ARMSTRONG

IVS 102

Operating Instructions 1.1-90 kW

Contents

1

1 Introduction

1.1 Purpose of the Manual

These operating instructions provide information for safe installation and commissioning of the frequency converter.

The operating instructions are intended for use by qualified personnel.
Read and follow the operating instructions to use the frequency converter safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep these operating instructions available with the frequency converter at all times.

1.2 Additional Resources

Other resources are available to understand advanced frequency converter functions and programming.

- The *Programming Guide* provides greater detail on working with parameters and many application examples.
- The *Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

1.3 Document and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version and the corresponding software version.

Edition	Remarks	Software version
MG12E5xx	Replaces MG12E4xx	3.92

Table 1.1 Document and Software Version

1.4 Product Overview

1.4.1 Intended Use

The frequency converter is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the frequency converter, the motor and equipment driven by the motor.
- System and motor status surveillance.

The frequency converter can also be used for motor protection.

Depending on configuration, the frequency converter can be used in stand-alone applications or form part of a larger appliance or installation.

The frequency converter is allowed for use in residential, industrial and commercial environments in accordance with local laws and standards.

NOTICE

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

Foreseeable misuse
Do not use the frequency converter in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

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1.4.2 Exploded Views
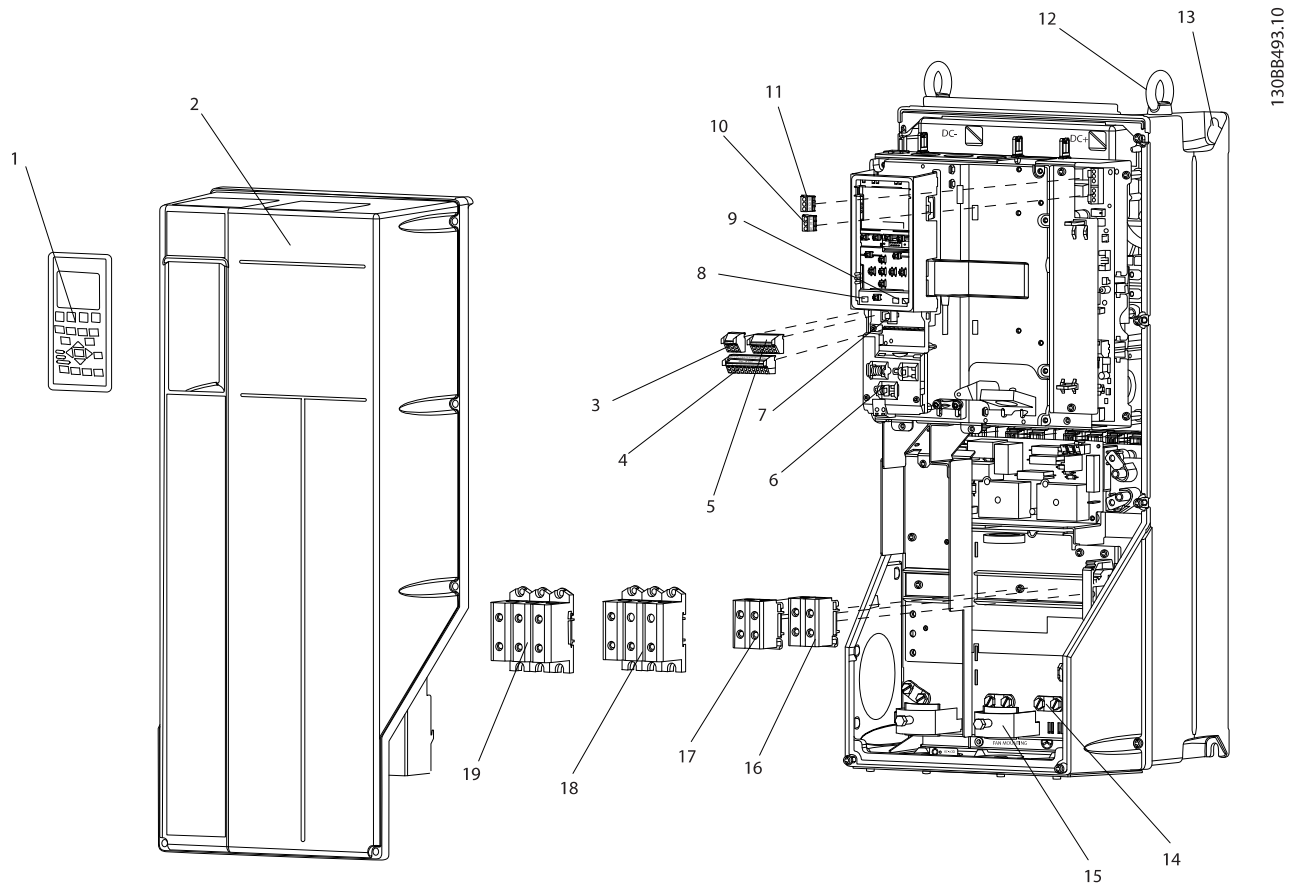
1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 serial bus connector	13	Mounting slot
4	Digital I/O and 24 V power supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable screen connector
6	Cable screen connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Serial bus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)		

Illustration 1.1 Exploded View Enclosure Types B and C, IP55 and IP66

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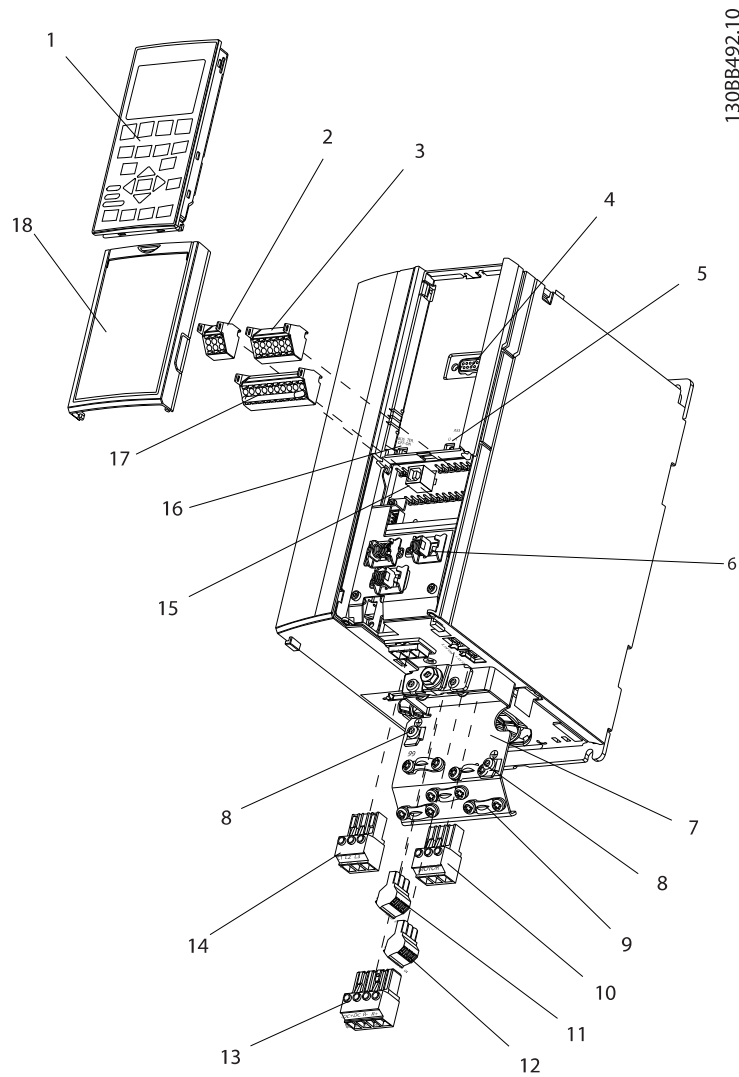
1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 serial bus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable screen connector	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Screened cable grounding clamp and strain relief	18	Cover

Illustration 1.2 Exploded View Enclosure Type A, IP20

Illustration 1.3 is a block diagram of the internal components of the frequency converter. See the table for Illustration 1.3 for their functions.
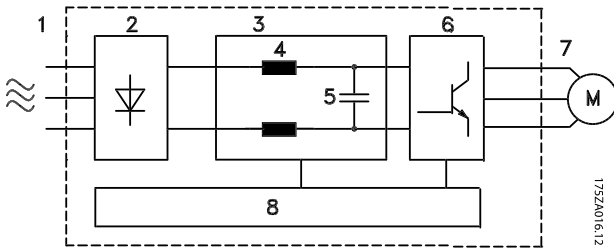
Area	Title	Functions
1	Mains input	• 3-phase AC mains supply to the frequency converter.
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power.
3	DC bus	• Intermediate DC bus circuit handles the DC current.
4	DC reactors	• Filter the intermediate DC circuit voltage. • Prove mains transient protection. • Reduce RMS current. • Raise the power factor reflected back to the line. • Reduce harmonics on the AC input.
5	Capacitor bank	• Stores the DC power. • Provides ride-through protection for short power losses.
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor.
7	Output to motor	• Regulated 3-phase output power to the motor.
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control. • User interface and external commands are monitored and performed. • Status output and control can be provided.

Illustration 1.3 Frequency Converter Block Diagram

1.4.3 Enclosure Types and Power Ratings

For enclosure types and power ratings of the frequency converters, refer to *chapter 8.9 Power Ratings, Weight and Dimensions*.

1.5 Approvals and Certifications

More approvals and certifications are available. Contact the local Armstrong partner. Frequency converters of enclosure type T7 (525–690 V) are UL certified for only 525–600 V.

The frequency converter complies with UL508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product specific design guide.

For compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to *ADN-compliant Installation* in the product specific design guide.

1.6 Disposal

Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.
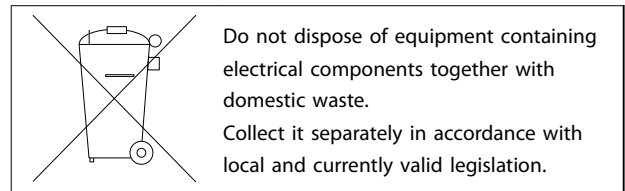
2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

⚠WARNING

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

⚠CAUTION

Indicates a potentially hazardous situation that 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.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel are allowed to install or operate this equipment.

Qualified personnel are defined as trained staff, who are authorised to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Additionally, the qualified personnel must be familiar with the instructions and safety measures described in these operating instructions.

2.3 Safety Precautions

⚠WARNING
HIGH VOLTAGE
Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

⚠WARNING
UNINTENDED START
When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a serial bus command, an input reference signal from the LCP, or after a cleared fault condition.
To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Fully wire and assembly the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

⚠WARNING
DISCHARGE TIME
The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. Failure to wait the specified time after power has been removed before performing service or repair work, could result in death or serious injury.

1. **Stop motor.**
2. **Disconnect AC mains, permanent magnet type motors, and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
3. **Wait for the capacitors to discharge fully, before performing any service or repair work. The duration of waiting time is specified in *Table 2.1*.**

Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200-240	1.1-3.7 kW		5.5-45 kW
380-480	1.1-7.5 kW		11-90 kW
525-600	1.1-7.5 kW		11-90 kW
525-690		1.1-7.5 kW	11-90 kW
High voltage may be present even when the warning LED indicator lights are off.			

Table 2.1 Discharge Time

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⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly can result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

⚠WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**

- **Ensure that electrical work conforms to national and local electrical codes.**

- **Follow the procedures in this manual.**

⚠WARNING

UNINTENDED MOTOR ROTATION
WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury, when the frequency converter is not properly closed.

- **Ensure that all safety covers are in place and securely fastened before applying power.**

3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configu-ration.

- Make sure the items supplied and the information on the nameplate correspond to the order confir-mation.
- Check the packaging and the frequency converter visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.
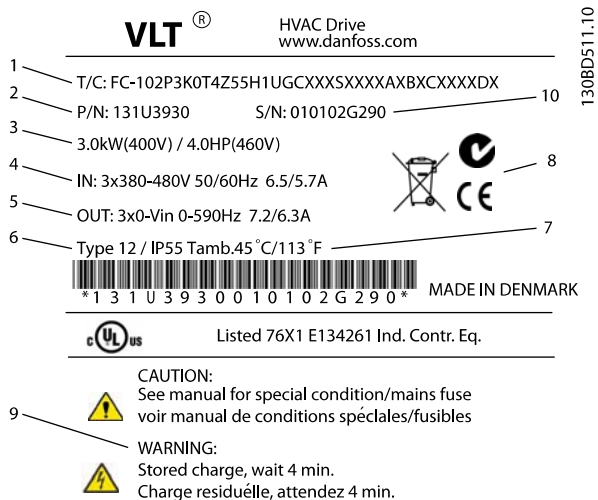
1	Type code
2	Order number
3	Power rating
4	Input voltage, frequency and current (at low/high voltages)
5	Output voltage, frequency and current (at low/high voltages)
6	Enclosure type and IP rating
7	Maximum ambient temperature
8	Certifications
9	Discharge time (Warning)
10	Serial number

Illustration 3.1 Product Nameplate (Example)

NOTICE

Do not remove the nameplate from the frequency converter (loss of warranty).

3.1.2 Storage

Ensure that the requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

NOTICE

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce the lifetime of the frequency converter. Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock
The frequency converter complies with requirements for units mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

3.3 Mounting

NOTICE

Improper mounting can result in overheating and reduced performance.

Cooling
- Ensure that top and bottom clearance for air cooling is provided. See *Illustration 3.2* for clearance requirements.

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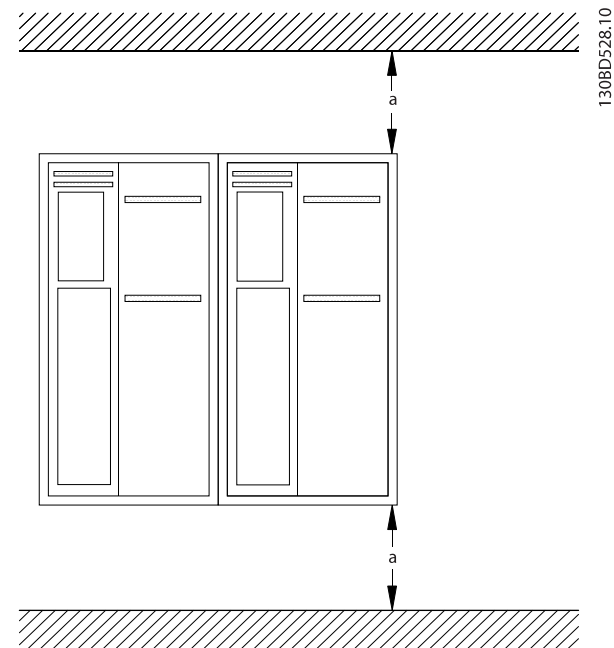
Enclosure	A2-A5	B1-B4	C1, C3	C2, C4
a [mm]	100	200	200	225

Illustration 3.2 Top and Bottom Cooling Clearance

Lifting

- To determine a safe lifting method, check the weight of the unit, see *chapter 8.9 Power Ratings, Weight and Dimensions*.

- Ensure that the lifting device is suitable for the task.

- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.

- For lifting, use the hoist rings on the unit, when provided.

Mounting

1. Ensure that the strength of the mounting location supports the unit weight. The frequency converter allows side-by-side installation.

2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.

3. Mount the unit vertically to a solid flat surface or to the optional back plate to provide cooling airflow.

4. Use the slotted mounting holes on the unit for wall mounting, when provided.

Mounting with back plate and railings
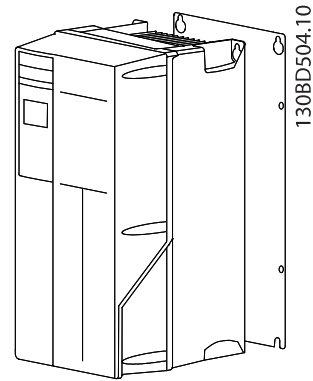
Illustration 3.3 Proper Mounting with Back Plate

NOTICE

A back plate is required when mounted on railings.

NOTICE

All A, B, and C enclosures allow side-by-side installation. Exception: if an IP21 kit is used, there has to be a clearance between the enclosures:

- **For enclosures A2, A3, A4, B3, B4 and C3, the minimum clearance is 50 mm.**

- **For enclosure C4, the minimum clearance is 75 mm.**

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠**WARNING**

INDUCED VOLTAGE
Induced voltage from output motor cables that run together can charge equipment capacitors, even with the equipment turned off and locked out. Failure to run output motor cables separately or use screened cables could result in death or serious injury.

- **Run output motor cables separately, or**
- **Use screened cables.**

⚠**CAUTION**

SHOCK HAZARD
The frequency converter can cause a DC current in the PE conductor. Failure to follow the recommendation means that the RCD may not provide the intended protection.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.**

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between frequency converter and motor, is required for applications with multiple motors.
- Input fusing is required to provide short-circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in *chapter 8.8 Fuses and Circuit Breakers*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC Compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Grounding

⚠**WARNING**

LEAKAGE CURRENT HAZARD
Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground one frequency converter to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2 (or 2 rated ground wires terminated separately).

For EMC-compliant installation

- Establish electrical contact between the cable screen and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment (see *chapter 4.6 Motor Connection*).
- Use high-strand wire to reduce electrical interference.
- Do not use pigtails.

NOTICE

POTENTIAL EQUALISATION
Risk of electrical interference, when the ground potential between the frequency converter and the control system is different. Install equalising cables between the system components. Recommended cable cross-section: 16 mm^2.

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4.4 Wiring Schematic
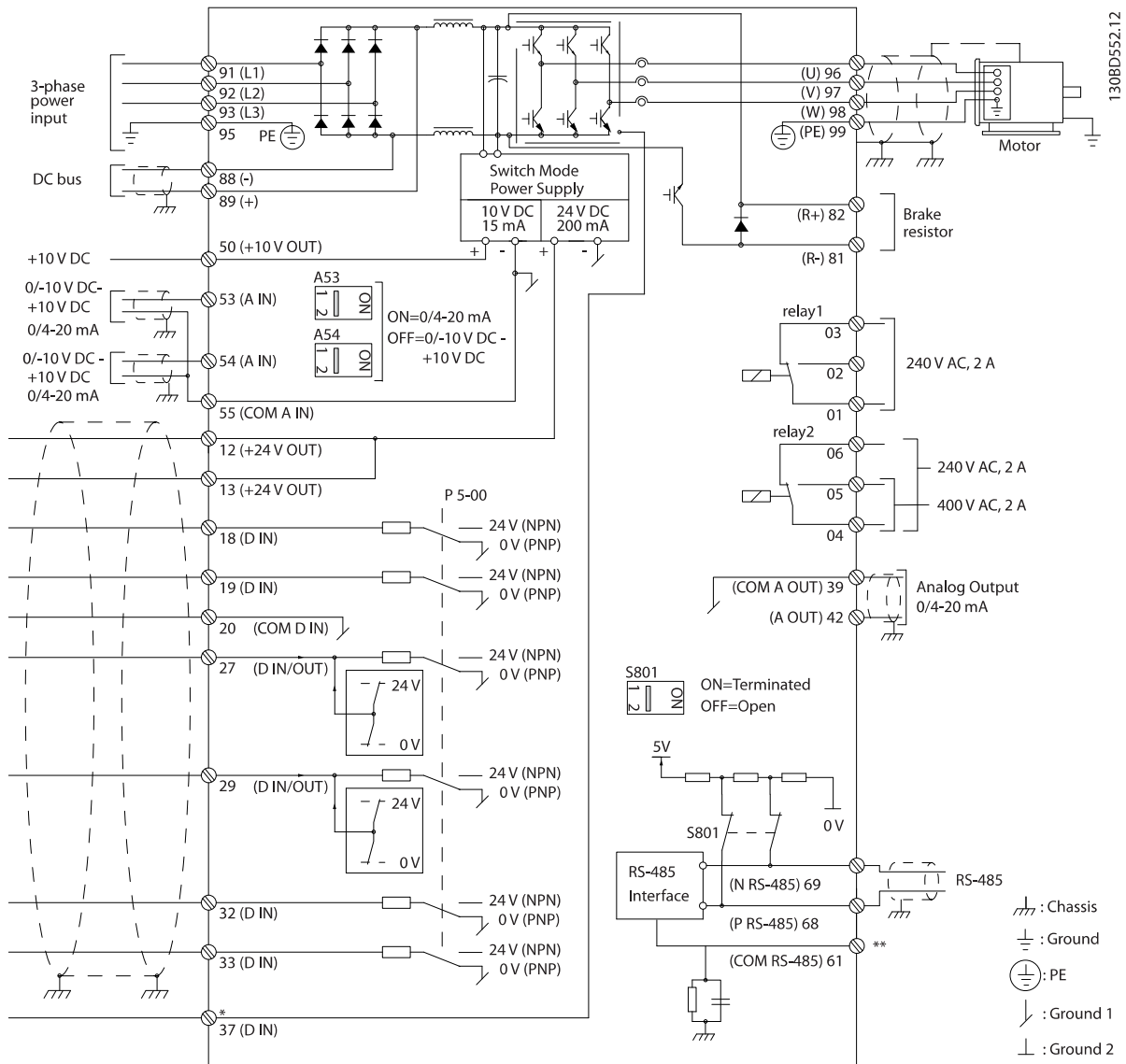
Illustration 4.1 Basic Wiring Schematic

A=Analog, D=Digital
*Terminal 37 (optional) is used for Safe Torque Off.
**Do not connect cable screen.

NOTICE

Actual configurations vary with unit types and optional equipment.

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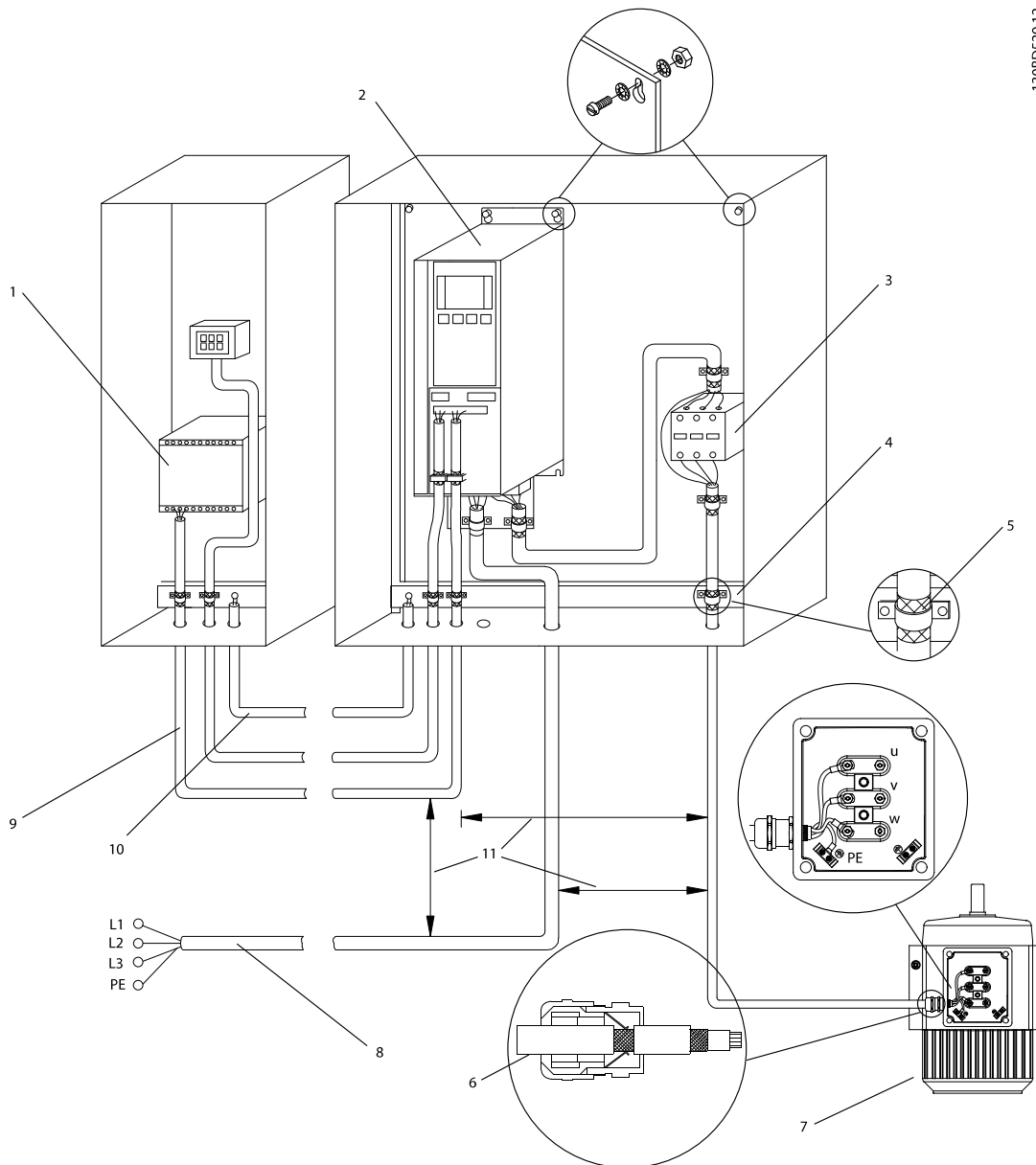
1	PLC	6	Cable gland
2	Frequency converter	7	Motor, 3-phase and PE
3	Output contactor	8	Mains, 3-phase and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalising min. 16 mm^2 (0.025 in^2)

Illustration 4.2 EMC-compliant Electrical Connection

NOTICE

EMC INTERFERENCE
Use screened cables for motor and control wiring and separate cables for input power, motor wiring, and control wiring.
Failure to isolate power, motor, and control cables can result in unintended behaviour or reduced performance.
Minimum clearance requirement between power, motor and control cables is 200 mm (7.9 in).

4.5 Access

- Remove the cover with a screw driver (See *Illustration 4.3*) or by loosening the attaching screws (See *Illustration 4.4*).

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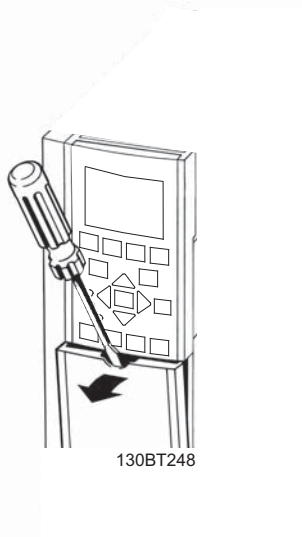
Illustration 4.3 Access to Wiring for IP20 and IP21 Enclosures

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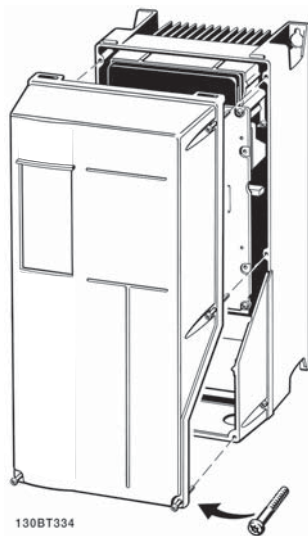
Illustration 4.4 Access to Wiring for IP55 and IP66 Enclosures

Tighten the cover screws using the tightening torques specified in *Table 4.1*.

Enclosure	IP55	IP66
A4/A5	2	2
B1/B2	2.2	2.2
C1/C2	2.2	2.2
No screws to tighten for A2/A3/B3/B4/C3/C4.		

Table 4.1 Tightening Torques for Covers [Nm]

4.6 Motor Connection

⚠WARNING

INDUCED VOLTAGE!
Induced voltage from output motor cables that run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use screened cables could result in death or serious injury.

- Comply with local and national electrical codes for cable sizes. For maximum wire sizes see *chapter 8.1 Electrical Data*.

- Follow motor manufacturer wiring requirements.

- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.

- Do not wire a starting or pole-changing device (e.g. Dahlander motor or slip ring induction motor) between the frequency converter and the motor.

Procedure

1. Strip a section of the outer cable insulation.

2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between cable screen and ground.

3. Connect ground wire to the nearest grounding terminal in accordance with grounding instructions provided in *chapter 4.3 Grounding*, see *Illustration 4.5*.

4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.5*.

5. Tighten terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.

4
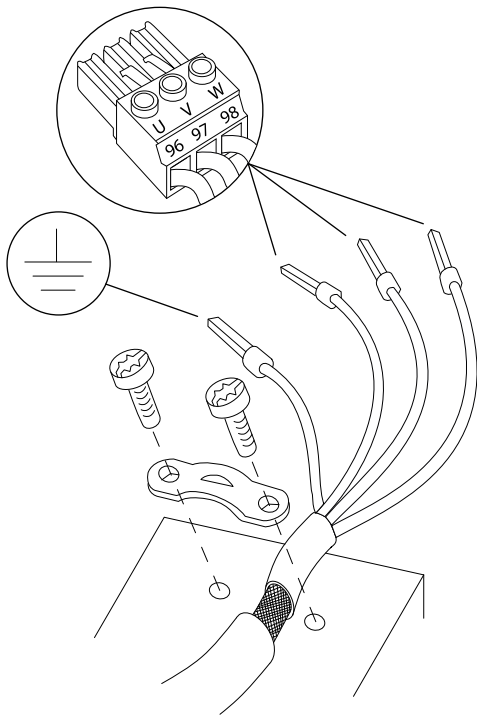
Illustration 4.5 Motor Connection

Procedure for frequency converter with Category C1 filter (see typecode on nameplate)

1. Strip a section of the outer cable insulation.

2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between cable screen and ground.

3. Run the 3-phase motor wiring through the rubber part, see *Illustration 4.6*.

4. Run the 3-phase motor wiring through the ferrite, see *Illustration 4.6*.

5. Connect ground wire to the nearest grounding terminal in accordance with grounding instructions.

6. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Illustration 4.6*.

7. Position the ferrite as shown in *Illustration 4.6*.

8. Squeeze the plastic clamps together. The teeth lock to fasten the ferrite to the wires.

9. Tighten terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.

Illustration 4.6 Motor Connection for Frequency Converter with Category C1 Filter
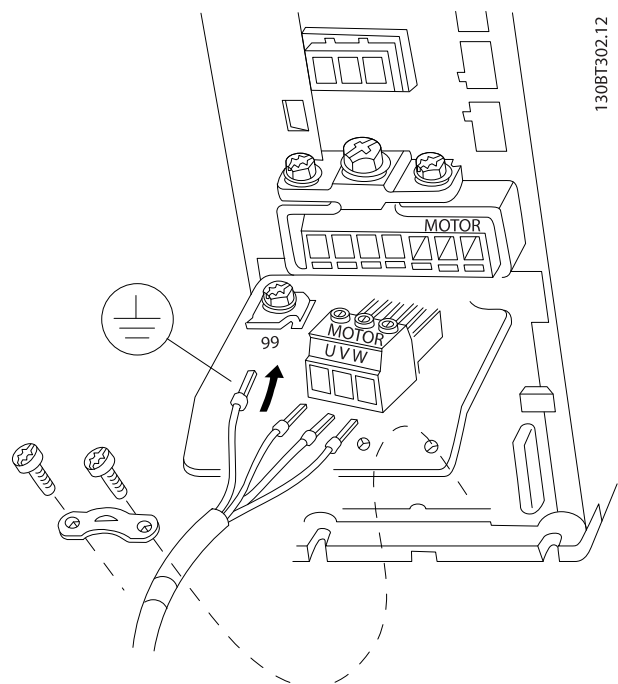
Illustration 4.7 Motor Connection for Enclosure Type A2 and A3

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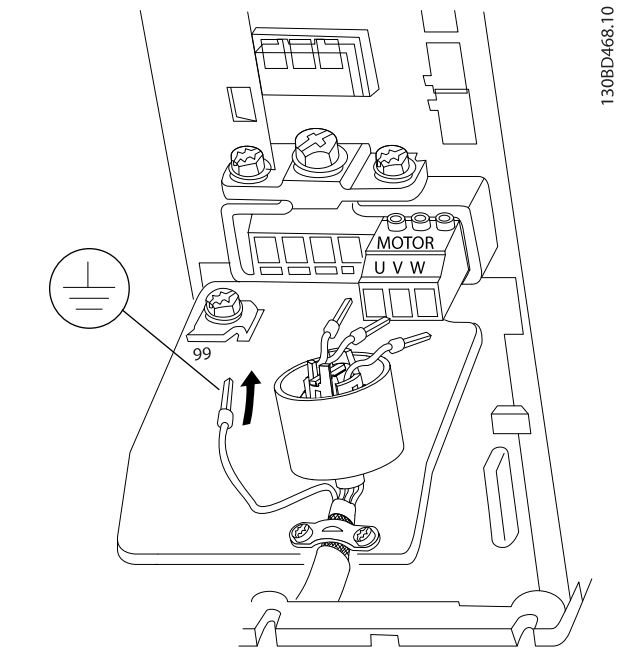
Illustration 4.8 Motor Connection with Category C1 Filter for Enclosure Type A2 and A3
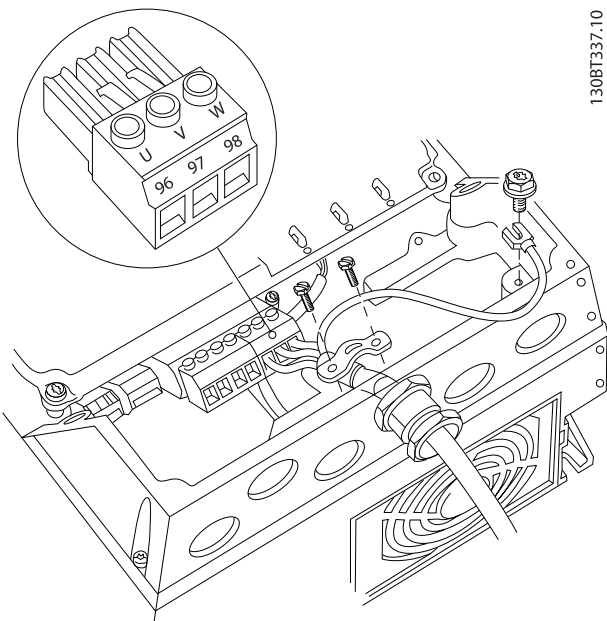
Illustration 4.9 Motor Connection for Enclosure Type A4/A5 (IP55/66/NEMA Type 12)
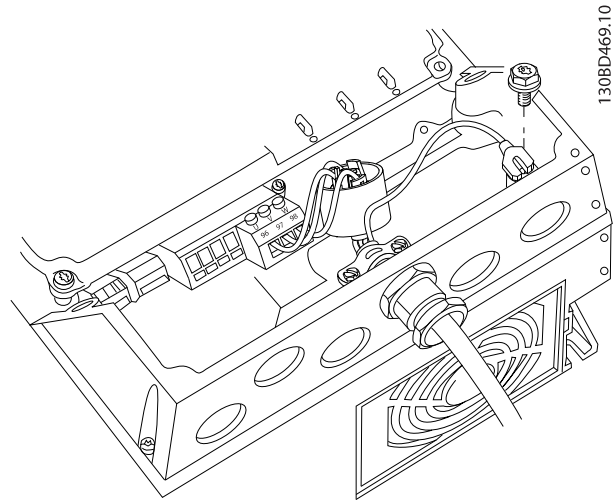
Illustration 4.10 Motor Connection with Category C1 filter for Enclosure Type A4/A5 (IP55/66/NEMA Type 12)
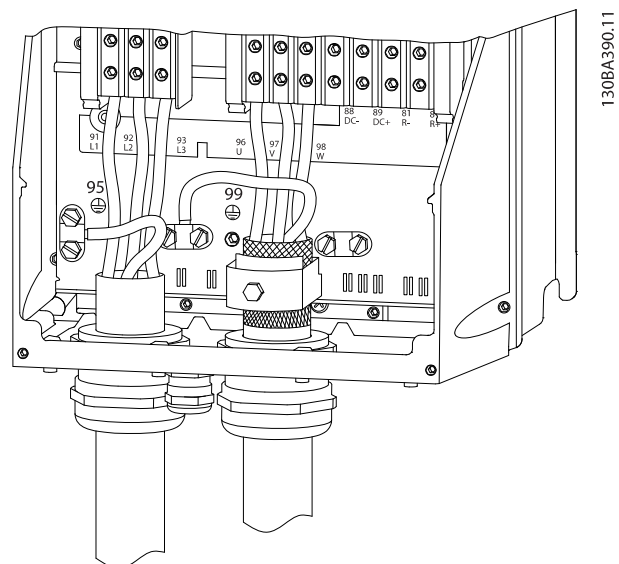
Illustration 4.11 Motor, Mains and Ground Wiring for Enclosure Types B and C Using Shielded Cable

4.7 AC Mains Connection

- Size wiring based upon the input current of the frequency converter. For maximum wire sizes, see *chapter 8.1 Electrical Data*.

- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 4.12*).

2. Depending on the configuration of the equipment, input power will be connected to the mains input terminals or the input disconnect.

3. Ground the cable in accordance with grounding instructions provided in *chapter 4.3 Grounding*.

4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *14-50 RFI Filter* is set to OFF to avoid damage to the intermediate circuit and to reduce earth capacity currents in accordance with IEC 61800-3.
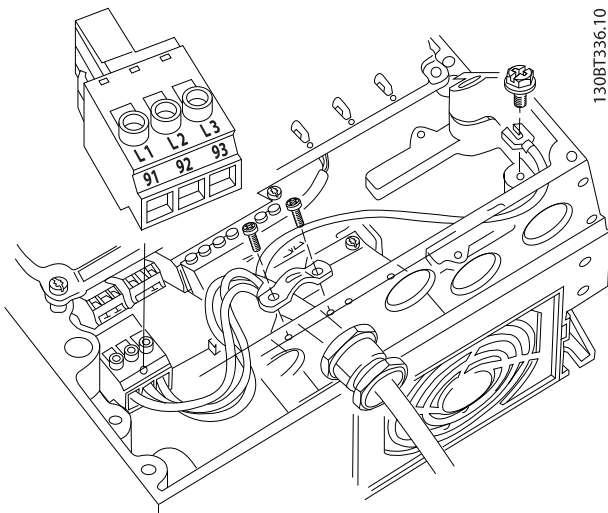
Illustration 4.12 Connecting to AC Mains

4.8   Control Wiring

- Isolate the control wiring from the high-power components in the frequency converter.

- When the frequency converter is connected to a thermistor, ensure that the thermistor control wiring is screened and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 4.13*.

4.8.1 Control Terminal Types

Illustration 4.13 and *Illustration 4.14* show the removable frequency converter connectors. Terminal functions and default settings are summarised in *Table 4.2*.
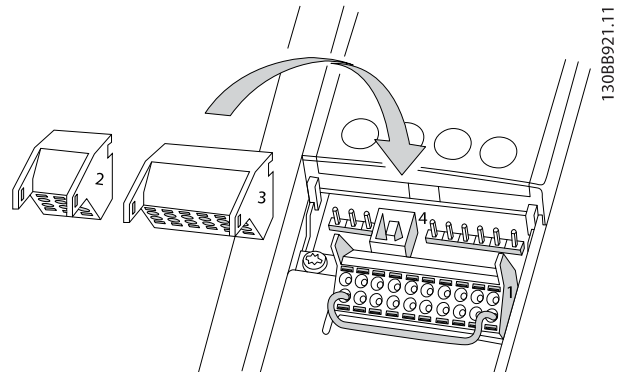
Illustration 4.13 Control Terminal Locations
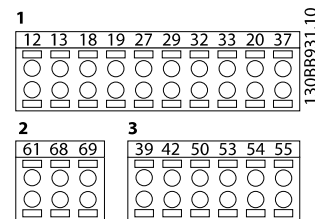
Illustration 4.14 Terminal Numbers

- **Connector 1** provides:
    - 4 programmable digital inputs terminals.
    - 2 additional digital terminals programmable as either input or output.
    - 24 V DC terminal supply voltage.
    - Optional customer supplied 24 V DC voltage.

- **Connector 2** terminals (+)68 and (-)69 are for an RS485 serial communication connection.

- **Connector 3** provides:
    - 2 analog inputs.
    - 1 analog output.
    - 10 V DC supply voltage.
    - Commons for the inputs and output.

 MG12E502

- **Connector 4** is a USB port available for use with the MCT 10 Setup Software.

Terminal description			
Terminal	Parameter	Default setting	Description
Digital Inputs/Outputs			
12, 13	-	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.
18	5-10	[8] Start	Digital inputs.
19	5-11	[0] No operation	
32	5-14	[0] No operation	
33	5-15	[0] No operation	
27	5-12	[2] Coast inverse	For digital input or output. Default setting is input.
29	5-13	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
37	-	Safe Torque Off (STO)	Safe input (optional). Used for STO.
Analog Inputs/Outputs			
39	-		Common for analog output
42	6-50	Speed 0 - High Limit	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω
50	-	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum
53	6-1	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	6-2	Feedback	
55	-		Common for analog input
Serial Communication			
61	-		Integrated RC-Filter for cable screen. ONLY for connecting the screen in the event of EMC problems.

Terminal description			
Terminal	Parameter	Default setting	Description
68 (+)	8-3		RS485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3		
Relays			
01, 02, 03	5-40 [0]	[9] Alarm	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[5] Running	

Table 4.2 Terminal Description

Additional terminals:

- 2 form C relay outputs. Location of the outputs depends on frequency converter configuration.

- Terminals located on built-in optional equipment. See the manual provided with the equipment option.

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 4.15*.

NOTICE

Keep control wires as short as possible and separate from high power cables to minimise interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.
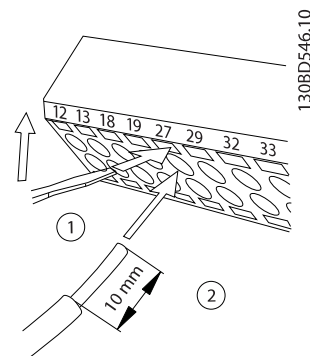
Illustration 4.15 Connecting Control Wires

2. Insert the bare control wire into the contact.

3. Remove the screwdriver to fasten the control wire into the contact.

4

4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

A jumper wire is required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive 24 V DC external interlock command.

- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. The jumper provides an internal 24 V signal on terminal 27.

- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, it indicates that the unit is ready to operate but is missing an input signal on terminal 27.

- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter setting:
- Terminal 53: Speed reference signal in open loop (see *16-61 Terminal 53 Switch Setting*).

- Terminal 54: Feedback signal in closed loop (see *16-63 Terminal 54 Switch Setting*).

NOTICE

Disconnect power to the frequency converter before changing switch positions.

1. Remove the LCP (local control panel) (see *Illustration 4.16*).

2. Remove any optional equipment covering the switches.

3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
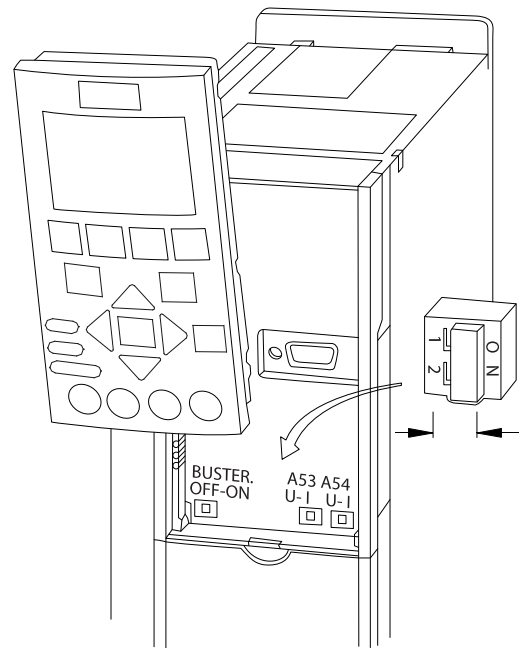
Illustration 4.16 Location of Terminal 53 and 54 Switches

To run STO, additional wiring for the frequency converter is required. .

4.8.5 RS-485 Serial Communication

Up to 32 nodes can be connected as a bus, or via drop cables from a common trunk line to 1 network segment. Repeaters can divide network segments. Each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address, across all segments.

- Connect RS-485 serial communication wiring to terminals (+)68 and (-)69.

- Terminate each segment at both ends, using either the termination switch (bus term on/off, see *Illustration 4.16*) on the frequency converters, or a biased termination resistor network.

- Connect a large surface of the screen to ground, for example with a cable clamp or a conductive cable gland.

- Apply potential-equalising cables to maintain the same ground potential throughout the network.

- Use the same type of cable throughout the entire network to prevent impedance mismatch.

Cable	Screened twisted pair (STP)
Impedance	120 Ω
Max. cable length [m]	1200 (including drop lines) 500 station-to-station

Table 4.3 Cable Information

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.4*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers, residing on the input power side of the frequency converter, or output side to the motor. Ensure that they are ready for full-speed operation. • Check the function and installation of any sensors used for feedback to the frequency converter. • Remove any power factor correction caps on the motor. • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that the motor wiring and control wiring are separated, screened, or in 3 separate metallic conduits for high-frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that the control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. The use of screened cable or twisted pair is recommended. Ensure that the screen is terminated correctly.	
Cooling clearance	• Ensure that the top and bottom clearance is adequate to ensure proper air flow for cooling, see *chapter 3.3 Mounting*.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that the motor and mains cables are in separate conduit or separated screened cables.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted, metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 4.4 Installation Check List

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE
Risk of personal injury if the frequency converter is not properly closed.

• **Before applying power, ensure that all safety covers are in place and securely fastened.**

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

Before applying power:

1. Close the cover properly.

2. Check that all cable glands are firmly tightened.

3. Ensure that input power to the unit is OFF and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.

4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground.

5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.

6. Confirm continuity of the motor by measuring Ω values on U-V (96-97), V-W (97-98), and W-U (98-96).

7. Check for proper grounding of the frequency converter as well as the motor.

8. Inspect the frequency converter for loose connections on the terminals.

9. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

5.2 Applying Power

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a serial bus command, an input reference signal from the LCP, or after a cleared fault condition.
To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**

- **Press [Off/Reset] on the LCP before programming parameters.**

- **Fully wire and assembly the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

Apply power to the frequency converter using the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.

2. Ensure that any optional equipment wiring, matches the installation application.

3. Ensure that all operator devices are in the OFF position. Panel doors must be closed and covers securely fastened.

4. Apply power to the unit. DO NOT start the frequency converter now. For units with a disconnect switch, turn it to the ON position to apply power to the frequency converter.

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The low harmonic drive includes 2 LCPs: 1 each to control the frequency converter side and the filter side independently.

The LCP has several user functions:

- Control speed of frequency converter when in local mode.
- Start and stop in local mode.
- Display operational data, status, warnings and cautions.
- Programme frequency converter and active filter functions.
- Manually reset the frequency converter or active filter after a fault when auto-reset is inactive.

NOTICE

For commissioning via PC, install the MCT 10 Setup Software.

5.3.2 LCP Layout

The LCP is divided into 4 functional groups (see *Illustration 5.1*).

- A. Display area
- B. Display menu keys
- C. Navigation keys and indicator lights (LEDs)
- D. Operation keys and reset
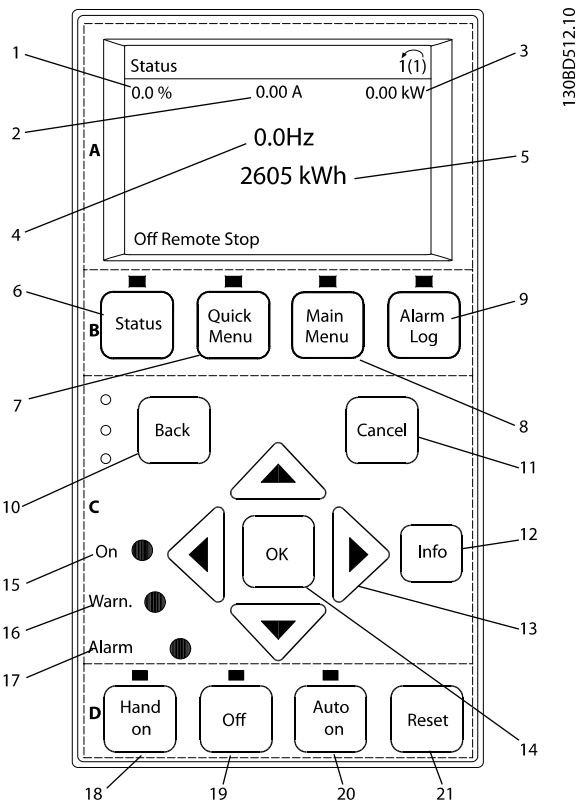
Illustration 5.1 Local Control Panel (LCP)

A. Display Area

The display area is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customised for user application. Select options in the Quick Menu *Q3-13 Display Settings*.

Callout	Display	Parameter number	Default setting
1	1.1	0-20	Reference %
2	1.2	0-21	Motor current
3	1.3	0-22	Power [kW]
4	2	0-23	Frequency
5	3	0-24	kWh counter

Table 5.1 Legend to *Illustration 5.1*, Display Area (Frequency Converter Side)

B. Display Menu Keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

Callout	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	Main Menu	Allows access to all programming parameters.
9	Alarm Log	Displays a list of current warnings, the last 10 alarms, and the maintenance log.

Table 5.2 Legend to *Illustration 5.1*, Display Menu Keys

C. Navigation Keys and Indicator Lights (LEDs)

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. There are also 3 frequency converter status indicator lights in this area.

Callout	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode has not changed.
12	Info	Press for a definition of the function being displayed.
13	Navigation keys	Press to move between items in the menu.
14	OK	Press to access parameter groups or to enable a choice.

Table 5.3 Legend to *Illustration 5.1*, Navigation Keys

Callout	Indicator	Light	Function
15	ON	Green	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply.
16	WARN	Yellow	When a warning is issued, the yellow WARN light comes on and text appears in the display area identifying the problem.
17	ALARM	Red	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 5.4 Legend to *Illustration 5.1*, Indicator Lights (LEDs)

D. Operation Keys and Reset
Operation keys are located at the bottom of the LCP.

Callout	Key	Function
18	Hand On	Starts the frequency converter in local control. • An external stop signal by control input or serial communication overrides the local hand on.
19	Off	Stops the operation but does not remove power to the frequency converter.
20	Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
21	Reset	Resets the frequency converter or active filter manually after a fault has been cleared.

Table 5.5 Legend to *Illustration 5.1*, Operation Keys and Reset

NOTICE

The display contrast can be adjusted by pressing [Status] and [▲]/[▼] keys.

5.3.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters.

Programming data are stored internally in the frequency converter.

- For back-up, upload data into the LCP memory
- To download data to another frequency converter, connect the LCP to that unit and download the stored settings
- Restoring factory default settings does not change data stored in the LCP memory

5.3.4 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop operation before uploading or downloading data.

2. Press [Main Menu] *0-50 LCP Copy* and press [OK].

3. Select *[1] All to LCP* to upload data to the LCP or select *[2] All from LCP* to download data from the LCP.

4. Press [OK]. A progress bar shows the uploading or downloading progress.

5. Press [Hand On] or [Auto On] to return to normal operation.

5.3.5 Changing Parameter Settings

Parameter settings can be accessed and changed from the Quick Menu or from the Main Menu. The Quick Menu only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.

2. Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.

3. Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.

4. Press [▲] [▼] to change the value of a parameter setting.

5. Press [◄] [►] to shift digit when a decimal parameter is in the editing state.

6. Press [OK] to accept the change.

7. Press either [Back] twice to enter Status, or press [Main Menu] once to enter the Main Menu.

View changes
Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list only shows parameters, which have been changed in the current edit set-up.

- Parameters, which have been reset to default values, are not listed.

- The message *Empty* indicates that no parameters have been changed.

5.3.6 Restoring Default Settings

NOTICE

Risk of losing programming and monitoring records by restoration of default settings. To provide a back-up, upload data to the LCP before initialisation.

Restoring the default parameter settings is done by initialisation of the frequency converter. Initialisation is carried out through *14-22 Operation Mode* (recommended) or manually.

- Initialisation using *14-22 Operation Mode* does not reset frequency converter settings, such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.

- Manual initialisation erases all motor, programming, localisation, and monitoring data and restores factory default settings.

Recommended initialisation procedure, via
14-22 Operation Mode

1. Press [Main Menu] twice to access parameters.
2. Scroll to *14-22 Operation Mode* and press [OK].
3. Scroll to *[2] Initialisation* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. This may take slightly longer than normal.

6. Alarm 80 is displayed.
7. Press [Reset] to return to operation mode.

Manual initialisation procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. This may take slightly longer than normal.

Manual initialisation does not reset the following frequency converter information:

- *15-00 Operating hours*
- *15-03 Power Up's*
- *15-04 Over Temp's*
- *15-05 Over Volt's*

5.4 Basic Programming

5.4.1 VLT® Low Harmonic Drive Programming

The low harmonic drive includes 2 LCPs: One each to control the frequency converter side and the filter side independently. Because of this unique design, the detailed parameter information for the product is found in 2 places.

Detailed programming information for the frequency converter portion can be found in the relevant *Programming Guide*. Detailed programming information for the filter is in the *VLT® Active Filter Operating Instructions*. The remaining sections in this chapter apply to the frequency converter side. The active filter of the Low Harmonic Drives is pre-configured for optimal performance and must only be turned on by pressing its Hand On key after frequency converter side is commissioned.

5.4.2 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- SmartStart starts automatically, at first power up or after initialisation of the frequency converter.

- Follow the on-screen instructions to complete the commissioning of the frequency converter. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.

- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.3 Commissioning via [Main Menu]* or the programming guide.

NOTICE

Motor data is required for the SmartStart set-up. The required data is normally available on the motor nameplate.

5.4.3 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and check-out purposes. Application settings may vary.

Enter data with power ON, but before operating the frequency converter.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to parameter group *0-** Operation/Display* and press [OK].
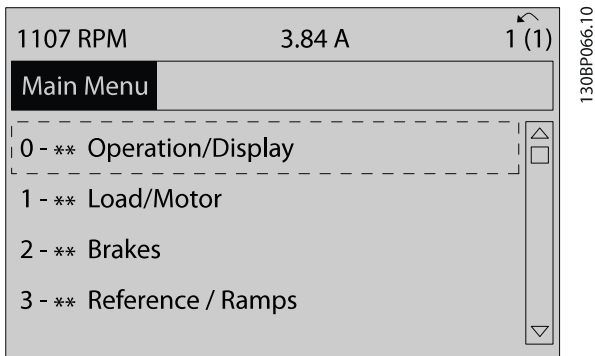
Illustration 5.2 Main Menu

3. Press the navigation keys to scroll to parameter group *0-0* Basic Settings* and press [OK].
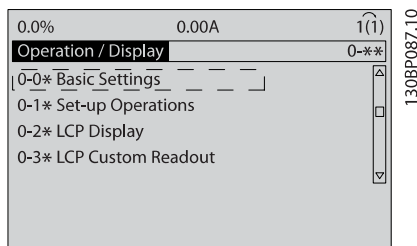
Illustration 5.3 Operation/Display

4. Press the navigation keys to scroll to *0-03 Regional Settings* and press [OK].
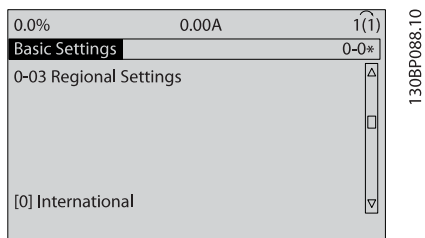
Illustration 5.4 Basic Settings

5. Press the navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters).

6. Press [Main Menu] on the LCP.

7. Press the navigation keys to scroll to *0-01 Language*.

8. Select the language and press [OK].

9. If a jumper wire is in place between control terminals 12 and 27, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *No Operation* in *5-12 Terminal 27 Digital Input*.

10. Make the application specific settings in the following parameters:

   10a *3-02 Minimum Reference*.

   10b *3-03 Maximum Reference*.

   10c *3-41 Ramp 1 Ramp Up Time*.

   10d *3-42 Ramp 1 Ramp Down Time*.

   10e *3-13 Reference Site*. Linked to Hand/Auto Local Remote.

5.4.4 Asynchronous Motor Set-up

Enter the following motor data. The information can be found on the motor nameplate.

1. *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]*.

2. *1-22 Motor Voltage*.

3. *1-23 Motor Frequency*.

4. *1-24 Motor Current*.

5. *1-25 Motor Nominal Speed*.

When running in flux mode, or for optimum performance in VVC+ mode, extra motor data is required to set up the following parameters. The data can be found in the motor datasheet (this data is typically not available on the motor nameplate). Run a complete AMA using *1-29 Automatic Motor Adaptation (AMA) [1] Enable Complete AMA* or enter the parameters manually. *1-36 Iron Loss Resistance (Rfe)* is always entered manually.

1. *1-30 Stator Resistance (Rs)*.

2. *1-31 Rotor Resistance (Rr)*.

3. *1-33 Stator Leakage Reactance (X1)*.

4. *1-34 Rotor Leakage Reactance (X2)*.

5. *1-35 Main Reactance (Xh)*.

6. *1-36 Iron Loss Resistance (Rfe)*.

Application-specific adjustment when running VVC+
VVC+ is the most robust control mode. In most situations, it provides optimum performance without further adjustments. Run a complete AMA for best performance.

Application-specific adjustment when running Flux
Flux mode is the preferred control mode for optimum shaft performance in dynamic applications. Perform an AMA since this control mode requires precise motor data. Depending on the application, further adjustments may be required.

See *Table 5.6* for application-related recommendations.

Application	Settings
Low-inertia applications	Keep calculated values.

Application	Settings
High-inertia applications	*1-66 Min. Current at Low Speed*. Increase current to a value between default and maximum depending on the application. Set ramp times matching the application. Too fast ramp up causes an overcurrent or overtorque. Too fast ramp down causes an overvoltage trip.
High load at low speed	*1-66 Min. Current at Low Speed*. Increase current to a value between default and maximum depending on the application.
No-load application	Adjust *1-18 Min. Current at No Load* to achieve smoother motor operation by reducing torque ripple and vibration.
Flux sensorless only	Adjust *1-53 Model Shift Frequency*. Example 1: If the motor oscillates at 5 Hz and dynamics performance is required at 15 Hz, set *1-53 Model Shift Frequency* to 10 Hz. Example 2: If the application involves dynamic load changes at low speed, reduce *1-53 Model Shift Frequency*. Observe the motor behaviour to make sure that the model shift frequency is not reduced too much. Symptoms of inappropriate model shift frequency are motor oscillations or frequency converter tripping.

Table 5.6 Recommendations for Flux Applications

5.4.5 Permanent Magnet Motor Set-up

NOTICE

Only use permanent magnet (PM) motor with fans and pumps.

Initial Programming Steps

1. Activate PM motor operation *1-10 Motor Construction*, select *(1) PM, non salient SPM*

2. Set *0-02 Motor Speed Unit* to *[0] RPM*

Programming motor data
After selecting PM motor in *1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Adv. Motor Data* and *1-4** are active.
The necessary data can be found on the motor nameplate and in the motor data sheet.
Program the following parameters in the listed order

1. *1-24 Motor Current*

2. *1-26 Motor Cont. Rated Torque*

3. *1-25 Motor Nominal Speed*

4. *1-39 Motor Poles*

5. *1-30 Stator Resistance (Rs)*
   Enter line to common stator winding resistance (R_s). If only line-line data are available, divide the line-line value with 2 to achieve the line to common (starpoint) value.
   It is also possible to measure the value with an ohmmeter, which takes the resistance of the cable into account. Divide the measured value by 2 and enter the result.

6. *1-37 d-axis Inductance (Ld)*
   Enter line to common direct axis inductance of the PM motor.
   If only line-line data are available, divide the line-line value with 2 to achieve the line-common (starpoint) value.
   It is also possible to measure the value with an inductancemeter, which takes the inductance of the cable into account. Divide the measured value by 2 and enter the result.

7. *1-40 Back EMF at 1000 RPM*
   Enter line to line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1000 RPM measured between 2 lines. If the value is not available for a motor speed of 1000 RPM, calculate the correct value as follows: If back EMF is e.g. 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *1-40 Back EMF at 1000 RPM*.

Test motor operation

1. Start the motor at low speed (100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.

2. Check if start function in *1-70 PM Start Mode* fits the application requirements.

Rotor detection
This function is the recommended choice for applications where the motor starts from standstill, e.g. pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

Parking
This function is the recommended choice for applications where the motor is rotating at slow speed eg. windmilling in fan applications. *2-06 Parking Current* and *2-07 Parking*

5

Time can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC$^+$ PM settings. Recommendations in different applications can be seen in *Table 5.6*.

Application	Settings
Low inertia applications I$_{Load}$/I$_{Motor}$ <5	*1-17 Voltage filter time const.* to be increased by factor 5 to 10 *1-14 Damping Gain* should be reduced *1-66 Min. Current at Low Speed* should be reduced (<100%)
Low inertia applications 50>I$_{Load}$/I$_{Motor}$ >5	Keep calculated values
High inertia applications I$_{Load}$/I$_{Motor}$ > 50	*1-14 Damping Gain*, *1-15 Low Speed Filter Time Const.* and *1-16 High Speed Filter Time Const.* should be increased
High load at low speed <30% (rated speed)	*1-17 Voltage filter time const.* should be increased *1-66 Min. Current at Low Speed* should be increased (>100% for a prolonged time can overheat the motor)

Table 5.7 Recommendations in Different Applications

If the motor starts oscillating at a certain speed, increase *1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

Starting torque can be adjusted in *1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.6 Automatic Energy Optimisation (AEO)

NOTICE

AEO is not relevant for permanent magnet motors.

AEO is a procedure which minimises voltage to the motor, thereby reducing energy consumption, heat, and noise.

To activate AEO, set *1-03 Torque Characteristics* to *[2] Auto Energy Optim. CT* or *[3] Auto Energy Optim. VT*.

5.4.7 Automatic Motor Adaptation (AMA)

AMA is a procedure which optimises compatibility between the frequency converter and the motor.

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the entered nameplate data.

- The motor shaft does not turn and no harm is done to the motor while running the AMA.

- Some motors may be unable to run the complete version of the test. In that case, select *[2] Enable reduced AMA*.

- If an output filter is connected to the motor, select *[2] Enable reduced AMA*.

- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.

- Run this procedure on a cold motor for best results.

To run AMA
1. Press [Main Menu] to access parameters.
2. Scroll to parameter group *1-** Load and Motor* and press [OK].
3. Scroll to parameter group *1-2* Motor Data* and press [OK].
4. Scroll to *1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicates when it is complete.
8. The advanced motor data is entered in parameter group *1-3* Adv. Motor Data*.

5.5 Checking Motor Rotation

NOTICE

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the frequency converter, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in *4-12 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to *1-28 Motor Rotation Check* and press [OK].
3. Scroll to *[1] Enable*.

The following text appears: *Note! Motor may run in wrong direction*.
4. Press [OK].
5. Follow the on-screen instructions.

NOTICE

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any 2 of the 3 motor wires on the motor or frequency converter side of the connection.

5.6 Local-control Test

1.   Press [Hand On] to provide a local start command to the frequency converter.

2.   Accelerate the frequency converter by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.

3.   Note any acceleration problems.

4.   Press [Off]. Note any deceleration problems.

In the event of acceleration or deceleration problems, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* for resetting the frequency converter after a trip.

5.7 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

1.   Press [Auto On].

2.   Apply an external run command.

3.   Adjust the speed reference throughout the speed range.

4.   Remove the external run command.

5.   Check the sound and vibration levels of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.3 Warning and Alarm Types* or *chapter 7.4 List of Warnings and Alarms*.

6 Application Set-up Examples

The examples in this section are intended as a quick reference for common applications.

- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*).

- Parameters associated with the terminals and their settings are shown next to the drawings.

- Required switch settings for analog terminals A53 or A54 are also shown.

NOTICE

When using the optional STO feature, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the frequency converter to operate with factory default programming values.

6.1 Application Examples

6.1.1 Speed

Parameters		
Function	**Setting**	
6-10 Terminal 53 Low Voltage	0.07 V*	
6-11 Terminal 53 High Voltage	10 V*	
6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz	
6-15 Terminal 53 High Ref./Feedb. Value	50 Hz	
* = Default Value		
Notes/comments: D IN 37 is an option.		

Table 6.1 Analog Speed Reference (Voltage)

Parameters		
Function	**Setting**	
6-12 Terminal 53 Low Current	4 mA*	
6-13 Terminal 53 High Current	20 mA*	
6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz	
6-15 Terminal 53 High Ref./Feedb. Value	50 Hz	
* = Default Value		
Notes/comments: D IN 37 is an option.		

Table 6.2 Analog Speed Reference (Current)

Parameters		
Function	**Setting**	
6-10 Terminal 53 Low Voltage	0.07 V*	
6-11 Terminal 53 High Voltage	10 V*	
6-14 Terminal 53 Low Ref./Feedb. Value	0 Hz	
6-15 Terminal 53 High Ref./Feedb. Value	1500 Hz	
* = Default Value		
Notes/comments: D IN 37 is an option.		

Table 6.3 Speed Reference (Using a Manual Potentiometer)

ARMSTRONG

FC		Parameters	
		Function	**Setting**
+24 V	12	5-10 Terminal 18 Digital Input	[8] Start*
+24 V	13		
D IN	18	5-12 Terminal 27 Digital Input	[19] Freeze Reference
D IN	19		
COM	20	5-13 Terminal 29 Digital Input	[21] Speed Up
D IN	27		
D IN	29	5-14 Terminal 32 Digital Input	[22] Speed Down
D IN	32		
D IN	33	* = Default Value	
D IN	37	**Notes/comments:**	
+10 V	50	D IN 37 is an option.	
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.4 Speed Up/Down
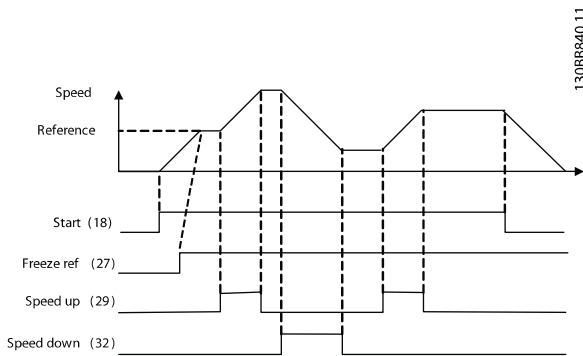
Illustration 6.1 Speed Up/Down

6.1.2 Start/Stop

FC		Parameters	
		Function	**Setting**
+24 V	12	5-10 Terminal 18 Digital Input	[8] Start*
+24 V	13		
D IN	18	5-12 Terminal 27 Digital Input	[0] No operation
D IN	19		
COM	20	5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
D IN	27		
D IN	29	* = Default Value	
D IN	32	**Notes/comments:**	
D IN	33	If *5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	
D IN	37		
+10	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.5 Start/Stop Command with Safe Stop Option
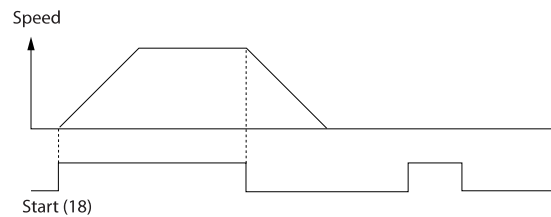
Illustration 6.2 Start/Stop Command with Safe Stop

6

FC		Parameters	
		Function	**Setting**
+24 V	12	5-10 Terminal 18 Digital Input	[9] Latched Start
+24 V	13		
D IN	18	5-12 Terminal 27 Digital Input	[6] Stop Inverse
D IN	19		
COM	20	* = Default Value	
D IN	27	**Notes/comments:**	
D IN	29	If *5-12 Terminal 27 Digital Input* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	
D IN	32		
D IN	33		
D IN	37		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

130BB803.10

Table 6.6 Pulse Start/Stop

Speed

Latched Start (18)
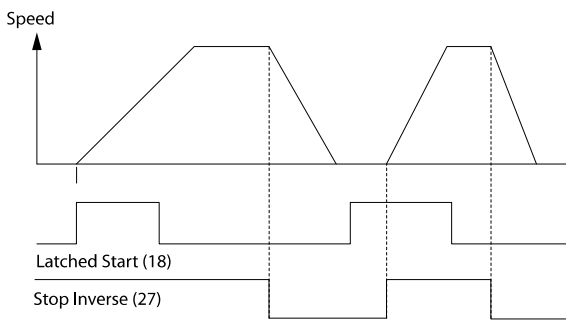
Stop Inverse (27)

130BB806.10

Illustration 6.3 Latched Start/Stop Inverse

FC		Parameters	
		Function	**Setting**
+24 V	12	5-10 Terminal 18 Digital Input	[8] Start
+24 V	13		
D IN	18	5-11 Terminal 19 Digital Input	[10] Reversing*
D IN	19		
COM	20		
D IN	27	5-12 Terminal 27 Digital Input	[0] No operation
D IN	29		
D IN	32	5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
D IN	33		
D IN	37	5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
+10 V	50	3-10 Preset Reference	
A IN	53	Preset ref. 0	25%
A IN	54	Preset ref. 1	50%
COM	55	Preset ref. 2	75%
A OUT	42	Preset ref. 3	100%
COM	39	* = Default Value	
		Notes/comments:	
		D IN 37 is an option.	

130BB934.10

Table 6.7 Start/Stop with Reversing and 4 Preset Speeds

6.1.3 External Alarm Reset

FC		Parameters	
		Function	**Setting**
+24 V	12	5-11 Terminal 19 Digital Input	[1] Reset
+24 V	13	* = Default Value	
D IN	18	**Notes/comments:**	
D IN	19	D IN 37 is an option.	
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

130BB928.10

Table 6.8 External Alarm Reset

6.1.4 RS485

			Parameters	
FC		130BB685.10	**Function**	**Setting**
+24 V	12		8-30 Protocol	FC*
+24 V	13		8-31 Address	1*
D IN	18		8-32 Baud Rate	9600*
D IN	19		* = Default Value	
COM	20			
D IN	27		**Notes/comments:**	
D IN	29		Select protocol, address and	
D IN	32		baud rate in the above	
D IN	33		mentioned parameters.	
D IN	37		D IN 37 is an option.	
+10 V	50			
A IN	53			
A IN	54			
COM	55			
A OUT	42			
COM	39			
R1	01			
	02			
	03			
R2	04			
	05			
	06	RS-485		
	61			
	68	+		
	69	−		

Table 6.9 RS485 Network Connection

6.1.5 Motor Thermistor

⚠️WARNING

THERMISTOR INSULATION
Risk of personal injury or equipment damage.

- Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.

			Parameters	
VLT		130BB686.12	**Function**	**Setting**
+24 V	12		*1-90 Motor Thermal Protection*	[2] Thermistor trip
+24 V	13			
D IN	18			
D IN	19		1-93 Thermistor Source	[1] Analog input 53
COM	20			
D IN	27		* = Default Value	
D IN	29			
D IN	32		**Notes/comments:**	
D IN	33		If only a warning is desired,	
D IN	37		*1-90 Motor Thermal Protection*	
+10 V	50		should be set to *[1] Thermistor*	
A IN	53		*warning*.	
A IN	54		D IN 37 is an option.	
COM	55			
A OUT	42			
COM	39			
U - I				
A53				

Table 6.10 Motor Thermistor

6

7 Diagnostics and Troubleshooting

This chapter includes maintenance and service guidelines, status messages, warnings and alarms, and basic trouble-shooting.

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the frequency converter is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the frequency converter at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts.

7.2 Status Messages

When the frequency converter is in *Status mode*, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 7.1*).
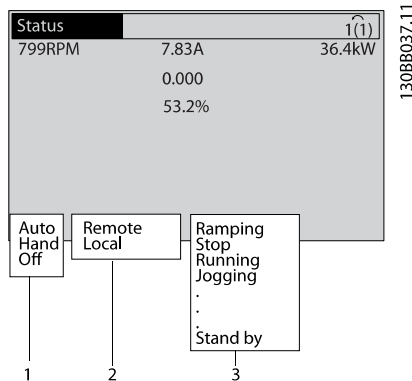
1	Operation mode (see *Table 7.1*)
2	Reference site (see *Table 7.2*)
3	Operation status (see *Table 7.3*)

Illustration 7.1 Status Display

Table 7.1 to *Table 7.3* describe the displayed status messages.

Off	The frequency converter does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The frequency converter is controlled from the control terminals and/or the serial communication.

Hand On	The frequency converter is controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 7.1 Operation Mode

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand On] control or reference values from the LCP.

Table 7.2 Reference Site

AC Brake	*AC Brake* was selected in *2-10 Brake Function*. The AC brake overmagnetises the motor to achieve a controlled slow-down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *2-12 Brake Power Limit (kW)* has been reached.
Coast	• *Coast inverse* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication.
Ctrl. ramp-down	*[1] Control Ramp-down* was selected in *14-10 Mains Failure*. • The mains voltage is below the value set in *14-11 Mains Voltage at Mains Fault* at mains fault • The frequency converter ramps down the motor using a controlled ramp down.
Current High	The frequency converter output current is above the limit set in *4-51 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *4-52 Warning Speed Low*.
DC Hold	*[1] DC hold* is selected in *1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *2-00 DC Hold/Preheat Current*.

DC Stop	The motor is held with a DC current (*2-01 DC Brake Current*) for a specified time (*2-02 DC Braking Time*). • The *DC Brake* cut in speed is reached in *2-03 DC Brake Cut In Speed [RPM]* and a stop command is active. • *DC Brake* (inverse) is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The *DC Brake* is activated via serial communication.		Motor check	In *1-80 Function at Stop*, *[2] Motor Check* was selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *4-57 Warning Feedback High*.		OVC control	Overvoltage control was activated in *2-17 Over-voltage Control*, *[2] Enabled*. The connected motor supplies the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *4-56 Warning Feedback Low*.		PowerUnit Off	(Only frequency converters with an external 24 V power supply installed). Mains supply to the frequency converter was removed, and the control card is supplied by the external 24 V.
Freeze output	The remote reference is active, which holds the present speed. • *Freeze output* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal functions *Speed Up* and *Speed Down*. • *Hold ramp* is activated via serial communication.		Protection md	Protection mode is active. The unit has detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *14-26 Trip Delay at Inverter Fault*.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.		QStop	The motor is decelerating using *3-81 Quick Stop Ramp Time*. • *Quick stop inverse* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The *quick stop* function was activated via serial communication.
Freeze ref.	*Freeze Reference* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal functions *Speed Up* and *Speed Down*.		Ramping	The motor is accelerating/decelerating using the active ramp up/down. The reference, a limit value, or a standstill is not yet reached.
Jog request	A jog command was given, but the motor remains stopped until a run permissive signal is received via a digital input.		Ref. high	The sum of all active references is above the reference limit set in *4-55 Warning Reference High*.
Jogging	The motor is running as programmed in *3-19 Jog Speed [RPM]*. • *Jog* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal (for example Terminal 29) is active. • The *Jog* function is activated via the serial communication. • The *Jog* function was selected as a reaction for a monitoring function (for example No signal). The monitoring function is active.		Ref. low	The sum of all active references is below the reference limit set in *4-54 Warning Reference Low*.
			Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
			Run request	A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.
			Running	The motor is driven by the frequency converter.

7

Sleep Mode	The energy-saving function is enabled. The motor has stopped, but restarts automatically when required.
Speed high	Motor speed is above the value set in *4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *4-52 Warning Speed Low*.
Standby	In *Auto On* mode, the frequency converter starts the motor with a start signal from a digital input or serial communication.
Start delay	In *1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	*Start forward* and *start reverse* were selected as functions for 2 different digital inputs (parameter group *5-1* Digital Inputs*). The motor starts in forward or reverse direction depending on which corresponding terminal is activated.
Stop	The frequency converter has received a stop command from the LCP, digital input, or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the frequency converter. The frequency converter can then be reset manually by pressing [Reset], or remotely by control terminals or serial communication.

Table 7.3 Operation Status

NOTICE

In auto/remote mode, the frequency converter requires external commands to execute functions.

7.3 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition ceases.

Alarms
Trip

An alarm is issued when the frequency converter is tripped, meaning that the frequency converter suspends operation to prevent frequency converter or system damage. The motor coasts to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. After the fault condition is

remedied, the frequency converter can be reset. It is then ready to start operation again.

Resetting the frequency converter after trip/trip lock
A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.

- Digital reset input command.

- Serial communication reset input command.

- Auto reset.

Trip lock
Input power is cycled. The motor coasts to a stop. The frequency converter continues to monitor the frequency converter status. Remove input power to the frequency converter, correct the cause of the fault, and reset the frequency converter.

Warning and alarm displays

- A warning is displayed in the LCP along with the warning number.

- An alarm flashes along with the alarm number.
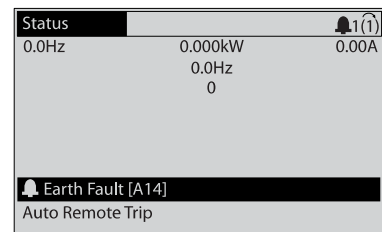
Illustration 7.2 Alarm Display Example

In addition to the text and alarm code in the LCP, there are 3 status indicator lights.

130BB467.10
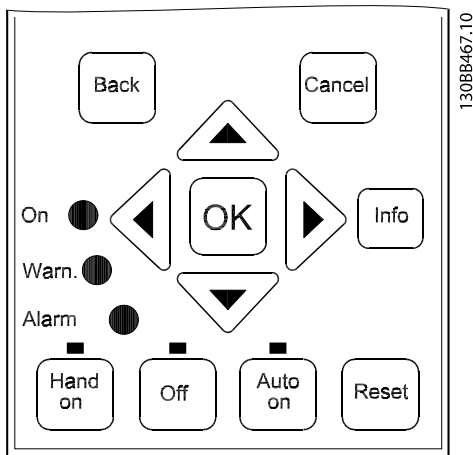
	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (Flashing)
Trip-Lock	On	On (Flashing)

Illustration 7.3 Status Indicator Lights

7.4 List of Warnings and Alarms

The following warning/alarm information defines each warning/alarm condition, provides the probable cause for the condition, and details a remedy or troubleshooting procedure.

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

A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

 Troubleshooting
- Remove the wiring from terminal 50. If the warning clears, the problem is with the wiring. If the warning does not clear, replace the control card.

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed in *6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

 Troubleshooting
- Check the connections on all the analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - MCB 101 terminals 11 and 12 for signals, terminal 10 common.

  - MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the frequency converter programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier on the frequency converter. Options are programmed in *14-12 Function at Mains Imbalance*.

 Troubleshooting
- Check the supply voltage and supply currents to the frequency converter.

WARNING 5, DC link voltage high
The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The DC-link voltage (DC) is lower than the low-voltage warning limit. The limit depends on the frequency converter voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the DC-link voltage exceeds the limit, the frequency converter trips after a time.

 Troubleshooting
- Connect a brake resistor.
- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *2-10 Brake Function*.
- Increase *14-26 Trip Delay at Inverter Fault*.
- If the alarm/warning occurs during a power sag, use kinetic back-up (*14-10 Mains Failure*).

WARNING/ALARM 8, DC under voltage
If the DC-link voltage drops below the undervoltage limit, the frequency converter checks if a 24 V DC back-up supply is connected. If no 24 V DC back-up supply is connected, the frequency converter trips after a fixed time delay. The time delay varies with unit size.

 Troubleshooting
- Check that the supply voltage matches the frequency converter voltage.
- Perform an input voltage test.
- Perform a soft charge circuit test.

WARNING/ALARM 9, Inverter overload
The frequency converter has run with more than 100% overload for too long and is about to cut-out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100%, while giving an alarm. The frequency converter cannot be reset until the counter is below 90%.

7

7

Troubleshooting

- Compare the output current shown on the LCP with the frequency converter rated current.

- Compare the output current shown on the LCP with the measured motor current.

- Display the thermal frequency converter load on the LCP and monitor the value. When running above the frequency converter continuous current rating, the counter increases. When running below the frequency converter continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

- Check for motor overheating.

- Check if the motor is mechanically overloaded.

- Check that the motor current set in *1-24 Motor Current* is correct.

- Ensure that the motor data in *parameters 1–20* to *1–25* are set correctly.

- If an external fan is in use, check that it is selected in *1-91 Motor External Fan*.

- Running AMA in *1-29 Automatic Motor Adaptation (AMA)* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor overtemp
Check whether the thermistor is disconnected. Select whether the frequency converter issues a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating.

- Check if the motor is mechanically overloaded.

- When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 or 54 is set for voltage. Check that *1-93 Thermistor Source* selects terminal 53 or 54.

- When using terminal 18, 19, 31, 32, or 33 (digital inputs), check that the thermistor is connected correctly between the digital input terminal used (digital input PNP only) and terminal 50. Select the terminal to use in *1-93 Thermistor Source*.

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.

- If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.

- If torque limit occurs while running, increase the torque limit. Make sure that the system can operate safely at a higher torque.

- Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up. If extended mechanical brake control is selected, a trip can be reset externally.

Troubleshooting

- Remove the power and check if the motor shaft can be turned.

- Check that the motor size matches the frequency converter.

- Check that the motor data is correct in *parameters 1–20* to *1–25*.

ALARM 14, Earth (ground) fault
There is current from the output phase to ground, either in the cable between the frequency converter and the motor or in the motor itself.

Troubleshooting

- Remove power to the frequency converter and repair the ground fault.

- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact Armstrong:

- *15-40 FC Type*

- *15-41 Power Section*

- *15-42 Voltage*

- *15-43 Software Version*

- *15-45 Actual Typecode String*
- *15-49 SW ID Control Card*
- *15-50 SW ID Power Card*
- *15-60 Option Mounted*
- *15-61 Option SW Version* (for each option slot)

ALARM 16, Short circuit
There is short-circuiting in the motor or motor wiring.

Troubleshooting
- Remove the power to the frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter. The warning is only active when *8-04 Control Word Timeout Function* is NOT set to *[0] Off*.

If *8-04 Control Word Timeout Function* is set to *[5] Stop and Trip*, a warning appears and the frequency converter ramps down until it stops, and then it displays an alarm.

Troubleshooting
- Check the connections on the serial communication cable.
- Increase *8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.
- Verify a proper installation based on EMC requirements.

ALARM 18, Start failed
The speed has not been able to exceed *1-77 Compressor Start Max Speed [RPM]* during start within the allowed time (set in *1-79 Compressor Start Max Time to Trip*.) A blocked motor may cause this alarm.

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

For frequency converters with DC fans, there is a feedback sensor mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For frequency converters with AC fans, the voltage to the fan is monitored.

Troubleshooting
- Check for proper fan operation.
- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink and control card.

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

For frequency converters with DC fans, there is a feedback sensor mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For frequency converters with AC fans, the voltage to the fan is monitored.

Troubleshooting
- Check for proper fan operation.
- Cycle power to the frequency converter and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink and control card.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational, but without the brake function.

Troubleshooting
- Remove the power to the frequency converter and replace the brake resistor (see *2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in *2-16 AC brake Max. Current*. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option *[2] Trip* is selected in *2-13 Brake Power Monitoring*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational but, since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

Troubleshooting
- Remove power to the frequency converter and remove the brake resistor.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working. Check *2-15 Brake Check*.

ALARM 29, Heat Sink temp
The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the frequency converter power size.

7

7

Troubleshooting

Check for the following conditions.

- Ambient temperature too high.
- Motor cables too long.
- Incorrect airflow clearance above and below the frequency converter.
- Blocked airflow around the frequency converter.
- Damaged heat sink fan.
- Dirty heat sink.

ALARM 30, Motor phase U missing

Motor phase U between the frequency converter and the motor is missing.

Troubleshooting

- Remove the power from the frequency converter and check motor phase U.

ALARM 31, Motor phase V missing

Motor phase V between the frequency converter and the motor is missing.

Troubleshooting

- Remove the power from the frequency converter and check motor phase V.

ALARM 32, Motor phase W missing

Motor phase W between the frequency converter and the motor is missing.

Troubleshooting

- Remove the power from the frequency converter and check motor phase W.

ALARM 33, Inrush fault

Too many power-ups have occurred within a short time period.

Troubleshooting

- Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault

The fieldbus on the communication option card is not working.

WARNING/ALARM 36, Mains failure

This warning/alarm is only active if the supply voltage to the frequency converter is lost and *14-10 Mains Failure* is not set to option *[0] No Function*. Check the fuses to the frequency converter and mains supply to the unit.

ALARM 38, Internal fault

When an internal fault occurs, a code number defined in *Table 7.4* is displayed.

Troubleshooting

- Cycle power
- Check that the option is properly installed
- Check for loose or missing wiring

It may be necessary to contact your Armstrong supplier or service department. Note the code number for further troubleshooting directions.

No.	Text
0	Serial port cannot be initialised. Contact your Armstrong supplier or Armstrong Service Department.
256-258	Power EEPROM data is defective or too old. Replace power card.
512-519	Internal fault. Contact your Armstrong supplier or Armstrong Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your Armstrong supplier or the Armstrong Service Department.
1299	Option SW in slot A is too old
1300	Option SW in slot B is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1379-2819	Internal fault. Contact your Armstrong supplier or Armstrong Service Department.
2561	Replace control card
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware
5376-6231	Internal fault. Contact your Armstrong supplier or Armstrong Service Department.

Table 7.4 Internal Fault Codes

ALARM 39, Heat sink sensor

No feedback from the heat sink 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 gatedrive card, or the ribbon cable between the power card and gatedrive card.

WARNING 40, Overload of digital output terminal 27

Check the load connected to terminal 27 or remove the 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 the short circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7

For X30/6, check the load connected to X30/6 or remove the short circuit connection. Check *5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 45, Earth fault 2

Ground fault.

 MG12E502

Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

ALARM 46, Power card supply

The supply on the power card is out of range.

There are 3 supplies generated by the switch mode 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 3-phase mains voltage, all 3 supplies are monitored.

Troubleshooting

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24 V DC supply is used, verify proper supply power.

WARNING 47, 24 V supply low

The supply on the power card is out of range.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- ±18 V.

Troubleshooting

- Check for a defective power card.

WARNING 48, 1.8 V supply low

The 1.8 V DC supply used on the control card is outside of the allowable limits. The supply is measured on the control card. Check for a defective control card. If an option card is present, check for overvoltage.

WARNING 49, Speed limit

When the speed is outside of the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the frequency converter shows a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping), the frequency converter trips.

ALARM 50, AMA calibration failed

Contact the Armstrong supplier or Armstrong Service.

ALARM 51, AMA check U_{nom} and I_{nom}

The settings for motor voltage, motor current, and motor power are wrong. Check the settings in *parameters 1–20 to 1–25*.

ALARM 52, AMA low I_{nom}

The motor current is too low. Check the settings in *4-18 Current Limit*.

ALARM 53, AMA motor too big

The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small

The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range

The parameter values of the motor are outside of the acceptable range. AMA cannot run.

ALARM 56, AMA interrupted by user

The user has interrupted AMA.

ALARM 57, AMA internal fault

Try to restart AMA. Repeated restarts can overheat the motor.

ALARM 58, AMA Internal fault

Contact the Armstrong supplier.

WARNING 59, Current limit

The current is higher than the value in *4-18 Current Limit*. Ensure that motor data in *parameters 1–20 to 1–25* are set correctly. Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

WARNING 60, External interlock

A digital input signal is indicating a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock. Reset the frequency converter.

WARNING 62, Output frequency at maximum limit

The output frequency has reached the value set in *4-19 Max Output Frequency*. Check the application for possible causes. Possibly increase the output frequency limit. Be sure that the system can operate safely at a higher output frequency. The warning clears when the output drops below the maximum limit.

WARNING/ALARM 65, Control card over temperature

The cut-out temperature of the control card is 80 °C.

Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check the fan operation.
- Check the control card.

WARNING 66, Heat sink temperature low

The frequency converter is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

7

7

Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the frequency converter whenever the motor is stopped by setting *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*.

ALARM 67, Option module configuration has changed
1 or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
STO has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting
- Check that the ambient operating temperature is within limits.
- Check for clogged filters.
- Check fan operation.
- Check the power card.

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. To check compatibility, contact the Armstrong supplier with the type code of the unit from the nameplate and the part numbers of the cards.

ALARM 80, Drive initialised to default value
Parameter settings are initialised to default settings after a manual reset. To clear the alarm, reset the unit.

ALARM 92, No flow
A no-flow condition has been detected in the system. *22-23 No-Flow Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 93, Dry pump
A no-flow condition in the system with the frequency converter operating at high speed may indicate a dry pump. *22-26 Dry Pump Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 94, End of curve
The feedback is lower than the setpoint. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *22-60 Broken Belt Function* is set for alarm.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

ALARM 96, Start delayed
Motor start has been delayed due to short-cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the frequency converter after the fault has been cleared.

WARNING 97, Stop delayed
Stopping the motor has been delayed due to short cycle protection. *22-76 Interval between Starts* is enabled.

Troubleshooting
- Troubleshoot the system and reset the frequency converter after the fault has been cleared.

WARNING 98, Clock fault
Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 200, Fire mode
This warning indicates that the frequency converter is operating in fire mode. The warning clears when fire mode is removed. See the fire mode data in the alarm log.

WARNING 201, Fire mode was active
This indicates that the frequency converter has entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode, 1 or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 203, Missing motor
With a frequency converter operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a frequency converter operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

WARNING 250, New spare part
A component in the frequency converter has been replaced.

Troubleshooting
- Reset the frequency converter for normal operation.

WARNING 251, New typecode
The power card or other components have been replaced and the type code has been changed.

Troubleshooting

- Reset to remove the warning and resume normal operation.

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See *Table 4.4*	Check the input power source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55.	Wire the terminals properly.
	Incompatible LCP		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective		Contact supplier.
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the frequency converter	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No mains power with 24 V DC option card	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit.
	LCP Stop	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor.
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check *5-12 Coast inv*. for correct setting for terminal 27 (use default setting)..	Apply 24 V on terminal 27 or program this terminal to *No operation*.
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
	AIC not running	Check the following for current: • *2-70 AIC L1 Current* • *2-71 AIC L2 Current* • *2-72 AIC L3 Current*	Troubleshoot the AIC (Active In-Converter).<<**More info here**>>
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs*..	Deactivate reversing signal.
	Wrong motor phase connection		See *chapter 5.5 Checking Motor Rotation*.

7

7

Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *4-13 Motor Speed High Limit [RPM]*, *4-14 Motor Speed High Limit [Hz]* and *4-19 Max Output Frequency*.	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in *6-0* Analog I/O Mode* and parameter group *3-1* References*. Reference limits in parameter group *3-0* Reference Limit*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in parameter group *1-6* Load Depen.Setting*. For closed-loop operation, check settings in parameter group *20-0* Feedback*.
Motor runs rough	Possible over-magnetisation	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor Data*, *1-3* Adv Motor Data*, and *1-5* Load Indep. Setting*..
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times	Check brake parameters. Check ramp-time settings.	Check parameter group *2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase for shorts.	Eliminate any short circuits detected.
	Motor overload	Motor is overloaded for the application.	Perform startup test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (See *Alarm 4 Mains phase loss* description)	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check mains power supply.
	Problem with the frequency converter	Rotate input power leads into the frequency converter 1 position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads 1 position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the frequency converters	Rotate output motor leads 1 position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Frequency converter acceleration problems	Motor data are entered incorrectly	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms* Check that motor data are entered correctly	Increase the ramp-up time in *3-41 Ramp 1 Ramp Up Time*. Increase current limit in *4-18 Current Limit*. Increase torque limit in *4-16 Torque Limit Motor Mode*.
Frequency converter deceleration problems	Motor data are entered incorrectly	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms* Check that motor data are entered correctly	Increase the ramp-down time in *3-42 Ramp 1 Ramp Down Time*. Enable overvoltage control in *2-17 Over-voltage Control*.

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration (e.g. a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g. in the motor/fan system	Bypass critical frequencies by using parameters in parameter group *4-6* Speed Bypass*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off over-modulation in *14-03 Overmo-dulation*.	
		Change switching pattern and frequency in parameter group *14-0* Inverter Switching*.	
		Increase Resonance Dampening in *1-64 Resonance Dampening*.	

Table 7.5 Troubleshooting

7

8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 1x200-240 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P3K7	P5K5	P7K5	P15K	P22K
Typical Shaft Output [kW]	1.1	1.5	2.2	3.0	3.7	5.5	7.5	15	22
Typical Shaft Output [HP] at 240 V	1.5	2.0	2.9	4.0	4.9	7.5	10	20	30
IP20/Chassis	A3	-	-	-	-	-	-	-	-
IP21/NEMA 1	-	B1	B1	B1	B1	B1	B2	C1	C2
IP55/NEMA 12	A5	B1	B1	B1	B1	B1	B2	C1	C2
IP66	A5	B1	B1	B1	B1	B1	B2	C1	C2
Output current									
Continuous (3x200-240 V) [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8	59.4	88
Intermittent (3x200-240 V) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.4	65.3	96.8
Continuous kVA (208 V AC) [kVA]						5.00	6.40	12.27	18.30
Max. input current									
Continuous (1x200-240 V) [A]	12.5	15	20.5	24	32	46	59	111	172
Intermittent (1x200-240 V) [A]	13.8	16.5	22.6	26.4	35.2	50.6	64.9	122.1	189.2
Max. pre-fuses[1] [A]	20	30	40	40	60	80	100	150	200
Additional specifications									
Estimated power loss at rated max. load [W][4]	44	30	44	60	74	110	150	300	440
Max. cable size (mains, motor, brake) [mm^2]/(AWG)[2]	[0.2-4]/(4-10)					[10]/(7)	[35]/(2)	[50]/(1)/0	[95]/(4/0)
Maximum cable cross-section for mains with disconnect switch [mm2] ([AWG])	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	2 x 50 (2 x 1/0)[8] [9]
Maximum cable cross-section for mains without disconnect switch [mm2] ([AWG])	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	95 (4/0)
Cable insulation temperature rating [°C]	75	75	75	75	75	75	75	75	75
Efficiency[3]	0.968	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.1 Mains Supply 1x200-240 V AC - Normal Overload 110% for 1 Minute, P1K1-P22K

8.1.2 Mains Supply 3x200-240 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P3K7
Overload[1]	NO	NO	NO	NO	NO
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7
Typical shaft output [hp] at 208 V	1.5	2.0	2.9	4.0	4.9
IP20/chassis[6]	A2	A2	A2	A3	A3
IP55/NEMA 12	A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X	A4/A5	A4/A5	A4/A5	A5	A5
Output current					
Continuous (3x200-240 V) [A]	6.6	7.5	10.6	12.5	16.7
Intermittent (3x200-240 V) [A]	7.3	8.3	11.7	13.8	18.4
Continuous kVA (208 V AC) [kVA]	2.38	2.70	3.82	4.50	6.00
Maximum input current					
Continuous (3x200-240 V) [A]	5.9	6.8	9.5	11.3	15.0
Intermittent (3x200-240 V) [A]	6.5	7.5	10.5	12.4	16.5
More specifications					
Estimated power loss[3] at rated maximum load [W][4]	63	82	116	155	185
IP20, IP21 maximum cable cross-section[2] (mains, motor, brake, and load sharing) [mm²/(AWG)]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))				
IP55, IP66 maximum cable cross-section[2] (mains, motor, brake, and load sharing) [mm²/(AWG)]	4, 4, 4 (12, 12, 12)				
Maximum cable cross-section with disconnect	6, 4, 4 (10, 12, 12)				
Efficiency[5]	0.96	0.96	0.96	0.96	0.96

Table 8.2 Mains Supply 3x200-240 V AC

8

Specifications

8

Type Designation	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K
Overload[1]	NO	NO	NO	NO	NO	NO	NO	NO	NO
Typical shaft output [kW]	5.5	7.5	11	15	18.5	22	30	37	45
Typical shaft output [hp] at 208 V	7.5	10	15	20	25	30	40	50	60
IP20/chassis[6]	B3	B3	B3	B4	B4	C3	C3	C4	C4
IP21/NEMA 1	B1	B1	B1	B2	C1	C1	C1	C2	C2
IP55/NEMA 12	B1	B1	B1	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B1	B2	C1	C1	C1	C2	C2
Output current									
Continuous (3x200-240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	115	143	170
Intermittent (3x200-240 V) [A]	26.6	33.9	50.8	65.3	82.3	96.8	127	157	187
Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9	31.7	41.4	51.5	61.2
Maximum input current									
Continuous (3x200-240 V) [A]	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0
Intermittent (3x200-240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0
More Specifications									
Estimated power loss[3] at rated maximum load [W][4]	269	310	447	602	737	845	1140	1353	1636
IP20 maximum cable cross-section[2] (mains, brake, motor, and load sharing) [mm2/(AWG)]	10, 10 (8,8,-)		35,-,-(2,-,-)	35 (2)	50 (1)				
IP21, IP55, IP66 maximum cable cross-section[2] (mains, motor) [mm2/(AWG)]	10, 10 (8,8,-)		35, 25, 25 (2, 4, 4)		50 (1)			150 (300MCM)	150 (300MCM)
IP21, IP55, IP66 maximum cable cross-section[2] (brake, load sharing) [mm2/(AWG)]	16, 10, 16 (6, 8, 6)		35,-,-(2,-,-)		50 (1)			95 (3/0)	
Efficiency[5]	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97

Table 8.3 Mains Supply 3x200-240 V AC

8.1.3 Mains Supply 3x380-480 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Overload[1]	NO	NO	NO	NO	NO	NO	NO
Typical shaft output [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Typical shaft output [hp] at 460 V	1.5	2.0	2.9	4.0	5.0	7.5	10
IP20/chassis[6]	A2	A2	A2	A2	A2	A3	A3
IP55/NEMA 12	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current							
Continuous (3x380-440 V) [A]	3	4.1	5.6	7.2	10	13	16
Intermittent (3x380-440 V) [A]	3.3	4.5	6.2	7.9	11	14.3	17.6
Continuous (3x441-480 V) [A]	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (3x441-480 V) [A]	3.0	3.7	5.3	6.9	9.0	12.1	15.4
Continuous kVA (400 V AC) [kVA]	2.1	2.8	3.9	5.0	6.9	9.0	11.0
Continuous kVA (460 V AC) [kVA]	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Maximum input current							
Continuous (3x380-440 V) [A]	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (3x380-440 V) [A]	3.0	4.1	5.5	7.2	9.9	12.9	15.8
Continuous (3x441-480 V) [A]	2.7	3.1	4.3	5.7	7.4	9.9	13.0
Intermittent (3x441-480 V) [A]	3.0	3.4	4.7	6.3	8.1	10.9	14.3
More specifications							
Estimated power loss[3] at rated maximum load [W][4]	58	62	88	116	124	187	255
IP20, IP21 maximum cable cross-section[2] (mains, motor, brake, and load sharing) [mm²/(AWG)][2]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))						
IP55, IP66 maximum cable cross-section[2] (mains, motor, brake, and load sharing) [mm²/(AWG)][2]	4, 4, 4 (12, 12, 12)						
Maximum cable cross-section[2] with disconnect	6, 4, 4 (10, 12, 12)						
Efficiency[5]	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 8.4 Mains Supply 3x380-480 V AC

Type Designation	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Overload[1]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Typical shaft output [kW]	11	15	18.5	22	30	37	45	55	75	90
Typical shaft output [hp] at 460 V	15	20	25	30	40	50	60	75	100	125
IP20/chassis[7]	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/NEMA 12	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current										
Continuous (3x380-439 V) [A]	24	32	37.5	44	61	73	90	106	147	177
Intermittent (3x380-439 V) [A]	26.4	35.2	41.3	48.4	67.1	80.3	99	117	162	195
Continuous (3x440-480 V) [A]	21	27	34	40	52	65	80	105	130	160
Intermittent (3x440-480 V) [A]	23.1	29.7	37.4	44	61.6	71.5	88	116	143	176
Continuous kVA (400 V AC) [kVA]	16.6	22.2	26	30.5	42.3	50.6	62.4	73.4	102	123
Continuous kVA (460 V AC) [kVA]	16.7	21.5	27.1	31.9	41.4	51.8	63.7	83.7	104	128
Maximum input current										
Continuous (3x380-439 V) [A]	22	29	34	40	55	66	82	96	133	161
Intermittent (3x380-439 V) [A]	24.2	31.9	37.4	44	60.5	72.6	90.2	106	146	177
Continuous (3x440-480 V) [A]	19	25	31	36	47	59	73	95	118	145
Intermittent (3x440-480 V) [A]	20.9	27.5	34.1	39.6	51.7	64.9	80.3	105	130	160
More specifications										
Estimated power loss[3] at rated maximum load [W][4]	278	392	465	525	698	739	843	1083	1384	1474
IP20 maximum cable cross-section[2] (mains, brake, motor, and load sharing) [mm²/(AWG)]	16, 10, - (8, 8, -)			35, -, - (2, -, -)	35 (2)	50 (1)			150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section[2] (mains, motor) [mm²/(AWG)]	10, 10, 16 (6, 8, 6)			35, 25, 25 (2, 4, 4)	50 (1)				150 (300 MCM)	
IP21, IP55, IP66 maximum cable cross-section[2] (brake, load sharing) [mm²/(AWG)]	10, 10, - (8, 8, -)			35, -, - (2, -, -)	50 (1)				95 (3/0)	
With mains disconnect switch included:			16/6			35/2		35/2	70/3/0	185/kcmil350
Efficiency[5]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99

Table 8.5 Mains Supply 3x380-480 V AC

 MG12E502

Specifications

8.1.4 Mains Supply 3x525-600 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5
Typical Shaft Output [kW]	1.1	1.5	2.2	3.0	3.7	4.0	5.5	7.5
IP20/Chassis	A3	A3	A3	A3	A2	A3	A3	A3
IP21/NEMA 1	A3	A3	A3	A3	A2	A3	A3	A3
IP55/Type 12	A5	A5	A5	A5	A5	A5	A5	A5
IP66/NEMA 4X	A5	A5	A5	A5	A5	A5	A5	A5
Output current								
Continuous (3x525-550 V) [A]	2.6	2.9	4.1	5.2	-	6.4	9.5	11.5
Intermittent (3x525-550 V) [A]	2.9	3.2	4.5	5.7	-	7.0	10.5	12.7
Continuous (3x525-600 V) [A]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0
Intermittent (3x525-600 V) [A]	2.6	3.0	4.3	5.4	-	6.7	9.9	12.1
Continuous kVA (525 V AC) [kVA]	2.5	2.8	3.9	5.0	-	6.1	9.0	11.0
Continuous kVA (575 V AC) [kVA]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0
Max. input current								
Continuous (3x525-600 V) [A]	2.4	2.7	4.1	5.2	-	5.8	8.6	10.4
Intermittent (3x525-600 V) [A]	2.7	3.0	4.5	5.7	-	6.4	9.5	11.5
Additional specifications								
Estimated power loss at rated max. load [W][4]	50	65	92	122	-	145	195	261
IP20 max. cable cross-section[5] (mains, motor, brake and load sharing) [mm^2/(AWG)]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))							
IP55, IP 66 max. cable cross-section[5] (mains, motor, brake and load sharing) [mm^2/(AWG)]	4, 4, 4 (12, 12, 12) (min. 0.2 (24))							
Max. cable cross-section with disconnect	6, 4, 4 (12, 12, 12)							
Mains disconnect switch included:	4/12							
Efficiency[3]	0.97	0.97	0.97	0.97	-	0.97	0.97	0.97

Table 8.6 Mains Supply 3x525-600 V AC - Normal overload 110% for 1 minute, P1K1-P7K5

8

8

Type Designation	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	11	15	18.5	22	30	37	45	55	75	90
IP20/Chassis	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current										
Continuous (3x525-550 V) [A]	19	23	28	36	43	54	65	87	105	137
Intermittent (3x525-550 V) [A]	21	25	31	40	47	59	72	96	116	151
Continuous (3x525-600 V) [A]	18	22	27	34	41	52	62	83	100	131
Intermittent (3x525-600 V) [A]	20	24	30	37	45	57	68	91	110	144
Continuous kVA (525 V AC) [kVA]	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
Continuous kVA (575 V AC) [kVA]	17.9	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. input current										
Continuous (3x525-600 V) [A]	17.2	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
Intermittent (3x525-600 V) [A]	19	23	28	36	43	54	65	87	105	137
Additional specifications										
Estimated power loss at rated max. load [W][4]	300	400	475	525	700	750	850	1100	1400	1500
IP21, IP55, IP66 max. cable cross-section (mains, brake and load sharing) [mm²/(AWG)]	16, 10, 10 (6, 8, 8)		35, -, - (2, -, -)			50, -, - (1, -, -)		95 (4/0)		
IP21, IP55, IP66 max. cable cross-section (motor) [mm²/(AWG)]	10, 10, - (8, 8, -)		35, 25, 25 (2, 4, 4)			50, -, - (1, -, -)		150 (300 MCM)		
IP20 max. cable cross-section (mains, brake and load sharing) [mm²/(AWG)]	10, 10, - (8, 8, -)		35, -, - (2, -, -)			50, -, - (1, -, -)		50, -, (1, -, -)		150 (300 MCM)
Max. cable cross-section with disconnect	16, 10, 10 (6, 8, 8)				50, 35, 35 (1, 2, 2)			95, 70, 70 (3/0, 2/0, 2/0)	185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Mains disconnect switch included:			16/6				35/2		70/3/0	185/kcmil350
Efficiency[3]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.7 Mains supply 3x525-600 V AC - Normal overload 110% for 1 minute, P11K-P90K

ARMSTRONG

8.1.5 Mains Supply 3x525-690 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Enclosure IP20 (only)	A3	A3	A3	A3	A3	A3	A3
Output current							
Continuous (3x525-550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11
Intermittent (3x525-550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (3x551-690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10
Intermittent kVA (3x551-690 V) [A]	2.6	3.5	5.1	7.2	8.8	12	16
Continuous kVA 525 V AC	1.9	2.5	3.5	4.5	5.5	8.2	10
Continuous kVA 690 V AC	1.9	2.6	3.8	5.4	6.6	9.0	12
Max. input current							
Continuous (3x525-550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.0	10
Intermittent (3x525-550 V) [A]	3.0	3.9	5.6	7.1	8.8	13	16
Continuous kVA (3x551-690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent kVA (3x551-690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
Additional specifications							
Estimated power loss at rated max. load [W][4]	44	60	88	120	160	220	300
Max. cable cross section[5] (mains, motor, brake and load sharing) [mm^2]/(AWG)	6, 4, 4 (10, 12, 12) (min. 0.2 (24))
Max. cable cross-section with disconnect	6, 4, 4 (10, 12, 12)
Efficiency[3]	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Table 8.8 Mains Supply 3x525-690 V AC - Normal overload 110% for 1 minute, P1K1-P7K5

Type designation	P11K	P15K	P18K	P22K	P30K
High/Normal Load	NO	NO	NO	NO	NO
Typical Shaft Output at 550 V [kW]	7.5	11	15	18.5	22
Typical Shaft Output at 690 V [kW]	11	15	18.5	22	30
IP20/Chassis	B4	B4	B4	B4	B4
IP21/NEMA 1	B2	B2	B2	B2	B2
IP55/NEMA 12	B2	B2	B2	B2	B2
Output current					
Continuous (3 x 525-550 V) [A]	14	19	23	28	36
Intermittent (60 s overload) (3 x 525-550 V) [A]	22.4	20.9	25.3	30.8	39.6
Continuous (3 x 551-690 V) [A]	13	18	22	27	34
Intermittent (60 s overload) (3 x 551-690 V) [A]	20.8	19.8	24.2	29.7	37.4
Continuous kVA (550 V AC) [kVA]	13.3	18.1	21.9	26.7	34.3
Continuous kVA (690 V AC) [kVA]	15.5	21.5	26.3	32.3	40.6
Max. input current					
Continuous (at 550 V) [A]	15	19.5	24	29	36
Intermittent (60 s overload) (at 550 V) [A]	23.2	21.5	26.4	31.9	39.6
Continuous (at 690 V) [A]	14.5	19.5	24	29	36
Intermittent (60 s overload) (at 690 V) [A]	23.2	21.5	26.4	31.9	39.6
Max. pre-fuses[1] [A]	63	63	63	80	100
Additional specifications					
Estimated power loss at rated max. load [W][4]	150	220	300	370	440
Max. cable cross-section (mains/motor, load sharing and brake) [mm^2]/(AWG)[2]	35, 25, 25 (2, 4, 4)
Max. cable size with mains disconnect [mm^2]/(AWG) [2]	16, 10, 10 (6, 8, 8)
Efficiency[3]	0.98	0.98	0.98	0.98	0.98

Table 8.9 Mains Supply 3 x 525-690 V AC - Normal overload 110% for 1 minute, P11K-P30K

Type designation	P37K	P45K	P55K	P75K	P90K
High/Normal Load	NO	NO	NO	NO	NO
Typical Shaft Output at 550 V [kW]	30	37	45	55	75
Typical Shaft Output at 690 V [kW]	37	45	55	75	90
IP20/Chassis	B4	C3	C3	D3h	D3h
IP21/NEMA 1	C2	C2	C2	C2	C2
IP55/NEMA 12	C2	C2	C2	C2	C2
Output current					
Continuous (3 x 525-550 V) [A]	43	54	65	87	105
Intermittent (60 s overload) (3 x 525-550 V) [A]	47.3	59.4	71.5	95.7	115.5
Continuous (3 x 551-690 V) [A]	41	52	62	83	100
Intermittent (60 s overload) (3 x 551-690 V) [A]	45.1	57.2	68.2	91.3	110
Continuous kVA (550 V AC) [kVA]	41	51.4	61.9	82.9	100
Continuous kVA (690 V AC) [kVA]	49	62.1	74.1	99.2	119.5
Max. input current					
Continuous (at 550 V) [A]	49	59	71	87	99
Intermittent (60 s overload) (at 550 V) [A]	53.9	64.9	78.1	95.7	108.9
Continuous (at 690 V) [A]	48	58	70	86	94.3
Intermittent (60 s overload) (at 690 V) [A]	52.8	63.8	77	94.6	112.7
Max. pre-fuses[1] [A]	125	160	160	160	-
Additional specifications					
Estimated power loss at rated max. load [W][4]	740	900	1100	1500	1800
Max. cable cross-section (mains and motor) [mm²]/(AWG)[2]	150 (300 MCM)				
Max. cable cross-section (load sharing and brake) [mm²]/(AWG)[2]	95 (3/0)				
Max. cable size with mains disconnect [mm²]/(AWG)[2]	95, 70, 70 (3/0, 2/0, 2/0)			185, 150, 120 (350 MCM, 300 MCM, 4/0)	
Efficiency[3]	0.98	0.98	0.98	0.98	0.98

Table 8.10 Mains Supply 3 x 525-690 V - Normal overload 110% for 1 minute, P37K-P90K

1) For type of fuse see chapter 8.8 Fuses and Circuit Breakers.

2) American Wire Gauge.

3) Efficiency measured at nominal current. For energy efficiency class see chapter 8.4.1 Ambient Conditions.

4) Applies for dimensioning of frequency converter cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included.

5) The three values for the max. cable cross section are for single core, flexible wire and flexible wire with sleeve, respectively. Motor and mains cable: 300 MCM/150 mm².

6) A2+A3 may be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

7) B3+4 and C3+4 may be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

8) Two wires are required.

9) Variant not available in IP21.

10) Type 3R is not available in the A4 enclosure.

8.2 Mains Supply

Mains supply

Supply Terminals	L1, L2, L3
Supply voltage	200-240 V ±10%
Supply voltage	380-480 V/525-600 V ±10%
Supply voltage	525-600 V ±10%

Mains voltage low/mains drop-out:
During low mains voltage or a mains drop-out, the drive continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the frequency converter'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) ≤ 7.5 kW	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 11-90 kW	maximum 1 time/min.
Environment according to EN60664-1	overvoltage 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, 240/500/600 V maximum.

8.3 Motor Output and Motor Data

Motor output (U, V, W)

Output voltage	0 - 100% of supply voltage
Output frequency (1.1-90 kW)	0-590[1] Hz
Switching on output	Unlimited
Ramp times	1-3600 s

1) From software version 3.92 the output frequency of the frequency converter is limited to 590 Hz. Contact local Armstrong partner for further information.

Torque characteristics

Starting torque (Constant torque)	maximum 110% for 60 s[1]
Starting torque	maximum 135% up to 0.5 s[1]
Overload torque (Constant torque)	maximum 110% for 60 s[1]
Starting torque (Variable torque)	maximum 110% for 60 s[1]
Overload torque (Variable torque)	maximum 110% for 60 s
Torque rise time in VVC+ (independent of fsw)	10 ms

1) Percentage relates to the nominal torque.

2) The torque response time depends on application and load but as a general rule, the torque step from 0 to reference is 4-5 x torque rise time.

8.4 Ambient Conditions

Environment

IP rating	IP00/Chassis, IP20[1]/Chassis, IP21[2]/Type 1, IP54/Type 12, IP55/Type 12, IP66/Type 4X
Vibration test	1.0 g
Max. relative humidity	5% - 93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Ambient temperature[3]	Max. 50 °C (24-hour average maximum 45 °C)
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	1000 m

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

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3
Energy efficiency class[4]	IE2

See section on special conditions in the Design Guide.

1) Only for ≤ 3.7 kW (200-240 V), ≤ 7.5 kW (400-480 V)

2) As enclosure kit for ≤ 3.7 kW (200-240 V), ≤ 7.5 kW (400-480 V)

3) Derating for high ambient temperature, see special conditions in the Design Guide

4) Determined according to EN50598-2 at:

- *Rated load*

- *90% rated frequency*

- *Switching frequency factory setting*

- *Switching pattern factory setting*

8.5 Cable Specifications

Cable lengths and cross-sections for control cables[1]

Max. motor cable length, screened	150 m (492 ft)
Max. motor cable length, unscreened	300 m (984 ft)
Maximum cross-section to control terminals, flexible/ rigid wire without cable end sleeves	1.5 mm²/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm²/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm²/20 AWG
Minimum cross-section to control terminals	0.25 mm²/24AWG

1) For power cables, see electrical data tables in chapter 8.1 Electrical Data.

8.6 Control Input/Output and Control Data

Digital inputs

Programmable digital inputs	4 (6)[1]
Terminal number	18, 19, 27 [1], 29[1], 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) Min. pulse width	4.5 ms
Input resistance, R_i	approx. 4 kΩ

Specifications

Safe Torque Off (STO) Terminal 37 [3], [4] (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
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA$_{rms}$
Typical 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 Torque Off input terminal 37.

4) When using a contactor with a DC coil in combination with STO, always make a return path for the current from the coil when turning it off. The return path can be made by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

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 V to +10 V (scalable)
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 (scalable)
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	20 Hz/100 Hz

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
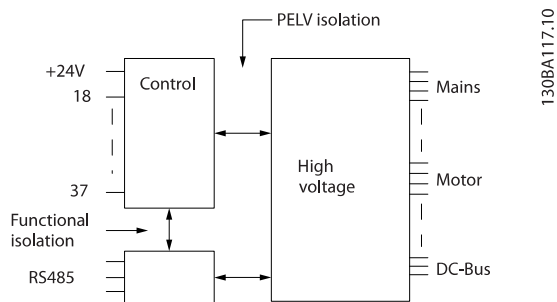
Illustration 8.1 PELV Isolation

Pulse

Programmable pulse	2/1
Terminal number pulse	29[1], 32[2]/33
Max. frequency at terminal 29, 33	110 kHz (Push-pull driven)
Max. frequency at terminal 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see *chapter 8.6.1 Digital Inputs*
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale

Specifications

Encoder input accuracy (1-11 kHz)	Max. error: 0.05 % of full scale

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) IVS 102 only
2) Pulse inputs are 29 and 33

Analog output

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Max. load GND - analog output	500 Ω
Accuracy on analog output	Max. 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, RS485 serial communication

Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS485 serial communication circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

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) Terminals 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.

Control card, 24 V DC output

Terminal number	12, 13
Output voltage	24 V +1, –3 V
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.

Relay outputs

Programmable relay outputs	2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)[1] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1 A
Max. terminal load (DC-13)[1] (Inductive load)	24 V DC, 0.1 A
Relay 02 (IVS 102 only) Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1] on 4-5 (NO) (Resistive load)[2][3] Overvoltage cat. II	400 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-5 (NO) (Inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1)[1] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A

Max. terminal load (DC-1)[1] on 4-6 (NC) (Resistive load)	50 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-6 (NC) (Inductive load)	24 V DC, 0.1 A
Min. 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).
2) Overvoltage Category II
3) UL applications 300 V AC 2A

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 characteristics

Resolution of output frequency at 0–590 Hz	± 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)	≤ 10 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30–4,000 RPM: error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6,000 RPM: error ±0.15 RPM

All control characteristics are based on a 4-pole asynchronous motor

Control card performance

Scan interval	5 ms

Control card, USB serial communication

USB standard	1.1 (full speed)
USB plug	USB type B device 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 protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

8

MG12E502   Rev. 03/2015   59

8.7 Connection Tightening Torques

Enclo-sure	Power [kW]			Torque [Nm]					
	200-240 V	380-480/500 V	525-600 V	Mains	Motor	DC connection	Brake	Earth	Relay
A2	0.25-2.2	0.37-4.0		1.8	1.8	1.8	1.8	3	0.6
A3	3.0-3.7	5.5-7.5	0.75-7.5	1.8	1.8	1.8	1.8	3	0.6
A4	0.25-2.2	0.37-4.0		1.8	1.8	1.8	1.8	3	0.6
A5	0.25-3.7	0.37-7.5	0.75-7.5	1.8	1.8	1.8	1.8	3	0.6
B1	5.5-7.5	11-15	11-15	1.8	1.8	1.5	1.5	3	0.6
B2	11	18	18	4.5	4.5	3.7	3.7	3	0.6
		22	22	4.5	4.5	3.7	3.7	3	0.6
B3	5.5 -7.5	11-15	11-15	1.8	1.8	1.8	1.8	3	0.6
B4	11-15	18-30	18-30	4.5	4.5	4.5	4.5	3	0.6
C1	15-22	30-45	30-45	10	10	10	10	3	0.6
C2	30-37	55 -75	55-75	14/24[1]	14/24[1]	14	14	3	0.6
C3	18-22	37-45	37-45	10	10	10	10	3	0.6
C4	30-37	55-75	55-75	14/24 [1]	14/24 [1]	14	14	3	0.6

Table 8.11 Tightening of Terminals

1) For different cable dimensions x/y, where x ≤ 95 mm^2 and y ≥ 95 mm^2.

8

8.8 Fuses and Circuit Breakers

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

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

Recommendations:

- gG type fuses.

- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the frequency converter is equal to or lower than the energy provided by Moeller types.

Use of recommended fuses and circuit breakers ensures that possible damage to the frequency converter is limited to damages inside the unit. For further information, see *Application Note Fuses and Circuit Breakers*.

The fuses in *chapter 8.8.1 CE Compliance* to *chapter 8.8.2 UL Compliance* are suitable for use on a circuit capable of delivering 100000 A_{rms} (symmetrical), depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short-circuit current rating (SCCR) is 100000 A_{rms}.

8

8.8.1 CE Compliance

200-240 V

Enclosure type	Power [kW]	Recommended fuse size	Recommended max. fuse size	Recommended circuit breaker (Moeller)	Max. trip level [A]
A2	1.1-2.2	gG-10 (1.1-1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	3.0-3.7	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
B3	5.5-11	gG-25 (5.5-7.5) gG-32 (11)	gG-63	PKZM4-50	50
B4	15-18	gG-50 (15) gG-63 (18)	gG-125	NZMB1-A100	100
C3	22-30	gG-80 (22) aR-125 (30)	gG-150 (22) aR-160 (30)	NZMB2-A200	150
C4	37-45	aR-160 (37) aR-200 (45)	aR-200 (37) aR-250 (45)	NZMB2-A250	250
A4	1.1-2.2	gG-10 (1.1-1.5) gG-16 (2.2)	gG-32	PKZM0-25	25
A5	0.25-3.7	gG-10 (0.25-1.5) gG-16 (2.2-3) gG-20 (3.7)	gG-32	PKZM0-25	25
B1	5.5-11	gG-25 (5.5) gG-32 (7.5-11)	gG-80	PKZM4-63	63
B2	15	gG-50	gG-100	NZMB1-A100	100
C1	18-30	gG-63 (18.5) gG-80 (22) gG-100 (30)	gG-160 (18.5-22) aR-160 (30)	NZMB2-A200	160
C2	37-45	aR-160 (37) aR-200 (45)	aR-200 (37) aR-250 (45)	NZMB2-A250	250

Table 8.12 200-240 V, Enclosure Types A, B and C

![ARMSTRONG]

380-480 V

Enclosure type	Power [kW]	Recommended fuse size	Recommended max. fuse size	Recommended circuit breaker (Moeller)	Max. trip level [A]
A2	1.1-4.0	gG-10 (1.1-3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5-7.5	gG-16	gG-32	PKZM0-25	25
B3	11-18	gG-40	gG-63	PKZM4-50	50
B4	22-37	gG-50 (22) gG-63 (30) gG-80 (37)	gG-125	NZMB1-A100	100
C3	45-55	gG-100 (45) gG-160 (55)	gG-150 (45) gG-160 (55)	NZMB2-A200	150
C4	75-90	aR-200 (75) aR-250 (90)	aR-250	NZMB2-A250	250
A4	1.1-4	gG-10 (1.1-3) gG-16 (4)	gG-32	PKZM0-25	25
A5	1.1-7.5	gG-10 (1.1-3) gG-16 (4-7.5)	gG-32	PKZM0-25	25
B1	11-18.5	gG-40	gG-80	PKZM4-63	63
B2	22-30	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
C1	37-55	gG-80 (37) gG-100 (45) gG-160 (55)	gG-160	NZMB2-A200	160
C2	75-90	aR-200 (75) aR-250 (90)	aR-250	NZMB2-A250	250

Table 8.13 380-480 V, Enclosure Types A, B and C

525-600 V

Enclosure type	Power [kW]	Recommended fuse size	Recommended max. fuse size	Recommended circuit breaker (Moeller)	Max. trip level [A]
A3	5.5-7.5	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B3	11-18	gG-25 (11) gG-32 (15-18)	gG-63	PKZM4-50	50
B4	22-37	gG-40 (22) gG-50 (30) gG-63 (37)	gG-125	NZMB1-A100	100
C3	45-55	gG-63 (45) gG-100 (55)	gG-150	NZMB2-A200	150
C4	75-90	aR-160 (75) aR-200 (90)	aR-250	NZMB2-A250	250
A5	1.1-7.5	gG-10 (1.1-5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11-18	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22-30	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
C1	37-55	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37-45) aR-250 (55)	NZMB2-A200	160
C2	75-90	aR-200 (75-90)	aR-250	NZMB2-A250	250

Table 8.14 525-600 V, Enclosure Types A, B and C

525-690 V

Enclosure type	Power [kW]	Recommended fuse size	Recommended max. fuse size	Recommended circuit breaker (Moeller)	Max. trip level [A]
A3	1.1	gG-6	gG-25		
	1.5	gG-6	gG-25		
	2.2	gG-6	gG-25		
	3	gG-10	gG-25	PKZM0-16	16
	4	gG-10	gG-25		
	5.5	gG-16	gG-25		
	7.5	gG-16	gG-25		
B2/B4	11	gG-25 (11)	gG-63	-	-
	15	gG-32 (15)			
	18	gG-32 (18)			
	22	gG-40 (22)			
B4/C2	30	gG-63 (30)	gG-80 (30)		
C2/C3	37	gG-63 (37)	gG-100 (37)	-	-
	45	gG-80 (45)	gG-125 (45)		
C2	55	gG-100 (55)	gG-160 (55-75)	-	-
	75	gG-125 (75)			

Table 8.15 525-690 V, Enclosure Types A, B and C

8.8.2 UL Compliance

3x200-240 V

Power [kW]	Recommended max. fuse					
	Bussmann Type RK1 [1]	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
1.1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.0	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
3.7	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5-7.5	KTN-R-50	JKS-50	JJN-50	-	-	-
11	KTN-R-60	JKS-60	JJN-60	-	-	-
15	KTN-R-80	JKS-80	JJN-80	-	-	-
18.5-22	KTN-R-125	JKS-125	JJN-125	-	-	-
30	KTN-R-150	JKS-150	JJN-150	-	-	-
37	KTN-R-200	JKS-200	JJN-200	-	-	-
45	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 8.16 3x200-240 V, Enclosure Types A, B and C

Specifications

Power [kW]	SIBA Type RK1	Little fuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1[3]	Bussmann Type JFHR2[2]	Littel fuse JFHR2	Ferraz-Shawmut JFHR2[4]	Ferraz-Shawmut J
				Recommended max. fuse				
1.1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	-	-	HSJ-10
1.5	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	-	-	HSJ-15
2.2	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	-	-	HSJ-20
3.0	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	-	-	HSJ-25
3.7	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	-	-	HSJ-30
5.5-7.5	5014006-050	KLN-R-50	-	A2K-50-R	FWX-50	-	-	HSJ-50
11	5014006-063	KLN-R-60	-	A2K-60-R	FWX-60	-	-	HSJ-60
15	5014006-080	KLN-R-80	-	A2K-80-R	FWX-80	-	-	HSJ-80
18.5-22	2028220-125	KLN-R-125	-	A2K-125-R	FWX-125	-	-	HSJ-125
30	2028220-150	KLN-R-150	-	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
37	2028220-200	KLN-R-200	-	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
45	2028220-250	KLN-R-250	-	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.17 3x200-240 V, Enclosure Types A, B and C

1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.

2) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.

3) A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240 V frequency converters.

4) A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240 V frequency converters.

3x380-480 V

Power [kW]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
				Recommended max. fuse		
1.1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11-15	KTS-R-40	JKS-40	JJS-40	-	-	-
18	KTS-R-50	JKS-50	JJS-50	-	-	-
22	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
37	KTS-R-100	JKS-100	JJS-100	-	-	-
45	KTS-R-125	JKS-125	JJS-125	-	-	-
55	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-200	JKS-200	JJS-200	-	-	-
90	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 8.18 3x380-480 V, Enclosure Types A, B and C

Power [kW]	Recommended max. fuse							
	SIBA Type RK1	Little fuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1	Bussmann JFHR2	Ferraz-Shawmut J	Ferraz-Shawmut JFHR2[1]	Littel fuse JFHR2
1.1	5017906-006	KLS-R-6	ATM-R-6	A6K-10-6	FWH-6	HSJ-6	-	-
1.5-2.2	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	-	-
3	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	-	-
4	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	-	-
5.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	-	-
7.5	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	-	-
11-15	5014006-040	KLS-R-40	-	A6K-40-R	FWH-40	HSJ-40	-	-
18	5014006-050	KLS-R-50	-	A6K-50-R	FWH-50	HSJ-50	-	-
22	5014006-063	KLS-R-60	-	A6K-60-R	FWH-60	HSJ-60	-	-
30	2028220-100	KLS-R-80	-	A6K-80-R	FWH-80	HSJ-80	-	-
37	2028220-125	KLS-R-100	-	A6K-100-R	FWH-100	HSJ-100	-	-
45	2028220-125	KLS-R-125	-	A6K-125-R	FWH-125	HSJ-125	-	-
55	2028220-160	KLS-R-150	-	A6K-150-R	FWH-150	HSJ-150	-	-
75	2028220-200	KLS-R-200	-	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
90	2028220-250	KLS-R-250	-	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.19 3x380-480 V, Enclosure Types A, B and C

1) Ferraz-Shawmut A50QS fuses may substitute A50P fuses.

3x525-600 V

Power [kW]	Recommended max. fuse									
	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC	SIBA Type RK1	Littel fuse Type RK1	Ferraz-Shawmut Type RK1	Ferraz-Shawmut J
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11-15	KTS-R-35	JKS-35	JJS-35	-	-	-	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
18	KTS-R-45	JKS-45	JJS-45	-	-	-	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
22	KTS-R-50	JKS-50	JJS-50	-	-	-	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
30	KTS-R-60	JKS-60	JJS-60	-	-	-	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
37	KTS-R-80	JKS-80	JJS-80	-	-	-	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
45	KTS-R-100	JKS-100	JJS-100	-	-	-	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
55	KTS-R-125	JKS-125	JJS-125	-	-	-	2028220-125	KLS-125	A6K-125-R	HSJ-125
75	KTS-R-150	JKS-150	JJS-150	-	-	-	2028220-150	KLS-150	A6K-150-R	HSJ-150
90	KTS-R-175	JKS-175	JJS-175	-	-	-	2028220-200	KLS-175	A6K-175-R	HSJ-175

Table 8.20 3x525-600 V, Enclosure Types A, B and C

Specifications

3x525-690 V

Power	Recommended max. fuse					
[kW]	**Bussmann Type RK1**	**Bussmann Type J**	**Bussmann Type T**	**Bussmann Type CC**	**Bussmann Type CC**	**Bussmann Type CC**
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11-15	KTS-R-35	JKS-35	JJS-35	-	-	-
18	KTS-R-45	JKS-45	JJS-45	-	-	-
22	KTS-R-50	JKS-50	JJS-50	-	-	-
30	KTS-R-60	JKS-60	JJS-60	-	-	-
37	KTS-R-80	JKS-80	JJS-80	-	-	-
45	KTS-R-100	JKS-100	JJS-100	-	-	-
55	KTS-R-125	JKS-125	JJS-125	-	-	-
75	KTS-R-150	JKS-150	JJS-150	-	-	-
90	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 8.21 3x525-690 V, Enclosure Types A, B and C

Power		Recommended max. fuse						
[kW]	**Max. prefuse**	**Bussmann E52273 RK1/JDDZ**	**Bussmann E4273 J/JDDZ**	**Bussmann E4273 T/JDDZ**	**SIBA E180276 RK1/JDDZ**	**LittelFuse E81895 RK1/JDDZ**	**Ferraz-Shawmut E163267/E2137 RK1/JDDZ**	**Ferraz-Shawmut E2137 J/HSJ**
11-15	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
18.5	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
30	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
37	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
45	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
55	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
75	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
90	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.22 3x525-690 V, Enclosure Types B and C

8

8.9 Power Ratings, Weight and Dimensions

Enclosure Type		A2	A3	A4	A5	B1	B2	B3	B4	C1	C2	C3	C4
Rated Power [kW]	200-240V	1.1-2.2	3.0-3.7	1.1-2.2	1.1-3.7	5.5-11	15	5.5-11	15-18	18-30	37-45	22-30	37-45
	380-480/500V	1.1-4.0	5.5-7.5	1.1-4.0	1.1-7.5	11-18	22-30	11-18	22-37	37-55	75-90	45-55	75-90
	525-600V		1.1-7.5		1.1-7.5	11-18	22-30	11-18	22-37	37-55	75-90	45-55	75-90
	525-690V		1.1-7.5			11-37	11-30		11-37		37-90	45-55	
IP		20 / 21	20 / 21	55/66	55/66	21/55/66	21/55/66	20	20	21/55/66	21/55/66	20	20
NEMA		Chassis / Type 1	Chassis / Type 1	Type 12	Type 12	Type 1/Type 12	Type 1/Type 12	Chassis	Chassis	Type 1/Type 12	Type 1/Type 12	Chassis	Chassis
Height [mm]													
Height of back plate	A	268 / 375	268 / 375	390	420	480	650	399	520	680	770	550	660
Height with de-coupling plate for Fieldbus cables	A	374	374	-	-	-	-	420	595			630	800
Distance between mounting holes	a	257 / 350	257 / 350	401	402	454	624	380	495	648	739	521	631
Width [mm]													
Width of back plate	B	90 / 90	130 / 130	200	242	242	242	165	230	308	370	308	370
Width of back plate with one C option	B	130 / 130	170 / 170		242	242	242	205	230	308	370	308	370
Width of back plate with two C options [mm]	B	150 / 150	190 / 190		242	242	242	225	230	308	370	308	370
Distance between mounting holes	b	70 / 70	110 / 110	171	215	210	210	140	200	272	334	270	330
Depth [mm]													
Depth without option A/B	C	205 / 207	205 / 207	175	200	260	260	249	242	310	335	333	333
With option A/B	C	220 / 222	220 / 222	175	200	260	260	262	242	310	335	333	333
Screw holes [mm]	c	8.0	8.0	8.25	8.25	12	12	8		12.5	12.5		
	d	ø11	ø11	ø12	ø12	ø19	ø19	12		ø19	ø19		
	e	ø5.5	ø5.5	ø6.5	ø6.5	ø9	ø9	6.8	8.5	ø9	ø9	8.5	8.5
	f	9	6.5 / 7.0	6	9	9	9	7.9	15	9.8	9.8	17	17
Max. weight [kg]		4.9 / 5.3	6.6 / 7.0	9.7	13.5/14.2	23	27	12	23.5	45	65	35	50
Front cover tightening torque [Nm]													
Plastic cover (low IP)		Click	Click			Click	Click	Click	Click	Click	Click	2.0	2.0
Metal cover (IP55/66)		-	-	1.5	1.5	2.2	2.2	-	-	2.2	2.2	2.0	2.0

Table 8.23 Power Ratings, Weight and Dimensions

8

9 Appendix

9.1 Symbols, Abbreviations and Conventions

°C	Degrees celsius
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
I_{INV}	Rated inverter output current
I_{LIM}	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
n_s	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM Motor	Permanent magnet motor
PWM	Pulse width modulation
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

Table 9.1 Symbols and Abbreviations

Conventions
Numbered lists indicate procedures.
Bullet lists indicate other information.
Italicised text indicates:

- Cross reference.

- Link.

- Parameter name.

All dimensions are in [mm].

9.2 Parameter Menu Structure

ARMSTRONG

No.	Name
0-**	**Operation/Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups/Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Custom Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Access Password
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1-**	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-03	Torque Characteristics
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [hp]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Adv. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-46	Position Detection Gain
1-5*	**Load Indep. Setting**
1-50	Motor Magnetisation at Zero Speed
1-51	Min Speed Normal Magnetising [RPM]
1-52	Min Speed Normal Magnetising [Hz]
1-58	Flystart Test Pulses Current
1-59	Flystart Test Pulses Frequency
1-6*	**Load Depen. Setting**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
1-70	PM Start Mode
1-71	Start Delay
1-72	Start Function
1-73	Flying Start
1-77	Compressor Start Max Speed [RPM]
1-78	Compressor Start Max Speed [Hz]
1-79	Compressor Start Max Time to Trip
1-8*	**Stop Adjustments**
1-80	Function at Stop
1-81	Min Speed for Function at Stop [RPM]
1-82	Min Speed for Function at Stop [Hz]
1-86	Trip Speed Low [RPM]
1-87	Trip Speed Low [Hz]
1-9*	**Motor Temperature**
1-90	Motor Thermal Protection
1-91	Motor External Fan
1-93	Thermistor Source
2-**	**Brakes**
2-0*	**DC Brake**
2-00	DC Hold/Preheat Current
2-01	DC Brake Current
2-02	DC Braking Time
2-03	DC Brake Cut In Speed [RPM]
2-04	DC Brake Cut In Speed [Hz]
2-06	Parking Current
2-07	Parking Time
2-1*	**Brake Energy Funct.**
2-10	Brake Function
2-11	Brake Resistor (ohm)
2-12	Brake Power Limit (kW)
2-13	Brake Power Monitoring
2-15	Brake Check
2-16	AC brake Max. Current
2-17	Over-voltage Control
3-**	**Reference/Ramps**
3-0*	**Reference Limits**
3-02	Minimum Reference
3-03	Maximum Reference
3-04	Reference Function
3-1*	**References**
3-10	Preset Reference
3-11	Jog Speed [Hz]
3-13	Reference Site
3-14	Preset Relative Reference
3-15	Reference 1 Source
3-16	Reference 2 Source
3-17	Reference 3 Source
3-19	Jog Speed [RPM]
3-4*	**Ramp 1**
3-41	Ramp 1 Ramp Up Time
3-42	Ramp 1 Ramp Down Time
3-5*	**Ramp 2**
3-51	Ramp 2 Ramp Up Time
3-52	Ramp 2 Ramp Down Time
3-8*	**Other Ramps**
3-80	Jog Ramp Time
3-81	Quick Stop Ramp Time
3-82	Starting Ramp Up Time
3-9*	**Digital Pot.Meter**
3-90	Step Size
3-91	Ramp Time
3-92	Power Restore
3-93	Maximum Limit
3-94	Minimum Limit
3-95	Ramp Delay
4-**	**Limits/Warnings**
4-1*	**Motor Limits**
4-10	Motor Speed Direction
4-11	Motor Speed Low Limit [RPM]
4-12	Motor Speed Low Limit [Hz]
4-13	Motor Speed High Limit [RPM]
4-14	Motor Speed High Limit [Hz]
4-16	Torque Limit Motor Mode
4-17	Torque Limit Generator Mode
4-18	Current Limit
4-19	Max Output Frequency
4-5*	**Adj. Warnings**
4-50	Warning Current Low
4-51	Warning Current High
4-52	Warning Speed Low
4-53	Warning Speed High
4-54	Warning Reference Low
4-55	Warning Reference High
4-56	Warning Feedback Low
4-57	Warning Feedback High
4-58	Missing Motor Phase Function
4-6*	**Speed Bypass**
4-60	Bypass Speed From [RPM]
4-61	Bypass Speed From [Hz]
4-62	Bypass Speed To [RPM]
4-63	Bypass Speed To [Hz]
4-64	Semi-Auto Bypass Set-up
5-**	**Digital In/Out**
5-0*	**Digital I/O mode**
5-00	Digital I/O mode
5-01	Terminal 27 Mode
5-02	Terminal 29 Mode
5-1*	**Digital Inputs**
5-10	Terminal 18 Digital Input
5-11	Terminal 19 Digital Input
5-12	Terminal 27 Digital Input
5-13	Terminal 29 Digital Input
5-14	Terminal 32 Digital Input
5-15	Terminal 33 Digital Input
5-16	Terminal X30/2 Digital Input
5-17	Terminal X30/3 Digital Input
5-18	Terminal X30/4 Digital Input
5-19	Terminal 37 Safe Stop
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-02	Fire Mode Live Zero Timeout Function
6-1*	**Analog Input 53**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-17	Terminal 53 Live Zero
6-2*	**Analog Input 54**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-27	Terminal 54 Live Zero
6-3*	**Analog Input X30/11**
6-30	Terminal X30/11 Low Voltage
6-31	Terminal X30/11 High Voltage
6-34	Term. X30/11 Low Ref./Feedb. Value
6-35	Term. X30/11 High Ref./Feedb. Value
6-36	Term. X30/11 Filter Time Constant
6-37	Term. X30/11 Live Zero
6-4*	**Analog Input X30/12**
6-40	Terminal X30/12 Low Voltage
6-41	Terminal X30/12 High Voltage
6-44	Term. X30/12 Low Ref./Feedb. Value
6-45	Term. X30/12 High Ref./Feedb. Value
6-46	Term. X30/12 Filter Time Constant
6-47	Term. X30/12 Live Zero
6-5*	**Analog Output 42**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
6-52	Terminal 42 Output Max Scale
6-53	Terminal 42 Output Bus Control
6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter
6-6*	**Analog Output X30/8**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
6-62	Terminal X30/8 Max. Scale
6-63	Terminal X30/8 Output Bus Control

9

9

No.	Parameter
6-64	Terminal X30/8 Output Timeout Preset
8-**	**Comm. and Options**
8-0*	**General Settings**
8-01	Control Site
8-02	Control Source
8-03	Control Timeout Time
8-04	Control Timeout Function
8-05	End-of-Timeout Function
8-06	Reset Control Timeout
8-07	Diagnosis Trigger
8-08	Readout Filtering
8-09	Communication Charset
8-1*	**Control Settings**
8-10	Control Profile
8-13	Configurable Status Word STW
8-3*	**FC Port Settings**
8-30	Protocol
8-31	Address
8-32	Baud Rate
8-33	Parity/Stop Bits
8-34	Estimated cycle time
8-35	Minimum Response Delay
8-36	Maximum Response Delay
8-37	Maximum Inter-Char Delay
8-4*	**FC MC protocol set**
8-40	Telegram Selection
8-42	PCD Write Configuration
8-43	PCD Read Configuration
8-5*	**Digital/Bus**
8-50	Coasting Select
8-52	DC Brake Select
8-53	Start Select
8-54	Reversing Select
8-55	Set-up Select
8-56	Preset Reference Select
8-7*	**BACnet**
8-70	BACnet Device Instance
8-72	MS/TP Max Masters
8-73	MS/TP Max Info Frames
8-74	"I-Am" Service
8-75	Initialisation Password
8-8*	**FC Port Diagnostics**
8-80	Bus Message Count
8-81	Bus Error Count
8-82	Slave Messages Rcvd
8-83	Slave Error Count
8-84	Slave Messages Sent
8-85	Slave Timeout Errors
8-89	Diagnostics Count
8-9*	**Bus Jog/Feedback**
8-90	Bus Jog 1 Speed
8-91	Bus Jog 2 Speed
8-94	Bus Feedback 1
8-95	Bus Feedback 2
8-96	Bus Feedback 3
9-**	**Profibus**
9-00	Setpoint
9-07	Actual Value
9-15	PCD Write Configuration
9-16	PCD Read Configuration
9-18	Node Address
9-22	Telegram Selection
9-23	Parameters for Signals
9-27	Parameter Edit
9-28	Process Control
9-44	Fault Message Counter
9-45	Fault Code
9-47	Fault Number
9-52	Fault Situation Counter
9-53	Profibus Warning Word
9-63	Actual Baud Rate
9-64	Device Identification
9-65	Profile Number
9-67	Control Word 1
9-68	Status Word 1
9-71	Profibus Save Data Values
9-72	ProfibusDriveReset
9-75	DO Identification
9-80	Defined Parameters (1)
9-81	Defined Parameters (2)
9-82	Defined Parameters (3)
9-83	Defined Parameters (4)
9-84	Defined Parameters (5)
9-90	Changed Parameters (1)
9-91	Changed Parameters (2)
9-92	Changed Parameters (3)
9-93	Changed Parameters (4)
9-94	Changed Parameters (5)
9-99	Profibus Revision Counter
11-**	**LonWorks**
11-0*	**LonWorks ID**
11-00	Neuron ID
11-1*	**LON Functions**
11-10	Drive Profile
11-15	LON Warning Word
11-17	XIF Revision
11-18	LonWorks Revision
11-2*	**LON Param. Access**
11-21	Store Data Values
12-**	**Ethernet**
12-0*	**IP Settings**
12-00	IP Address Assignment
12-01	IP Address
12-02	Subnet Mask
12-03	Default Gateway
12-04	DHCP Server
12-05	Lease Expires
12-06	Name Servers
12-07	Domain Name
12-08	Host Name
12-09	Physical Address
12-1*	**Ethernet Link Parameters**
12-10	Link Status
12-11	Link Duration
12-12	Auto Negotiation
12-13	Link Speed
12-14	Link Duplex
12-2*	**Process Data**
12-20	Control Instance
12-21	Process Data Config Write
12-22	Process Data Config Read
12-27	Primary Master
12-28	Store Data Values
12-29	Store Always
12-3*	**Ethernet/IP**
12-30	Warning Parameter
12-31	Net Reference
12-32	Net Control
12-33	CIP Revision
12-34	CIP Product Code
12-35	EDS Parameter
12-37	COS Inhibit Timer
12-38	COS Filter
12-4*	**Modbus TCP**
12-40	Status Parameter
12-41	Slave Message Count
12-42	Slave Exception Message Count
12-8*	**Other Ethernet Services**
12-80	FTP Server
12-81	HTTP Server
12-82	SMTP Service
12-89	Transparent Socket Channel Port
12-9*	**Advanced Ethernet Services**
12-90	Cable Diagnostic
12-91	Auto Crossover
12-92	IGMP Snooping
12-93	Cable Error Length
12-94	Broadcast Storm Protection
12-95	Broadcast Storm Filter
12-96	Port Config
12-98	Interface Counters
12-99	Media Counters
13-**	**Smart Logic**
13-0*	**SLC Settings**
13-00	SL Controller Mode
13-01	Start Event
13-02	Stop Event
13-03	Reset SLC
13-1*	**Comparators**
13-10	Comparator Operand
13-11	Comparator Operator
13-12	Comparator Value
13-2*	**Timers**
13-20	SL Controller Timer
13-4*	**Logic Rules**
13-40	Logic Rule Boolean 1
13-41	Logic Rule Operator 1
13-42	Logic Rule Boolean 2
13-43	Logic Rule Operator 2
13-44	Logic Rule Boolean 3
13-5*	**States**
13-51	SL Controller Event
13-52	SL Controller Action
14-**	**Special Functions**
14-0*	**Inverter Switching**
14-00	Switching Pattern
14-01	Switching Frequency
14-03	Overmodulation
14-04	PWM Random
14-1*	**Mains On/Off**
14-10	Mains Failure
14-11	Mains Voltage at Mains Fault
14-12	Function at Mains Imbalance
14-2*	**Reset Functions**
14-20	Reset Mode
14-21	Automatic Restart Time
14-22	Operation Mode
14-23	Typecode Setting
14-25	Trip Delay at Torque Limit
14-26	Trip Delay at Inverter Fault
14-28	Production Settings
14-29	Service Code
14-3*	**Current Limit Ctrl.**
14-30	Current Lim Ctrl, Proportional Gain
14-31	Current Lim Ctrl, Integration Time
14-32	Current Lim Ctrl, Filter Time
14-4*	**Energy Optimising**
14-40	VT Level
14-41	AEO Minimum Magnetisation
14-42	Minimum AEO Frequency
14-43	Motor Cosphi
14-5*	**Environment**
14-50	RFI Filter
14-51	DC Link Compensation
14-52	Fan Control
14-53	Fan Monitor
14-55	Output Filter
14-59	Actual Number of Inverter Units
14-6*	**Auto Derate**
14-60	Function at Overtemperature
14-61	Function at Inverter Overload
14-62	Inv. Overload Derate Current
14-9*	**Fault Settings**
14-90	Fault Level
15-**	**Drive Information**
15-0*	**Operating Data**
15-00	Operating Hours
15-01	Running Hours
15-02	kWh Counter
15-03	Power Up's
15-04	Over Temp's
15-05	Over Volt's
15-06	Reset kWh Counter
15-07	Reset Running Hours Counter
15-08	Number of Starts
15-1*	**Data Log Settings**
15-10	Logging Source
15-11	Logging Interval
15-12	Trigger Event
15-13	Logging Mode
15-14	Samples Before Trigger
15-2*	**Historic Log**
15-20	Historic Log: Event
15-21	Historic Log: Value
15-22	Historic Log: Time
15-23	Historic log: Date and Time
15-3*	**Alarm Log**
15-30	Alarm Log: Error Code
15-31	Alarm Log: Value
15-32	Alarm Log: Time
15-33	Alarm Log: Date and Time
15-4*	**Drive Identification**
15-40	FC Type
15-41	Power Section
15-42	Voltage
15-43	Software Version
15-44	Ordered Typecode String
15-45	Actual Typecode String
15-46	Frequency Converter Ordering No
15-47	Power Card Ordering No
15-48	LCP D No
15-49	SW ID Control Card
15-50	SW ID Power Card
15-51	Frequency Converter Serial Number
15-53	Power Card Serial Number
15-55	Vendor URL
15-56	Vendor Name
15-59	CSIV Filename
15-6*	**Option Ident**
15-60	Option Mounted
15-61	Option SW Version
15-62	Option Ordering No
15-63	Option Serial No
15-70	Option in Slot A
15-71	Slot A Option SW Version
15-72	Option in Slot B
15-73	Slot B Option SW Version
15-8*	**Operating Data II**
15-80	Fan Running Hours
15-81	Preset Fan Running Hours
15-9*	**Parameter Info**
15-92	Defined Parameters
15-93	Modified Parameters
15-98	Drive Identification
15-99	Parameter Metadata
16-**	**Data Readouts**
16-0*	**General Status**
16-00	Control Word
16-01	Reference [Unit]
16-02	Reference [%]
16-03	Status Word
16-05	Main Actual Value [%]
16-09	Custom Readout
16-1*	**Motor Status**
16-10	Power [kW]
16-11	Power [hp]
16-12	Motor Voltage
16-13	Frequency
16-14	Motor current
16-15	Frequency [%]
16-16	Torque [Nm]
16-17	Speed [RPM]
16-18	Motor Thermal
16-20	Motor Angle
16-22	Torque [%]

16-26 Power Filtered [kW]
16-27 Power Filtered [hp]
16-3* **Drive Status**
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 Logging Buffer Full
16-43 Timed Actions Status
16-49 Current Fault Source
16-5* **Ref. & Feedb.**
16-50 External Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-54 Feedback 1 [Unit]
16-55 Feedback 2 [Unit]
16-56 Feedback 3 [Unit]
16-58 PID Output [%]
16-6* **Inputs & Outputs**
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Pulse Input #29 [Hz]
16-68 Pulse Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-8* **Fieldbus & FC Port**
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-9* **Diagnosis Readouts**
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-96 Maintenance Word
18-** **Info & Readouts**
18-0* **Maintenance Log**
18-00 Maintenance Log: Item

18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
18-03 Maintenance Log: Date and Time
18-1* **Fire Mode Log**
18-10 Fire Mode Log: Event
18-11 Fire Mode Log: Time
18-12 Fire Mode Log: Date and Time
18-3* **Inputs & Outputs**
18-30 Analog Input X42/1
18-31 Analog Input X42/3
18-32 Analog Input X42/5
18-33 Analog Out X42/7 [V]
18-34 Analog Out X42/9 [V]
18-35 Analog Out X42/11 [V]
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-5* **Ref. & Feedb.**
18-50 Sensorless Readout [unit]
20-** **Drive Closed Loop**
20-0* **Feedback**
20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
20-02 Feedback 1 Source Unit
20-03 Feedback 2 Source
20-04 Feedback 2 Conversion
20-05 Feedback 2 Source Unit
20-06 Feedback 3 Source
20-07 Feedback 3 Conversion
20-08 Feedback 3 Source Unit
20-12 Reference/Feedback Unit
20-13 Minimum Reference/Feedb.
20-14 Maximum Reference/Feedb.
20-2* **Feedback/Setpoint**
20-20 Feedback Function
20-21 Setpoint 1
20-22 Setpoint 2
20-23 Setpoint 3
20-3* **Feedb. Adv. Conv.**
20-30 Refrigerant
20-31 User-defined Refrigerant A1
20-32 User-defined Refrigerant A2
20-33 User-defined Refrigerant A3
20-34 Duct 1 Area [m2]
20-35 Duct 1 Area [in2]
20-36 Duct 2 Area [m2]
20-37 Duct 2 Area [in2]
20-38 Air Density Factor [%]
20-6* **Sensorless**
20-60 Sensorless Unit
20-69 Sensorless Information
20-7* **PID Autotuning**
20-70 Closed Loop Type
20-71 PID Performance
20-72 PID Output Change
20-73 Minimum Feedback Level
20-74 Maximum Feedback Level
20-79 PID Autotuning

20-8* **PID Basic Settings**
20-81 PID Normal/Inverse Control
20-82 PID Start Speed [RPM]
20-83 PID Start Speed [Hz]
20-84 On Reference Bandwidth
20-9* **PID Controller**
20-91 PID Anti Windup
20-93 PID Proportional Gain
20-94 PID Integral Time
20-95 PID Differentiation Time
20-96 PID Diff. Gain Limit
21-** **Ext. Closed Loop**
21-0* **Ext. CL Autotuning**
21-00 Closed Loop Type
21-01 PID Performance
21-02 PID Output Change
21-03 Minimum Feedback Level
21-04 Maximum Feedback Level
21-09 PID Autotuning
21-1* **Ext. CL 1 Ref./Fb.**
21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
21-12 Ext. 1 Maximum Reference
21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* **Ext. CL 1 PID**
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
21-23 Ext. 1 Differentiation Time
21-24 Ext. 1 Dif. Gain Limit
21-3* **Ext. CL 2 Ref./Fb.**
21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
21-34 Ext. 2 Feedback Source
21-35 Ext. 2 Setpoint
21-37 Ext. 2 Reference [Unit]
21-38 Ext. 2 Feedback [Unit]
21-39 Ext. 2 Output [%]
21-4* **Ext. CL 2 PID**
21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
21-42 Ext. 2 Integral Time
21-43 Ext. 2 Differentiation Time
21-44 Ext. 2 Dif. Gain Limit
21-5* **Ext. CL 3 Ref./Fb.**
21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
21-52 Ext. 3 Maximum Reference
21-53 Ext. 3 Reference Source
21-54 Ext. 3 Feedback Source
21-55 Ext. 3 Setpoint
21-57 Ext. 3 Reference [Unit]

21-58 Ext. 3 Feedback [Unit]
21-59 Ext. 3 Output [%]
21-6* **Ext. CL 3 PID**
21-60 Ext. 3 Normal/Inverse Control
21-61 Ext. 3 Proportional Gain
21-62 Ext. 3 Integral Time
21-63 Ext. 3 Differentiation Time
21-64 Ext. 3 Dif. Gain Limit
22-** **Appl. Functions**
22-0* **Miscellaneous**
22-00 External Interlock Delay
22-01 Power Filter Time
22-2* **No-Flow Detection**
22-20 Low Power Auto Set-up
22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* **No-Flow Power Tuning**
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
22-35 Low Speed Power [hp]
22-36 High Speed [RPM]
22-37 High Speed [Hz]
22-38 High Speed Power [kW]
22-39 High Speed Power [hp]
22-4* **Sleep Mode**
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-42 Wake-up Speed [RPM]
22-43 Wake-up Speed [Hz]
22-44 Wake-up Ref./FB Difference
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-5* **End of Curve**
22-50 End of Curve Function
22-51 End of Curve Delay
22-6* **Broken Belt Detection**
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay
22-7* **Short Cycle Protection**
22-75 Short Cycle Protection
22-76 Interval between Starts
22-77 Minimum Run Time
22-78 Minimum Run Time Override
22-79 Minimum Run Time Override Value
22-8* **Flow Compensation**
22-80 Flow Compensation
22-81 Square-linear Curve Approximation
22-82 Work Point Calculation
22-83 Speed at No-Flow [RPM]
22-84 Speed at No-Flow [Hz]
22-85 Speed at Design Point [RPM]

22-86 Speed at Design Point [Hz]
22-87 Pressure at No-Flow Speed
22-88 Pressure at Rated Speed
22-89 Flow at Design Point
22-90 Flow at Rated Speed
23-** **Time-based Functions**
23-0* **Timed Actions**
23-00 ON Time
23-01 ON Action
23-02 OFF Time
23-03 OFF Action
23-04 Occurrence
23-0* **Timed Actions Settings**
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* **Maintenance**
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
23-14 Maintenance Date and Time
23-1* **Maintenance Reset**
23-15 Reset Maintenance Word
23-16 Maintenance Text
23-5* **Energy Log**
23-50 Energy Log Resolution
23-51 Period Start
23-53 Energy Log
23-54 Reset Energy Log
23-6* **Trending**
23-60 Trend Variable
23-61 Continuous Bin Data
23-62 Timed Bin Data
23-63 Timed Period Start
23-64 Timed Period Stop
23-65 Minimum Bin Value
23-66 Reset Continuous Bin Data
23-67 Reset Timed Bin Data
23-8* **Payback Counter**
23-80 Power Reference Factor
23-81 Energy Cost
23-82 Investment
23-83 Energy Savings
23-84 Cost Savings
24-** **Appl. Functions 2**
24-0* **Fire Mode**
24-00 Fire Mode Function
24-01 Fire Mode Configuration
24-02 Fire Mode Unit
24-03 Fire Mode Min Reference
24-04 Fire Mode Max Reference
24-05 Fire Mode Preset Reference
24-06 Fire Mode Reference Source
24-07 Fire Mode Feedback Source
24-09 Fire Mode Alarm Handling
24-1* **Drive Bypass**
24-10 Drive Bypass Function
24-11 Drive Bypass Delay Time

9

9

24-9* **Multi-Motor Funct.**
24-90 Missing Motor Function
24-91 Missing Motor Coefficient 1
24-92 Missing Motor Coefficient 2
24-93 Missing Motor Coefficient 3
24-94 Missing Motor Coefficient 4
24-95 Locked Rotor Function
24-96 Locked Rotor Coefficient 1
24-97 Locked Rotor Coefficient 2
24-98 Locked Rotor Coefficient 3
24-99 Locked Rotor Coefficient 4
25-** **Cascade Controller**
25-0* **System Settings**
25-00 Cascade Controller
25-02 Motor Start
25-04 Pump Cycling
25-05 Fixed Lead Pump
25-06 Number of Pumps
25-2* **Bandwidth Settings**
25-20 Staging Bandwidth
25-21 Override Bandwidth
25-22 Fixed Speed Bandwidth
25-23 SBW Staging Delay
25-24 SBW Destaging Delay
25-25 OBW Time
25-26 Destage At No-Flow
25-27 Stage Function
25-28 Stage Function Time
25-29 Destage Function
25-30 Destage Function Time
25-4* **Staging Settings**
25-40 Ramp Down Delay
25-41 Ramp Up Delay
25-42 Staging Threshold
25-43 Destaging Threshold
25-44 Staging Speed [RPM]
25-45 Staging Speed [Hz]
25-46 Destaging Speed [RPM]
25-47 Destaging Speed [Hz]
25-5* **Alternation Settings**
25-50 Lead Pump Alternation
25-51 Alternation Event
25-52 Alternation Time Interval
25-53 Alternation Timer Value
25-54 Alternation Predefined Time
25-55 Alternate If Load < 50%
25-56 Staging Mode at Alternation
25-58 Run Next Pump Delay
25-59 Run on Mains Delay
25-8* **Status**
25-80 Cascade Status
25-81 Pump Status
25-82 Lead Pump
25-83 Relay Status
25-84 Pump ON Time
25-85 Relay ON Time
25-86 Reset Relay Counters
25-9* **Service**
25-90 Pump Interlock

25-91 Manual Alternation
26-** **Analog I/O Option**
26-0* **Analog I/O Mode**
26-00 Terminal X42/1 Mode
26-01 Terminal X42/3 Mode
26-02 Terminal X42/5 Mode
26-1* **Analog Input X42/1**
26-10 Terminal X42/1 Low Voltage
26-11 Terminal X42/1 High Voltage
26-14 Term. X42/1 Low Ref./Feedb. Value
26-15 Term. X42/1 High Ref./Feedb. Value
26-16 Term. X42/1 Filter Time Constant
26-17 Term. X42/1 Live Zero
26-2* **Analog Input X42/3**
26-20 Terminal X42/3 Low Voltage
26-21 Terminal X42/3 High Voltage
26-24 Term. X42/3 Low Ref./Feedb. Value
26-25 Term. X42/3 High Ref./Feedb. Value
26-26 Term. X42/3 Filter Time Constant
26-27 Term. X42/3 Live Zero
26-3* **Analog Input X42/5**
26-30 Terminal X42/5 Low Voltage
26-31 Terminal X42/5 High Voltage
26-34 Term. X42/5 Low Ref./Feedb. Value
26-35 Term. X42/5 High Ref./Feedb. Value
26-36 Term. X42/5 Filter Time Constant
26-37 Term. X42/5 Live Zero
26-4* **Analog Out X42/7**
26-40 Terminal X42/7 Output
26-41 Terminal X42/7 Min. Scale
26-42 Terminal X42/7 Max. Scale
26-43 Terminal X42/7 Bus Control
26-44 Terminal X42/7 Timeout Preset
26-5* **Analog Out X42/9**
26-50 Terminal X42/9 Output
26-51 Terminal X42/9 Min. Scale
26-52 Terminal X42/9 Max. Scale
26-53 Terminal X42/9 Bus Control
26-54 Terminal X42/9 Timeout Preset
26-6* **Analog Out X42/11**
26-60 Terminal X42/11 Output
26-61 Terminal X42/11 Min. Scale
26-62 Terminal X42/11 Max. Scale
26-63 Terminal X42/11 Bus Control
26-64 Terminal X42/11 Timeout Preset
30-** **Special Features**
30-2* **Adv. Start Adjust**
30-22 Locked Rotor Detection
30-23 Locked Rotor Detection Time [s]
31-** **Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
35-** **Sensor Input Option**
35-0* **Temp. Input Mode**

35-00 Term. X48/4 Temperature Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temperature Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temperature Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* **Temp. Input X48/4**
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* **Temp. Input X48/7**
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* **Temp. Input X48/10**
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* **Analog Input X48/2**
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
35-47 Term. X48/2 Live Zero

Index

A