frequency.
[1]	60 Hz	

40-02 Mains Inductance

Range:		Function:
0.039 mH*	[0.000 - 65.000 mH]	Set the Inductance of the mains. This could be the transformer.

40-03 Mains Resistance

Range:		Function:
0.50 mOhm*	[0.00 - 650.00 mOhm]	Set the value of the mains resistance. This could be the transformer.

6.11.2 40-1* LCL Filter

40-10 Mains Side Inductance (Lm)

Range:		Function:
0.029 mH*	[0.000 - 65.000 mH]	Set the main side inductance of the LCL filter.

40-11 Mains Side Resistance (Rm)

Range:		Function:
0.19 mOhm*	[0.00 - 650.00 mOhm]	Set the main side resistance of the LCL filter.

40-12 Converter Side Inductance (Lc)

Range:		Function:
0.100 mH*	[0.000 - 65.000 mH]	Set the converter side inductance of the LCL filter.

40-13 Converter Side Resistance (Rc)

Range:		Function:
0.48 mOhm*	[0.00 - 650.00 mOhm]	Set the converter side resistance of the LCL filter.

40-14 Filter Capacity (Cf)

Range:		Function:
400 uF*	[0 - 65000 uF]	Set the capacitance of the LCL filter. The value is for the delta configuration.

6.12 Warnings/Alarm Messages

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over-voltage	X	X		
8	DC under voltage	X	X		
9	Inverter overloaded	X	X		
13	Over Current	X	X	X	
14	Earth Fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word time-out	(X)	(X)		*8-04 Control Word Timeout Function*
23	Internal Fan Fault	X			*14-53 Fan Monitor*
24	External Fan Fault	X			*14-53 Fan Monitor*
29	Heatsink temp	X	X	X	
33	Inrush Fault		X	X	
34	Fieldbus communication fault	X	X		
36	Mains failure	X	X		
37	Phase imbalance		X		
38	Internal Fault		X	X	
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			*5-00 Digital I/O Mode, 5-01 Terminal 27 Mode*
41	Overload of Digital Output Terminal 29	(X)			*5-00 Digital I/O Mode, 5-02 Terminal 29 Mode*
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
59	Current limit	X			
62	Output Frequency Limit	X			
64	Voltage Limit	X	X		
65	Control Board Over-temperature	(X)	(X)	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
68	Safe Stop				Alarm/trip only
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	Output voltage limit	X	X[1)]		
77	Reduced power mode	X			*Parameter 14-59 Actual Number of Inverter Units*
78	Power Unit Setup	X			*Parameter 14-59 Actual Number of Inverter Units*
79	Illegal PS config		X	X	
80	AFEInitialized to Default Value		X		
250	New spare part			X	*14-23 Typecode Setting*
251	New Type Code		X	X	

Table 6.6 Alarm/Warning Code List

(X) Dependent on parameter

A trip is the action when an alarm has appeared. The trip will stop the AFE operation and change the digital output at terminal 27 to Low, which will result in coasting the motor. It can be reset by pressing the reset button or make a reset by a digital input (parameter group *5-1* Digital Inputs* [1]). The origin event that caused an alarm cannot damage the AFE or cause dangerous conditions. A trip lock is an action when an alarm occurs, which may cause damage to AFE or connected units. A Trip Lock situation can only be reset by a power cycling.

Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Table 6.7 LED indication

Alarm Word Extended Status Word							
Bit	**Hex**	**Dec**	**Alarm Word**	**Alarm Word 2**	**Warning Word**	**Warning Word 2**	**Extended Status Word**
0	00000001	1		ServiceTrip, Read/ Write		reserved	Ramping
1	00000002	2	Heatsink temp. (A29)	ServiceTrip, (reserved)	Heatsink temp. (W29)	reserved	
2	00000004	4	Earth Fault (A14)	ServiceTrip, Typecode/ Sparepart	Earth Fault (W14)	reserved	
3	00000008	8	Ctrl.Card Temp (A65)	ServiceTrip, (reserved)	Ctrl.Card Temp (W65)	reserved	
4	00000010	16	Ctrl. Word TO (A17)	ServiceTrip, (reserved)	Ctrl. Word TO (W17)		
5	00000020	32	Over Current (A13)	reserved	Over Current (W13)	reserved	
6	00000040	64		reserved		reserved	
7	00000080	128		reserved		reserved	
8	00000100	256		reserved		reserved	
9	00000200	512	Inverter Overld. (A9)	reserved	Inverter Overld (W9)	reserved	Power limit (W253)
10	00000400	1024	DC under Volt (A8)	reserved	DC under Volt (W8)		Regen limit (W252)
11	00000800	2048	DC over Volt (A7)	reserved	DC over Volt (W7)		
12	00001000	4096	Short Circuit (A16)	reserved	DC Voltage Low (W6)	reserved	
13	00002000	8192	Inrush Fault (A33)	reserved	DC Voltage High (W5)		
14	00004000	16384	Mains ph. Loss (A4)	reserved			
15	00008000	32768		reserved			
16	00010000	65536		reserved			
17	00020000	131072	Internal Fault (A38)		10V Low (W1)		Password Timelock
18	00040000	262144		Fans error		Fans Warn	Password Protection
19	00080000	524288					
20	00100000	1048576		reserved		reserved	
21	00200000	2097152		reserved		reserved	
22	00400000	4194304	Fieldbus Fault (A34)	reserved	Fieldbus Fault (W34)	reserved	
23	00800000	8388608	24 V Supply Low (A47)	reserved	24V Supply Low (W47)	reserved	
24	01000000	16777216	Mains Failure (A36)	reserved	Mains Failure (W36)	reserved	
25	02000000	33554432	1.8V Supply Low (A48)	reserved	Current Limit (W59)	reserved	
26	04000000	67108864		reserved	Low Temp (W66)	reserved	
27	08000000	134217728		reserved	Voltage Limit (W64)	reserved	
28	10000000	268435456	Option Change (A67)	reserved		reserved	
29	20000000	536870912	AFE Initialized(A80)	Feedback Fault (A61, A90)	Feedback Fault (W61, W90)		
30	40000000	1073741824	Safe Stop (A68)				

Alarm Word Extended Status Word							
Bit	Hex	Dec	Alarm Word	Alarm Word 2	Warning Word	Warning Word 2	Extended Status Word
31	80000000	2147483648			Extended Status Word		

Table 6.8 Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional fieldbus for diagnose. See also *parameter 16-94 Ext. Status Word*.

WARNING 1, 10 Volts low
The 10 V voltage from terminal 50 on the control card is below 10 V.
Remove some of the load from terminal 50, as the 10V supply is overloaded. Max. 15 mA or minimum 590 Ω.

WARNING 5, DC-link voltage high
The DC bus voltage is higher than the overvoltage limit of the control system. The AFE is still active.

WARNING 6, DC link voltage low
The DC bus voltage is below the undervoltage limit of the control system. The AFE is still active.

WARNING/ALARM 7, DC over voltage
If the DC bus voltage exceeds the limit, the AFE trips after a time.

	3 x 525-690 V
	[V DC]
Undervoltage	553
Voltage warning low	585
Voltage warning high	1084
Overvoltage	1130
The voltages stated are the DC bus voltage of the AFE with a tolerance of ± 5%.	

Table 6.9 Alarm/Warning Limits

WARNING/ALARM 8, DC under voltage
If the DC bus voltage drops below the "voltage warning low" limit (see *Table 6.9*), the frequency converter checks if 24 V backup supply is connected.
If no 24 V backup supply is connected, the frequency converter trips after a given time (depending on the unit).
To check whether the supply voltage matches the AFE, see *chapter 5.1 General Specifications*.

WARNING/ALARM 9, Inverter overloaded
The AFE is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal protection gives a warning at 98% and trips at 100%, while giving an alarm. The AFE cannot be until the counter is below 90%.
The fault is that the frequency converter is overloaded by more than 100% for too long.

WARNING/ALARM 13, Over Current
The peak current limit (approx. 200% of the rated current) is exceeded. The warning will last approx. 8-12 s, then the AFE trips and issues an alarm.

ALARM 14, Earth fault
There is a discharge from the output phases to earth. Turn off the AFE and remove the earth fault.

ALARM 15, Incomplete hardware
A fitted option is not handled by the present control board (hardware or software).

ALARM 16, Short-circuit
There is short-circuiting in the outout phases.
Turn off the AFE and remove the short-circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the AFE.
The warning will only be active when *8-04 Control Word Timeout Function* is NOT set to *OFF*.
Parameter 8-03 Control Word Timeout Time could possibly be increased.

WARNING/ALARM 21, Parameter error
The parameter is out of range. The parameter number is reported in LCP. The affected parameter must be set to a valid value.

WARNING 23, Internal fan fault
The fan warning function is an extra protection function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (set to *[0] Disabled*).

WARNING 24, External fan fault
The fan warning function is an extra protection function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (set to *[0] Disabled*).

ALARM 29, Heat sink temperature
The temperature of the AFE heat sink has exeeded the limit.
P400; 110 °C
P800/PIM2: 95 °C
The temperature fault is cannot be reset untill the temperature of the heat sink has dropped th a safe level.
P400: 95 °C
P800/PIM2: 80 °C

ALARM 33, Inrush fault
Too many power ups have occured within a short time period. See the chapter *General Specifications* for the allowed number of power ups within one minute.

WARNING/ALARM 34, Fieldbus communication fault
The fieldbus on the communication option card is not working correctly. Please check parameters associated with the module and make sure module is properly inserted in

Slot A of the frequency converter. Check the wiring for fieldbus.

ALARM 36, Mains failure
The mains failure alarm is generated at the start of DC bus regulation if the AFE cannot detect a valid mains frequency.

ALARM 37, Phase imbalance
There is a current imbalance between the power units

ALARM 38, Internal fault
By this alarm it may be necessary to contact your Danfoss supplier. Some possible alarm messages:

256-511	A defect has been detected with the power EEPROM data. This could indicate that an incorrect spare part was used or that the power EEPROM was updated with incorrect data.
512-767	A defect has been detected with the control card EEPROM data.
768-1023	A problem has occurred while attempting to initialize or restore parameter information.
1024-1276	A problem has been encountered while attempting to send internal communication between options or the power card. A report value of 1027 may indicate a hardware failure.
1080-1295	A software version error has been detected.
1296-1311	An option with old software has been installed.
1312-1327	An unsupported option has been installed.
1360-1375	There is a version mismatch between the installed options and components.
1376-1391	An installed option did not properly initialize.
1536-1791	An exception in the control card has been registered. Extra information is written to the LCP.
1792-2047	The DSP has reported a communication fault.
2064-2079	An installed option has illegally restarted.
2080-2127	An installed option did not initialize within the allowed time period.
2304-2559	The is a communication problem with the power card or the power card configuration is invalid. Some possible values and reasons are listed below. 2314: Could not read any data from the power card EEPROM. 2315: Could not read software version from the power card. 2316: Did not receive initial communication from the power card. 2324: Power card configuration is determined to the incorrect at power up. 2330: Power size information between the power cards does not match. 2333: Unsupported power card installed. 2335: Unsupported power size. 2336: The power card has stopped communicating.
2560-2815	A communication problem has been encountered with the DSP.
2816-3071	An internal system error has occured.
3072-5119	Parameter value outside its limits. Perform an initialization. Subtract 3072 from the report value to obtain the parameter number causing the alarm. For example: Error code 3238: 3238-3072=166 is outside the limit. ***NOTICE*** **ALARM 21 replaces this report value range.**
5120-5375	An installed option is not compatible with the control card.
5376-5631	The control card has a encountered an internal memory error.
5632+	The control card has encountered an internal error.

Table 6.10 Internal Fault Codes

ALARM 39, Heatsink sensor
No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of Digital Output Terminal 27
Check the load connected to terminal 27 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of Digital Output Terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

ALARM 46, Power card supply
The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the MCB 107

option, only the 24 V and 5 V supplies are monitored. When powered with three phase mains voltage, all three supplied are monitored.

WARNING 47, 24 V supply low
The external 24 V DC backup power supply may be overloaded, otherwise Contact your Danfoss supplier.

WARNING 48, 1.8 V supply low
Contact your Danfoss supplier.

WARNING 59, Current limit
The required current for regulating the DC bus has exceeded the maximum rating of the AFE. The maximum rating is given in *16-37 Inv. Max. Current*

WARNING 62, Output Frequency at Maximum Limit
The output frequency exceeds the deviation limit specified in *4-91 Output Frequency Deviation Limit* and *4-92 Output Frequency Deviation Timeout*. ALARM/WARNING is generated after exceeding the timeout period.

WARNING 64, Voltage Limit
A warning is generated, when the AFE controller saturates. This indicated that the AFE no longer has enough voltage overhead for the real and reactive current control.
An alarm is generated , when the PWM controller has exceeded 98% duty cycle.

WARNING/ALARM/TRIP 65, Control Card Over Temperature
Control card over temperature: The cut-out temperature of the control card is 80 °C.

WARNING 66, Heatsink Temperature Low
The heat sink temperature is measured as 0 °C. This could indicate that the temperature sensor is defect and thus the fan speed is increased to the maximum in case the power unit or control card is very hot.

ALARM 67, Option Configuration has Changed
One or more options has either been added or removed since the last power down.

ALARM 68, Safe Stop
Safe Stop has been activated. To resume normal operation, apply 24 V DC to T-37. Press [Reset] key on LCP.

ALARM 70, Illegal FC Configuration
Actual combination of control board and power board is illegal.

ALARM 71, Output voltage limit
The output voltage exceeds the deviation limit specified in *4-94 Output Voltage Deviation Limit* and *4-95 Output Voltage Deviation Timeout*. ALARM/WARNING is generated after exceeding the timeout period.

WARNING 73, Safe stop auto restart
Safe stopped. Note that with automatic restart enabled, the AFE may start when the fault is cleared.

WARNING 77, Reduced power mode
This warning indicates that the AFE is operating in reduced power number of power units (Emergency Mode). All functionality is active, but reduced current limits are imposed.

WARNING 78, Power unit setup
The power unit setup warning indicates that the AFE detects a different number of power units than what it is configured for (*parameter 14-59 Actual Number of Inverter Units*) The AFE is not allowed to run in this mode.

Troubleshooting

When replacing an F-frame module, this will occur if the power specific data in the module power card does not match the rest of the frequency converter. Please confirm the spare part and its power card are the correct part number.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also MK102 connector on the power card could not be installed.

ALARM 80, Drive Initialised to Default Value
Parameter settings are initialised to default setting after a manual (three-finger) reset. Or a programmed reset(*parameter 14-22 Operation Mode*).

ALARM 244, Heatsink temperature
This alarm is only for F Frame size units. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in frame size F2 or F4.

2 = right inverter module in frame size F1 or F3.

3 = right inverter module in frame size F2 or F4.

5 = rectifier module.

ALARM 245, Heatsink sensor
This alarm is only for F Frame size units. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in frame size F2 or F4.

2 = right inverter module in frame size F1 or F3.

3 = right inverter module in frame size F2 or F4.

5 = rectifier module.

ALARM 246, Power card supply
This alarm is only for F Frame size units. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in frame size F2 or F4.

2 = right inverter module in frame size F1 or F3.

3 = right inverter module in frame size F2 or F4.

5 = rectifier module.

ALARM 247, Power card temperature
This alarm is only for F Frame size units. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in frame size F2 or F4.

2 = right inverter module in frame size F1 or F3.

3 = right inverter module in frame size F2 or F4.

5 = rectifier module.

ALARM 248, Illegal power section configuration
This alarm is only for F Frame unit size. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in frame size F2 or F4.

2 = right inverter module in frame size F1 or F3.

3 = right inverter module in frame size F2 or F4.

5 = rectifier module.

ALARM 250, New Spare Part
The power or Switch Mode Power Supply has been exchanged. The AFE type code must be restored in the EEPROM. Select the correct type code in *14-23 Typecode Setting* according to the label on unit. Remember to select 'Save to EEPROM' to complete.

ALARM 251, New Type Code
The AFE has got a new type code.

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