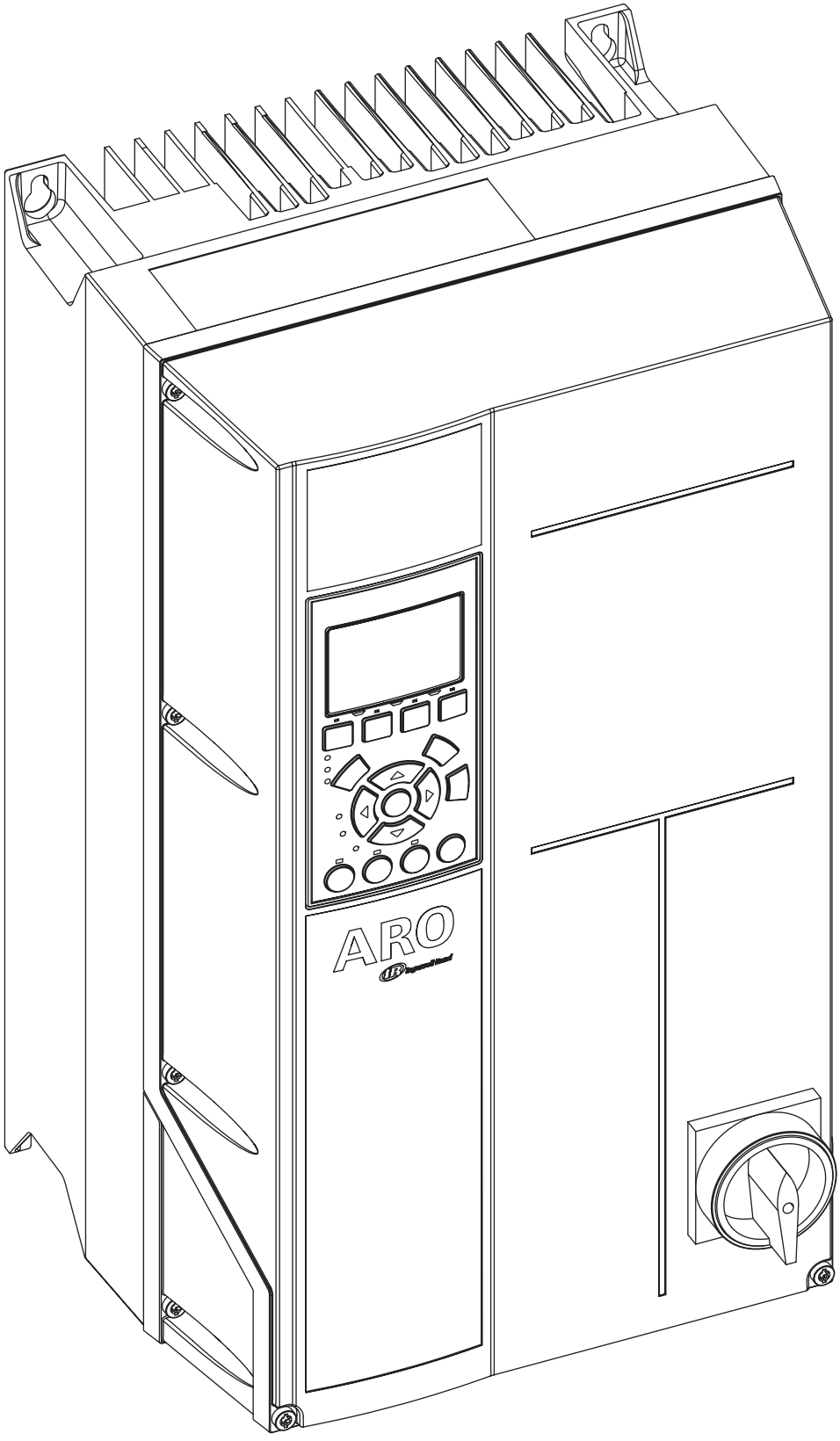
OPERATOR'S MANUAL IR-302

INCLUDING: OPERATION, INSTALLATION AND MAINTENANCE

VARIABLE FREQUENCY DRIVE

0.25–22 kW, Enclosure sizes A-B



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Contents

1 Introduction

1.1 Purpose of this Operating Guide

This Operating Guide provides information for safe installation and commissioning of the product. It is intended for use by qualified personnel. Read and follow the instructions to use the drive safely and professionally. Pay particular attention to the safety instructions and general warnings. Always keep this Operating Guide available with the drive.

1.2 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1: Manual and Software Version

Version	Remarks	Software version
AQ366525980359, version 0101	First edition.	SW 8.72

1.3 Product Overview

1.3.1 Intended Use

The drive 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 AC drive, the motor, and equipment driven by the motor.
- System and motor status surveillance.

The drive can also be used for motor overload protection.

Depending on the configuration, the drive can be used in standalone applications or form part of a larger appliance or installation.

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

N O T I C E

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 drive in applications which are non-compliant with the specified operating conditions and environments. Ensure compliance with the conditions specified in *Ambient Conditions*.

N O T I C E

OUTPUT FREQUENCY LIMIT

Due to export control regulations, the output frequency of the drive is limited to 590 Hz.

1.3.2 Exploded Views

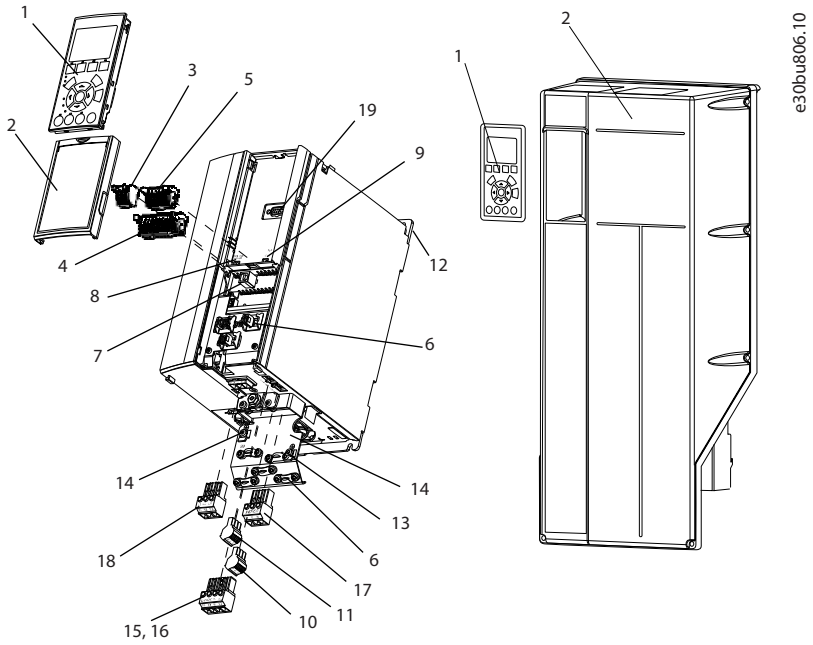

Illustration 1: Exploded View Enclosure Size A, IP20

1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Mounting slot
3	RS485 fieldbus connector	13	Ground connection (PE)
4	Digital input/output connector	14	Cable shield connector
5	Digital input/output connector	15	Brake terminal (-81, +82)
6	Shielded cable grounding and relief	16	Load sharing terminal (-88, +89)
7	USB connector	17	Motor terminals 96 (U), 97 (V), 98 (W)
8	RS485 termination switch	18	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
9	DIP switch for A53 and A54	19	LCP connector
10	Relay 1 (01, 02, 03)		

1.4 Type Approvals and Certifications

The following list is a selection of possible type approvals and certifications:

Table 2: Type Approvals and Certifications

CE	ErP READY		TÜVRheinland CERTIFIED Functional Safety Type Approved www.tuv.com ID 0600000000	TÜV SÜD	DNV·GL	
c UL us	EAC	089	OSHPD	RINA 1861	ABS	
BUREAU VERITAS	LR		ClassNK			

NOTICE

The specific approvals and certification for the drive are on the nameplate of the drive.

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

⚠ D A N G E R ⚠

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G ⚠

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N ⚠

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

N O T I C E

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

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

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

2.3 Safety Precautions

⚠ W A R N I N G

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

- Only skilled personnel must perform installation, start-up, and maintenance.

⚠ W A R N I N G ⚠

UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, or after a cleared fault condition.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

⚠ WARNING ⚠

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.
- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully. The minimum waiting time is specified in the table *Discharge time* and is also visible on the nameplate on the top of the drive.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Table 3: Discharge Time

Voltage [V]	Minimum waiting time (minutes)	
	4	**15**
200–240	0.25–3.7 kW (0.34–5 hp)	5.5–15 kW (7.5–20 hp)
380–500	0.37–7.5 kW (0.5–10 hp)	11–22 kW (15–30 hp)
525–600	0.75–7.5 kW (1.0–10 hp)	11–22 kW (15–30 hp)

⚠ WARNING

ELECTRICAL SHOCK HAZARD - LEAKAGE CURRENT HAZARD >3.5 MA

Leakage currents exceed 3.5 mA. Failure to connect the drive properly to protective earth (PE) can result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the can be done with:
- a PE conductor with a cross-section of at least 10 mm^2 (8 AWG) Cu or 16 mm^2 (6 AWG) Al
- an extra PE conductor of the same cross-sectional area as the original PE conductor as specified by IEC 60364-5-54 with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) (mechanical protected) or 4 mm^2 (12 AWG) (not mechanical protected).
- a PE conductor completely enclosed with an enclosure or otherwise protected throughout its length against mechanical damage.
- a PE conductor part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) (permanently connected or pluggable by an industrial connector. The multi-conductor power cable shall be installed with an appropriate strain relief).
- NOTE: In IEC/EN 60364-5-54 cl. 543.7 and some application standards (for example IEC/EN 60204-1), the limit for requiring reinforced protective earthing conductor is 10 mA leakage current.

⚠ WARNING ⚠

ROTATING SHAFTS

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 guide.

⚠ 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 drive can result in serious injury when the drive 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 vary according to product configuration.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

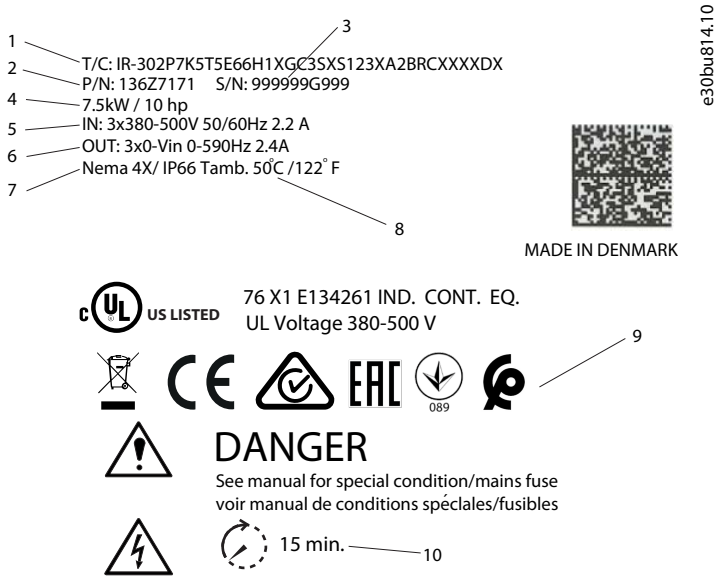

Illustration 2: Product Nameplate (Example)

1	Type code	6	Output voltage, frequency, and current (at low/high voltages)
2	Code number	7	Enclosure size and IP rating
3	Serial number	8	Maximum ambient temperature
4	Power rating	9	Certifications
5	Input voltage, frequency, and current (at low/high voltages)	10	Discharge time (Warning)

N O T I C E

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

3.1.2 Storage

Ensure that the requirements for storage are fulfilled, see 8.4 Ambient Conditions.

3.2 Installation Environment

N O T I C E

REDUCED LIFETIME

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 lifetime of the drive.

– Ensure that requirements for air humidity, temperature, and altitude are met.

Vibration and shock

The drive complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors. For detailed ambient conditions, refer to 8.4 Ambient Conditions.

3.3 Mounting

3.3.1 Cooling

- Ensure that top and bottom clearance for air cooling is provided. See Table 4 for clearance requirements.

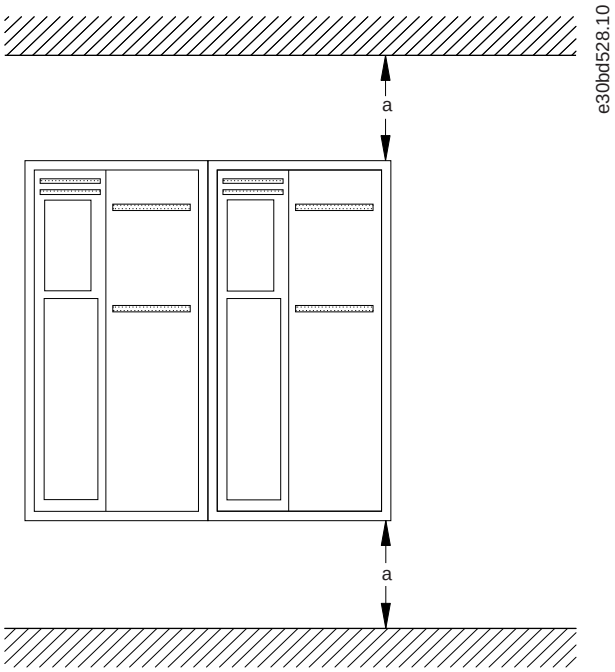

Illustration 3: Top and Bottom Cooling Clearance

Table 4: Minimum Airflow Clearance Requirements

Enclosure	A1–A5	B1–B2
a [mm (in)]	100 (3.9)	200 (7.8)

3.3.2 Lifting

⚠ W A R N I N G ⚠

HEAVY LOAD

Unbalanced loads can fall and loads can tip over. Failure to take proper lifting precautions increases risk of death, serious injury, or equipment damage.

- Never walk under suspended loads.
- To guard against injury, wear personal protective equipment such as gloves, safety glasses, and safety shoes.
- Be sure to use lifting devices with the appropriate weight rating. To determine a safe lifting method, check the weight of the unit.
- The angle from the top of the drive module to the lifting cables has an impact on the maximum load force on the cable. This angle must be 65° or greater. Attach and dimension the lifting cables properly.

- To determine a safe lifting method, check the weight of the unit in 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 hoist rings on the unit, when provided.

3.3.3 Mounting

Procedure

1. Ensure that the strength of the mounting location supports the unit weight.

   The drive allows side-by-side installation.

2. Place 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 backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

3.3.3.1 Mounting with Mounting Plate and Railings

A mounting plate is required when mounted on railings.

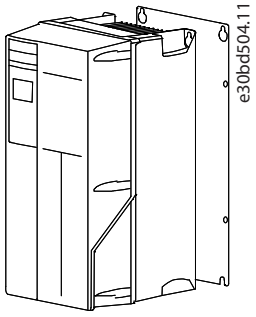

Illustration 4: Proper Mounting with Mounting Plate

4 Electrical Installation

4.1 Safety Instructions

See 2.3 Safety Precautions 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/tagged out. Failure to run output motor cables separately or to use shielded cables could result in death or serious injury.

- Run output motor cables separately or use shielded cables.
- Simultaneously lock out/tag out all the drives.

⚠ WARNING ⚠

ELECTRICAL SHOCK AND FIRE HAZARD - RCD COMPLIANCE

The unit can cause a DC fault current in the PE conductor. Failure to use a Type B residual current-operated protective device (RCD) may lead to the RCD not providing the intended protection and therefore may result in death, fire, or other serious hazard.

- When an RCD is used for protection against electrical shock or against fire, only a Type B device is allowed on the supply side.

Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between drive 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 8.7.2 CE Compliance and 8.7.3 UL Compliance.

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 (167 °F) rated copper wire. See the tables in 8.1.1 Mains Supply 200–240 V, 8.1.2 Mains Supply 380–500 V, 8.1.3 Mains Supply 525–600 V, and 8.5.1 Cable Lengths and Cross-sections for Control Cables for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in 4.3 Grounding, 4.4 Wiring Schematic, 4.5 Connecting the Motor, and 4.7 Control Wiring.

NOTICE

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

4.3 Grounding

⚠ W A R N I N G

ELECTRICAL SHOCK HAZARD - LEAKAGE CURRENT HAZARD >3.5 MA

Leakage currents exceed 3.5 mA. Failure to connect the drive properly to protective earth (PE) can result in death or serious injury.

- Ensure reinforced protective earthing conductor according to IEC 60364-5-54 cl. 543.7 or according to local safety regulations for high touch current equipment. The reinforced protective earthing of the can be done with:
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- an extra PE conductor of the same cross-sectional area as the original PE conductor as specified by IEC 60364-5-54 with a minimum cross-sectional area of 2.5 mm^2 (14 AWG) (mechanical protected) or 4 mm^2 (12 AWG) (not mechanical protected).
- a PE conductor completely enclosed with an enclosure or otherwise protected throughout its length against mechanical damage.
- a PE conductor part of a multi-conductor power cable with a minimum PE conductor cross-section of 2.5 mm^2 (14 AWG) (permanently connected or pluggable by an industrial connector. The multi-conductor power cable shall be installed with an appropriate strain relief).
- NOTE: In IEC/EN 60364-5-54 cl. 543.7 and some application standards (for example IEC/EN 60204-1), the limit for requiring reinforced protective earthing conductor is 10 mA leakage current.

For electrical safety

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy-chain fashion (see Illustration 5.)
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section for the ground wires: 10 mm^2 (7 AWG).
- Separately terminate individual ground wires, both complying with the dimension requirements.

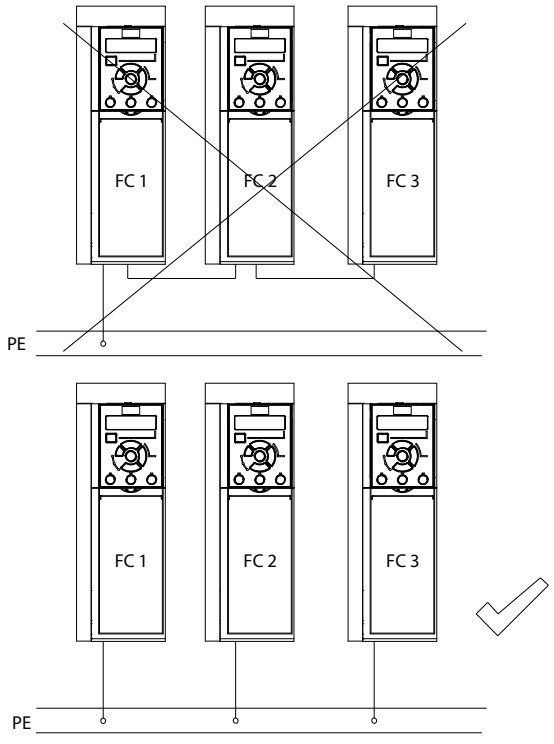


Illustration 5: Grounding Principle

For EMC-compliant installation

- Establish electrical contact between the cable shield and the drive enclosure by using metal cable glands or by using the clamps provided on the equipment.
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

N O T I C E

POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (6 AWG).

4.4 Wiring Schematic

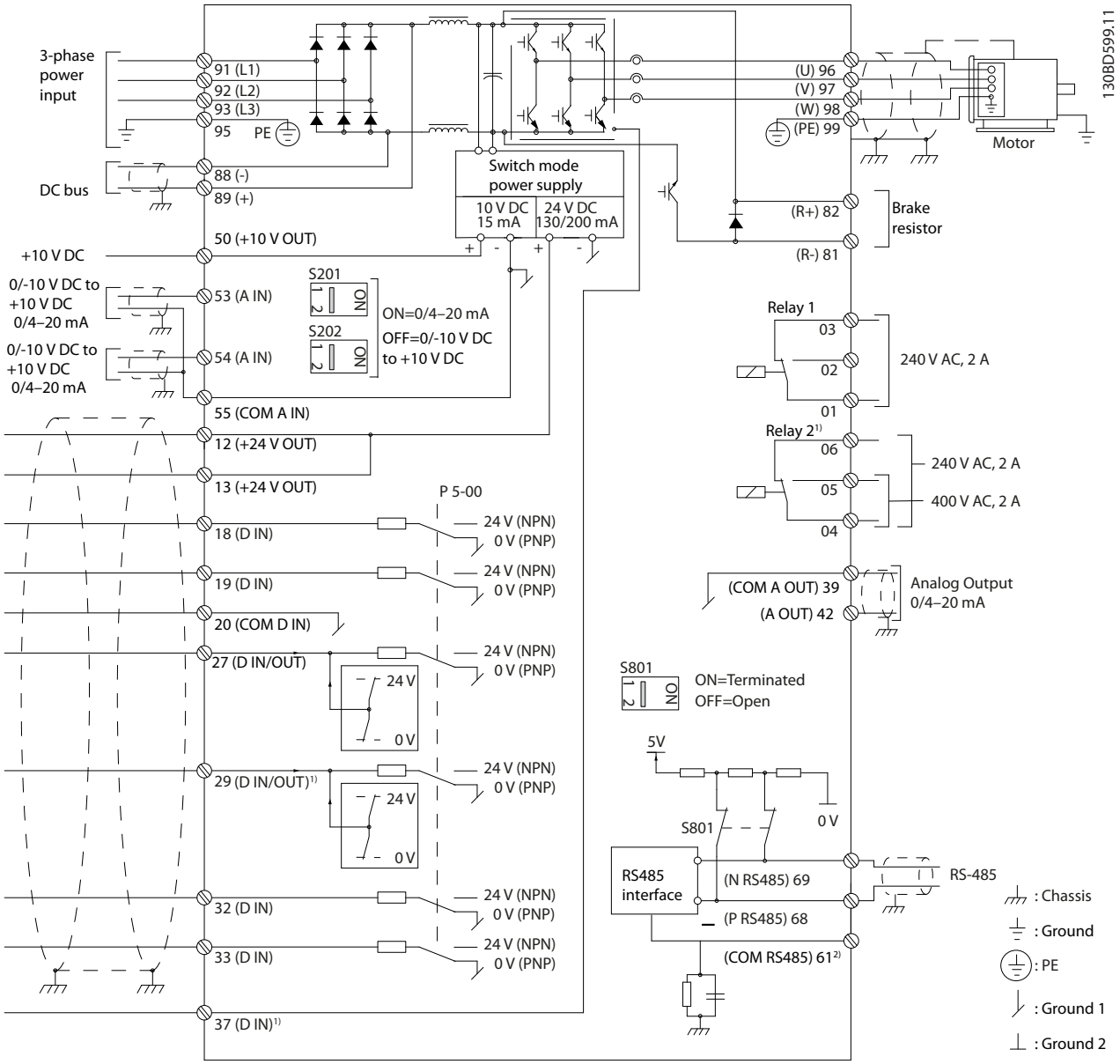


Illustration 6: Basic Wiring Schematic

A	Analog	1	Terminal 37 (optional) is used for Safe Torque Off (STO).
D	Digital	2	Do not connect cable shield.

Read more in 4.2 EMC-compliant Installation.

4.5 Connecting the Motor

⚠ 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/tagged out. Failure to run output motor cables separately or to use shielded cables could result in death or serious injury.

- Run output motor cables separately or use shielded cables.
- Simultaneously lock out/tag out all the drives.

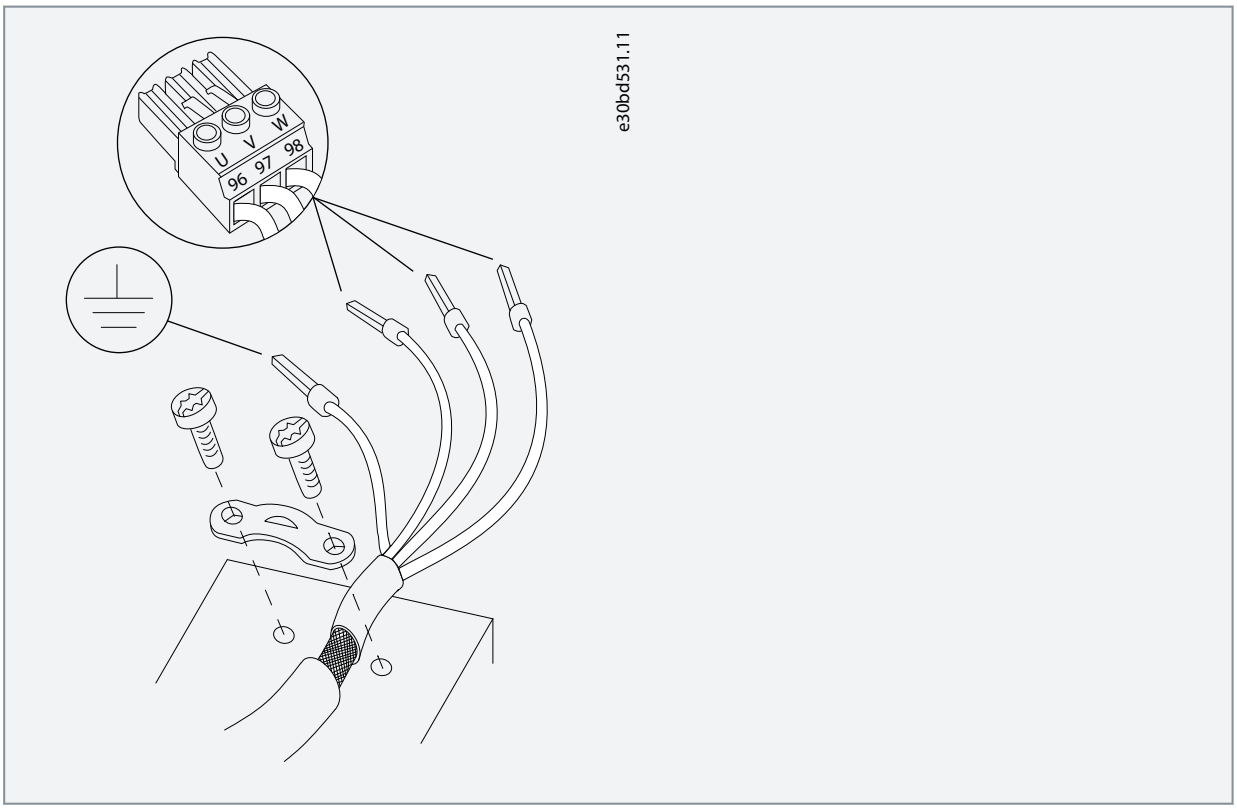
- Run output separately or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see the tables in 8.1.1 Mains Supply 200–240 V, 8.1.2 Mains Supply 380–500 V, and 8.1.3 Mains Supply 525–600 V.
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA 1/12) and higher units.
- Do not wire a starting or pole-changing device (for example a Dahlander motor or slip ring asynchronous motor) between the drive and the motor.

4.5.1 Grounding the Cable Shield

Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to esatblish mechanical fixation and electrical contact between the cable shield and ground.

3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions, see 4.3 Grounding.



4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
5. Torque-tighten the terminals, see 8.8 Connection Tightening Torques.

Example

Mains input, motor, and grounding for basic drives. Actual configurations vary with unit types and optional equipment.

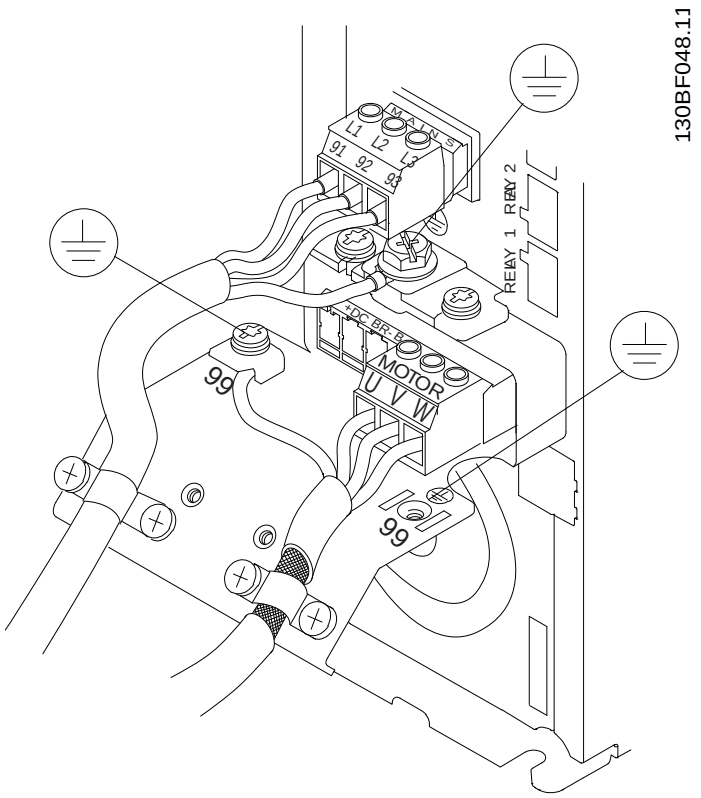


Illustration 7: Example of Motor, Mains, and Ground Wiring

4.6 Connecting AC Mains

- Size the wiring based on the input current of the drive. For maximum wire sizes, see the tables in 8.1.1 Mains Supply 200–240 V, 8.1.2 Mains Supply 380–500 V, and 8.1.3 Mains Supply 525–600 V.
- Comply with local and national electrical codes for cable sizes.

4.6.1 Connecting the Drive to Mains

Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3.
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions, see 4.3 Grounding and 4.5.1 Grounding the Cable Shield.
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 *parameter 14-50 RFI Filter* is set to *[0] Off*. This setting prevents damage to the DC link and reduces ground capacity currents in accordance with IEC 61800-3.

4.7 Control Wiring

- Isolate the control wiring from the high-power components in the drive.
- When the drive is connected to a thermistor, enusre that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended.

4.7.1 Safe Torque Off (STO)

To run STO, additional wiring for the drive is required.

4.7.2 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to control an electro-mechanical brake.

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the drive is unable to keep the motor at standstill, for example due to the load being too heavy.

- Select *[32] Mechanical brake control* in *parameter group 5-4* Relays* for applications with an electromechanical brake.
- The brake is released when the motor current exceeds the value in *parameter 2-20 Release Brake Current*.
- The brake is engaged when the output frequency is less than the frequency set in *parameter 2-21 Activate Brake Speed [RPM]* or *parameter 2-22 Activate Brake Speed [Hz]*, and only if the drive carries out a stop command.

If the drive is in alarm mode or in an overvoltage situation, the mechanical brake immediately closes.

N O T I C E

The drive is not a safety device. It is the responsibility of the system designer to integrate safety devices according to relevant national crane/lift regulations.

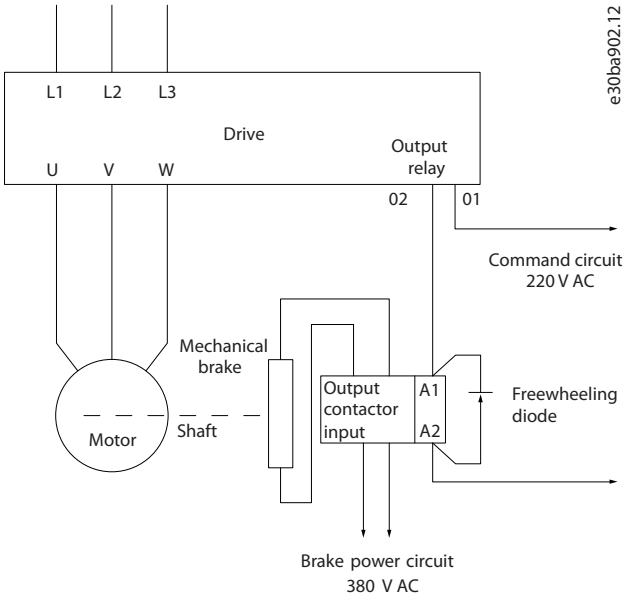


Illustration 8: Connecting the Mechanical Brake to the Drive

4.8 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in the following table. Check and mark the items when completed.

Table 5: Installation Check List

Inspect for	Description	√
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers residing on the input power side of the drive, 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 drive. • Remove any power factor correction capacitors on the motor. • Adjust any power factor correction capacitors on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that the motor wiring and control wiring are separated, shielded, 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 shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	

Inspect for	Description	√
Cooling clearance	• Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see 3.3.1 Cooling.	
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 shielded 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.	

⚠ C A U T I O N ⚠

INTERNAL FAILURE HAZARD

An internal failure in the drive can result in serious injury when the drive is not properly closed.

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

5 Commissioning

5.1 Safety Instructions

See chapter Safety for general safety instructions.

⚠ WARNING

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

- Only skilled personnel must perform installation, start-up, and maintenance.

NOTICE

The front covers with warning signs are an integrated part of the drive and considered safety covers. The covers must be in place before applying power and at all times.

5.1.1 Before Applying Power

Procedure

1. Close the safety 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 drive 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 drive and the motor.
8. Inspect the drive for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the drive and the motor.

5.2 Local Control Panel Operation

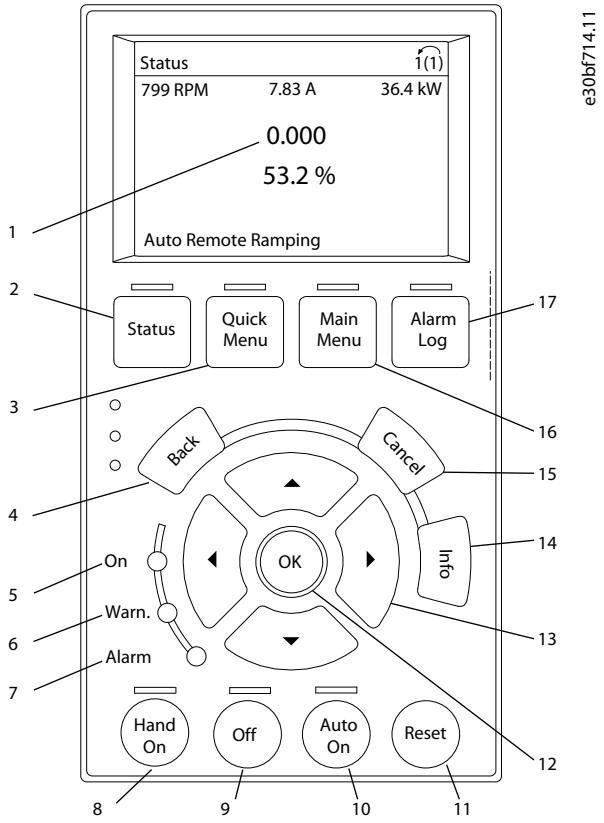


Illustration 9: Graphical Local Control Panel (GLCP)

1	The information shown in the display area depends on the selected function or menu (in this case *Quick Menu Q3-13 Display Settings*).
2	[Status] shows operational status.
3	[Quick Menu] allows access to programming parameters for initial setup instructions and many detailed application instructions.
4	[Back] reverts to the previous step or list in the menu structure.
5	A green indicator light indicates that power is on.
6	A yellow indicator light comes on when a warning is active. A text appears in the display area identifying the problem.
7	A red flashing indicator light indicates a fault condition, and an alarm text is shown.
8	[Hand On] puts the drive in local control mode, so that it responds to the LCP. • An external stop signal by control input or serial communication overrides local [Hand On] key.
9	[Off] stops the motor but does not remove power to the drive.
10	[Auto On] puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication.
11	[Reset] resets the drive manually after a fault has been cleared.
12	[OK] gives access to parameter groups or enables a selection.
13	[▵][▹] [▿] [◃] enables moving between items in the menu.
14	[Info] shows a definition of the function being shown.
15	[Cancel] cancels the last change or command as long as the display mode is not changed.
16	[Main Menu] gives access to all programming parameters.
17	[Alarm Log] shows a list of current warnings, the last 10 alarms, and the maintenance log.

5.3 System Set-up

Procedure

1. Perform automatic motor adaption (AMA):
    a. Set the basic motor parameters before performing AMA.

Table 6: Basic Parameters to be Checked before AMA

	Parameter 1-10 Motor Construction				
	ASM	**SPM**	**IPM**	**SynRM**	**PMaSynRM**
Parameter 1-20 Motor Power [kW]/parameter 1-21 Motor Power [hp]	X				
Parameter 1-22 Motor Voltage	X				
Parameter 1-23 Motor Frequency	X			X	X
Parameter 1-24 Motor Current	X	X	X	X	X
Parameter 1-25 Motor Nominal Speed	X	X	X	X	X
Parameter 1-26 Motor Cont. Rated		X	X	X	X
Parameter 1-39 Motor Poles		X	X	X	X

    b. Optimize the compatibility between motor and drive via *parameter 1-29 Automatic Motor Adaptation (AMA)*.
2. Check motor rotatation.
3. If encoder feedback is used, perform the following steps:
    a. Select *[0] Speed open loop* in *parameter 1-00 Configuration Mode*.
    b. Select *[1] 24V encoder* in *parameter 7-00 Speed PID Feedback Source*.
    c. Press [Hand On].
    d. Press [▹] for positive speed reference (*parameter 1-06 Clockwise Direction at [0]*).
    e. In *parameter 16-57 Feedback [RPM]*, check that the feedback is positive.

6 Basic I/O Configuration

6.1 Application 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 *parameter 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.

6.1.1 Programming a Closed-loop Drive System

A closed-loop drive system usually consists of:

- Motor.
- Drive.
- Encoder (as feedback system).
- Mechanical brake.
- Brake resistor (for dynamic braking).
- Transmission.
- Gear box.
- Load.

Applications demanding mechanical brake control typically need a brake resistor.

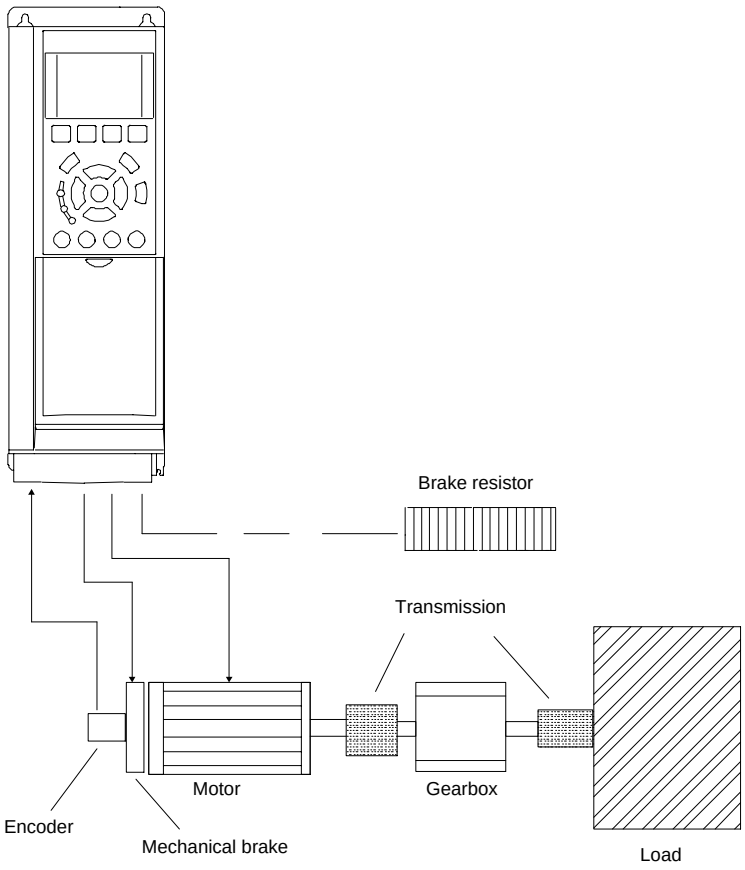
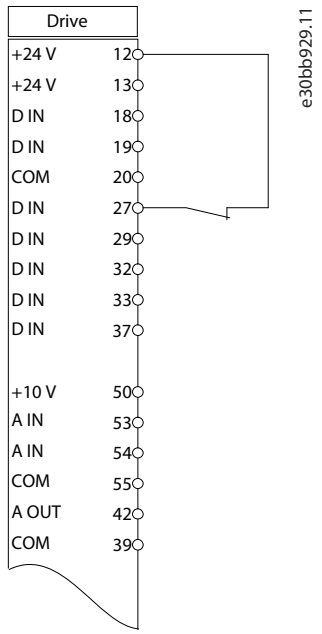


Illustration 10: Basic Setup for Closed-loop Speed Control

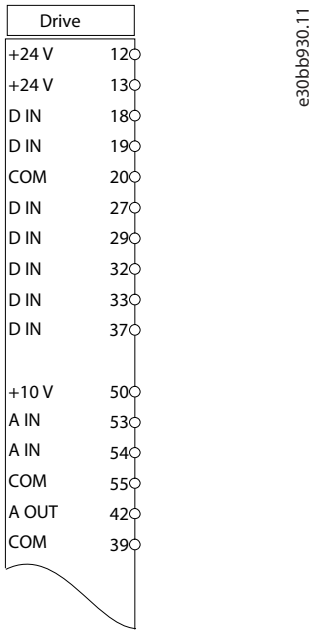
6.1.2 Wiring Configuration for Automatic Motor Adaptation (AMA)

Table 7: Wiring Configuration for AMA with T27 Connected

	Parameters	
	**Function**	**Setting**
	Parameter 1-29 Automatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 Terminal 27 Digital Input	*[2]* Coast inverse*
	*=Default value	
	Notes/comments: Set *parameter group 1-2* Motor Data* according to motor nameplate.	

6.1.3 Wiring Configuration for Automatic Motor Adaptation without T27

Table 8: AMA without T27 Connected

	Parameters	
	**Function**	**Setting**
	Parameter 1-29 Automatic Motor Adaptation (AMA)	*[1] Enable complete AMA*
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	*=Default value	
	Notes/comments: *Parameter group 1-2* Motor Data* must be set according to motor.	

6.1.4 Wiring Configuration: Speed

Table 9: Analog Speed Reference (Voltage)

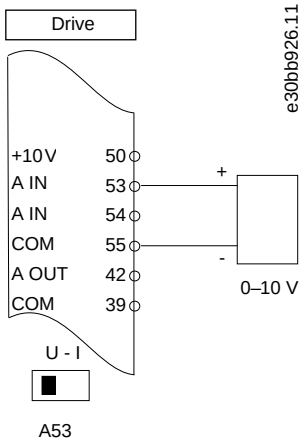
	Parameters	
	**Function**	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 10: Analog Speed Reference (Current)

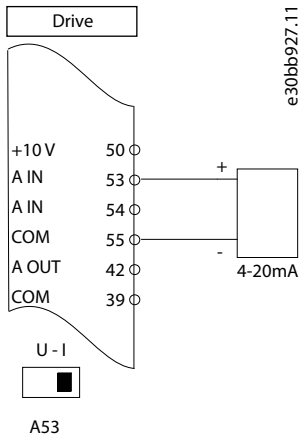
	Parameters	
	**Function**	**Setting**
	Parameter 6-12 Terminal 53 Low Current	4 mA*
	Parameter 6-13 Terminal 53 High Current	20 mA*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 11: Speed Reference (Using a Manual Potentiometer)

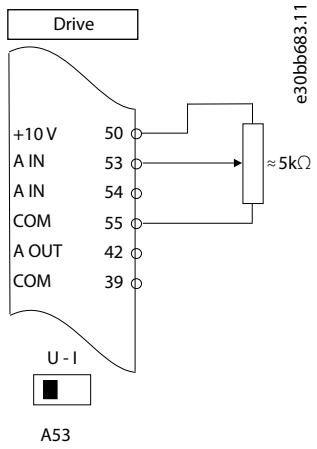
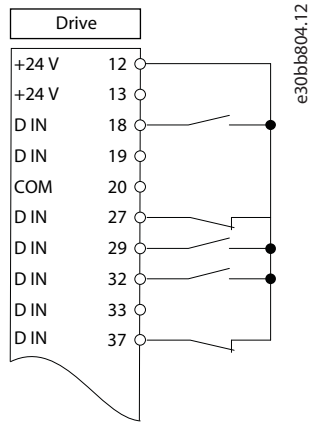
	Parameters	
	**Function**	**Setting**
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
	Parameter 6-11 Terminal 53 High Voltage	10 V*
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 12: Speed Up/Down

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[19] Freeze Reference*
	Parameter 5-13 Terminal 29 Digital Input	*[21] Speed Up*
	Parameter 5-14 Terminal 32 Digital Input	*[22] Speed Down*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

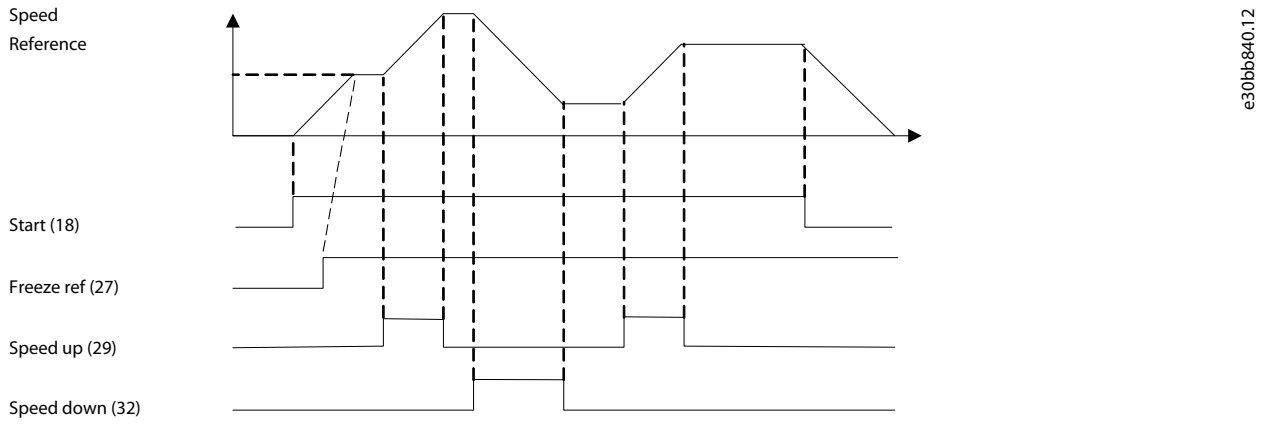


Illustration 11: Speed Up/Down

6.1.5 Wiring Configuration: Feedback

Table 13: Analog Current Feedback Transducer (2-wire)

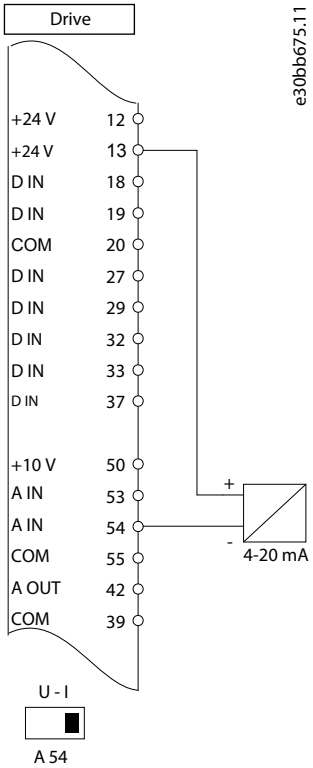
	Parameters	
	**Function**	**Setting**
	Parameter 6-22 Terminal 54 Low Current	4 mA*
	Parameter 6-23 Terminal 54 High Current	20 mA*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 14: Analog Voltage Feedback Transducer (3-wire)

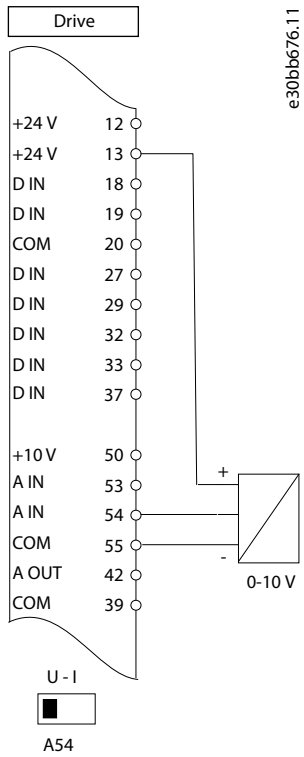
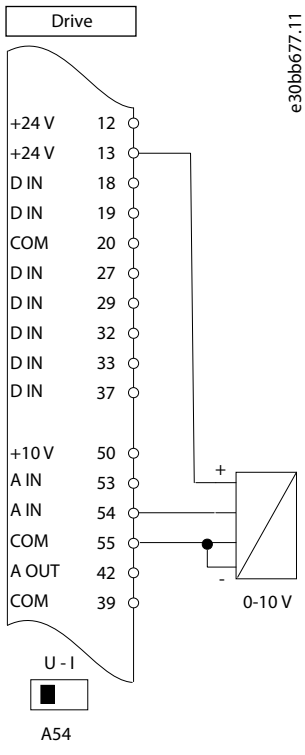
	Parameters	
	**Function**	**Setting**
	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
	Parameter 6-21 Terminal 54 High Voltage	10 V*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

Table 15: Analog Voltage Feedback Transducer (4-wire)

	Parameters	
	**Function**	**Setting**
	Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
	Parameter 6-21 Terminal 54 High Voltage	10 V*
	Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
	Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.6 Wiring Configuration: Run/Stop

Table 16: Run/Stop Command with External Interlock

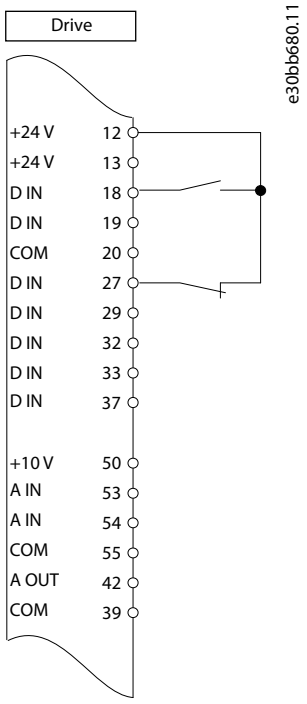
<table>
<tr><th></th><th colspan="2">Parameter</th></tr>
<tr><td rowspan="5"> 
</td><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 5-10 Terminal 18 Digital Input</td><td>[8] Start*</td></tr>
<tr><td>Parameter 5-12 Terminal 27 Digital Input</td><td>[7] External interlock</td></tr>
<tr><td colspan="2">*=Default value</td></tr>
<tr><td colspan="2">Notes/comments:
D IN 37 is an option.</td></tr>
</table>

Table 17: Run/Stop Command without External Interlock

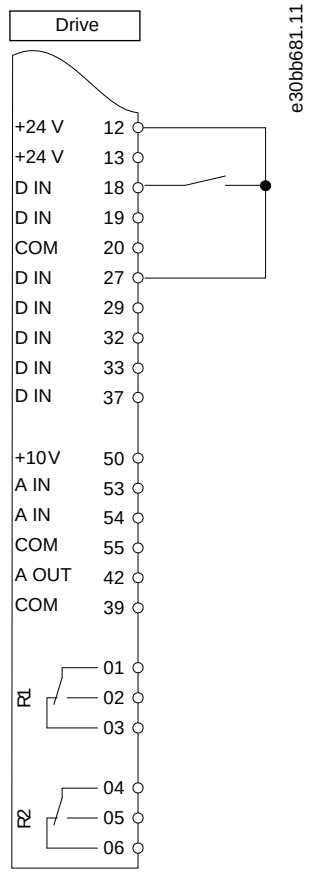
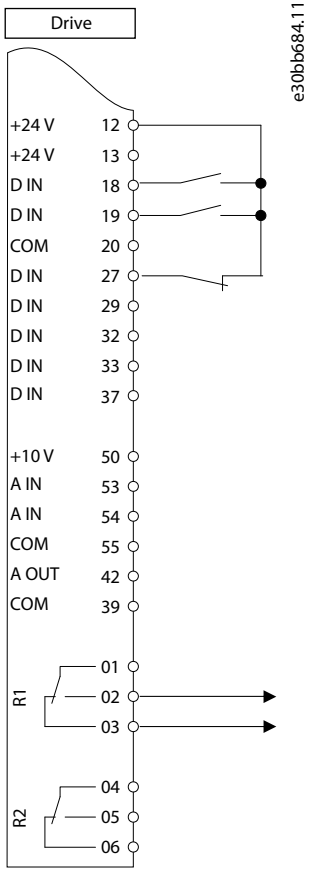
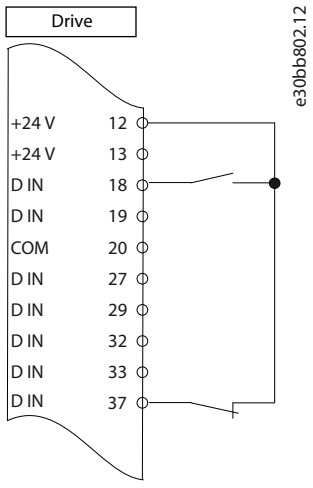
	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Inputs* is set to *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

Table 18: Run Permissive

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-11 Terminal 19 Digital Input	*[52] Run permissive*
	Parameter 5-12 Terminal 27 Digital Input	*[7] External interlock*
	Parameter 5-40 Function Relay	*[167] Start command act.*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.7 Wiring Configuration: Start/Stop

Table 19: Start/Stop Command with Safe Torque Off Option

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[Start]**
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-19 Terminal 37 Safe Stop	*[1] Safe Stop Alarm*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

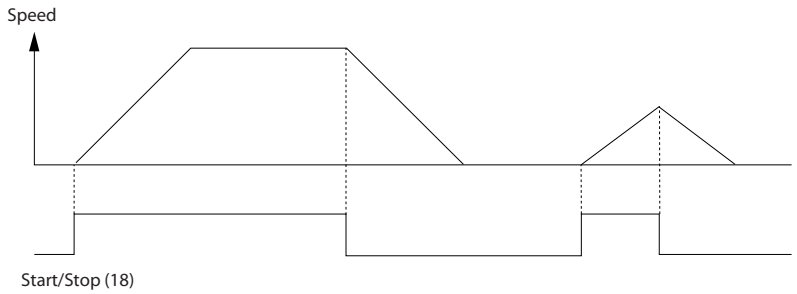
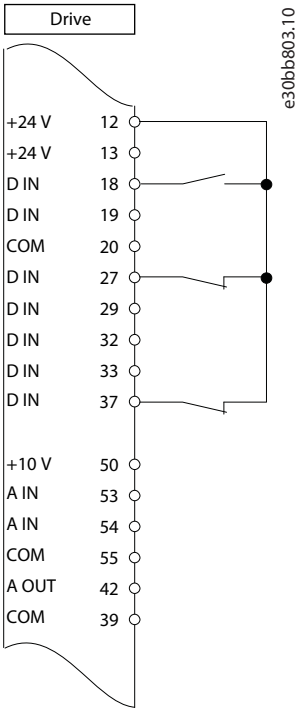


Illustration 12: Start/Stop Command with Safe Torque Off

Table 20: Pulse Start/Stop

	Parameter	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[9] Latched Start*
	Parameter 5-12 Terminal 27 Digital Input	*[6] Stop Inverse*
	*=Default value	
	Notes/comments: If *parameter 5-12 Terminal 27 Digital Input* is set *[0] No operation*, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

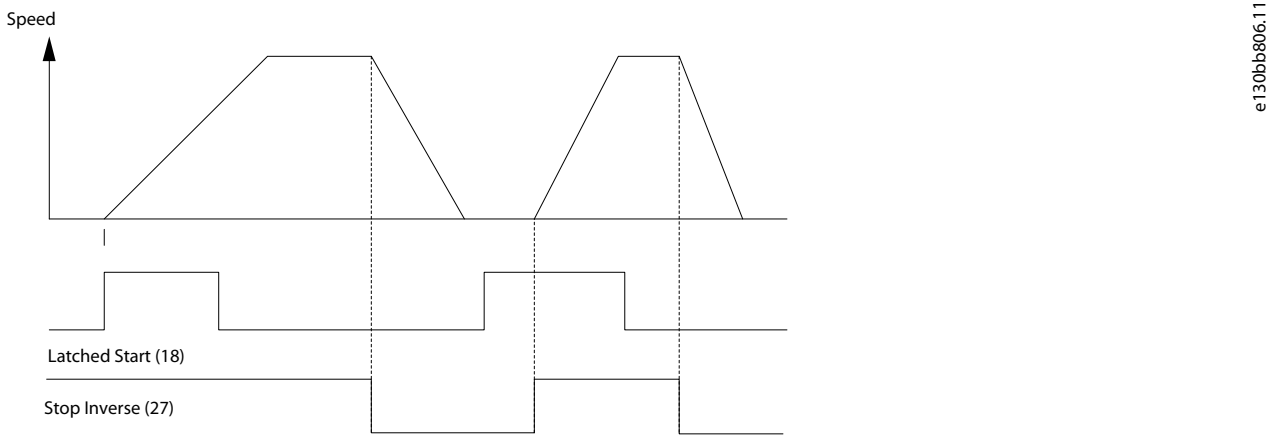
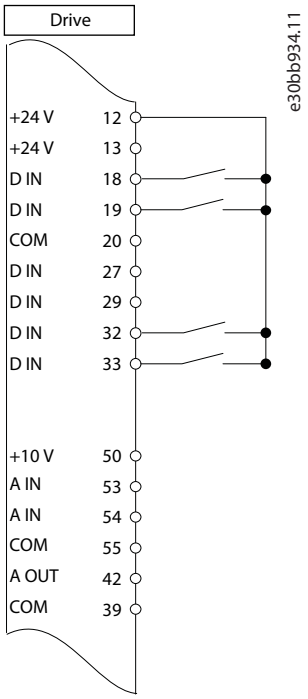


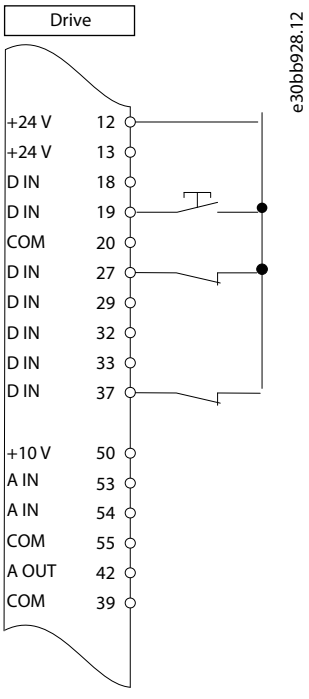
Illustration 13: Latched Start/Stop Inverse

Table 21: Start/Stop with Reversing and 4 Preset Speeds

	Parameters	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start*
	Parameter 5-11 Terminal 19 Digital Input	*[10] Reversing**
	Parameter 5-12 Terminal 27 Digital Input	*[0] No operation*
	Parameter 5-14 Terminal 32 Digital Input	*[16] Preset ref bit 0*
	Parameter 5-15 Terminal 33 Digital Input	*[17] Preset ref bit 1*
	Parameter 3-10 Preset Reference Preset ref. 0 Preset ref. 1 Preset ref. 2 Preset ref. 3	25% 50% 75% 100%
	*=Default value	
	Notes/comments: D IN 37 is an option.	

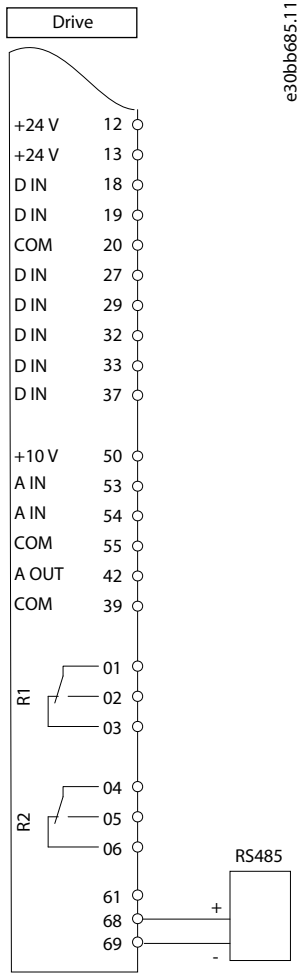
6.1.8 Wiring Configuration: External Alarm Reset

Table 22: External Alarm Reset

	Parameter	
	**Function**	**Setting**
	Parameter 5-11 Terminal 19 Digital Input	*[1] Reset*
	*=Default value	
	Notes/comments: D IN 37 is an option.	

6.1.9 Wiring Configuration: RS485

Table 23: RS485 Network Connection

<table>
<tr><th></th><th colspan="2">Parameter</th></tr>
<tr><td rowspan="6"> 
</td><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 8-30 Protocol</td><td>FC*</td></tr>
<tr><td>Parameter 8-31 Address</td><td>1*</td></tr>
<tr><td>Parameter 8-32 Baud Rate</td><td>9600*</td></tr>
<tr><td colspan="2">*=Default value</td></tr>
<tr><td colspan="2">Notes/comments:
Select protocol, address, and baud rate in the above-mentioned parameters.
D IN 37 is an option.</td></tr>
</table>

6.1.10 Wiring Configuration: Motor Thermistor

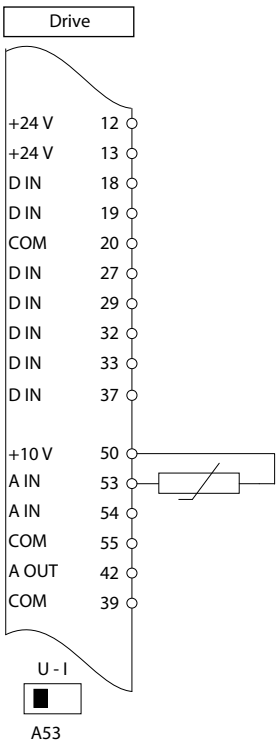
⚠ C A U T I O N ⚠

THERMISTOR INSULATION

Risk of personal injury or equipment damage.

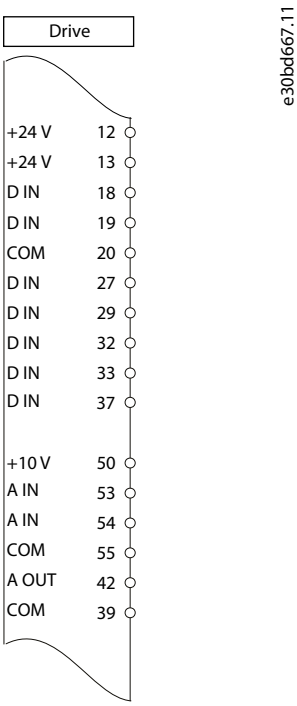
- To meet PELV insulation requirements, use only thermistors with reinforced or double insulation.

Table 24: Motor Thermistor

	Parameters	
	**Function**	**Setting**
	Parameter 1-90 Motor Thermal Protection	*[2] Thermistor trip*
	Parameter 1-93 Thermistor Source	*[1] Analog input 53*
	* = Default value	
	If only a warning is required, set *parameter 1-90 Motor Thermal Protection* to *[1] Thermistor warning*. D IN 37 is an option.	

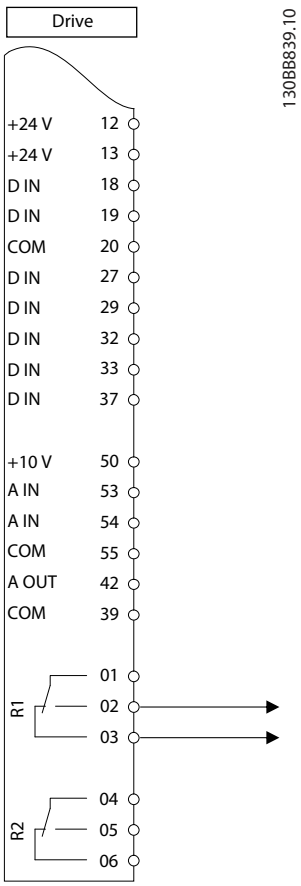
6.1.11 Wiring for Regen

Table 25: Regen

	Parameters	
	**Function**	**Setting**
	Parameter 1-90 Motor Thermal Protection	100%*
	* = Default value	
	To disable regen, decrease *parameter 1-90 Motor Thermal Protection* to 0%. If the application uses motor brake power and regen is not enabled, the unit trips.	

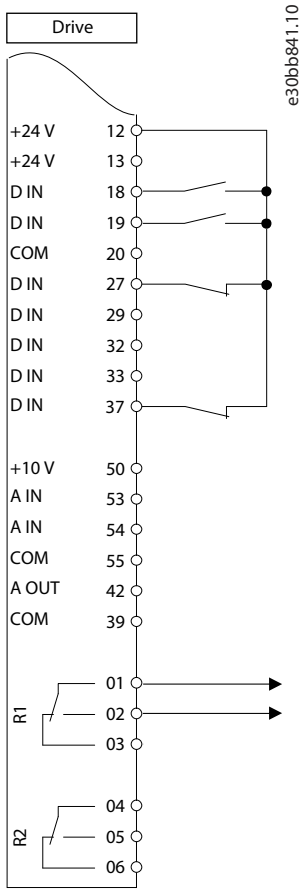
6.1.12 Wiring Configuration for a Relay Setup with Smart Logic Control

Table 26: Wiring Configuration for a Relay Setup with Smart Logic Control

<table>
<tr><td rowspan="18"> 
</td><td colspan="2">Parameters</td></tr>
<tr><td>Function</td><td>Setting</td></tr>
<tr><td>Parameter 4-30 Motor Feedback Loss Function</td><td>[1] Warning</td></tr>
<tr><td>Parameter 4-31 Motor Feedback Speed Error</td><td>100 RPM</td></tr>
<tr><td>Parameter 4-32 Motor Feedback Loss Timeout</td><td>5 s</td></tr>
<tr><td>Parameter 7-00 Speed PID Feedback Source</td><td>[2] MCB 102</td></tr>
<tr><td>Parameter 17-11 Resolution (PPR)</td><td>1024*</td></tr>
<tr><td>Parameter 13-00 SL Controller Mode</td><td>[1] On</td></tr>
<tr><td>Parameter 13-01 Start Event</td><td>[19] Warning</td></tr>
<tr><td>Parameter 13-02 Stop Event</td><td>[44] Reset key</td></tr>
<tr><td>Parameter 13-10 Comparator Operand</td><td>[21] Warning no.</td></tr>
<tr><td>Parameter 13-11 Comparator Operator</td><td>[1] ≈ (equal)*</td></tr>
<tr><td>Parameter 13-12 Comparator Value</td><td>90</td></tr>
<tr><td>Parameter 13-51 SL Controller Event</td><td>[22] Comparator 0</td></tr>
<tr><td>Parameter 13-52 SL Controller Action</td><td>[32] Set digital out A low</td></tr>
<tr><td>Parameter 5-40 Function Relay</td><td>[80] SL digital output A</td></tr>
<tr><td colspan="2">*=Default value</td></tr>
<tr><td colspan="2">Notes/comments:
If the limit in the feedback monitor is exceeded, warning 90, Feedback Mon. is issued. The SLC monitors warning 90, Feedback Mon. and if the warning becomes true, relay 1 is triggered. External equipment may require service. If the feedback error goes below the limit again within 5 s, the drive continues and the warning disappears. Reset relay 1 by pressing [Reset] on the LCP.</td></tr>
</table>

6.1.13 Wiring Configuration: Mechanical Brake Control

Table 27: Mechanical Brake Control

	Parameters	
	**Function**	**Setting**
	Parameter 5-10 Terminal 18 Digital Input	*[8] Start**
	Parameter 5-11 Terminal 19 Digital Input	*[11] Start reversing*
	Parameter 1-71 Start Delay	0.2
	Parameter 1-72 Start Function	*[5] VVC+/ FLUX Clockwise*
	Parameter 1-76 Start Current	$I_{m,n}$
	Parameter 2-20 Release Brake Current	Application dependent
	Parameter 2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
	* = Default value	
	–	

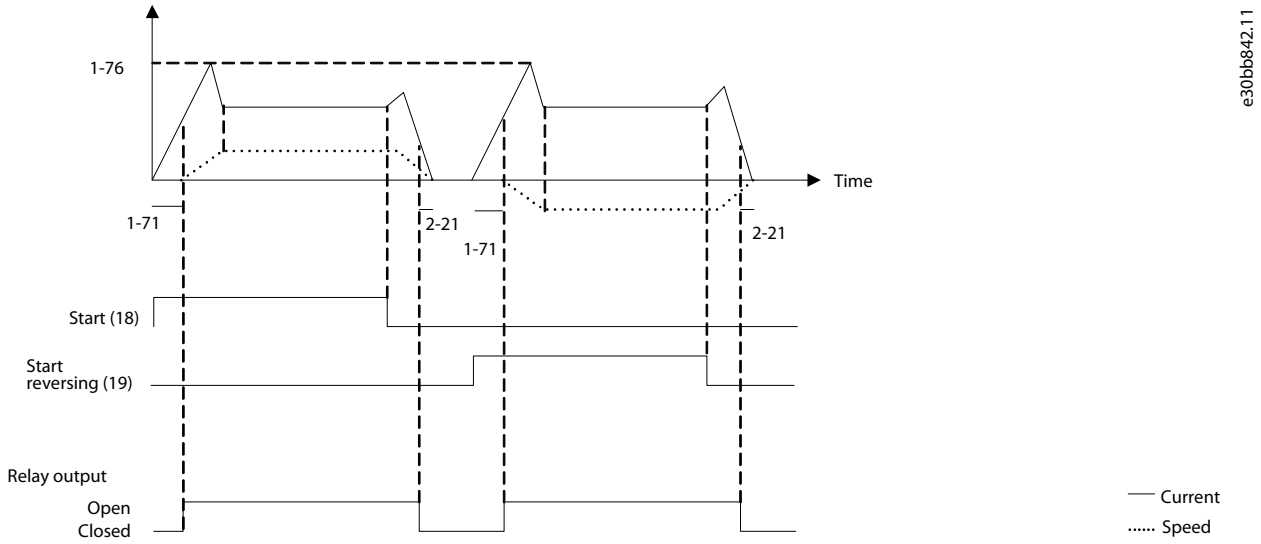


Illustration 14: Mechanical Brake Control

6.1.14 Wiring Configuration for the Encoder

The direction of the encoder, identified by looking into the shaft end, is determined by which order the pulses enter the drive.

- Clockwise (CW) direction means channel A is 90 electrical degrees before channel B.
- Counterclockwise (CCW) direction means channel B is 90 electrical degrees before A.

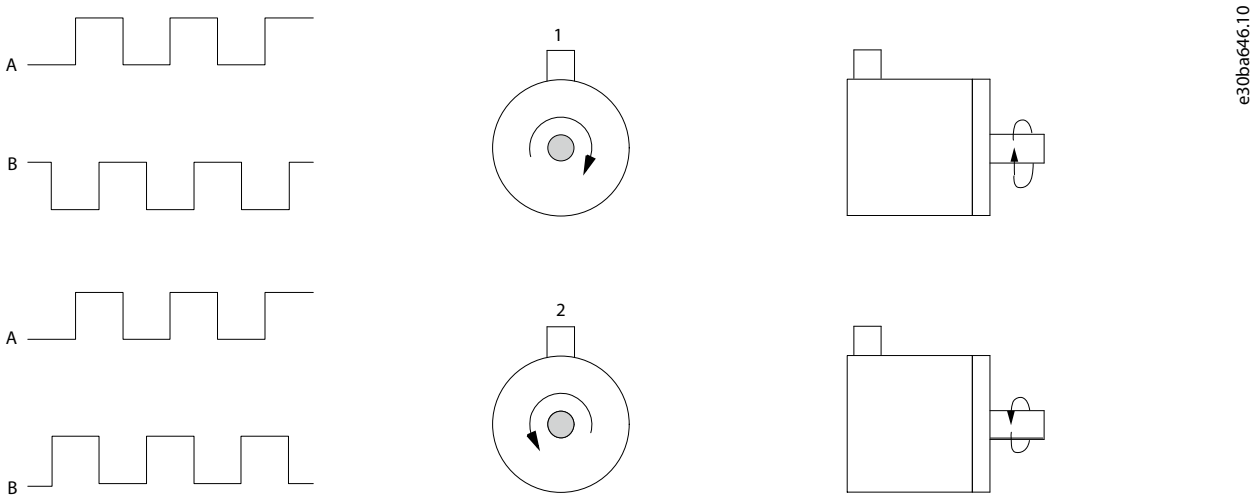


Illustration 15: Determining Encoder Direction

N O T I C E
Maximum cable length is 5 m (16 ft.)

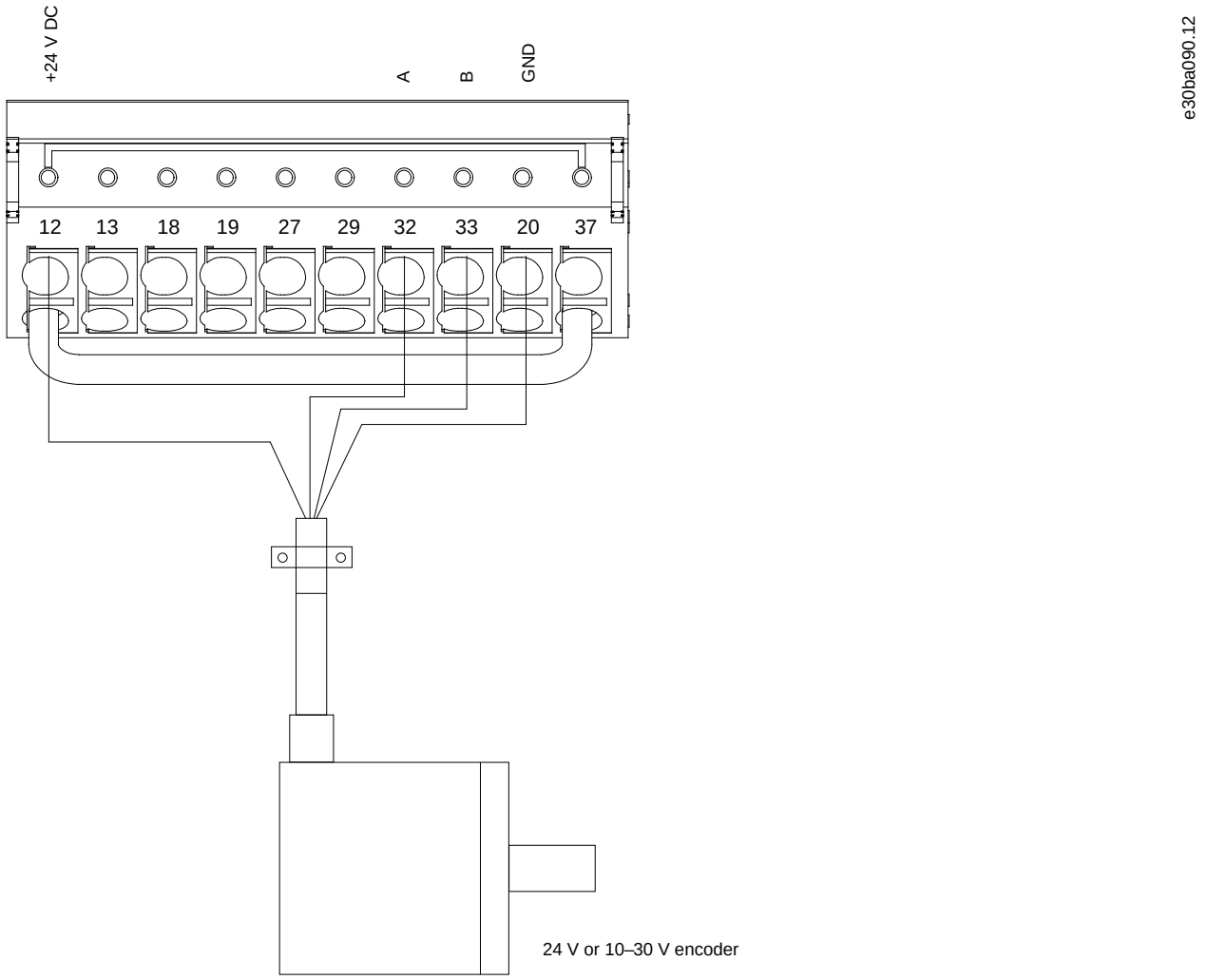


Illustration 16: Wire Configuration for the Encoder

6.1.15 Wiring Configuration for Torque and Stop Limit

In applications with an external electro-mechanical brake, such as hoisting applications, it is possible to stop the drive via a standard stop command and simultaneously activate the external electro-mechanical brake. Programming of these drive connections is shown in Illustration 17.

If a stop command is active via terminal 18 and the drive is not at the torque limit, the motor ramps down to 0 Hz. If the drive is at the torque limit and a stop command is activated, the system activates terminal 29 output (programmed to *[27] Torque limit & stop*). The signal to terminal 27 changes from logic 1 to logic 0 and the motor starts to coast. This process ensures that the hoist stops even if the drive itself cannot handle the required torque, for example due to excessive overload.

To program the stop and torque limit, connect to the following terminals:

- Start/stop via terminal 18 (*Parameter 5-10 Terminal 18 Digital Input [8] Start*).
- Quick stop via terminal 27 (*Parameter 5-12 Terminal 27 Digital Input [2] Coasting Stop, Inverse*).
- Terminal 29 output (*Parameter 5-02 Terminal 29 Mode [1] Terminal 29 Mode Output* and *parameter 5-31 Terminal 29 Digital Output [27] Torque limit & stop*).
- Relay output [0] (Relay 1) (*Parameter 5-40 Function Relay [32] Mechanical Brake Control*).

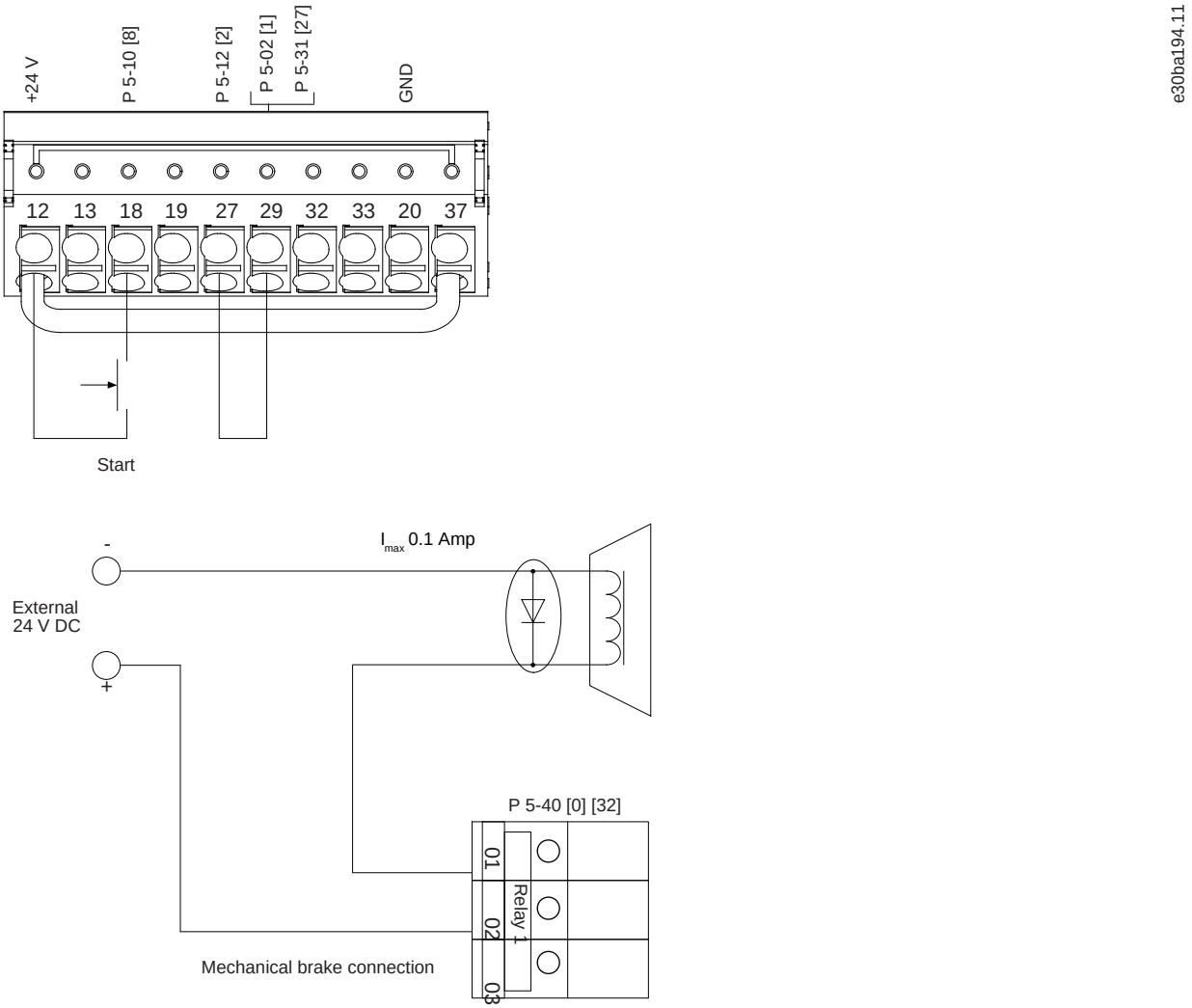


Illustration 17: Wire Configuration for Torque and Stop Limit

7 Maintenance, Diagnostics, and Troubleshooting

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the drive for loose terminal connections, excessive dust buildup, and so on, at regular intervals. Replace worn or damaged parts with authorized parts.

⚠ WARNING ⚠

UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment, or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, or after a cleared fault condition.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment is in operational readiness.

7.2 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 drive issuing an alarm. A warning clears by itself when the abnormal condition ceases.

Alarms

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

Trip

An alarm is issued when the drive is tripped, meaning that the drive suspends operation to prevent damage to the drive or system. The motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive can be reset. It is then ready to start operation again.

Trip lock

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

Resetting the drive after a 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.

7.3 Warning and Alarm Displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

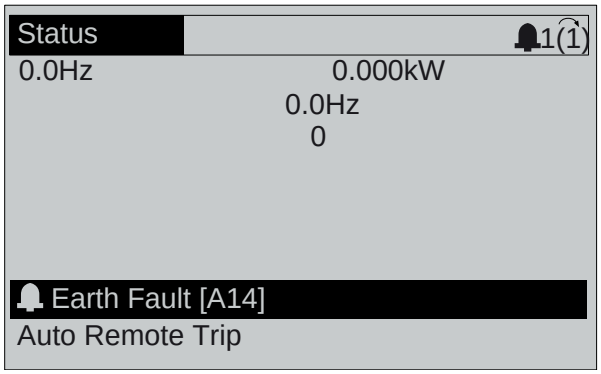


Illustration 18: Alarm Example

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

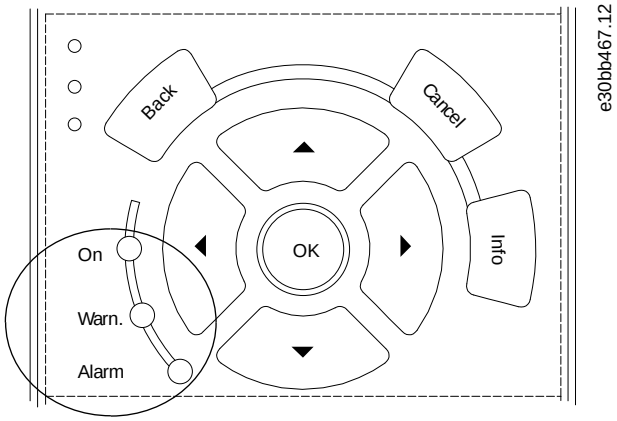


Illustration 19: Status Indicator Lights

	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

7.4 Descriptions of Warnings and Alarms

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

7.4.1 WARNING 1, 10 Volts Low

Cause

The control card voltage is less than 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.

7.4.2 WARNING/ALARM 2, Live Zero Error

Cause

This warning or alarm only appears if programmed in *parameter 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 connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

7.4.3 WARNING/ALARM 3, No Motor

Cause

No motor is connected to the output of the drive.

7.4.4 WARNING/ALARM 4, Mains Phase Loss

Cause

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. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

Troubleshooting

- Check the supply voltage and supply currents to the drive.

7.4.5 WARNING 5, DC Link Voltage High

Cause

The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

7.4.6 WARNING 6, DC Link Voltage Low

Cause

The DC-link voltage (DC) is lower than the low voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

7.4.7 WARNING/ALARM 7, DC Overvoltage

Cause

If the DC-link voltage exceeds the limit, the drive trips after a certain time.

Troubleshooting

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

7.4.8 WARNING/ALARM 8, DC Undervoltage

Cause

If the DC-link voltage drops below the undervoltage limit, the drive checks for 24 V DC back-up supply. If no 24 V DC back-up supply is connected, the drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

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

7.4.9 WARNING/ALARM 9, Inverter Overload

Cause

The drive 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% with an alarm. The drive cannot be reset until the counter is below 90%.

Troubleshooting

- Compare the output current shown on the LCP with the drive rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Show the thermal drive load on the LCP and monitor the value. When running above the drive continuous current rating, the counter increases. When running below the drive continuos current rating, the counter decreases.

7.4.10 WARNING/ALARM 10, Motor Overload Temperature

Cause

According to the electronic thermal protection (ETR), the motor is too hot.

Select 1 of these options:

- The drive issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The drive trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options.

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 *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20* to *1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the drive to the motor more accurately and reduces thermal loading.

7.4.11 WARNING/ALARM 11, Motor Thermistor Overtemp

Cause

The motor thermistor indicates that the motor temperature is too high.

Troubleshooting

- Check for motor overheating.
- Check that the thermistor is securely connected.
- 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 and 54 is set for voltage. Check that *parameter 1-93 Thermistor Resource* selects 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 *parameter 1-93 Thermistor Resource*.

7.4.12 WARNING/ALARM 12, Torque Limit

Cause

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 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 time, 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.

7.4.13 WARNING/ALARM 13, Overcurrent

Cause

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the drive 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 power and check if the motor shaft can be turned.
- Check that the motor size matches the drive.
- Check that the motor data is correct in *parameters 1-20* to *1-25*.

7.4.14 ALARM 14, Earth (Ground) Fault

Cause

There is current from the output phase to ground, either in the cable between the drive and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

Troubleshooting

- Remove power to the drive 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.
- Reset any potential individual offset in the 3 current transducers in the drive. Perform a manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

7.4.15 ALARM 15, Hardware Mismatch

Cause

A fitted option is not operational with the present control card hardware or software.

Troubleshooting

Record the value of the following parameters and contact the supplier.

- *Parameter 15-40 FC Type*.
- *Parameter 15-41 Power Section*.
- *Parameter 15-42 Voltage*.
- *Parameter 15-43 Software Version*.
- *Parameter 15-45 Actual Typecode String*.
- *Parameter 15-49 SW ID Control Card*.
- *Parameter 15-50 SW ID Power Card*.
- *Parameter 15-60 Option Mounted*.
- *Parameter 15-61 Option SW Version* (for each option slot).

7.4.16 ALARM 16, Short Circuit

Cause

There is short-circuiting in the motor or motor wiring.

Troubleshooting

⚠ W A R N I N G

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

– Only skilled personnel must perform installation, start-up, and maintenance.

- Disconnect power before proceeding.
- Remove the power to the drive and repair the short circuit.

7.4.17 WARNING/ALARM 17, Control Word Timeout

Cause

There is no communication to the drive. The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to *[0] Off*.

If *parameter 8-04 Control Word Timeout Function* is set to *[5] Stop and trip*, a warning appears, and the drive ramps down to a stop and shows an alarm.

Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.
- Verify that proper EMC installation was performed.

7.4.18 WARNING/ALARM 20, Temp. Input Error

Cause

The temperature sensor is not connected.

7.4.19 WARNING/ALARM 21, Parameter Error

Cause

The parameter is out of range. The parameter number is shown in the display.

Troubleshooting

- Set the affected parameter to a valid value.

7.4.20 WARNING/ALARM 22, Hoist Mechanical Brake

Cause

The value of this warning/alarm shows the type of warning/alarm.

0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Up Time*).

1 = Expected brake feedback was not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

7.4.21 WARNING 23, Internal Fan Fault

Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

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

Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the control card.

7.4.22 WARNING 24, External Fan Fault

Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* (*[0] Disabled*).

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

Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink.

7.4.23 WARNING 25, Brake Resistor Short Circuit

Cause

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

Troubleshooting

- Remove the power to the drive and replace the brake resistor (refer to *parameter 2-15 Brake Check*).

7.4.24 WARNING/ALARM 26, Brake Resistor Power Limit

Cause

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 *parameter 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 *parameter 2-13 Brake Power Monitoring*, the drive trips when the dissipated braking power reaches 100%.

7.4.25 WARNING/ALARM 27, Brake Chopper Fault

Cause

The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The drive 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 the power to the drive and remove the brake resistor.

7.4.26 WARNING/ALARM 28, Brake Check Failed

Cause

The brake resistor is not connected or not working.

Troubleshooting

- Check *parameter 2-15 Brake Check*.

7.4.27 ALARM 29, Heat Sink Temp

Cause

The maximum temperature of the heat sink is exceeded. The temperature fault is not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the drive power size.

Troubleshooting

Check for the following conditions:

- The ambient temperature is too high.
- The motor cables are too long.
- Incorrect airflow clearance above and below the drive.
- Blocked airflow around the drive.
- Damaged heat sink fan.
- Dirty heat sink.

7.4.28 ALARM 30, Motor Phase U Missing

Cause

Motor phase U between the drive and the motor is missing.

Troubleshooting

⚠ W A R N I N G

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

– Only skilled personnel must perform installation, start-up, and maintenance.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase U.

7.4.29 ALARM 31, Motor Phase V Missing

Cause

Motor phase V between the drive and the motor is missing.

Troubleshooting

⚠ WARNING

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

– Only skilled personnel must perform installation, start-up, and maintenance.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase V.

7.4.30 ALARM 32, Motor Phase W Missing

Cause

Motor phase W between the drive and the motor is missing.

Troubleshooting

⚠ WARNING

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

– Only skilled personnel must perform installation, start-up, and maintenance.

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase W.

7.4.31 ALARM 33, Inrush Fault

Cause

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

Troubleshooting

- Let the unit cool to operating temperature.
- Check potential DC-link fault to ground.

7.4.32 WARNING/ALARM 34, Fieldbus Communication Fault

Cause

The fieldbus on the communication option card is not working.

7.4.33 WARNING/ALARM 35, Option Fault

Cause

An option alarm is received. The alarm is option-specific. The most likely cause is a power-up or a communication fault.

7.4.34 WARNING/ALARM 36, Mains Failure

Cause

This warning/alarm is only active if the supply voltage to the drive is lost and *parameter 14-10 Mains Failure* is not set to *[0] No Function*.

Troubleshooting

- Check the fuses to the drive and mains supply to the unit.

7.4.35 ALARM 37, Phase Imbalance

Cause

There is a current imbalance between the power units.

7.4.36 ALARM 38, Internal Fault

Cause

When an internal fault occurs, a code number defined in Table 28 is shown.

Troubleshooting

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

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

Table 28: Internal Fault Codes

Number	Text
0	The serial port cannot be initialized. Contact the supplier or service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the supplier or service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the supplier or service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
1379–2819	Internal fault. Contact the supplier or service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive also uses this fault code if the MCO does not power up correctly. This situation can occur due to poor EMC protection or improper grounding.
1796	RAM copy error.
2561	Replace the 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 the control board hardware.

Number	Text
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376– 6231	Internal fault. Contact the supplier or service department.

7.4.37 ALARM 39, Heat Sink Sensor

Cause

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 gate-drive card, or on the ribboncable between the power card and the gatedrive card.

7.4.38 WARNING 40, Overload of Digital Output Terminal 27

Troubleshooting

- Check the load connected to terminal 27 or remove the short-circuit connection.
- Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

7.4.39 WARNING 41, Overload of Digital Output Terminal 29

Troubleshooting

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

7.4.40 WARNING 42, Ovrld X30/6-7

Troubleshooting

For terminal X30/6:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-32 Term X30/6 Digi out (MCB 101)* (General Purpose I/O MCB 101).

For terminal X30/7:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)* (General Purpose I/O MCB 101).

7.4.41 ALARM 43, Ext. Supply

Cause

Extended Relay Option MCB 113 is mounted without 24 V DC.

Troubleshooting

Choose 1 of the following:

- Connect a 24 V DC external supply.
- Specify that no external supply is used via *parameter 14-80 Option Supplied by External 24 V DC*, *[0] No*. A change in *parameter 14-80 Option Supplied by External 24 V DC* requires a power cycle.

7.4.42 ALARM 45, Earth Fault 2

Cause

Ground fault.

Troubleshooting

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

7.4.43 ALARM 46, Power Card Supply

Cause

The supply on the power card is out of range. Another reason can be a defective heat sink fan.

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 Supply MCB 107, only 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.
- Check for a defective heat sink fan.

7.4.44 WARNING 47, 24 V Supply Low

Cause

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.

7.4.45 WARNING 48, 1.8 V Supply Low

Cause

The 1.8 V DC supply used on the control card is outside of the allowed limits. The supply is measured on the control card.

Troubleshooting

- Check for a defective control card.
- If an option card is present, check for overvoltage.

7.4.46 WARNING 49, Speed Limit

Cause

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

7.4.47 ALARM 50, AMA Calibration Failed

Cause

A calibration error has occurred.

Troubleshooting

- Contact the supplier or service department.

7.4.48 ALARM 51, AMA Check Unom and Inom

Cause

The settings for motor voltage, motor current, and motor power are wrong.

Troubleshooting

- Check settings in *parameters 1-20* to *1-25*.

7.4.49 ALARM 52, AMA Low Inom

Cause

The motor current is too low.

Troubleshooting

- Check the settings in *parameter 1-24 Motor Current*.

7.4.50 ALARM 53, AMA Motor Too Big

Cause

The motor is too big for the AMA to operate.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.4.51 ALARM 54, AMA Motor Too Small

Cause

The motor is too small for the AMA to operate.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.4.52 ALARM 55, AMA Parameter Out of Range

Cause

The AMA cannot run because the paramenter values of the motor are out of the acceptable range.

Troubleshooting

- Check the settings in *parameter group 1-2* Motor Data*.

7.4.53 ALARM 56, AMA Interrupted by User

Cause

The AMA is manually interrupted.

Troubleshooting

- Re-run th AMA calibration.

7.4.54 ALARM 57, AMA Internal Fault

Troubleshooting

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

7.4.55 ALARM 58, AMA Internal Fault

Troubleshooting

Contact the supplier.

7.4.56 WARNING 59, Current Limit

Cause

The current is higher than the value in *parameter 4-18 Current Limit*.

Troubleshooting

- Ensure that the motor data in *parameters 1-20* to *1-25* is set correctly.
- Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

7.4.57 WARNING 60, External Interlock

Cause

A digital input signal indicates a fault condition external to the drive. An external interlock has commanded the drive to trip.

Troubleshooting

- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the drive.

7.4.58 WARNING/ALARM 61, Feedback Error

Cause

An error between calculated speed and speed measurement from feedback device.

Troubleshooting

- Check the settings for warning/alarm/disabling in *parameter 4-30 Motor Feedback Loss Function*.
- Set the tolerable error in *parameter 4-31 Motor Feedback Speed Error*.
- Set the tolerable feedback loss time in *parameter 4-32 Motor Feedback Loss Timeout.*

7.4.59 WARNING 62, Output Frequency at Maximum Limit

Cause

The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*.

Troubleshooting

- Check the application for possible causes.
- 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.

7.4.60 ALARM 63, Mechanical Brake Low

Cause

The actual motor current has not exceeded the release brake current within the start delay time window.

7.4.61 WARNING 64, Voltage Limit

Cause

The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

7.4.62 WARNING/ALARM 65, Control Card Overtemperature

Cause

The cutout temperature of the control card has exceeded the upper limit.

Troubleshooting

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

7.4.63 WARNING 66, Heat Sink Temperature Low

Cause

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

Troubleshooting

- Increase the ambient temperature of the unit.
- Supply a trickle amount of current to the drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* to 5% and *parameter 1-80 Function at Stop*.

7.4.64 ALARM 67, Option Module Configuration has Changed

Cause

One or more options have either been added or removed since the last power-down.

Troubleshooting

- Check that the configuration change is intentional and reset the unit.

7.4.65 ALARM 68, Safe Stop Activated

Cause

Safe Torque Off (STO) has been activated.

Troubleshooting

- To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital, or by pressing [Reset]).

7.4.66 ALARM 69, Power Card Temperature

Cause

The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

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

7.4.67 ALARM 70, Illegal FC Configuration

Cause

The control card and power card are incompatible.

Troubleshooting

- To check compatibility, contact the supplier with the type code from the unit nameplate and the part numbers on the cards.

7.4.68 ALARM 71, PTC 1 Safe Stop

Cause

Because the motor is too warm, the PTC Thermistor Card MCB 112 activated the Safe Torque Off (STO).

Troubleshooting

- Once the motor temperature reaches an acceptable level and the digital input from MCB 112 is deactivated, perform 1 of the following:
  - Send a reset signal via bus or digital I/O.
  - Press [Reset].

7.4.69 ALARM 72, Dangerous Failure

Cause

Safe Torque Off (STO) with trip lock.

Troubleshooting

An unexpected combination of STO commands has occurred:

- PTC Thermistor Card MCB 112 enables X44/10, but STO is not enabled.
- MCB 112 is the only device using STO (specified through selection *[4] PTC 1 alarm* or *[5] PTC 12 warning* in *parameter 5-19 Terminal 37 Safe Stop*). STO is activated, but X44/10 is not activated.

7.4.70 WARNING 73, Safe Stop Auto Restart

Cause

STO activated.

Troubleshooting

- With automatic restart enabled, the motor can start when the fault is cleared.

7.4.71 ALARM 74, PTC Thermistor

Cause

The PTC is not working. Alarm is related to PTC Thermistor Card MCB 112.

7.4.72 ALARM 75, Illegal Profile Sel.

Cause

There was an attempt to write the parameter value while the motor was running.

Troubleshooting

- Stop the motor before writing the MCO profile to *parameter 8-10 Control Word Profile*.

7.4.73 WARNING 77, Reduced Power Mode

Cause

The drive is operating in reduced power mode (less than allowed number of inverter sections). The warning is generated on power cycle when the drive is set to run with fewer inverters and remains on.

7.4.74 ALARM 78, Tracking Error

Cause

The difference between setpoint value and actual value exceeds the value in *parameter 4-35 Tracking Error*.

Troubleshooting

- Disable the function or select an alarm/warning in *parameter 4-34 Tracking Error Function*.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to drive.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

7.4.75 ALARM 79, Illegal Power Section Configuration

Cause

The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

7.4.76 ALARM 80, Drive Initialized to Default Value

Cause

Parameter settings are initialized to default settings after a manual reset.

Troubleshooting

To clear the alarm, reset the unit.

7.4.77 ALARM 81, CSIV Corrupt

Cause

The CSIV file has syntax errors.

7.4.78 ALARM 82, CSIV Parameter Error

Cause

CSIV failed to initialize a parameter.

7.4.79 ALARM 83, Illegal Option Combination

Cause

The mounted options are incompatible.

7.4.80 ALARM 84, No Safety Option

Cause

The safety option was removed without applying a general reset.

Troubleshooting

Reconnect the safety option.

7.4.81 ALARM 88, Option Detection

Cause

A change in the option layout is detected. *Parameter 14-89 Option Detection* is set to *[0] Frozen configuration* and the option layout has been changed.

Troubleshooting

- To apply the change, enable option layout changes in *parameter 14-89 Option Detection*.
- Alternatively, restore the correct option configuration.

7.4.82 WARNING 89, Mechanical Brake Sliding

Cause

The hoist brake monitor detects a motor speed exceeding 10 RPM.

7.4.83 ALARM 90, Feedback Monitor

Troubleshooting

- Check the connection to the encoder/resolver option and, if necessary, replace the Encoder Input MCB 102 or Resolver Input MCB 103.

7.4.84 ALARM 91, Analog Input 54 Wrong Settings

Troubleshooting

- Set switch S202 in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

7.4.85 ALARM 99, Locked Rotor

Cause

The rotor is blocked.

Troubleshooting

- Check if the motor shaft is locked.
- Check if the start current triggers the current limit set in *parameter 4-18 Current Limit*.
- Check if it increases the value in *parameter 30-23 Locked Rotor Detection Time [s]*.

7.4.86 WARNING/ALARM 104, Mixing Fan Fault

Cause

The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing fan fault can be configured as a warning or an alarm in *parameter 14-53 Fan Monitor*.

Troubleshooting

- Cycle power to the drive to determine if the warning/alarm returns.

7.4.87 WARNING/ALARM 122, Mot. Rotat. Unexp.

Cause

The drive performs a function that requires the motor to be at standstill, for example DC hold for PM motors.

7.4.88 WARNING 163, ATEX ETR Cur.Lim.Warning

Cause

The drive has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 85% of the allowed thermal overload.

7.4.89 ALARM 164, ATEX ETR Cur.Lim.Alarm

Cause

Running above the characteristic curve for more than 60 s within a period of 600 s activates the alarm, and the drive trips.

7.4.90 WARNING 165, ATEX ETR Freq.Lim.Warning

Cause

The drive has run for more than 50 s below the allowed minimum frequency (*parameter 1-98 ATEX ETR Interpol. Points Freq.*).

7.4.91 ALARM 166, ATEX ETR Freq.Lim.Alarm

Cause

The drive has run for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR Interpol. Points. Freq.*).

7.4.92 WARNING 250, New Spare Part

Cause

A component in the drive system has been replaced.

Troubleshooting

- Reset the drive system to restore normal operation.

7.4.93 WARNING 251, New Typecode

Cause

The power card or other components have been replaced, and the typecode has changed.

8 Specifications

8.1 Electrical Data

8.1.1 Mains Supply 200–240 V

Table 29: Mains Supply 200–240 V, PK25–P3K7

Type designation	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical shaft output [kW/(hp)], high overload	0.25 (0.34)	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	3.7 (5.0)
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current									
Continuous (200–240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7
Intermittent (200–240 V) [A]	2.9	3.8	5.6	7.4	10.6	12	17	20	26.7
Continuous kVA (208 V) [kVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.0
Maximum input current									
Continuous (200–240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15
Intermittent (200–240 V) [A]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24
Additional specifications									
Estimated power loss at rated maximum load [W][1]	21	29	42	54	63	82	116	155	185
Efficiency[2]	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96

[1] Applies for dimensioning of drive 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. For power loss data according to EN 50598-2.

[2] Efficiency measured at nominal current. For energy efficiency class, see 8.4 Ambient Conditions.

Table 30: Mains Supply 200–240 V, P5K5–P11K

Type designation	P5K5		P7K5		P11K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	5.5 (7.5)	7.5 (10)	7.5 (10)	11 (15)	11 (15)	15 (20)
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2	
Output current						
Continuous (200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (60 s overload) (200–240 V [A]	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA (208 V) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4
Maximum input current						

Type designation	P5K5		P7K5		P11K	
Continuous (200–240 V) [A]	22	28	28	42	42	54
Intermittent (60 s overload) (200–240 V [A]	35.2	30.8	44.8	46.2	67.2	59.4
Additional specifications						
Estimated power loss at rated maximum load [W] [2]	239	310	371	514	463	602
Efficiency[3]	0.96		0.96		0.96	

[1] High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

[2] Applies for dimensioning of drive 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. For power loss data according to EN 50598-2.

[3] Efficiency measured at nominal current. For energy efficiency class, see 8.4 Ambient Conditions.

8.1.2 Mains Supply 380–500 V

Table 31: Mains Supply 380–500 V, PK37–P7K5

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)], high overload	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current high overload 160% for 1 minute										
Shaft output [kW/(hp)]	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Continuous (380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.6	7.2	10	13	16
Intermittent (380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	9.0	11.5	16	20.8	25.6
Continuous (441–500 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (441–500 V) [A]	1.9	2.6	3.4	4.3	5.4	7.7	10.1	13.1	17.6	23.2
Continuous kVA (400 V) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0	6.9	9.0	11
Continuous kVA (460 V) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Maximum input current										
Continuous (380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (380–440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4	14.4	18.7	23

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Continuous (441–500 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13
Intermittent (441–500 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1	11.8	15.8	20.8
Additional specifications										
Estimated power loss at rated maximum load [W][1]	35	42	46	58	62	88	116	124	187	255
Efficiency[2]	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97

[1] Applies for dimensioning of drive 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. For power loss data according to EN 50598-2.

[2] Efficiency measured at nominal current. For energy efficiency class, see 8.4 Ambient Conditions.

Table 32: Mains Supply 380–500 V, P11K–P22K

Type designation	P11K		P15K		P18K		P22K	
High/normal overload[1]	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2	
Output current								
Continuous (380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (441–500 V) [A]	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (441–500 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
Continuous kVA (400 V) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA (460 V) [kVA]	–	21.5	–	27.1	–	31.9	–	41.4
Maximum input current								
Continuous (380–440 V) [A]	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (441–500 V) [A]	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (441–500 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7

Type designation	P11K		P15K		P18K		P22K	
Additional specifications								
Estimated power loss at rated maximum load [W] (2)	291	392	379	465	444	525	547	739
Efficiency(3)	0.98		0.98		0.98		0.98	

[1] High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

[2] Applies for dimensioning of drive 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. For power loss data according to EN 50598-2.

[3] Efficiency measured at nominal current. For energy efficiency class, see 8.4 Ambient Conditions.

8.1.3 Mains Supply 525–600 V

Table 33: Mains Supply 525–600 V, PK75–P7K5

Type designation	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)]	0.75 (1)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3 (4.0)	4 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20, IP21	A3	A3	A3	A3	A3	A3	A3	A3
Enclosure protection rating IP55	A5	A5	A5	A5	A5	A5	A5	A5
Output current								
Continuous (525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5
Intermittent (525–550 V) [A]	2.9	4.2	4.6	6.6	8.3	10.2	15.2	18.4
Continuous (551–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11
Intermittent (551–600 V) [A]	2.7	3.8	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (525 V) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11
Continuous kVA (57 V) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11
Maximum input current								
Continuous (525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4
Intermittent (525–600 V) [A]	2.7	3.8	4.3	6.6	8.3	9.3	13.8	16.6
Additional specifications								
Estimated power loss at rated maximum load [W] (1)	35	50	65	92	122	145	195	261
Efficiency(2)	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

[1] Applies for dimensioning of drive 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. For power loss data according to EN 50598-2.

[2] Efficiency measured at nominal current. For energy efficiency class, see 8.4 Ambient Conditions.

8.1.4 Power Cable Cross-sections

Table 34: Maximum Cable Cross-section [mm² (AWG)]

Enclosure	Mains	Motor	Brake	Loadshare	Disconnect
A1	4(12)	4(12)	4(12)	4(12)	4(12)
A2	4(12)	4(12)	4(12)	4(12)	4(12)
A3	4(12)	4(12)	4(12)	4(12)	4(12)
A4	4(12)	4(12)	4(12)	4(12)	4(12)
A5	4(12)	4(12)	4(12)	4(12)	4(12)
B1	10(7)	10(7)	10(7)	10(7)	10(7)
B2	35(2)	35(2)	35(2)	35(2)	35(2)

8.2 Mains Supply

Supply terminals (6-pulse)	L1, L2, L3
Supply voltage[1][2]	200–240 V ±10%
Supply voltage[1][2]	380–500 V ±10%
Supply voltage[1][2]	525–600 V ±10%
Supply frequency	47.5–63 Hz
Maximum 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 the input supply L1, L2, L3 (power-ups) ≤7.5 kW (10 hp)	Maximum twice per minute
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW (15–101 hp)	Maximum once per minute
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

[1] Mains voltage low/mains dropout: During low mains voltage or a mains dropout, the drive continues until the DC-link voltage drops below the minimum stop level, which typically corresponds to 15% below the drive's lowest rated supply voltage. Power-up and full torque cannot be exptected at mains voltage lower than 10% below the drive's lowest rated supply voltage.

[2] The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/500/600 V maximum.

8.3 Motor Output and Motor Data

8.3.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz[1]
Output frequency in flux mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

[1] Dependent on voltage and power.

8.3.2 Torque Characteristics

Starting torque (constant torque)	Maximum 160% for 60 s[1] once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s[1] once in 10 minutes
Torque rise time in flux (for 5 KHz f_{sw})	1 ms

Torque rise time in VVC$^+$ (independent of f_{sw})	10 ms

[1] Percentage relates to the nominal torque

8.4 Ambient Conditions

Enclosure	IP20 (Chassis), IP21 (Type 1), IP54 (Type 12)
Vibration test (standard/ruggedized)	0.7 g/1.0 g
Relative humidty	5%-95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Aggressive gases (IEC 60721-3-3)	Class 3C3
Test method according to IEC 60068-2-43	H2S (10 days)
Ambient temperature (at SFAVM switching mode)	
- with derating	Maximum 55° C (131° F)
- with full output power of typical EFF2 motors (up to 90% output current)	Maximum 50° C (122° F)
- at full continuous FC output current	Maximum 45° C (113° F)
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced speed performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65/70 °C (-13 to +149/158 °F)
Maximum altitude above sea level without derating	1000 m (3280 ft)
Maximum altitude above sea level with derating	3000 m (9842 ft)
EMC standards, Emission	IEC/EN 61800-3
EMC standards, Immunity	IEC/EN 61800-3
Energy efficiency class	IE2[1]

[1] Determined according to IEC 61800-9-2 (EN 50598-2) at:

- Rated load.
- 90% rated frequency.
- Switching frequency factory setting.
- Switching pattern factory setting.

8.5 Cable Specifications

8.5.1 Cable Lengths and Cross-sections for Control Cables

Maximum motor cable length, shielded	150 m (492 ft)
Maximum motor cable length, unshielded	300 m (984 ft)
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

For power cables, see the tables in 8.1.1 Mains Supply 200–240 V, 8.1.2 Mains Supply 380–500 V, and 8.1.3 Mains Supply 525–600 V.
For power cables cross-sections, see 8.1.4 Power Cable Cross-sections.

8.6 Control Input/Output and Control Data

8.6.1 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) minimum pulse width	4.5 ms
Input resistance, R_i	Approximately 4 kΩ

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

[2] Except STO input terminal 37.

8.6.2 STO Terminal 37 (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.

See 4.7.1 Safe Torque Off (STO) for further information about terminal 37 and Safe Torque Off.

When using a contactor with a DC coil inside in combination with STO, it is important to make a return way for the current from the coil when turning it off. This can be done 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.

8.6.3 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 (scaleable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)

Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

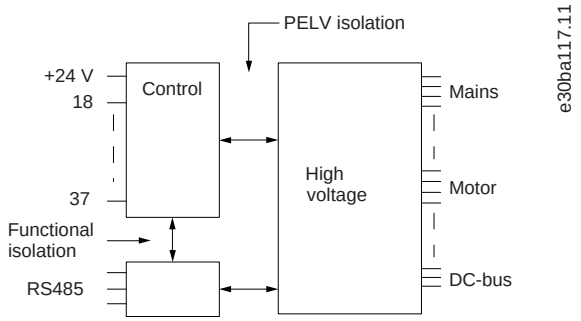


Illustration 20: PELV Isolation

8.6.4 Pulse/Encoder Inputs

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33[1]/32[2], 33[2]
Maximum frequency at terminals 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminals 29, 32, 33	5 kHz (Open collector)
Maximum frequency at terminals 29, 32, 33	4 Hz
Voltage level	See 8.6.1 Digital Inputs.
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

[1] Pulse inputs are 29 and 33.

[2] Encoder inputs: 32=A, 33=B.

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

8.6.5 Digital Outputs

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.

8.6.6 Analog Output

Number of programmable outputs	1

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

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

8.6.7 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.

8.6.8 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.

8.6.9 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 galvanically isolated from the supply voltage (PELV).

8.6.10 Control Card, USB Serial Communication

USB standard	1.1 (full speed)
USB plug	USB type B plug

Connection to the 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 drive.

8.6.11 Relay Outputs

Programmable relay outputs	1/2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1] on 4–5 (NO) (resistive load)[2][3]	400 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–5 (NO) (resistive load)	80 V DC, 2 A

Maximum terminal load (DC-13)[1] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[1] IEC 60947 parts 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 2 A.

8.6.12 Control Card Performance

Scan interval	1 ms

8.6.13 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)	≤2 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)	30–4000 RPM: Error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: Error ±0.15 RPM
Torque control accuracy (speed feedback)	Maximum error ±5% of rated torque

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

8.7 Fuses and Circuit Breakers

8.7.1 Fuse Recommendations

Fuses ensure that possible damage to the drive is limited to damage inside the unit. It is recommended that fuses and/or circuit breakers on the supply side as protection. For further information, see *Application Guide Fuses and Circuit Breakers*.

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 drive is equal to or lower than the energy provided by Moeller types.

For further information, see *Application Guide Fuses and Circuit Breakers*.

The recommended fuses in 8.7.2 CE Compliance and 8.7.3 UL Compliance are suitable for use on a circuit capable of 100000 A_{rms} (symmetrical), depending on the drive voltage rating. With the proper fusing, the drive short circuit current rating (SCCR) is 10000 A_{rms}.

8.7.2 CE Compliance

Table 35: 200–240 V, Enclosure Sizes A and B

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-25	25
	2.2 (3.0)	gG-16			
A3	3.0 (4.0)	gG-16	gG-32	PKZM0-25	25
	3.7 (5.0)	gG-20			
A4	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2 (3.0)	gG-16			
A5	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2–3.0 (3.0–4.0)	gG-16			
	3.7 (5.0)	gG-20			
B1	5.5 (7.5)	gG-25	gG-80	PKZM4-63	63
	7.5 (10)	gG-32			
B2	11 (15)	gG-50	gG-100	NZMB1-A100	100

Table 36: 380–500 V, Enclosure Sizes A and B

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.37–1.5 (0.5–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.37–3.0 (0.5–4.0)	gG-10	gG-25	PKZM0-25	25
	4.0 (5.0)	gG-16			
A3	5.5–7.5 (7.5–10)	gG-16	gG-32	PKZM0-25	25
A4	0.37-3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0 (5.0)	gG-16			
A5	0.37–3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0–7.5 (5.0–10)	gG-16			
B1	11–15 (15–20)	gG-40	gG-80	PKZM4-63	63
B2	18.5 (25)	gG-50	gG-100	NZMB1-A100	100
	22 (30)	gG-63			

Table 37: 525–600 V, Enclosure Sizes A and B

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0-75-4.0 (1.0-5.0)	gG-10	gG-25	PKZM0-25	25
A3	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10)	gG-16			
A5	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10)	gG-16			
B1	11 (15)	gG-25	gG-80	PKZM4-63	63
	15 (20)	gG-32			
	18.5 (25)	gG-40			
B2	22 (30)	gG-50	gG-100	NZMB1-A100	100
	30 (40)	gG-63			

8.7.3 UL Compliance

Fuse classification for UL Compliance.

NOTICE

UL COMPLIANCE

To comply with NEC 2017, it is mandatory to use fuses or circuit breakers. It is recommended that use a selection of the fuses listed in the following tables. These fuses are suitable for use on a circuit capable of delivering 100000 A_{rms} (symmetrical), 240 V or 500 V depending on the drive voltage rating. With the proper fusing, the drive short circuit current rating (SCCR) is 10000 A_{rms}.

For semiconcutor fuse types, the drive controller and the overcurrent protection device must be integrated within the same overall assembly.

Table 38: UL Fuse Classification Chart

UL class	Fuse overload characteristics	Interrupting rating [A]	AC voltage rating [V]	Available ampere rating
RK1	Ultra fast-acting	200.000	250 600	1–600
T	Fast-acting	200.000	300 600	1–1.200
J	Fast-acting	200.000	600	1–600
CC	Fast acting	200.000	600	5–30

Table 39: Recommended Maximum UL Fuse Class, Voltage Range 3x200–240 V, Enclosure Sizes A and B

	Class fuses		Semiconductor fuses			
Power [kW (hp)]	RK1/J/T [A]	CC [A]	SIBA	Littelfuse	Ferraz-Shawmut (Mersen)	Bussmann (Eaton)
0.25–0.37 (0.34–0.5)	5	5	5017906-005	–	–	FWX-5
0.55–1.1 (0.75–1.5)	10	10	5017906-010	–	–	FWX-10
1.5 (2.0)	15	15	5017906-016	–	–	FWX-15

	Class fuses		Semiconductor fuses			
2.2 (3.0)	20	20	5017906-020	–	–	FWX-20
3.0 (4.0)	25	25	5017906-025	–	–	FWX-25
3.7 (5.0)	30	30	5012406-032	–	–	FWX-30
5.5 (7.5)	50	–	5014006-050	–	–	FWX-50
7.5 (10)	60	–	5014006-063	–	–	FWX-60
11 (15)	80	–	5014006-080	–	–	FWX-80
15–18.5 (20–25)	125	–	2028220-125	–	–	FWX-125

Table 40: Recommended Maximum UL Fuse Class, Voltage Range 380–500 V, Enclosure Sizes A and B

	Class fuses		Semiconductor fuses			
Power [kW (hp)]	**RK1/J/T [A]**	**CC [A]**	**SIBA**	**Littelfuse**	**Ferraz-Shawmut (Mersen)**	**Bussmann (Eaton)**
0.37–1.1 (0.5–1.5)	6	6	5017906-006	–	–	FWH-6
1.5–2.2 (2.0–3.0)	10	10	5017906-010	–	–	FWH-10
3.0 (4.0)	15	15	5017906-016	–	–	FWH-15
4.0 (5.0)	20	20	5017906-020	–	–	FWH-20
5.5 (7.5)	25	25	5017906-025	–	–	FWH-25
7.5 (10)	30	30	5012406-032	–	–	FWH-30
11 (15)	40	–	5014006-040	–	–	FWH-40
15 (20)	50	–	5014006-050	–	–	FWH-50
18.5 (25)	60	–	5014006-063	–	–	FWH-60
22 (30)	80	–	2028220-100	–	–	FWH-80

Table 41: Recommended Maximum UL Fuse Class, Voltage Range 525–600 V, Enclosure Sizes A and B

	Class fuses		Semiconductor fuses
Power [kW (hp)]	**RK1/J/T [A]**	**CC [A]**	**SIBA**
1.1 (1.5)	5[1]	5	5017906-005
1.5–2.2 (2.0–3.0)	10	10	5017906-010
3.0 (4.0)	15	15	5017906-016
4.0 (5.0)	20	20	5017906-020
5.5 (7.5)	25	25	5017906-025
7.5 (10)	30	30	5017906-030

[1] Bussmann Class T allowed up to 6 A.

Table 42: External (Customer Supplied) Branch Circuit Protection

Enclosure sizes	Enclosure[1]	Voltage	Power [kW (hp)] HO	Maximum interrupting rating for listed circuit breakers	Maximum ampere rating	Further information
A4/A5	Type 12, 4X	380–500 V (T5)	0.37 (0.5), 0.55 (0.75), 0.75 (1), 1.1 (1.5), 2.2 (3), 3.0 (4), 4.0 (5), 5.5 (7.5), 7.5 (10)	100 kA (at 480 V)	25 A	Any UL 489 listed circuit breaker maximum 25 A.
A5	Type 12, 4X	200–240 V (T2)	3.0 (4), 3.7 (5)	Specific type	25 A	ABB MS165–25 480 V/277 Y 65 kA
A5	Type 12, 4X	380–500 V (T5)	5.5 (7.5), 7.5 (10)	Specific type	25 A	ABB MS165–25 480 V/277 Y 65 kA
A5	Type 12, 4X	525–600 V (T6)	4.0 (5), 5.5 (7.5), 7.5 (10)	Specific type	25 A	ABB MS165–25 600 V/347 Y 30 kA
B1	Type 12, 4X	200–240 V (T2)	7.5 (15), 11 (20)	Specific type	40..54 A	ABB MS165–54 480 V/277 Y 65 kA
B1	Type 12, 4X	380–500 V (T5)	11 (15), 15 (20), 18 (25)	Specific type	40..54 A	ABB MS165–54 480 V/277 Y 65 kA
B1	Type 12, 4X	380–500 V (T5)	11 (15), 15 (20), 18 (25)	100 kA	60 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B1	Type 12, 4X	525–600 V (T6)	11 (15), 15 (20), 18 (25)	50 kA	40 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B2	Type 12, 4X	380–500 V (T5)	22 (30), 30 (40)	100 kA	100 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B2	Type 12, 4X	525–600 V (T6)	22 (30), 30 (40)	100 kA	60 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.

[1] Only type 12 and 4X enclosures can be used. Not valid for open type (IP20) or type 1 (IP21) units.

NOTICE

UL Compliance only 525–600 V.

8.8 Connection Tightening Torques

Table 43: Tightening Torque for Cables

Enclosure size	200–240 V [kW (hp)]	380–500 V [kW (hp)]	525–600 V [kW (hp)]	Purpose	Tightening torque [Nm] ([in-lb])
A2	0.25–2.2 (0.34–3.0)	0.37–4 (0.5– 5.0)	–	Mains, brake resistor, load sharing, motor cables.	0.5–0.6 (4.4–5.3)
A3	3–3.7 (4.0– 5.0)	5.5–7.5 (7.5–10)	1.1–7.5 (1.5–10)		

Enclosure size	200–240 V [kW (hp)]	380–500 V [kW (hp)]	525–600 V [kW (hp)]	Purpose	Tightening torque [Nm] ([in-lb])
A4	0.25–2.2 (0.34–3.0)	0.37–4 (0.5– 5.0)	–		
A5	3–3.7 (4.0– 5.0)	5.5–7.5 (7.5–10)	–		
B1	5.5–7.5 (7.5–10)	11–15 (15-20)	–	Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B2	18.5–22 (25–30)	11–22 (15– 30)	11–22 (15–30)	Mains, brake resistor, load sharing cables.	4.5 (39.8)
				Motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)

8.9 Power Ratings, Weight, and Dimensions

Table 44: Power Ratings, Weight, and Dimensions, Enclosure Size A

Enclosure size			**A1**	**A2**		**A3**		**A4**	**A5**
Rated power [kW (hp)]	**200–240 V**		**0.25–1.5 (0.34–2)**	**0.25–2.2 (0.34–3)**		**3–3.7 (4–5)**		**0.25–2.2 (0.34–3)**	**0.25–3.7 (0.34–5)**
	380-480/500 V		**0.37–1.5 (0.5–2)**	**0.37–4 (0.5–5)**		**5.5–7.5 (7.5–10)**		**0.37–4 (0.5–5)**	**0.37–7.5 (0.5–10)**
	525–600 V		–	–		**0.75–7.5 (1–10)**		–	**0.75–7.5 (1–10)**
IP NEMA	–		20 Chassis	20 Chassis	21 Type 1	20 Chassis	21 Type 1	55/66 Type 12/4X	55/66 Type 12/4X
Height [mm (in)]									
Height of mounting plate		A[1]	200 (7.9)	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with ground termination plate for fieldbus cables		A	316 (12.4)	374 (14.7)	–	374 (14.7)	–	–	–
Distance between mounting holes		a	190 (7.5)	257 (10.1)	350 (13.8)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)
Width [mm (in)]									
Width of mounting plate		B	75 (3)	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of mounting plate with 1 C option		B	–	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of mounting plate with 2 C options		B	–	150 (5.9)	150 (5.9)	190 (7.5)	190 (7.5)	–	242 (9.5)

Enclosure size		A1	A2		A3		A4	A5
Distance between mounting holes	b	60 (2.4)	70 (2.8)	70 (2.8)	110 (4.3)	110 (4.3)	171 (6.7)	215 (8.5)
Depth [mm (in)]								
Depth without option A/B	C	207 (8.1)	205 (8.1)	207 (8.1)	205 (8.1)	207 (8.1)	175 (6.9)	200 (7.9)
With option A/B	C	222 (8.7)	220 (8.7)	222 (8.7)	220 (8.7)	222 (8.7)	175 (6.9)	200 (7.9)
Screw holes [mm (in)]								
	c	6.0 (0.24)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.25 (0.32)
	d	ø8 (ø0.31)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø12 (ø0.47)	ø12 (ø0.47)
	e	ø5 (ø0.2)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø6.5 (ø0.26)	ø6.5 (ø0.26)
	f	5 (0.2)	9 (0.35)	9 (0.35)	6.5 (0.26)	6.5 (0.26)	6 (0.24)	9 (0.35)
Maximum weight [kg (lb)]		2.7 (6)	4.9 (10.8)	5.3 (11.7)	6.6 (14.6)	7 (15.4)	9.7 (21.4)	13.5/14.2 (30/31)
Front cover tightening torque [Nm (in-lb)]								
Plastic cover (low IP)		Click	Click		Click		–	–
Metal cover (IP55/66)		–	–		–		1.5 (13.3)	1.5 (13.3)

[1] See Illustration 21.

Table 45: Power Ratings, Weight, and Dimensions, Enclosure Size B

Enclosure size			B1	B2
Rated power [kW (hp)]	**200–240 V**		**5.5–7.5 (7.5–10)**	**15**
	380-480/500 V		**11–15 (15–20)**	**18.5–22 (25–30)**
	525–600 V		**11–15 (15–20)**	**18.5–22 (25–30)**
IP NEMA	–		21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X
Height [mm (in)]				
Height of mounting plate		A[(1)]	480 (18.9)	650 (25.6)
Height with ground termination plate for fieldbus cables		A	–	–
Distance between mounting holes		a	454 (17.9)	624 (24.6)
Width [mm (in)]				
Width of mounting plate		B	242 (9.5)	242 (9.5)
Width of mounting plate with 1 C option		B	242 (9.5)	242 (9.5)
Width of mounting plate with 2 C options		B	242 (9.5)	242 (9.5)

Enclosure size			B1	B2
Distance between mounting holes		b	210 (8.3)	210 (8.3)
Depth [mm (in)]				
Depth without option A/B		C	260 (10.2)	260 (10.2)
With option A/B		C	260 (10.2)	260 (10.2)
Screw holes [mm (in)]				
	c		12 (0.47)	12 (0.47)
	d		ø19 (ø0.75)	ø19 (ø0.75)
	e		ø9 (ø0.35)	ø9 (ø0.35)
	f		9 (0.35)	9 (0.35)
Maximum weight [kg (lb)]			23 (51)	27 (60)
Front cover tightening torque [Nm (in-lb)]				
Plastic cover (low IP)			Click	Click
Metal cover (IP55/66)			2.2 (19.5)	2.2 (19.5)

[1] See Illustration 21.

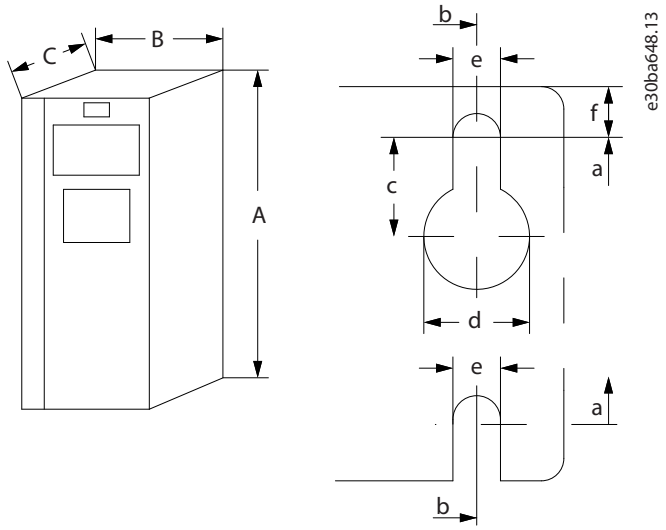


Illustration 21: Top and Bottom Mounting Holes

9 Appendix

9.1 Symbols and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
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
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 drive
IP	Ingress protection
LCP	Local control panel
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 motor
RPM	Revolutions per minute
Regen	Regenerative terminals
T_{LIM}	Torque limit
$U_{M,N}$	Nominal motor voltage

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