KONECRANES®
Lifting Businesses™

SERVICE MANUAL FOR FREQUENCY CONTROL SYSTEM

DynA60

English SUPDOC_SM_TDN001-0.ORD 10.7.2013

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Original instructions

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1 GENERAL INTRODUCTION

1.1 Foreword: About this manual

This manual offers guidance to enable safe and efficient service.

Taking the time to read this manual will help you to prevent damage to the product, and, most importantly, personnel situated close to it. The product is designed to be safe when used correctly. However, there are many potential hazards associated with incorrect operation and these can be avoided when you know how to recognize and anticipate them.

This manual is not intended as a substitute for proper training but provides recommendations and methods for safe and efficient service.

1.2 Symbols Used in this Manual

Readers should familiarize themselves with the following symbols which are used in this manual.

	Indicates that the product is slowing down or is moving at its slowest speed.
	Indicates that the product is accelerating or moving at its highest speed.
	**NOTE:** Indicates items which require special attention by the reader. There is no obvious risk of injury associated with notes.

1.3 Safety Alert Symbols and Signal Words

The following symbols are used in this manual to indicate potential safety hazards.

	**Obey all safety messages that follow this symbol to avoid possible injury or death.**
 **CAUTION**	**Indicates a potentially hazardous situation, which if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices.**
 **WARNING**	**Indicates a potentially hazardous situation, which if not avoided, COULD result in death or serious injury.**
 **DANGER**	**INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY.**
NOTICE	Addresses situations not related to personal injury, such as likely or possible damage to equipment.

Shall	Indicates that a rule is mandatory and must be followed.

Should	Indicates that a rule is a recommendation, the advisability of which depends on the facts in each situation.

1.4 Questions and Comments

Any questions or comments relating to the content of this manual and/or the operation, maintenance and/or service of manufacturer products should be directed to: **www.konecranes.com**

1.5 Manual Use

Every person exposed to the manufacturer's equipment must, prior to SERVICING AND/OR MAINTAINING SUCH PRODUCTS, read and understand the contents of this manual and strictly adhere AND CONFORM THEIR CONDUCT WITH AND TO THE INFORMATION, RECOMMENDATIONS AND warnings provided herein.

Note: Keep these instructions in a safe, accessible location for future reference by personnel operating the equipment or exposed to the equipment's operation.

⚠	**Read and understand the contents of this manual prior to operating, servicing, and or/maintaining the equipment. Failure to do so can result in serious injury or death.**

Manufacturer shall not be liable for and owner and READER shall release, and hold manufacturer, harmless from any and all claims, demands, AND damages, regardless of their nature or type losses and expenses , whether known or unknown, present or future, any and all liability, of and from any and all manner of actions, cause[s] of actions, all suits in law, in equity, or under statute, State or Federal, of whatever kind or nature, third party actions, including suits for contribution and/or indemnity on account of or in any way arising out of acts or omissions of the Owner or READER and relating in any way to this MANUAL or THE PRODUCTS referenced herein, including, but not limited to the Owner's or READER'S use thereof or any other cause identified herein or that may be reasonably inferred HEREFROM.

1.6 Terminology

The following terms and definitions may have been used in this manual:

Authorized personnel	Persons who are authorized by the owner and who have the necessary training to carry out operation or service actions.
Bridge	The bridge (main girder) moves along the runway.
CE marking	The product's CE-marking indicates that the product complies with the appropriate CE regulations.
Check	A visual and functional assessment (not a test) of the product without dismantling.
Compact brake	Motor with internal brake.
Controller	The pendant or other type of controller is used by the operator to give commands to the crane.
Current rating	The nominal current of the frequency converter.
EMC Filter	The frequency converter has an internal EMC filter in the power supply
Flux braking	Deceleration energy is dissipated as thermal energy in the motor(s)
Hoist	Drive mechanism for lifting and lowering the load.
Main girder	The main girder (bridge) is connected to the bridge end carriages.
Main isolation switch	The main isolation switch is the power switch which the operator should normally use to turn off the power.
Power supply	Power is supplied to the components via the power supply.
Qualified personnel	One with necessary qualification based on theoretical and practical knowledge of hoists or/and cranes. The person must be in a position to assess the safety of the installation in conjunction with the application. Persons with the authority to undertake certain maintenance work on products of manufacturers include manufacturers' service engineers and trained fitters with corresponding certification.
Resistor braking	Deceleration energy is dissipated as thermal energy in the braking resistor. In hoist movement, potential energy of the load is dissipated as thermal energy in the braking resistors while lowering.
Slowdown limit	Slowdown limit reduces the speed of the crane or trolley at the end of the runway.
Stop limit	Stop limit stops the crane or trolley before the end of the runway.
Travel	Drive mechanism for moving the trolley or main girder along the runway.
Trolley (hoisting unit)	The trolley (hoisting unit) moves along the main girder.

1.7 Directives and standards

1.7.1 CE/CSA/UL/CCC

This product complies with one or more of the following requirements and directives described in this section. For more detailed information about which requirements the product meets, see the main sticker attached to the device.

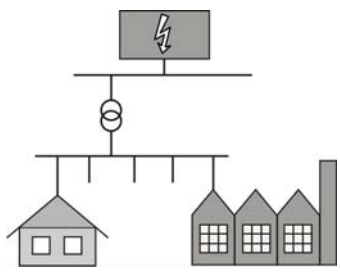
CE	The CE marking certifies that a product has met EU health, safety, and environmental requirements, which ensure consumer safety.
CSA	The CSA marking means that a product has been tested and meets applicable standards for safety and/or performance, including the applicable standards written or administered by the American National Standards Institute (ANSI), Underwriters Laboratories (UL), Canadian Standards Association (CSA), National Sanitation Foundation (NSF), and others.
UL	The UL marking means that Underwriters Laboratories (UL) has tested representative samples of the product and determined that they meet UL's requirements. These requirements are based primarily on UL's published and nationally recognized Standards for Safety.
CCC	The China Compulsory Certificate mark, commonly known as the CCC Mark, is a compulsory safety mark for a variety of products sold on the Chinese market. The CCC mark is required for both domestically manufactured products and products imported into China.
RoHS	The RoHS marking means that a product complies with the directive for the restriction of the use of certain hazardous substances in electrical and electronic equipment.
WEEE	The WEEE indicates that the product should be disposed of according to the WEEE directive regulations.

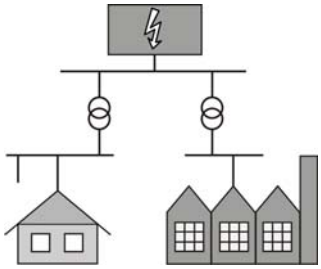
The frequency converters carry the CE label as a proof of compliance with the Low Voltage Directive (LVD) and the Electro Magnetic Compatibility (EMC).

1.7.2 EMC

The abbreviation "EMC" stands for Electromagnetic Compatibility. According to the European EMC directive, "the apparatus shall be so constructed that:

- The electromagnetic disturbance it generates does not exceed a level allowing other apparatus to operate as intended
- The apparatus has an adequate level of intrinsic immunity of electromagnetic disturbance to enable it to operate as intended".

<table>
<tr><td>Declaration of conformity</td><td colspan="2">With the declaration of conformity the manufacturer informs that a device is manufactured to fulfil required EMC standards.</td></tr>
<tr><td rowspan="2">Environments</td><td colspan="2">Immunity and emission requirements are divided in two levels in the product standard according to the environments.</td></tr>
<tr><td>First environment is an environment that includes domestic premises and other establishments directly connected to a low-voltage power supply network.</td><td>  </td></tr>
</table>

	Second environment is an environment that includes all the establishments other than those directly connected a low-voltage power supply network.	

EMC levels

There are three EMC levels: S, N and 0.

- S-level: No manufacturer's EMC solution is adopted and products will be used in other market areas than European Union (EU) when local power supply system is the grounded network.
- N-level: Manufacturer's EMC solution is adopted to fit for Second Environment and products will be used in EU when local power supply system is the grounded network.
- 0-level: No manufacturer's EMC solution is adopted, products can be used in either EU or other market areas when local power supply system is the non grounded network.

Fulfilled EMC-standards

- Immunity: All products fulfil the immunity requirements defined in the EN61000-6-2 (2005) and the EN 61800-3 Amendment 11 (2004) for the second environment.
- Emissions: N level products fulfil the emission requirements (lower than specification) of the EN 61800-3 A11 (2004) for the second environment. 0 level products fulfil the emission requirements (they might exceed the limit of N level products) of the EN 61800-3 A11 (2004) for the second environment.

Note: The involved products are designed for Second Environment (Industrial Environment) only. The disturbances emitting from the basic products are not filtered to the required level of residential, commercial and light industrial (e.g. offices, gasoline station, retailer shops etc.) environment (First Environment). In this sense, these products should not be used in First environments. If you still want to use them in First environments, additional requirements are needed, please contact product supplier.

Note: EMC filters in N level products might cause disturbances on residual current device (RCD).

2 SAFETY FIRST!

Safety requirements must be understood and followed.

2.1 Personal protective equipment (PPE)

For safety, the service personnel or others in close proximity to the product may be required to wear Personal Protective Equipment (PPE). Various types of PPE are available and must be selected according to the requirements of the working environment.

Note: Follow the local regulations and requirements of the working environment.

2.1.1 Fall Protection

While personnel are performing inspection or maintenance work at heights, they must follow fall protection procedures as required by local regulations. Fall prevention practices and fall protection equipment aim to protect personnel working on or around the equipment from exposure to falls.

If the equipment does not have a service platform or handrail, personnel must use a properly fitted safety harness that is attached to the dedicated fixing points on the building or equipment in order to prevent falls.

If the product does not have dedicated fixing points for fall protection, it is the owner's responsibility to make sure that there are suitable fixing points in the building structure.

If ladders must be used, personnel must practice setting and securing the ladders before using them for actual work.

A typical fall protection program may include:

- Documented and established site policies and procedures.
- Conducting site assessments for fall hazards.
- Selection of the proper fall protection system and equipment.
- Training on fall protection procedures and the proper use of fall protection systems.
- Inspection and proper maintenance of fall protection equipment.
- Measures to prevent falling objects.
- Rescue Plans.

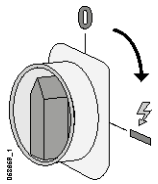
If necessary, contact your supplier or service organization for assistance with designing your fall protection program.

2.2 Fire Safety

In the event of a fire, only attempt to fight it if you can do so without putting yourself in danger. Turn the power off if it is possible to do so. Evacuate the area. Notify other people about the potential danger, and call for help.

WARNING	**Never use a powder type fire extinguisher on high voltage.**

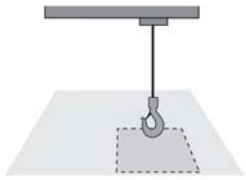
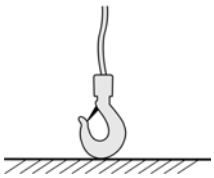
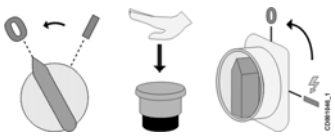
2.3 Main isolation switch

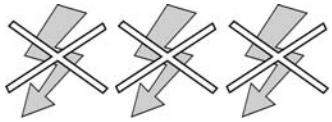
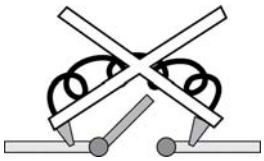
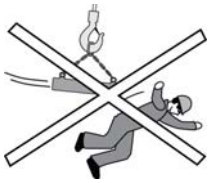
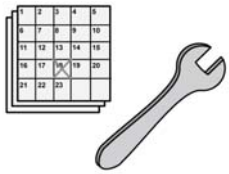


⚠ CAUTION	**Service personnel shall be aware of main isolation switch functionality. Eventhough one switch is turned off, there may still be voltage in some parts of the product. This may result in exposure to electric shocks.**

2.4 Safety during maintenance

Before and during product maintenance, the following precautions should be taken by maintenance personnel:

1	**Choose a safe working location** The product should be moved to a location where it will cause the least disturbance and where it can be accessed easily.	
2	**Prevent unauthorized access to the site** Prevent unauthorized persons and bystanders from walking on or below the work site. For example, you can lock doors, install barriers and display notices. Ensure that the secured area is spacious enough to prevent injuries which could occur as a result of falling components or tools.	
3	**Inform that equipment will be undergoing maintenance** Before starting maintenance, people must be properly informed that the equipment is being removed from operation.	
4	**Ensure that there is no load on the lifting device** Before starting maintenance there should be no load on the hook or lifting device. Park the hook on the ground if there is any chance that the hoisting brake will be opened during maintenance. A raised empty hook will fall to the ground if the hoisting brake is opened.	
5	**Turn all controllers and main switches off** All controllers and main isolation switches must be placed in the off position before starting maintenance.	
6	**Lockout – Tagout** The product power source must be locked out and tagged out when necessary, in accordance with local regulations. See chapter “Lockout – Tagout Procedure”	

7	**Verify that power is completely disconnected** Measure between the phases and between each phase to ground to ensure that power is completely disconnected from the product.	
8	**Use hand lines for lifting and lowering tools** Hand lines, securely attached to the building structure, should be used for lifting or lowering materials and tools. Use proper safety equipment to prevent objects from falling when working in high places.	
9	**Safety devices must be restored to operational status** Ensure that any safety devices which have been bypassed for testing purposes have been restored to full operational status before allowing the product to be used for normal operation.	
10	**Minimize the risks of moving machinery** Secure the area so that personnel are not at risk from the movements of machines, automatic doors or adjacent cranes at the installation site. Ensure that machinery and equipment cannot start up accidentally and cannot move during installation and servicing. Be prepared in case equipment moves in the wrong direction during testing.	
11	**Perform regular inspections and preventive maintenance** To ensure ongoing safe and efficient operation of the product, carry out regular inspections and preventive maintenance in compliance with the instructions. Keep a record of all inspections and servicing. If in doubt, contact the supplier of the product.	

3 IDENTIFICATION

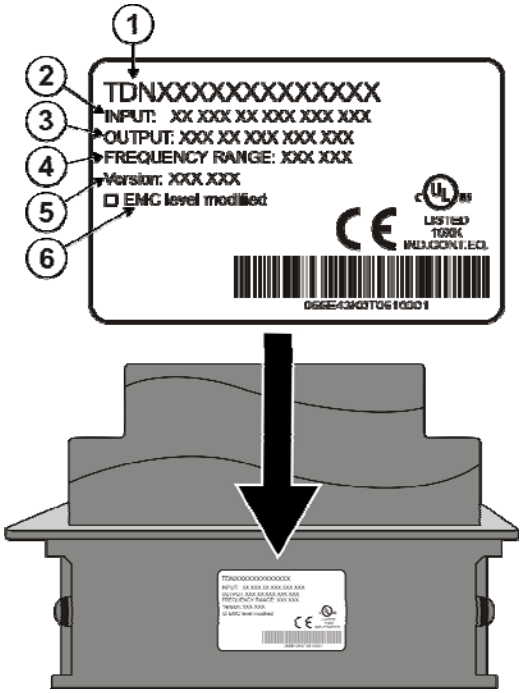
3.1 Manufacturer

Manufacturer:	**Konecranes Finland Corporation**
Address:	**Koneenkatu 8**
	FIN-05801 Hyvinkää
	Finland

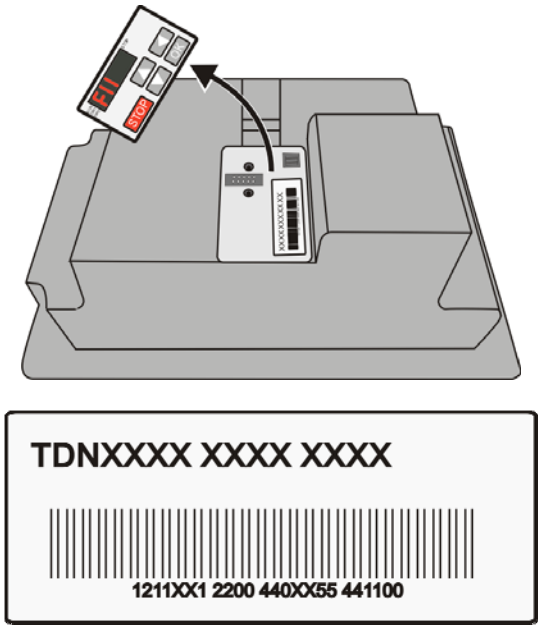
Note: For further information about the product, operational training or servicing, please contact the manufacturer or manufacturer's representative.

3.1.1 Main sticker

The main sticker shows, for example, the model and serial number of the frequency converter, as well as the rated voltage.



Barcode sticker location:



1	Type code	Indicates the exact model of the product.
2	Input	Indicates the acceptable mains voltage range, current and frequency that the product can be connected to.
3	Output	Indicates the voltage range, current and frequency range the product is able to provide at a specified output capacity.
4	Frequency range	Indicates the frequency of control signals that the product can be connected to.
5	Version	Indicates the product model version.
6	EMC level modified	Indicates whether the EMC level has been changed from the default level. By default, the EMC level is set as N. See chapter "EMC" for more information of EMC levels.

3.2 Factory code example (Factory: TDN)

TDN	004	E	1	10	0	W	M	0
(TR01)(BT01)	(ELE84)(ELE85)	(ELE84)(ELE85)	(ELE02)				(ELE97)(EL32)	
1-3	4-6	7	8	9,10	11	12	13	14

Pos.	Code	Feature code	Feature	Available properties	
1-3	**TDN**	(TR01) (BT01)	Device name	TDN	TR01 Type of trolley travel control BT01 Type of bridge travel control
4-6	**004**	(ELE84) (ELE85)	Power rating class	004, 007, 011, 020, 034	ELE84 Trolley travel inverter power rating ELE85 Bridge travel inverter power rating
7	**E**	(ELE84) (ELE85)	Supply voltage	E 380 – 480 VAC, 50/60 Hz	Values are composed of two features, Power rating class and Supply voltage. e.g. 004E = ELE84/ELE85 value
8	**1**	(ELE02)	Control voltage	1 48 – 230 VAC, 50/60 Hz	ELE02 Control voltage for digital input
9,10	**10**		Revision code	The latest revision may differ.	
11	**0**		Braking resistor type	0 External resistor	
12	**W**		Mounting	W Wall mounting	1 Through/Flange mounting
13	**M**		EMC level and grounding	M Modifiable (grounded -> non-grounded, not vice versa)	
14	**0**		Option board	0 Standard, includes 48…230 VAC digital input option card	

3.3 Konecranes code example (Konecranes: DynA60, Factory: TDN)

DynA60	004	E	1	10	0	W	M	0
(TR01)(BT01)	(ELE84)(ELE85)	(ELE84)(ELE85)	(ELE02)				(ELE97)(EL32)	
1-6	7-9	10	11	12,13	14	15	16	17

Pos.	Code	Feature code	Feature	Available properties	
1-6	**DynA60**	(TR01) (BT01)	Device name	**TR/BT01 value** DynA60 TDN	TR01 Type of trolley travel control BT01 Type of bridge travel control
7-9	**004**	(ELE84) (ELE85)	Power rating class	004, 007, 011, 020, 034	ELE84 Trolley travel inverter power rating ELE85 Bridge travel inverter power rating
10	**E**	(ELE84) (ELE85)	Supply voltage	E 380 – 480 VAC, 50/60 Hz	Values are composed of two features, Power rating class and Supply voltage. e.g. 004E = ELE84/ELE85 value
11	**1**	(ELE02)	Control voltage	1 48 – 230 VAC, 50/60 Hz	ELE02 Control voltage for digital input
12,13	**10**		Revision code	The latest revision may differ.	
14	**0**		Braking resistor type	0 External resistor	
15	**W**		Mounting	W Wall mounting	1 Through/Flange mounting
16	**M**		EMC level and grounding	M Modifiable (grounded -> non-grounded, not vice versa)	
17	**0**		Option board	0 Standard, includes 48…230 VAC digital input option card.	

4 CONSTRUCTION

4.1 Intended use of the frequency converter

These frequency converters are designed for industrial crane usage to control the speed of the speed of travelling motors. It is possible to use these frequency converters also with CAN-bus.

Possible motor control methods to be used are MS and EP. More information of the control methods can be found in chapter “Control methods”.

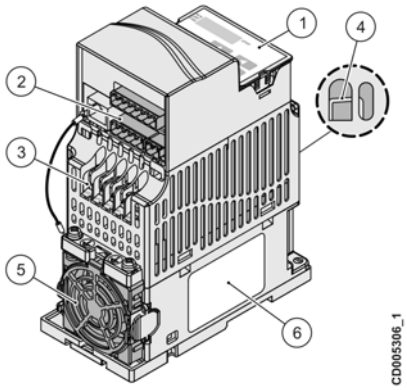
Note: The frequency converter shall be used only in crane applications.

Note: Only the product’s manufacturer shall perform any voltage withstand tests.

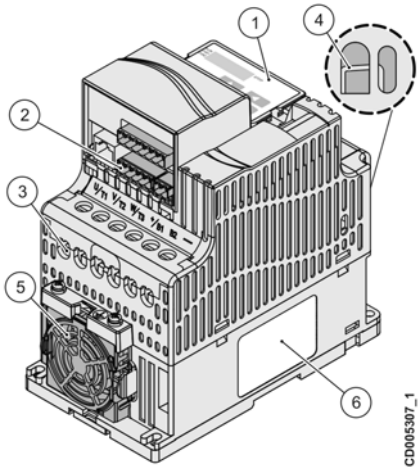
	Any alterations and/or modifications to the product not authorized by the manufacturer are strictly prohibited. Opening the product’s cover voids its warranty.

4.2 Main components

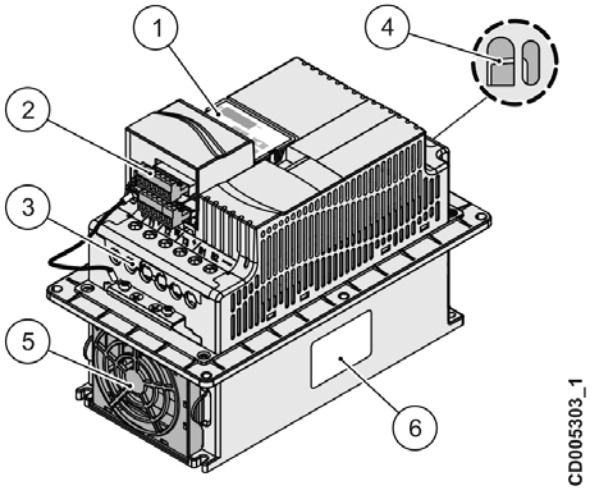
Frame A
Model 004



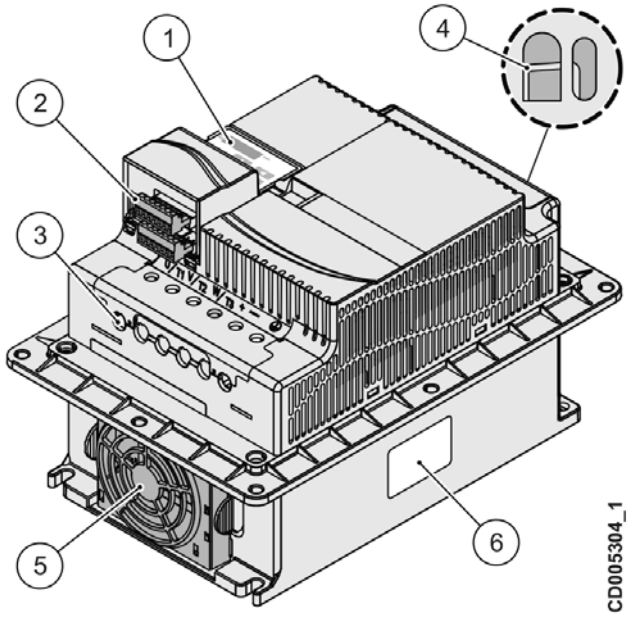
Frame B
Model 007



Frame C
Models 011 and 020



Frame D
Model 034

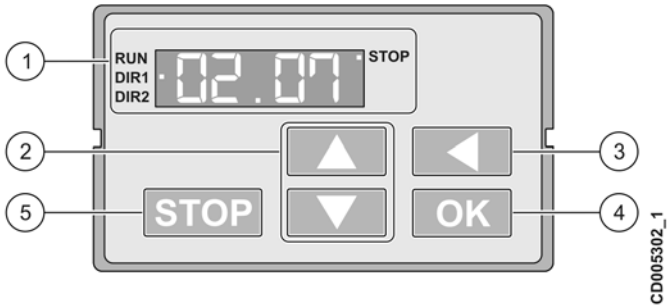


Pos.	Part	Description
1	Display	Display and navigation buttons
2	Digital input terminals	Digital input terminals
3	Terminals	3-phase power supply and motor supply terminals
4	EMC filter wire	EMC level of the frequency converter can be modified by cutting the EMC filter wire
5	Fan	Fan for cooling the frequency converter
6	Main sticker	Identification data

4.2.1 Display panel

The display panel contains:

- Display (1) indicating status, electrical values, operating, or fault parameters
- Navigation buttons (2-5) to view, select, and change the wanted items.



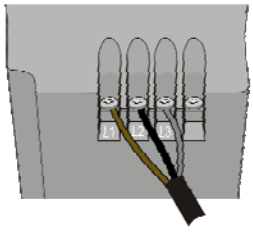
1 – Display
2 – UP and DOWN button
3 – LEFT button
4 – OK button
5 – STOP button

See chapter “User interface” for more detailed information of display options and navigating in the menu.

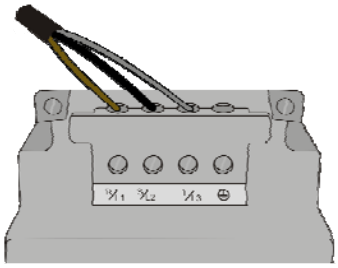
4.2.2 Terminals

WARNING	**To avoid an electrical shock, disconnect the mains supply. Before working on the terminals of frequency converter, wait at least 5 minutes after the cooling fan has stopped and indicators have switched off.**

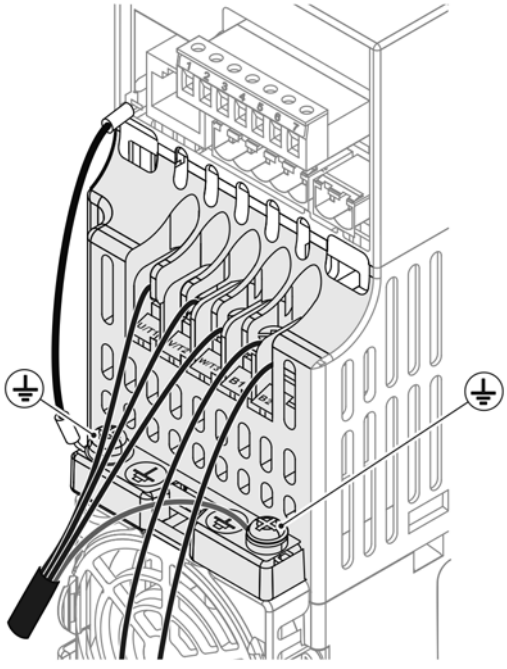
The frequency converter power module has terminals for 3-phase power supply and 3-phase motor supply. Frequency converters of the higher current rating also have terminals for an external braking resistor.



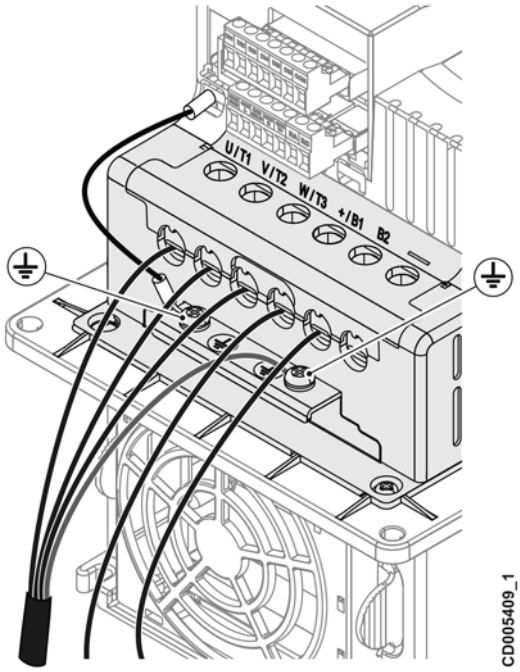
Power supply terminals of frame A



Power supply terminals of frames B, C, and D



Motor supply and braking resistor terminals of frame A



Motor supply and braking resistor terminals of frames B, C, and D

Power supply terminals (R/L1, S/L2, T/L3)	The mains power cable is connected to these terminals.
Motor cable terminals (U/T1, V/T2, W/T3)	The motor cable is connected to these terminals.
Braking resistor terminals (+/B1, -/B2)	The braking resistor wire is connected to these terminals.
Grounding wire terminals (E) ⏚	The protective grounding conductor is connected to this terminal.
Terminal (-)	**Warning! Must not be connected!** Connecting motor cables into this terminal may damage the device seriously.

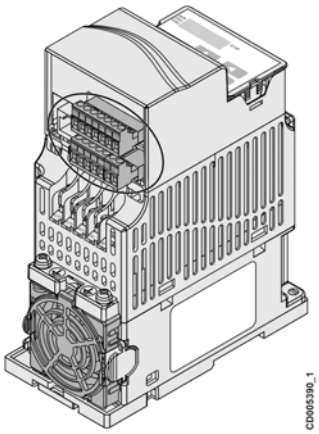
	Terminal / Name	Function	Cable size	
			mm2	AWG
Power module	R/L1	3-phase input	1.5 – 4.0	16 – 12
	S/L2			
	T/L3			
	U/T1	Motor output		
	V/T2			
	W/T3			
	+/B1, -/B2	External braking resistor		
	⏚	Protective earth		

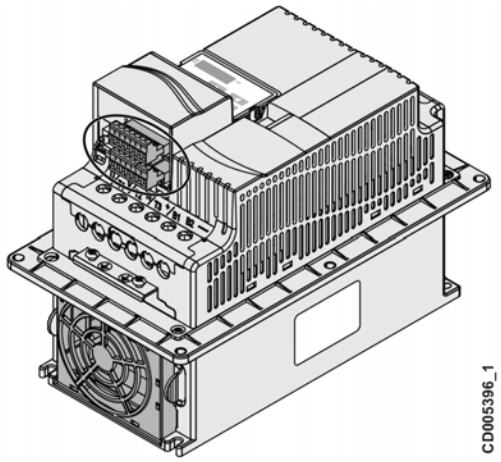
The control voltage for digital inputs can be 48 – 240 VAC. All digital inputs must be connected to same control voltage transformer.

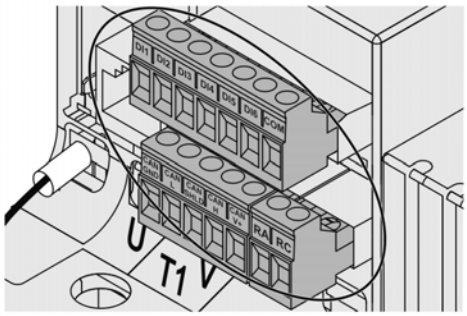
The transformer must have galvanically separated windings and the neutral phase of the secondary circuit must be connected to protective earth.

The frequency converter has protection against earth faults in the motor or in the motor cables.

The functions of inputs DI1 – DI6 vary depending on parameter settings.







Digital input terminals

I/O and CAN Bus Terminals

Terminal	Name	Description
1	DI1	External digital input
2	DI2	External digital input
3	DI3	External digital input
4	DI4	External digital input
5	DI5	External digital input
6	DI6	External digital input
7	COM	Common DI1-DI6
8	RA	Normally open relay contact RA/RC for brake control
9	RC	Normally open relay contact RA/RC for brake control
10	CAN_GND	CAN Ground
11	CAN_L	Dominant Low
12	CAN_SHLD	Shield
13	CAN_H	Dominant High
14	CAN_V+	Power 24 Vdc

Digital inputs and the control method:

	EP slow and stop	EP slow	MS slow and stop	MS slow	CAN slow and stop	CAN slow
DI1	S1	S1	S1	S1	n/a	S12
DI2	S2	S2	S2	S2		S22
DI3	AP	AP	MS2	MS2		n/a
DI4	S11/S21	S11	S11/S21	S11	S11/S21	S11
DI5	S12/S22	S21	S12/S22	S21	S12/S22	S21
DI6	ES	ES	ES	ES	ES	ES

Control signals:

S1	Drive command forward
S2	Drive command reverse
MS2	Multistep frequency
AP	Acceleration command
S11	Slowdown limit forward
S12	Stop limit forward
S21	Slowdown limit reverse
S22	Stop limit reverse
S11/S21	Common slowdown limit
S12/S22	Common stop limit
ES	External stop, which is used for thermal protection of the motor

DANGER	**THE MOTOR TERMINALS (U/V1, V/V2, W/T3) AND BRAKING RESISTOR TERMINALS (+/B1 AND -/B2 WHEN APPLICABLE) ARE LIVE WHEN THE FREQUENCY CONVERTER IS CONNECTED TO A MAINS SUPPLY, EVEN WHEN THE MOTOR IS NOT RUNNING. THE CONTROL BOARD'S RELAY OUTPUT TERMINALS (WHEN APPLICABLE) MAY HAVE A DANGEROUS CONTROL VOLTAGE, EVEN WHEN THE FREQUENCY CONVERTER IS DISCONNECTED FROM THE MAINS SUPPLY. THESE CONDITIONS MAKE A RISK OF ELECTRICAL SHOCK POSSIBLE.**

WARNING	**The RCD current from the frequency converter can exceed 3.5 mA AC. According to standard EN61800-5-1, a reinforced protective ground connection shall be ensured to reduce the risk of an electrical shock.**

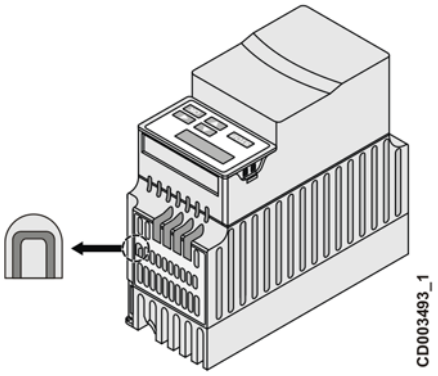
4.2.3 EMC Filter

The frequency converter has an internal EMC filter in the power supply. By default, the EMC level of the frequency converter is set to N by the manufacturer.

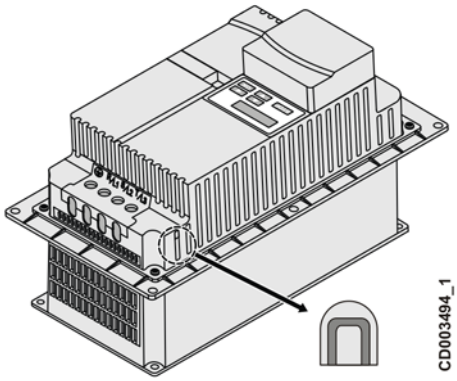
If the mains network is non-grounded (IT-network), the EMC level of the frequency converter shall be changed to 0 by cutting the filter capacitor disconnection wire.

Note: The filter capacitor disconnection wire cannot be reconnected after it has been cut.

NOTICE	If the frequency converter is connected to an IT network before the filter capacitor disconnection wire is cut, it will be irreparably damaged.



EMC filter wire of frames A and B



EMC filter wire of frames C and D

When the EMC filter wire is connected, the frequency converter has RC-filters connected to the power supply side to reduce disturbances to the network. The capacitors of these filters may cause the RCD (Residual Current Device) to trip. Therefore, the use of RCD with the frequency converter controlled cranes is not recommended.

4.2.4 Braking resistor

	TDN004	TDN007	TDN011	TDN020	TDN034
Minimum resistance [ohm]	205	100	68	36	22
Typical resistor					
Type	Flux braking	RK02	RK02	RK02	2*RK02
Resistance ohm		115	115	115	58

5 PREPARING THE PRODUCT FOR USE

5.1 Transport and storage

The product shall be stored in an environment meeting the following conditions:

- storage temperature between -20°C and +60°C
- relative humidity below 90%, no condensation
- installation site altitude below 1000 metres.

After unpacking the component, ensure that there are no visible signs of transport damage.

Make sure that the type code indicated on the main sticker corresponds with the type code of your order.

5.2 Safety precautions before installation

Before installing, check that there are no signs of damage on the frequency converter.

DANGER	**THE ELECTRICAL INSTALLATION SHALL BE PERFORMED ONLY BY PERSONNEL AUTHORIZED BY THE MANUFACTURER. IT IS POSSIBLE THAT INSTALLATIONS MADE BY UNAUTHORISED PERSONNEL ARE INCORRECT, AND CARRY AN INCREASED RISK OF AN ELECTRICAL SHOCK.**

DANGER	**TO REDUCE THE RISK OF ELECTRICAL SHOCK, THE FREQUENCY CONVERTER SHALL ALWAYS BE GROUNDED WITH A GROUNDING CONDUCTOR CONNECTED TO THE GROUNDING TERMINAL.**

DANGER	**THE FREQUENCY CONVERTER'S POWER UNIT COMPONENTS ARE LIVE WHEN THE CONVERTER IS CONNECTED TO MAINS. THE VOLTAGE IS DANGEROUS, AND DIRECT CONTACT WITH IT MAY CAUSE DEATH OR SERIOUS INJURY.**

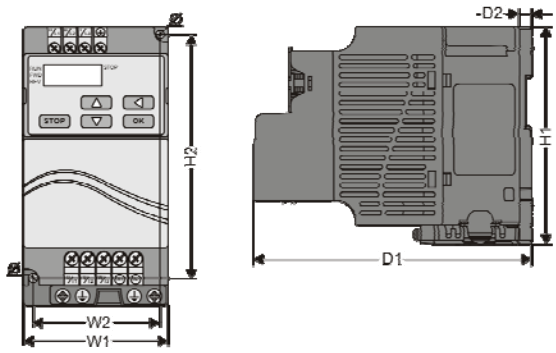
WARNING	**The frequency converter remains live while running a motor energized by a process. The motor acts as a generator that feeds energy to the frequency converter, creating a risk of an electrical shock.**

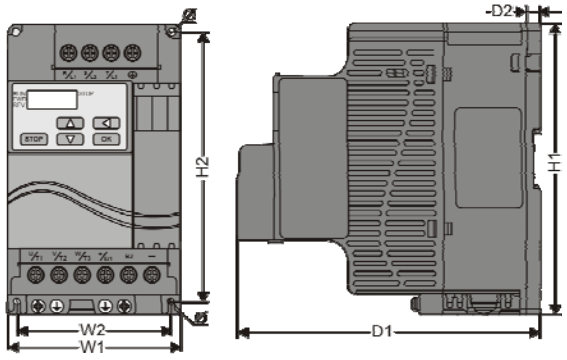
CAUTION	**The cover of the frequency converter shall not be opened. The converter's components may be damaged by a static voltage discharge from, for example, fingers.**

5.3 Mounting and installation

5.3.1 Dimensions

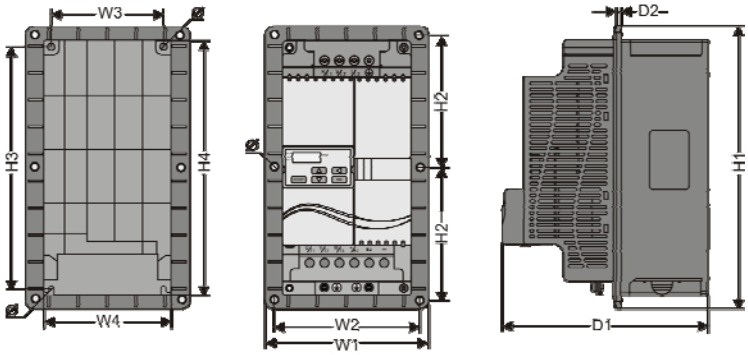
The main dimensions of the four frame sizes are described in the following illustrations.



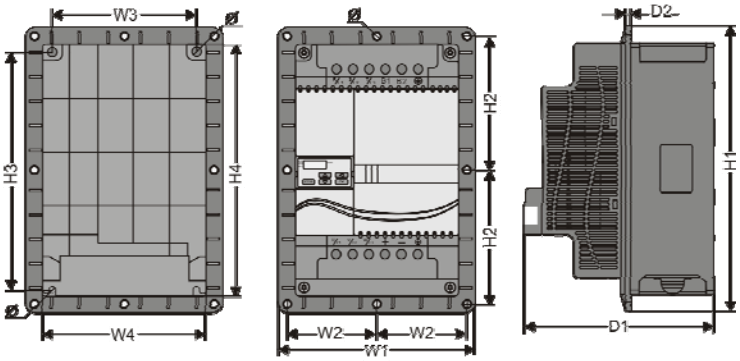


Frame A dimensions (mm)						
H1	H2	W1	W2	D1	D2	Ø
142.0	120.0	72.0	60.0	181.8	8.0	5.2

Frame B dimensions (mm)						
H1	H2	W1	W2	D1	D2	Ø
174.0	162.0	100.0	89.0	181.8	8.0	5.5



Frame C dimensions (mm)										
H1	H2	H3	H4	W1	W2	W3	W4	D1	D2	Ø
288.0	137.0	246.5	260.0	163.0	149.0	116.0	130.0	208.4	6	5.5



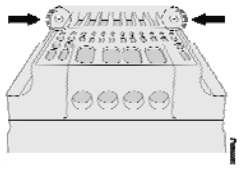
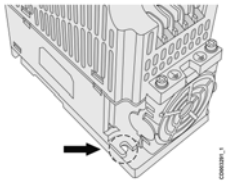
Frame D dimensions										
H1	H2	H3	H4	W1	W2	W3	W4	D1	D2	Ø
353.0	166.0	290	310	243.0	111.0	180	200.0	233.5	6	9

5.3.2 Mounting

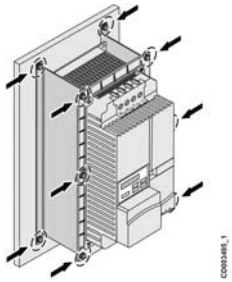
There are two possible ways to mount a frequency converter to the panel: wall mounting or through panel mounting.

The frequency converter has forced airflow cooling so the device can be mounted at any angle without affecting its operation.

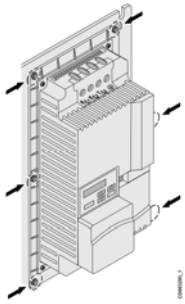
Wall mounting, frames A and B

1	Initially tighten the screws so that they can be fitted in the holes in the upper part of the frequency converter. Use screw locking liquid.	
2	Once the device is held up by the screws, tighten the upper screws and then secure the lower part with screws.	

Wall mounting, frames C and D

1	If wall mounting is used, it is recommended to use rising frames designed for this purpose.	
2	Fix the frequency converter to rising frame with screws. Fit the rising frames on the mounting panel and fix with screws. Use screw locking liquid. Once the device is fitted, tighten the screws.	

Through panel mounting

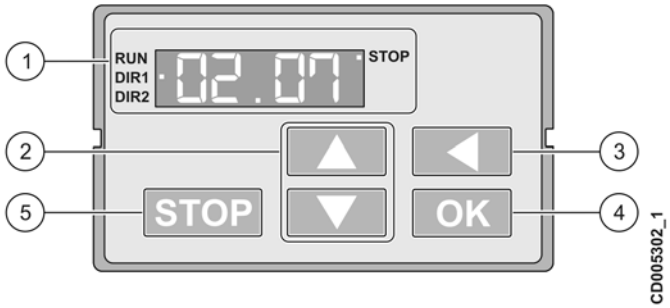
1	Fit the device into opening in the panel. Use screw size: M5 with screw locking liquid.	
2	Once the device is fitted, tighten the screws.	

6 USER INTERFACE

6.1 The display panel

The display panel is used for:

- Displaying the status, electrical values, operating, or fault parameters
- Altering the parameter settings



1 – Display
2 – UP and DOWN button
3 – LEFT button
4 – OK button
5 – STOP button

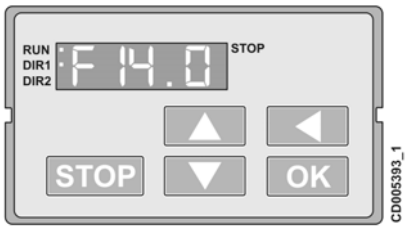
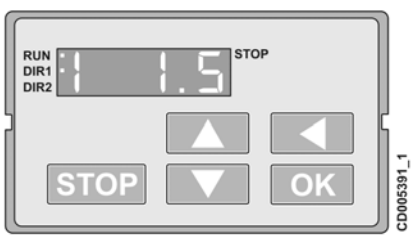
6.2 Display options

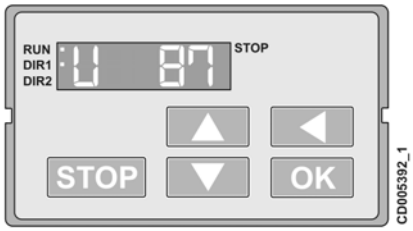
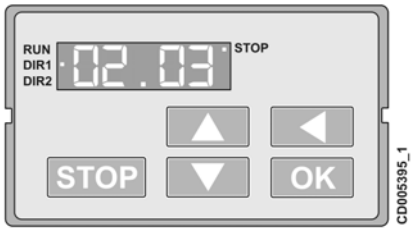
6.2.1 Drive status

Drive status is indicated with an LED light. The state is active when the LED next to corresponding text is lit. For example, when the drive is running, LED next to the text RUN is lit.

- RUN state indicates that the drive is running.
- STOP state indicates that the drive has been stopped.
- DIR1 state indicates that the direction 1 is active.
- DIR2 state indicates that the direction 2 is active.

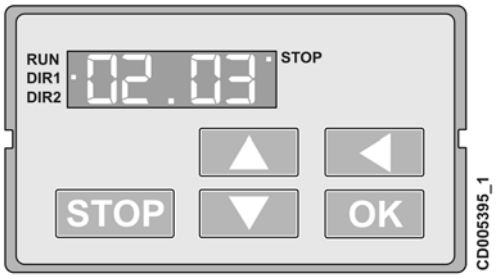
6.2.2 Display messages

Description	Display message
Frequency converter output frequency	
Frequency converter output current	

Motor voltage	
Parameter (Example 02-03)	
Fault (Example FA06)	

6.3 Navigation on the control keypad

The frequency converter is monitored and controlled with parameter groups. The parameters are identified with “gg-pp”, where “gg” denotes a parameter group and “pp” a parameter within that group. Parameter group numbers start from zero and parameter numbers from one.



Example: Parameter 02-03

6.3.1 Using buttons

Up	Down	Left	Right / OK	Stop
▲	▼	◀	OK	STOP

6.3.2 Setting parameters

Parameters are used for controlling and adjusting the functions of the frequency converter. Parameter values can only be changed when the motor is not running.

6.3.3 Changing a parameter value

1	Press Left repeatedly until output value F (frequency), U (voltage), or I (current) is shown.		
2	Press OK.		
3	Press UP or DOWN button repeatedly until the correct parameter group (gg) is shown.		
4	Press OK.		
5	Press UP or DOWN button repeatedly until the correct parameter (pp) is shown.		
6	Press OK.		
7	Press UP or DOWN button repeatedly until the correct parameter value is shown.		
8	Press OK. The value is stored and applied.		

7 PARAMETERS

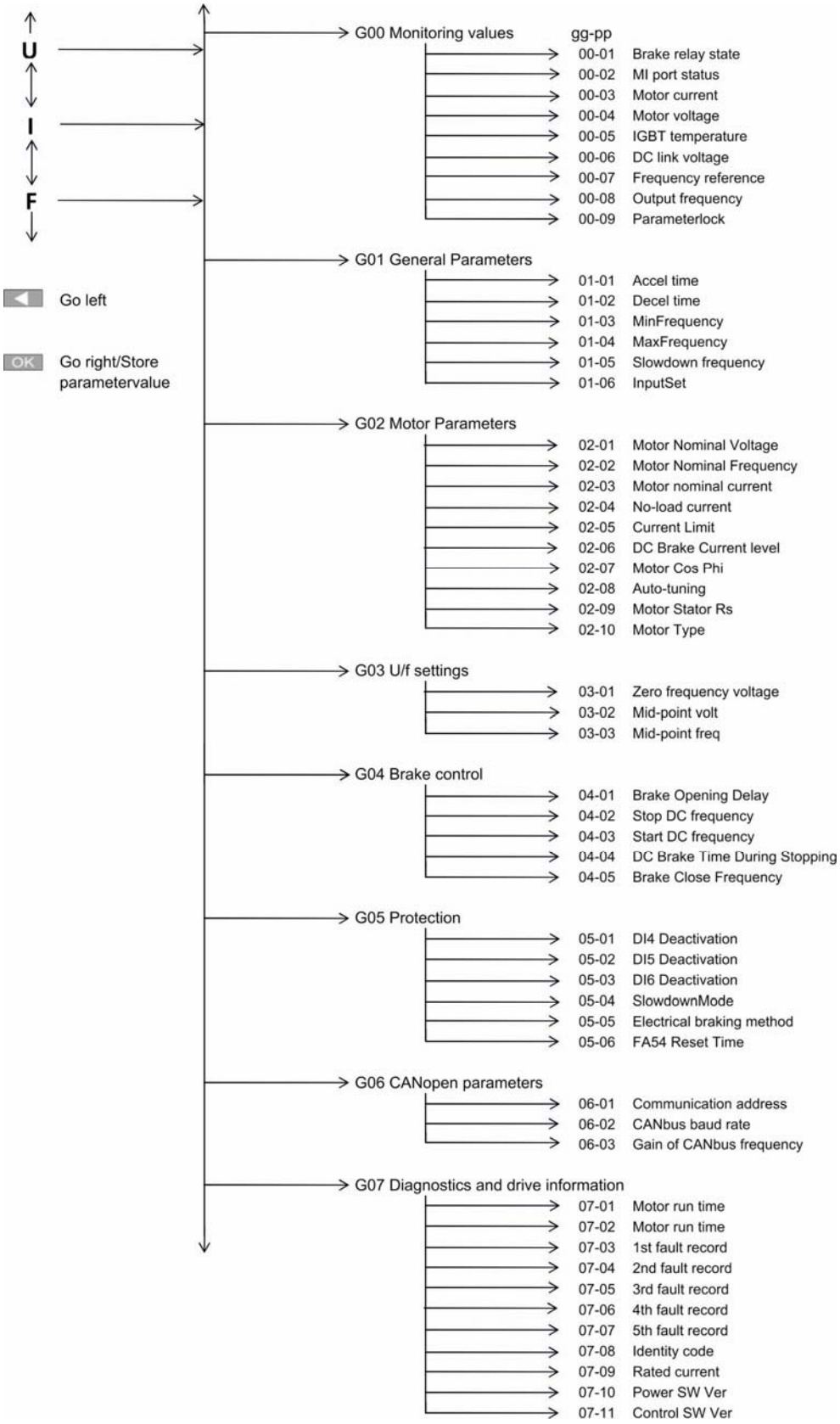
The listed parameters can be read from the display of the frequency converter.

WARNING	**Changing parameter settings during running may cause a hazardous situation. Parameter settings must not be changed during running.**

CAUTION	**Incorrect parameter settings can lead to unexpected functioning of the equipment or personal injuries.**

7.1 General Description

Parameters are assorted to Groups as shown in the parameter tree:



7.2 PARAMETER DESCRIPTIONS

Initially, the display shows the monitoring value “Output frequency” (F).

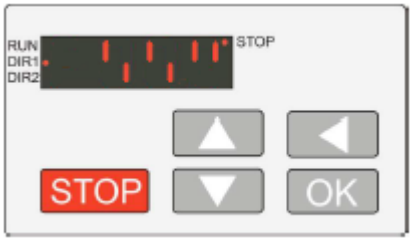
Pressing the (DOWN) button on the keypad shows the next monitoring value “Output voltage” (U) and output current (I).

Pressing the (UP) button shows the previous monitoring value.

7.2.1 Viewing monitoring values (group 00)

The first parameter group, which is identified with a group number “00”, contains monitoring values. Monitoring values show information about the current state of the frequency converter. Monitoring values differ from parameters; the values can only be browsed with the keypad, not changed.

Monitoring values available are:

Code	Parameter name	Unit	Range	Default	Description
00-01	Brake relay state		0 or 1		Output relay status: Contact between RA and RC 0: Contact is open 1: Contact is closed.
00-02	MI port status				Multi-function Input Terminal status. Leftmost bit corresponds to DI1 state and the rightmost bit corresponds to DI6 state. If the digital input is ON, then the upper vertical bar of the bit is lit. If the digital input is OFF, the lower vertical bar is lit  Example of value of parameter DI status DI1 = ON DI2 = OFF DI3 = ON DI4 = OFF DI5 = ON DI6 = ON Notice. Value 1 in parameters 05-01 (DI4), 05-02 (DI5) and 05-03 (DI6) will set the status of DI ”ON” even there is not voltage in the input Status indicator of digital inputs: bit 0: DI1 status bit 1: DI2 status bit 2: DI3 status bit 3: DI4 status bit 4: DI5 status bit 5: DI6 status
00-03	Motor current	%			Motor current as a percentage of the motor’s nominal current.
00-04	Motor voltage	V			Motor voltage.
00-05	IGBT temperature	°C			Insulated Gate Bipolar Transistor temperature.
00-06	DC link voltage	V			Voltage of DC link.
00-07	Frequency reference	Hz			Frequency reference before ramp generator.
00-08	Output frequency	Hz			Reference output frequency

00-09	Parameter lock			1 = disabled	Parameter modifying on keypad 0 = enabled 1 = disabled

7.2.2 General

Code	Parameter name	Unit	Range	Default	Description
01-01	Accel time	s	0.1 - 30.0	4.5	Acceleration time from zero to nominal frequency of motor. Set: according the crane calculation
01-02	Decel time	s	0.1 - 30.0	4.5	Deceleration time from nominal frequency of motor to zero. Set: according the crane calculation
01-03	MinFrequency	Hz	0.0 - MaxFrequency	10	Minimum driving frequency Set: according the crane calculation
01-04	MaxFrequency	Hz	MinFrequency – Motor nominal frequency	From motor type plate	Maximum driving frequency Set: according the crane calculation
01-05	Slowdown frequency	Hz	0.0 - MaxFrequency	15	Maximum driving frequency in slowdown area Set: according the crane calculation
01-06	InputSet		0 - 5		Selection of digital input function: 0: EP slow & stop 1: EP slow 2: MS slow & stop 3: MS slow 4: CAN slow & stop 5: CAN slow Set: according the application

7.2.3 Motor

Code	Parameter name	Unit	Range	Default	Description
02-01	Motor Nominal Voltage	V	50 - 500	From motor type plate	Nominal voltage of motor. Set: from motor type plate
02-02	Motor Nominal Frequency	Hz	10.0 - 600.0	From motor type plate	Nominal frequency of motor. Set: from motor type plate
02-03	Motor nominal current	A	0.0 – 2 x Nominal current of TDN	Number of motors x nominal current of one motor	Sum of Nominal current of motors. Set: Number of motors x nominal current of one motor
02-04	No-load current	A	0.0 – Nominal current of TDN	Number of motors x no load current of one motor	Current of motor without load. Set: Number of motors x no load current of one motor. If there is not Io in the name plate, set value to 0.
02-05	Current Limit	A	0.0 - 2xNominal current of TDN	1,5 x Nominal current of TDN	Maximum output current.
02-06	DC_Brake Current Level	A	0.0 – Nominal current of TDN		Current level during starting and stopping Set: Disc brake motors: 80% of sum of motor nominal currents Compact brake motors: number of motors x 3A, max 1.5 x nominal current of TDN
02-07	Motor Cos Phi		0.00 - 1.00	0.8	Nominal cos phi of motor. Set: from motor type plate

02-08	Auto-tuning		0 - 6		0: Auto-tuning not done 1: Start auto-tuning 3: Auto-tuning completed successfully 4: Auto-tuning has failed 6: U/f parameters and Motor Stator Rs are modified after successful auto-tuning When set to value 1, auto-tuning will start, brake is not opened and motor will not run
02-09	Motor Stator Rs	Ω			Phase to phase resistance [ohms] of motor. Value is automatically set during auto-tuning. For compact brake motors, check value from chapter “Default parameters with compackt brake motors” .
02-10	Motor Type		0 -1		0 = Normal, DC-brake 1 = Compact brake With 1 / Compact brake motors, auto-tuning will not change u/f-parameters nor Motor Stator Rs, check values from motor parameter table.

7.2.4 U/f settings

Code	Parameter name	Unit	Range	Default	Description
03-01	Zero Frequency Voltage	%	0.0 - 40.0	Compact brake motors: from table Normal motors: perform Auto-tuning	Output voltage in per cents of motor nominal voltage at zero frequency. Set: Normal motor: Do auto-tuning. Compact brake motors: Check value from chapter “Default parameters with compackt brake motors”.
03-02	Mid-Point Voltage	%	0.00 - 100.0	Compact brake motors: from table Normal motors: perform Auto-tuning	Output voltage in per cents of motor nominal voltage at mid-point frequency. Set: Normal motor: Do auto-tuning. Compact brake motors: Check value from chapter “Default parameters with compackt brake motors”. Note: The value is automatically set upon auto-tuning.
03-03	Mid-Point Frequency	Hz	0.0 - 120.0	Compact brake motors: from table Normal motors: perform Auto-tuning	U/f curve mid-point frequency. Set: Normal motor: Do auto-tuning. Compact brake motors: Check value from chapter “Default parameters with compackt brake motors”.

7.2.5 Brake control

Code	Parameter name	Unit	Range	Default	Description
04-01	Brake Opening Delay	s	0.00 - 10.00	0.05	Delay after brake relay closing before frequency starts to increase.
04-02	Stop DC frequency	Hz	0.0 - 250	0.5	Frequency when Stop DC braking begins during stopping.
04-03	Start DC frequency	Hz	0.0 - 250.0	2.0	Frequency when Start DC braking ends during starting.
04-04	DC Brake Time During Stopping	s	0.00 - 5.00	0.10	DC braking time during stopping.
04-05	Brake Close Frequency	Hz	0.0 - MaxFrequency	0.5	Frequency when the brake relay (RA) opens during stopping.

7.2.6 Protection

Code	Parameter name	Unit	Range	Default	Description
05-01	DI4 Deactivation		0 - 1	0	Specifies digital input 4 state: 0: input is active (normal operation) 1: input is inactive (DI4 always on)
05-02	DI5 Deactivation		0 - 1	0	Specifies digital input 5 state: 0: input is active (normal operation) 1: input is inactive (DI5 always on)
05-03	DI6 Deactivation		0 - 1	0	Specifies digital input 6 state: 0: input is active (normal operation) 1: input is inactive (DI6 always on)
05-04	SlowdownMode		0 - 1	0	Specifies slowdown mode: 0: Slow 1: Fast, allows fast speed to opposite direction.
05-05	Electrical braking method		0 - 2	TDN004: 1 = flux braking TDN007,TND011, TDN020, TDN034: 0 = resistor braking	Sets electrical braking method: 0: Resistor braking 1: Flux braking 2: Resistor and flux braking Set: TDN004: 1 = flux braking TDN007,TND011, TDN020, TDN034: 0 = resistor braking

7.2.7 CANopen

Code	Parameter name	Unit	Range	Default	Description
06-01	Communication address		1 - 254	0 = disable	Communication address 0 = disable
06-02	CANbus baud rate		0 - 5	1 = 500 K	CANbus baud rate 0: 1 M 1: 500 K 2: 250 K 3: 125 K 4: 100 K 5: 50 K
06-03	Gain of CANbus frequency		0.00 - 2.00	1.00	Gain of CANbus frequency
06-04	CANbus warning				Read-only parameter bit 0 : Guarding Time out bit 1 : Heartbeat Time out bit 2 : SYNC Time out bit 3 : SDO Time out bit 4 : SDO buffer overflow bit 5 : CANbus Off bit 6 : Error protocol of CANopen bit 7 : CANopen boot up fault

7.2.8 Diagnostics and drive information

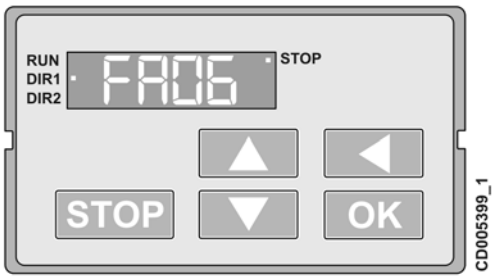
Code	Parameter name	Unit	Range		Description
07-01	Motor run time	min	0 - 1439		Shows accumulative motor operation time.
07-02	Motor run time	days	0 - 65535		Shows accumulative motor operation time.
07-03	1st fault record		See table in section “Fault record descriptions”		Shows the current fault record.
07-04	2nd fault record				Shows the second most recent fault record.
07-05	3rd fault record				Shows the third most recent fault record.
07-06	4th fault record				Shows the fourth most recent fault record.

07-07	5th fault record				Shows the fifth most recent fault record.
07-08	Identity code				Identity code of the TDN. TDN004: 7 TDN020: 17 TDN007: 11 TDN011: 13 TDN034: 23
07-09	Rated current				Rated output current of the TDN
07-10	Power SW Ver				Power board software version.
07-11	Control SW Ver				Control board software version.
07-12	DriveDir DI4		0 - 2		Driving direction inference variable A's value: 0: Direction 1 1: Direction 2 2: Unclear
07-13	DriveDir DI5		0 - 2		Driving direction inference variable B's value: 0: Direction 1 1: Direction 2 2: Unclear

7.2.9 Fault codes

The frequency converter display shows a fault code, if a fault situation occurs. The fault indicator turns on and the fault code starts to blink in the display.

Example: Fault code FA06 on display



Fault handling

In all fault situations, a fast stop is activated: the modulation of the drive is stopped and the brake relay is opened (brake closes). Restarting is disabled until the fault is reset by one of the following resetting methods:

Automatic reset: The fault is reset automatically after both direction commands have been switched off (DI1=0 and DI2=0 or if CAN control mode is used DIR1CAN=0 and DIR2CAN=0) for 500 ms.

Power-off-reset: The fault is reset by removing the AC input voltage of the frequency converter. The external voltage of 24 V does not need to be removed for the power-off-reset.

The resetting method depends on the type of the fault.

Fault code	Fault	Possible cause(s)	Solution(s) and check(s)	Resetting method	
				Automatic	Power-off
FA 01	Overcurrent	Too high a current in motor output due to, for example: • Sudden increase in heavy load • Motor or cable short circuit • Unsuitable motor • Incorrect motor parameter settings	Switch off power and turn back on after the display lights go out. Check the following: • Brake operation • Motor type and power rating • Parameters, uf-parameters, Auto-tuning • Motor cable connection • Motor insulation • Motor load		X
FA 02	Overvoltage	DC-link voltage is above 820 V with input voltage 440 V OR above 415 V with input voltage 220 V.	Reset automatically after both direction commands have been switched off for 500 ms. Check the following: • Deceleration time • Main supply voltage and wave form • Braking resistor cable • Braking resistor type and resistance • Braking chopper operation	X	
FA 03	Ground fault	Unbalanced motor phase currents. Asymmetric load. Insulation failure in motor or cable.	Switch off power and turn back on. Check the following: • Motor insulation • Cable insulation, phase-ground, phase-phase		X
FA 06	External Stop	DI6 is zero or STOP button of the keypad is pressed	Check the following: • ES external connections • Control mode selection • DI6 input state • Motor temperature (thermal protection of motor normally connected to ES signal) The fault is reset automatically after DI6 is switched back to 1 and both direction commands have been switched off for 500 ms.	X	
FA 08	Hardware error	Component failure Faulty operation	Switch off power and turn back on. If problem persists, contact an authorized service center.		X
FA 09	Undervoltage	DC link voltage below 333 Vdc with input voltage >= 380 V or below 166 V with input voltage <380 V Mains supply voltage interrupted Frequency converter fault External fault during operation	If voltage brake has been temporary, reset the fault and check the mains supply. If the mains supply is correct, an internal fault has occurred. Contact an authorized service center.		X
FA 10	Phase lost	One or more input phases are lost	Check the following: • Supply cable connections • Supply voltage		X
FA 13	Under temperature	Frequency converter IGBT temperature below -10°C	Check the following: • Operating environment temperature • Cubicle heating		X
FA 14	Overtemperature	Frequency converter IGBT temperature over +100°C.	Check the following: • Operating environment temperature • Frequency converter cooling fan operation • Air flow through heat sink • Heat sink cleanliness		X
FA 22	EEPROM programming error	Parameters not saved correctly.	Switch power off and back on. The parameter settings will automatically be reset. If the problem persists, contact an authorized service center.		X

FA 34	Inner communication error	Communication error between IO and control board	Switch off power and turn back on after the display lights go out. If the problem persists, contact an authorized service center.	X	
FA 52	Parameter fault	Motor Nominal Current has value 0	Device is not parameterized for the application. Check all parameters		X
FA 54	Stop limit	Signal S12 or S22 is inactive.	Reset by keeping the controller at 0 for over 500 ms. (Reset time is adjustable with parameter 05.06 FA54 Reset Time Check the following: • InputSet selection P01.06 • State of inputs DID4 and DID5, P00.02	X	
FA 56	Deceleration distance	Defined deceleration ramp cannot be followed	Check the deceleration ramp time parameter 01.02	X	
FA 59	Over voltage at start	Too high DC-link voltage at start	• Check Main supply voltage and wave form	X	
FA 68	External communication error	Communication error to external device	Check connection		X
FA 73	I/O fault	Signals S1 and S2 have been simultaneously on for over 500 ms. Short circuit in pendant cable.	Check the digital I/O cabling.	X	
FA 80	CAN fault	Both driving commands from CAN are simultaneously on for over 500 ms	Check CAN master	X	
FA 82	CAN communication	CAN communication does not work when CAN control mode is selected	Check CAN bus. Check correct input set selection P01.06	X	
FA 83	CAN bus fault	CAN bus is not detected	Check CAN bus		X

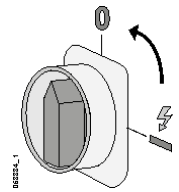
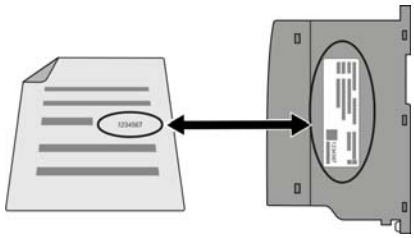
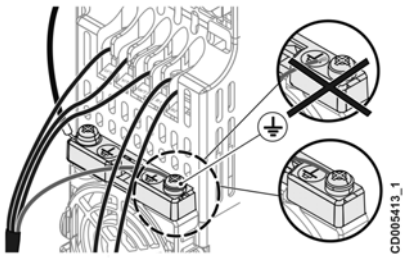
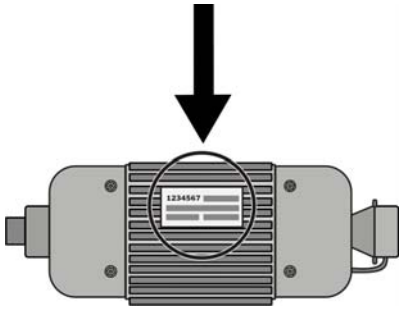
8 COMMISSIONING

If any problems or malfunctions occur during the commissioning, refer to the chapter “Troubleshooting” to find out the reason. The source of any problems with the product must be solved before continuing with the commissioning procedure.

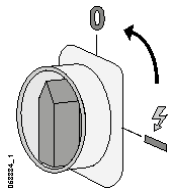
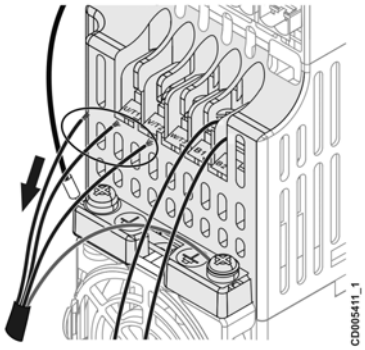
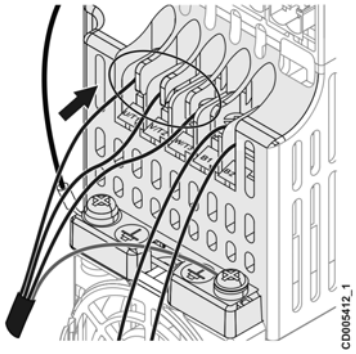
WARNING	**To avoid electrical shock, ensure that the main isolation switch is turned to the off position before connecting the frequency converter to the mains supply.**

WARNING	**To avoid damage to the equipment or persons, ensure the proper mounting of the motor before starting. Also, make sure that the machinery connected to the motor allows the motor to run.**

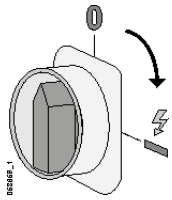
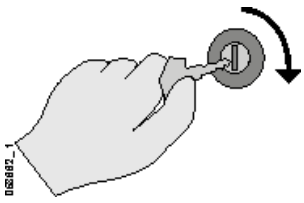
8.1 Visual checks

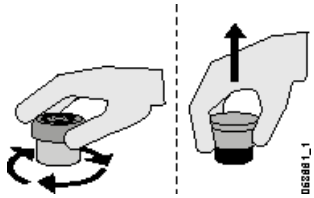
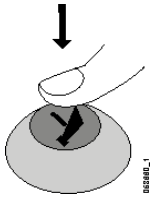
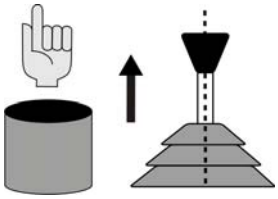
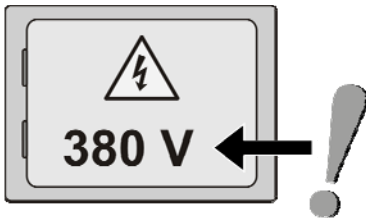
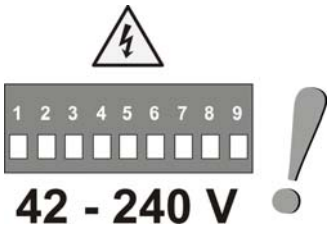
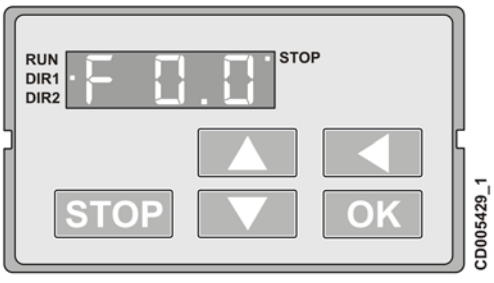
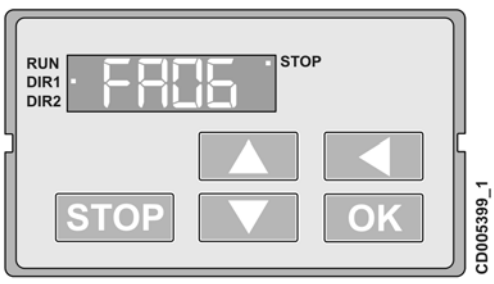
1	Check that the main power is switched off.	
2	Check that the serial number of the drive is the same as in the delivery documents.	
3	Check the connections and condition of cabling to motor, braking resistor, grounding, and thermistors.	
4	Check that motor type, nominal voltage, nominal current, and nominal frequency are same as parameterized values in electrical drawings.	

8.2 Checks before the first run

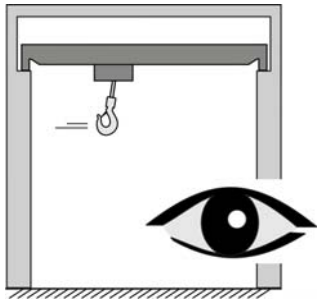
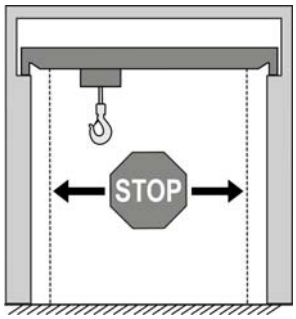
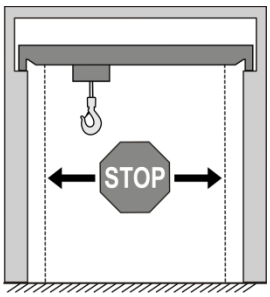
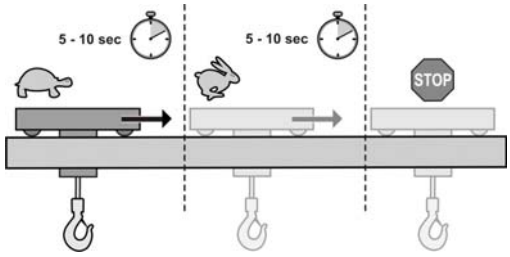
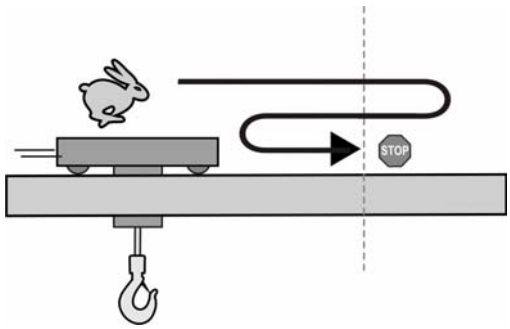
1	Check that the main power is switched off.	
2	When installing a new unit, disconnect the motor (U / T1, V / T2, W / T3) cables to prevent damage to the frequency converter. Measure the insulation resistance of the motor windings (each phase to ground). Insulation resistance requirement for new motor: Cold motor (10..40 °C): ≥ 5 MΩ Warm motor (40 °C or more): ≥ 1 MΩ If insulation resistance is less that requirement the motor shall be dried.	
3	Reconnect the motor cables and check the tightness of the other cables.	
4	Check that the external connections and project specific parameters are set according to electrical drawings.	

8.2.1 Power up procedure

1	Make sure that the main power isolation switch is ON. The product only becomes operational (energized) after the necessary steps have been followed to established communication between the product and controller.	
2	If applicable, use the key switch to turn on the controller.	

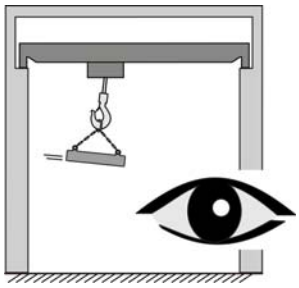
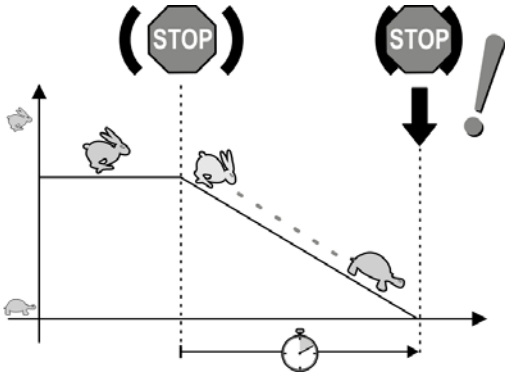
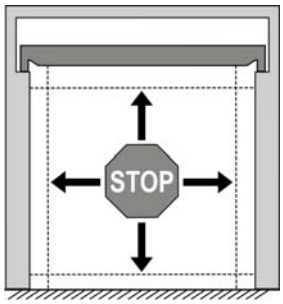
3	To prepare the controller for operation, release the emergency stop button.	
4	Energize the product by pressing the start pushbutton.	
5	The frequency converter goes into a ready-to-run state after the power supply is connected. The frequency converter verifies that both direction signals are switched off.	
7	Measure the power supply voltage. The main voltage shall be between 380-480VAC.	
8	Measure the control voltage at the transformer. The control voltage shall be between 42 and 240 VAC.	
6	After start up, if a DIR1 indicator is lit the frequency converter will accept driving commands.	
7	If a fault is indicated, the frequency converter does not accept drive commands until the cause of the fault is eliminated.	

8.3 Test run without load

1	Ensure that movement of the equipment will not cause any danger to the environment or to the crane itself. Avoid driving close to the limit areas.	
2	Check travel limit switch functionality manually, if possible, by measuring their state when they are turned into different positions. After check turn the limit switches back to neutral position.	
3	Check the limit switch functions: 1. Drive slowly in one direction and check the limit switch operates properly 2. Re-check using full speed 3. Repeat for the opposite direction. **Note:** One step slow down limit switch do not stop the motion.	
4	Ensure the motor operates properly: 1. Drive in one direction at minimum speed for 5 to 10 seconds. 2. Accelerate to full speed 3. Run for 5 to 10 seconds with full speed 4. Stop 5. Repeat for the opposite direction. If there are problems in the operation or fault situation in the frequency converter, see chapter “Troubleshooting”.	
5	Ensure the motor acceleration, deceleration and braking operatios work properly: Check the motor operation: 1. Accelerate to full speed in one direction 2. Change to full speed in the opposite direction 3. Again, change to full speed in the opposite direction 4. Stop. If there are problems in the operation or fault situation in the frequency converter, see chapter “Troubleshooting”.	

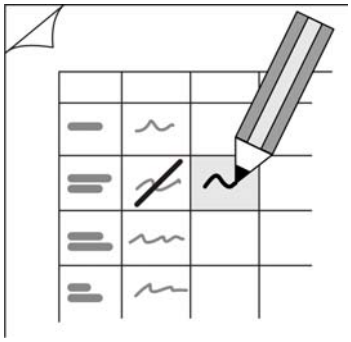
8.4 Test run with load

CAUTION	**Ensure that crane movements will not cause any danger to the environment or to the crane itself.**

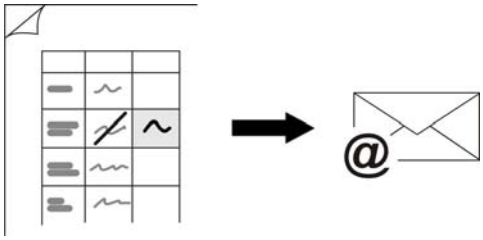
1	Drive the movements in both directions at minimum and maximum speeds. Check that the crane moves at both speeds. Drive runway length with full load.	
2	Check the deceleration ramp time. Ensure that the motor brake closes **after** the movement has stopped. If the movements stops suddenly during the deceleration, check the frequency converter fault code. If there are problems with the operation, see chapter “Troubleshooting”.	
3	Check the limit switch functions with full load. If slowdown limit is used: 1. Drive slowly in one direction and check the slow down limit operates properly. 2. Repeat for the opposite direction. If stop limit is used: 1. Drive full speed in one direction and check the stop limit operates properly. 2. Repeat for the opposite direction.	

Note: One step slow down limit switch do not stop the motion.

8.5 After the test run

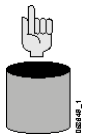
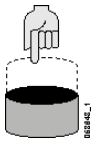
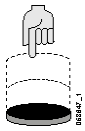
	Record the parameter value changes in the parameter list. Changed values are needed if the frequency converter will be replaced with a new one.	

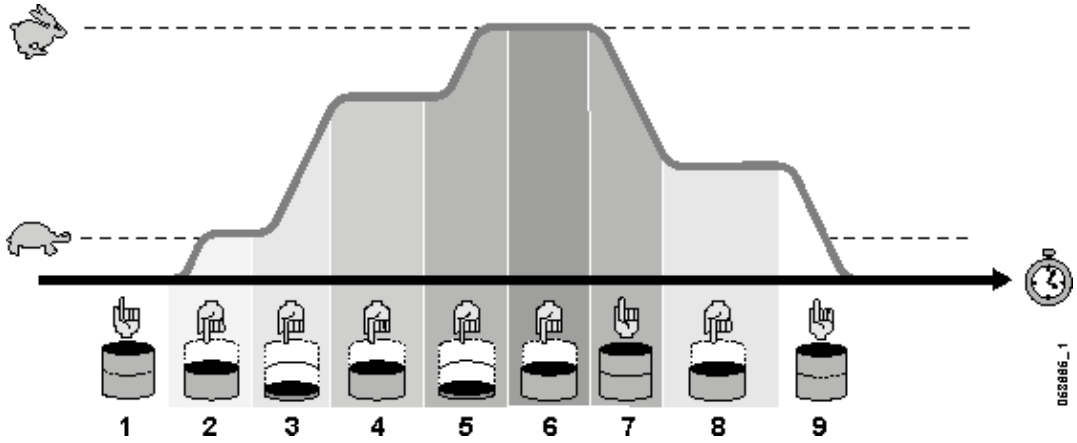
Upon completing the test:

	Ensure that all of the remarks and parameter values are sent to the manufacturer. Up to date parameter list ensure correct parameter settings in spare part deliveries. See the section “Manufacturer” for contact information.	

9 OPERATING INSTRUCTIONS

9.1 Control methods

EP (Electronic Potentiometer) push-button control	
	**Released** (stop): The device does not move or if it is already moving, it decelerates to a complete stop.
	**Step 1** (slow/hold): If push-button is half-pressed (step 1) the device accelerates, until it reaches the preset slow speed. If push-button is half-pressed (step 1) when the device is moving above the preset slow speed, the current speed is held without accelerating or decelerating.
	**Step 2** (accelerate): The device accelerates continuously until the push-button is released or the maximum speed is reached.



1 Push-button released: the motor does not turn

2 Push-button step 1 pressed: the motor accelerates until it reaches the preset slow speed

3 Push-button step 2 pressed: the motor accelerates towards maximum speed

4 Push-button step 1 pressed: the current speed is held

5 Push-button step 2 pressed: the motor accelerates until it reaches maximum speed

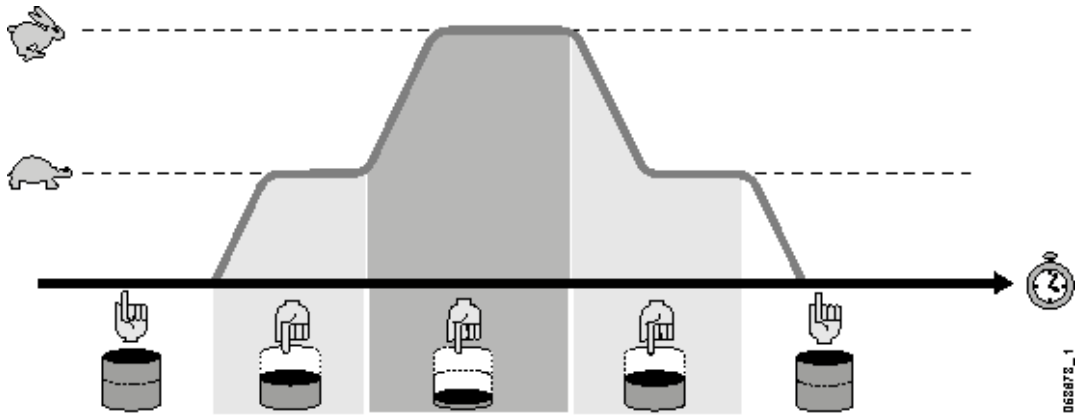
6 Push-button step 1 pressed: the current (maximum) speed is held

7 Push-button released: the motor decelerates

8 Push-button step 1 pressed: the current speed is held

9 Push-button released: the motor decelerates to a complete stop.

CAUTION	**When a push-button is pressed or released, the movement accelerates or decelerates smoothly. The operator SHALL account for the starting and stopping distances before making crane movements.**

MS2 Multistep 2 pushbutton control

The motor moves at a speed corresponding to the pushed step of the pushbutton. The motor moves at its slowest speed when the pushbutton is partially pushed and at its maximum speed when the pushbutton is fully pushed. The motor stops moving after ramp time when the pushbutton is released.

NOTICE	When a pushbutton is pressed or released, the movement will accelerate or decelerate smoothly. The operator SHALL account for the starting and stopping distances before making crane movements.

9.2 Slowdown-limit

The slowdown limit reduces the speed of the crane or trolley at both ends of the runway. In a normal state the limit switch contact is closed and control voltage connected to the input. When the limit switch contact is opened, the slowdown function is activated.

The slowdown function limits the output frequency. If the driving frequency is higher than the set slowdown frequency, the frequency converter decelerates to the slowdown frequency. Movement is possible between the slowdown frequency and minimum frequency. The movement speed is reduced in the running direction or both directions, depending on the setting.

9.3 Stop-limit

The stop limit stops the crane or trolley before the end of the runway. In a normal state the limit switch contact is closed. When the limit switch contact is opened the motion stops.

10 MAINTENANCE

Note: Mechanical and electrical maintenance work requires special skills and tools to ensure safe and reliable operation of the product. Maintenance work shall be carried out only by authorized service personnel or an experienced service technician authorized by the product's manufacturer or manufacturer's representative.

Ensure proper air flow and cooling of the frequency converter. Remove dust from cubicle and frequency converter during regular maintenance.

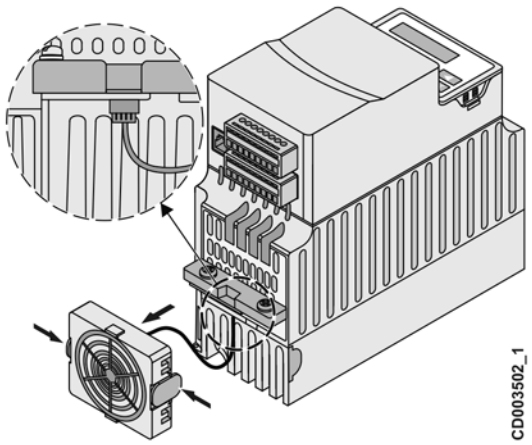
NOTICE	Do not use aerosol dust remover. Compressed air may damage the fan of the frequency converter.

Inspect the frequency converter and it's environment during regular maintenance of application:

- Check fault codes.
- Check fastening of frequency converter.
- Check condition of wiring and terminal connections.
- Check condition of cable bushings and door sealings on cubicle.
- Check operation and cleanliness of cooling fan of frequency converter.
- Check operation and cleanliness of cooling fan and filters of cubicle.

CAUTION	**Any defects or abnormalities which are detected during the inspections must be investigated and corrected in accordance with the instructions relevant to component in question.**

10.1 Replacing the fan

1	Push locking parts on the side of the fan gently and pull out the fan. Unplug the wire. Connect the new fan and adjust it into the place.	

10.2 Spare parts

Description	Type code	Id
Display	TDNKPEKC1	52487204

11 TROUBLESHOOTING

The purpose of troubleshooting is primarily to determine whether the frequency converter or external devices cause the problems. It is also possible that a faulty external device has damaged the frequency converter. In that case, it is important to repair or change any faulty devices to prevent recurring problems.

Note: When replacing a frequency converter with a new one, the parameter list of the old frequency converter is needed for copying parameter settings to the new frequency converter.

Note: Reducing of the ramp time from the value of the original delivery is not allowed.

11.1 Problems and solutions

	Problem	Suggested solution
	The frequency converter does not start (DIR1 indicator stays unlit) when it is started.	Check the main voltage between terminals L1, L2, and L3. Check that there are no devices causing disturbances connected in the same voltage supply as the crane. These are for example devices that require large currents: large motors, welding devices and so on. **NOTE:** When the EMC-wire is connected, the frequency converter has RC-filters connected to the power supply side to reduce disturbances to the network.
	The DIR1 indicator is lit (after previous fault) and there is no fault code that is displayed, but motor does not run.	Check the motor cable connection. Check the limit switches. Check the voltage in direction command terminal 1 (DI1) and terminal 2 (DI2). Also common (terminal 7).
	The motor runs poorly: trolley/bridge does not move as it supposed to move.	Check that the crane is not over loaded. Check that all cables are correctly connected and not loose. Check that all motor parameters are set according to the motor nominal values. See chapter “Motor Parameters”. Check that the U/f-curve parameters are set according to table (chapter “Default Parameters with Compact Brake Motors”) for compact brake motors. For disk brake motors, do Autotuning. Check the Input set selection from parameter 01-06. Check the status of inputs from parameter 00-02. Check digital input deactivation from parameter 05-01, 05-02, and 05-03. Check the voltage between digital input and common from terminals. Check that the brake of the motor opens completely. Check that the minimum speed parameter value has not been set too low. Drive with the device a couple of times the trolley/crane runway from end to end flatten the runway(s). Check the parameter settings for current limit.

11.2 Exceptional situations

11.2.1 Determining movement direction

The frequency converter has to know in which direction the motor is running to execute the limit functions properly. It has only one input for the slowdown limit and one input for the stop limit.

If the slowdown limit signal is deactivated when the motor is not running, the frequency converter cannot determine which direction is safe. Therefore, the maximum speed is limited in both directions until the slowdown limit signal is activated. Same applies if the slowdown limit signal is deactivated during a power shortage.

If the stop limit signal is deactivated when the motor is not running, the frequency converter cannot determine which direction is blocked. In this situation, it is possible to run in both directions with minimum speed. The normal operating speeds are restored when the stop limit signal is activated.

Note: Driving to a stop limit immediately cuts off power to the motor.

11.3 Warning and Fault codes

When the frequency converter detects an unacceptable situation, it stops the current movement and indicates a warning or fault code.

Software resets automatically some of the faults, while others may require the frequency converter to be powered down. The causes of the fault(s) must be resolved and both drive commands have to be at the OFF position for 0.5s before the motor can be started again. In a case of over current fault the supply voltage must be switched off and back on before it is possible to resume operation.

12 TAKING PRODUCT OUT OF OPERATION

12.1 Disposal of waste materials

Waste material from installation, maintenance or dismantling shall be disposed of according to local regulations.

	If the product is taken out of use, the metal and electrical parts should be recycled.	
	In addition to local regulations, liquids like oil, grease and other chemicals shall never be spilled onto the ground or soil. Used oil and grease shall be stored in containers indicated for the purpose.	

13 TECHNICAL DATA

Mains connection	Supply voltage U_{in}	380 - 480 V, -10%...+10% 3-phase
	Supply voltage frequency	45…66 Hz
	Connection to mains	Once per minute or less (normal case)
Motor connection	Output voltage	0 — U_{in}
	Nominal output current	004: I_N 3.4A (max 5.1A) 007: I_N 6.8A (max 10.2A) 011: I_N 10.4A (max 15.6A) 020: I_N 19.2A (max 28.8A) 034: I_N 33.8A (max 50.7A)
	Continuous output current	Rated current I_n at ambient temperature max +50°C, overload 1.5 x I_N max (1min/10min)
	Starting current	2 x I_N 2 sec every 20 sec
	Output frequency	0…250 Hz
Digital inputs	Control voltage	48 – 240 V_{ac}
Control features	Control method	Frequency Control U/f
	Switching frequency	3.6 kHz
	Acceleration time	0…20s (0,1s steps)
	Deceleration time	0…20s (0,1s steps)
Ambient conditions	Ambient operating temperature	–10°C (no frost)…+50°C (outside the cubicle + 40˚C), max ED 40%
	Storage temperature	–20°C…+60°C
	Relative humidity	0…95% RH, non-condensing, non-corrosive, no dripping water
	Air quality: - Chemical vapors - Mechanical particles	 IEC 721-3-3, unit in operation, class 3C2 IEC 721-3-3, unit in operation, class 3S2
	Altitude	100% load capacity (no derating) up to 1000 m. 1% derating for each 100 m above 1000 m; max. 2000 m
	Vibration: EN50178/EN60068-2-6	Amplitude/acceleration: • 10 Hz≦f≦57 Hz Fix Amplitude: 0.075mm • 57 Hz≦f≦150 Hz Fix Acceleration: 1G • Sweep rate: 1 octave/min Duration: 10 cycles per axis on each of three mutually perpendicular axes
	Shock EN50178, IEC 68-2-27	• Waveform: Half-sine • Operating: three shock pulses of 15G peak acceleration for 11 +/- 1 ms duration in each direction of three mutually perpendicular. • Non-operating: three shock pulses of 30G peak acceleration for 11 +/- 1 ms duration in each direction of three mutually perpendicular. Package drop test: ISTA Procedure 1A
	Enclosure class	IP20
	Weight	004: 1.2 kg, 007: 1.9 kg, 011: 4.2 kg, 020: 4.2 kg, 034: 7.5 kg
Safety		61800-5-1 (2007), EN60204-1 (2009), CE, UL, cUL, FI, IEC (see the unit's main sticker for more detailed approvals),
Protections	Over voltage protection	820 V_{DC} trip level
	Under voltage protection	333 V_{DC} trip level
	Earth-fault protection	$I_U+I_V+I_W > 0.05I_N$
	Unit over temperature	IGBT > 100 °C
	Unit under temperature	IGBT < -20 °C
	Overcurrent protection	Yes
	Motor overtemperature supervision	Yes

14 CABLES AND FUSES

Cabling can be done using cables recommended for crane installations. All cables must be dimensioned according to local regulations. Ambient temperature, cabling method (size of bundles, and so on) and allowable current for the cable must be taken into consideration. If there are no other regulations, the values in table below can be used (three phase 400V supply).

The table below is based on ED ≤ 60% and ambient temperature +40°C (104°F). A higher ambient temperature may require increased cable sizes.

The braking resistor cable is selected according to braking resistor current (I_{res}) for the resistors mentioned in document. Cables smaller than specified must not be used. The braking resistor current should be used only to select a thicker cable for higher ambient temperatures.

Power class	**004E**	**007E**	**011E**	**020E**	**034E**
Continuous current	3.4A	6.8A	10.4A	19.2A	33.8A
Fuse	10A	10A	16A	20A	35A
Motor cable default length	50m	50m	50m	50m	50m
Motor cable of default length at 40°C	1.5mm² AWG#14	1.5mm² AWG#14	2.5mm² AWG#14	4mm² AWG#12	10mm² AWG#8
Braking resistor current	2.5A	4.9A	4.9A	11.2A	19A
Braking resistor cable 40°C	2.5mm² AWG#14	2.5mm² AWG#14	2.5mm² AWG#14	2.5mm² AWG#14	2.5mm² AWG#14

Note: An ambient temperature higher than 40°C may require increased cable sizes.

To protect the supply cables against short circuit there must be fuses or motor circuit breakers (MCCBs) installed at the mains end of the supply cable. Dimensioning of the fuses or MCCBs depends on the cable used and on the type of primary fuses or MCCBs. If there are no other regulations, the values given in this section can be used to dimension fuses (three phase 400V supply).

Overload protection protects both the supply and the motor cables. Fuses of the supply provide protection against short circuit.

The maximum motor cable lengths in the preceding table are based on 150% of inverter rated current (=current during acceleration) and a 2.5 % voltage drop in the cable. For longer cables, the required conductor cross sectional area A (mm^2) is given by formula:

$$A = 2.43 \times \frac{l \times 1.5 \times I_F}{p \times U}$$

where
- l is the cable length (m)
- I_F is the motor current (A) at shaft power P_F
- p is the allowed voltage drop in %
- U is the nominal motor voltage

15 QUICK GUIDE

If any problems or malfunctions occur during the start-up, refer to *Chapter "Troubleshooting"*, to find out the reason. All problems must be solved before continuing.

WARNING	**High voltages inside device. Wait for at least five minutes after the supply voltage has been switched off before service actions. Display in operating condition (lights on) indicates a dangerous voltage on the DC-bus. When display turns off, the DC-bus voltage is about 100 V. Note also that there is a dangerous voltage in the braking resistor always when the DC-bus is charged.**

NOTICE	Do not connect any voltage to the output terminals (U/T1, V/T2, W/T3). Otherwise, the inverter will be damaged.

NOTICE	The overload protection protects both the supply and the motor cables. The supply fuses provide short circuit protection.

15.1 Visual checks

- Check condition of cubicles.
- Check that serial number of the drive is the same as in delivery documents.
- Check the cabling to braking resistor.
- Check the cabling to motor, brake, thermistors (and speed sensor).
- Check motor type.
- Check the wire terminations in the motor connection box
- Check connections for motor thermistors/ thermostat and brake wear.
- Disconnect motor (U, V, W) and brake cables to prevent damage of frequency converter. Measure insulation resistance of brake coil and motor windings (each phase to ground).
- Reconnect motor and brake cables.

15.2 Checks before the first test run

- Check power supply voltage (nominal voltage +/- 10%).
- Check control voltage (nominal voltage +/- 10%).
- Make sure that run commands are off (push-buttons / controller (zero position).
- Turn on power from main switch and control voltage switch.
- The control panel display is lit within about 1 second.
- In a fault situation, the FAULT status indicator blinks and the display shows a fault code instead of frequency.
- Check that RUN status indicator is off.
- Check that external connections and selected control parameters are according to application.
- Check that motor rotation direction is correct
- Check that motor runs steadily without abnormal noise and vibration
- Check that acceleration and deceleration are smooth

15.3 Check motor parameters

In most of cases parameters are properly set after factory tests and no adjustments are needed except for application-specific parameters.

If the factory has not had information about the motors, adjust the motor-related parameters with the steps described in this section. Write down on the parameter list all the values that have been changed and at the end save parameters to User parameters, see Chapter ″Parameters″.

15.3.1 Compact brake motors (MF06MA, MF06LA)

- Enter motor nominal voltage into parameter 02-01.

15.3.2 Other motors

- Enter motor nominal voltage into parameter 02-01. Enter motor parameter values according to the table in chapter “Default Parameters with Compact Brake Motors”.
- Enter motor nominal values into parameters 02-02 and 02-03.
- Perform Autotuning. See chapter "Autotuning"

15.4 Autotuning

Before Autotuning,

- Check motor connections.
- Check that parameters from 02-01 to 02-08 and 02-10 are set according to the delivery documentation and instructions in the chapter “Parameters”. Notice, parameter 02-09 is set by Autotuning.

- Set parameter Auto-tuning (02-08) value to 1 and Autotuning starts.

- If value changes to

    - 3, Autotuning was done successfully.
    - 4, Autotuning was failed. Try again, start from checking the connections.

NOTICE	Auto-tuning does not rotate the motor nor close the brake relay (i.e. open the brake).

The auto-tuning process determines the following U/f parameters:

Parameter number	Parameter name
02-09	Motor Stator Rs
03-01	Zero frequency voltage
03-02	Mid-point volt
03-03	Mid-point freq

15.5 Manual tuning

Before manual tuning,

- Check motor connections.
- Check that parameters from 02-01 to 02-08 and 02-10 are set according to the delivery documentation and instructions in the chapter “Parameters”.

Rs = stator resistance, parameter 02-09 Motor Stator Rs
Io = no-load current, parameter 02-04 No-load current
Uo = zero frequency voltage [% of motor nominal voltage], parameter 03-01
Umid = voltage at midpoint frequency [% of motor nominal voltage], parameter 03-02
Fmid = mid-point frequency, parameter 03-03

Measure motor stator resistance

- Switch off the power and disconnect the motor cables on motor output terminals.
- Measure the motor stator phase impedance Rs of cold motor on disconnected cable ends.
    - If there are several motors that are connected in parallel, the correct value is approximately the stator impedance of one motor that is divided by the number of motors.
- Connect the motor and switch on power.
- Set value to parameter 02-09 Motor Stator Rs.

Measure no-load current

- Check that there is no load on the hoist.
- Drive full speed and check motor current (Io) from display.
- Set value to parameter 02-04 No-load current.

Calculate starting values

- Calculate the values from where to start the tuning.
- Uo=Rs*Io/Un
- Umid=1.4*Uo
- fmid=Uo*fn
- Set values to parameters.
    - Uo to parameter 03-01 Zero frequency voltage
    - Umid to parameter 03-02 Mid-point voltage
    - fmid to parameter 03-03 Mid-point frequency

Adjust Umid

- Set minimum frequency parameter 01-03 to value fmid.
- Drive at minimum speed (=fmid).
- Check motor current from display. Motor current should be average of Io and sum of motor nominal currents.
- Increase or decrease Umid value (03-02) to increase or decrease current.

Adjust Uo

- Set minimum frequency parameter 01-03 to value fmid / 2.
- Drive at minimum speed (=fmid / 2).
- Check motor current from display. Motor current should be average of Io and sum of motor nominal currents.
- To increase or decrease current increase or decrease Uo (03-01) value.

Set minimum frequency parameter 01-03 back to original designed value

15.6 Test run without load

- Make sure that movement will not cause any danger to the environment or to the crane itself. Avoid driving close to the limit areas.
- Check limit switches manually if possible.
- Check the run commands on the display panel and correct the traveling direction. The arrow rotates clockwise if S1 is applied and counter-clockwise if S2 is applied.
- Drive direction S1 at minimum speed for 5 - 10 seconds. Accelerate to full speed. Run 5 - 10 seconds. Stop. Repeat the same in direction S2. Check the frequency display to make sure that the frequency changes through the whole operational frequency range from minimum to nominal speed.
- Check motor operation (acceleration, deceleration, and braking): accelerate to full speed direction S1, change to full speed direction S2 and full speed direction S1 again and stop.
- Check limit switch functions: drive direction S1 slowly and check the limit switch operations. Recheck using full speed. Repeat the same check for direction S2.

15.7 Test run with load

- Make sure that movement will not cause any danger to the environment or to the crane itself.
- Drive in both directions at minimum and maximum speeds.

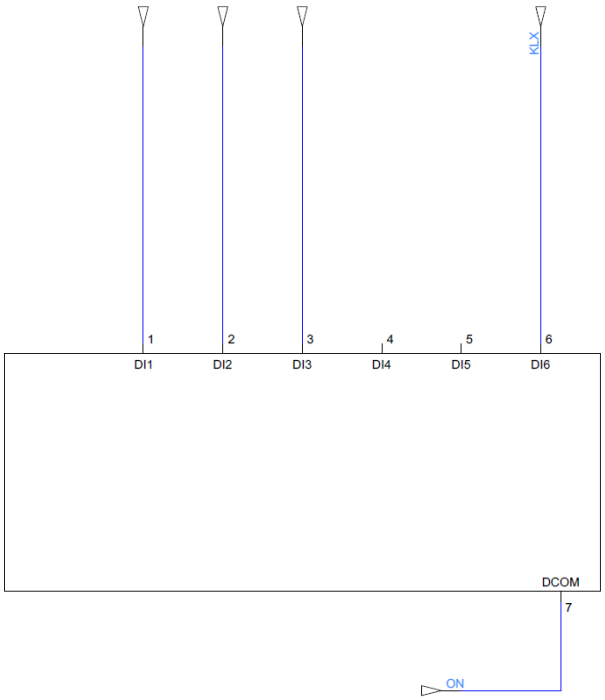
15.8 After the test run

- Record all parameter value changes in the parameter list.
- Make sure that all remarks and setting values are recorded.

NOTICE	It is recommended to store the parameter settings in file User parameters, see *chapter "Parameters"*.

16 APPENDIX 1, ELECTRICAL CONNECTIONS

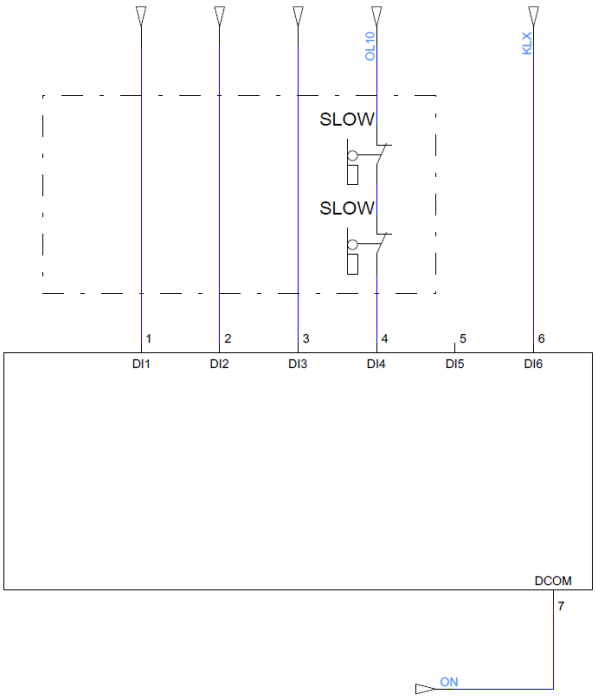
Sample electrical drawing for limit switch connections and brake control.



Parameter
01-06 InputSet = 1 :EP Slow
01-06 InputSet = 3: MS Slow
05-01 DI4 Deactivation = 1: input is inactive
05-02 DI5 Deactivation = 1: input is inactive
05-03 DI6 Deactivation = 0: input is active

DI1 Direction1
DI2 Direction2
DI3 Acceleration (EP) / Step 2 (MS)
DI4 inactive
DI5 inactive
DI6 External Stop
COM Control voltage neutral

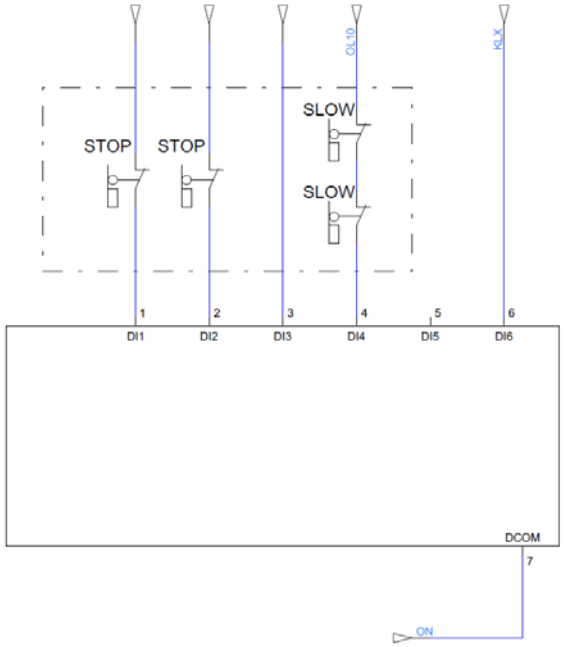
No limits



Parameter
01-06 InputSet = 1: EP Slow
01-06 InputSet = 3: MS Slow
05-01 DI4 Deactivation = 0: input is active
05-02 DI5 Deactivation = 1: input is inactive
05-03 DI6 Deactivation = 0: input is active

DI1 Direction1
DI2 Direction2
DI3 Acceleration (EP) / Step 2 (MS)
DI4 Slowdown limit S11/S21
DI5 inactive
DI6 External Stop
COM Control voltage neutral

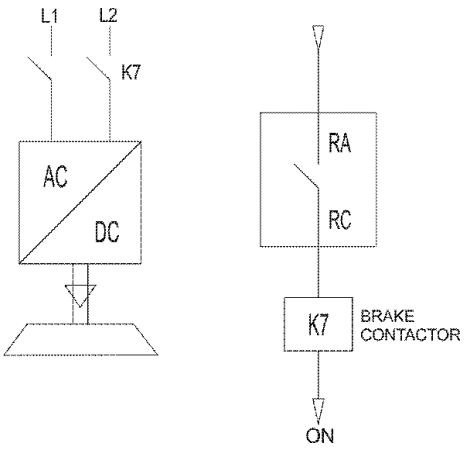
Slowdown limit



Parameter
01-06 InputSet = 1: EP Slow
01-06 InputSet = 3: MS Slow
05-01 DI4 Deactivation = 0: input is active
05-02 DI5 Deactivation = 1: input is inactive
05-03 DI6 Deactivation = 0: input is active

DI1 Direction1
DI2 Direction2
DI3 Acceleration (EP) / Step 2 (MS)
DI4 Slowdown limit S11/S21
DI5 inactive
DI6 External Stop
COM Control voltage neutral

Slowdown + stop limit



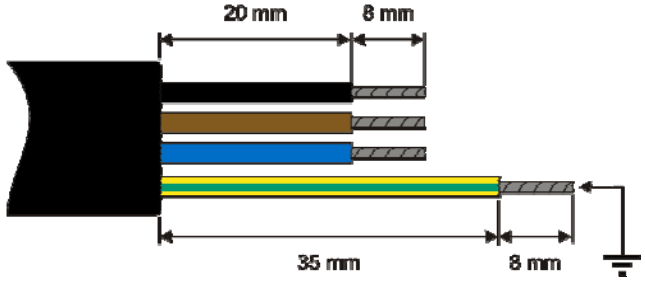
Brake control with diskbrake motors

NOTICE	All electrical connections shall do according to valid project specific electrical drawings.

17 APPENDIX, CABLE CONNECTIONS

17.1 Conductor diameter and stripping lengths

Use cables with heat resistance of at least 70°C.



17.2 Recommended tightening torques

CAUTION	**Loosen terminal screws with caution. Dropping terminal screws inside the equipment when unfitting them might cause serious damage to the equipment.**

The screw tightening torques of the power module terminals are:

Frame size (type)	Torque [Nm]
Frame A (004)	1.4
Frame B (007)	1.8
Frame C (011, 020)	2.9
Frame D (034)	5.6

Tightening torques for control input terminals:

		Torque [Nm]
Frame A, B, C	**Terminals 1**	0.5
	Terminals 2	0.2

CAUTION	**Do not over tighten the terminal screws. Over tightening can cause the terminal block to break. If the terminal block breaks, the entire frequency converter must be replaced.**

18 APPENDIX 2, DEFAULT PARAMETERS WITH COMPACT BRAKE MOTORS

02-06, DC-Brake Current Level: Maximum current of TDN can limit this value.

MF06MA100, 400V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	400	400	400
02-02	Motor Nominal Frequency	80	80	80
02-03	Motor Nominal Current	2.1	4.2	8.4
02-04	No-load Current	1.2	2.4	4.8
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0.63	0.63	0.63
02-09	Motor Stator Rs	19.50	9.75	4.87
02-10	Motor Type	0	0	0
03-01	Zero Frequency Voltage	9	9	9
03-02	Mid-Point Voltage	16	16	16
03-03	Mid-Point Frequency	8	8	8

MF06LA100, 400V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	400	400	400
02-02	Motor Nominal Frequency	80	80	80
02-03	Motor Nominal Current	2.1	4.2	8.4
02-04	No-load Current	1.1	2.2	4.4
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0.71	0.71	0.71
02-09	Motor Stator Rs	12.20	6.10	3.05
02-10	Motor Type	0	0	0
03-01	Zero Frequency Voltage	6	6	6
03-02	Mid-Point Voltage	12	12	12
03-03	Mid-Point Frequency	8	8	8

MF06LA200, 400V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	400	400	400
02-02	Motor Nominal Frequency	100	100	100
02-03	Motor Nominal Current	1.8	3.6	7.2
02-04	No-load Current	1.6	3.2	6.4
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0	0	0
02-09	Motor Stator Rs	14.70	7.35	3.67
02-10	Motor Type	0	0	0
03-01	Zero Frequency Voltage	8	8	8
03-02	Mid-Point Voltage	12	12	12
03-03	Mid-Point Frequency	10	10	10

MF06LA200, 460V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	460	460	460
02-02	Motor Nominal Frequency	120	120	120
02-03	Motor Nominal Current	1.8	3.6	7.2
02-04	No-load Current	1.6	3.2	6.4
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0	0	0
02-09	Motor Stator Rs	14.70	7.35	3.67
02-10	Motor Type	0.53	0.53	0.53
03-01	Zero Frequency Voltage	7	7	7
03-02	Mid-Point Voltage	10.4	10.4	10.4
03-03	Mid-Point Frequency	10	10	10

MF06MA200, 400V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	400	400	400
02-02	Motor Nominal Frequency	100	100	100
02-03	Motor Nominal Current	1.2	2.4	4.8
02-04	No-load Current	1	2	4
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0.57	0.57	0.57
02-09	Motor Stator Rs	34.00	17.00	8.50
02-10	Motor Type	0	0	0
03-01	Zero Frequency Voltage	10	10	10
03-02	Mid-Point Voltage	14	14	14
03-03	Mid-Point Frequency	10	10	10

MF06MA200, 460V		1 x	2 x	4 x
Code	Parameter name	Value	Value	Value
02-01	Motor Nominal Voltage	460	460	460
02-02	Motor Nominal Frequency	120	120	120
02-03	Motor Nominal Current	1.2	2.4	4.8
02-04	No-load Current	1	2	4
02-06	DC-Brake Current Level	3	6	12
02-07	Motor Cos Phi	0.59	0.59	0.59
02-09	Motor Stator Rs	34.00	17.00	8.50
02-10	Motor Type	0	0	0
03-01	Zero Frequency Voltage	8.7	8.7	8.7
03-02	Mid-Point Voltage	12.2	12.2	12.2
03-03	Mid-Point Frequency	10	10	10