Emotron VSD
Crane option 2.0

Instruction manual
English

emotron®
DEDICATED DRIVE

CRANE OPTION 2.0

Crane Option and Crane Interface

INSTRUCTION MANUAL — English

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Safety Instructions

Instruction manual

Read this instruction manual first!

Because this option is a supplementary part of the frequency inverter, the user must be acquainted with the original instruction manual of the main product. All safety instructions, warnings, etc. as mentioned in these instruction manual are to be known to the user.

Safety instructions

Read the safety instructions in the instruction manual for the main product.

Installation

Installation, commissioning, dismounting, making measurements, etc. on the main product may only be carried out by personnel who are technically qualified for the task. Installation must also be in accordance with the local standards. Ensure that all necessary safety measures are taken.

WARNING: Take all necessary safety precautions during installation and commissioning to prevent personal injuries, e.g. by an uncontrolled load.

Opening the frequency inverter

WARNING: Always switch off the mains supply before opening the inverter and wait at least 5 minutes to allow the buffer capacitors to discharge.

Always take adequate precautions before opening the frequency inverter, although the connections for the control signals and jumpers are isolated from the mains voltage.

Motor ID-run

For optimum performance of the inverter, it is recommended that a Motor ID-run be performed, menu [229]. For cranes only, a short ID-run without rotating the motor should be performed.

WARNING: Perform a short ID-run only without rotating the motor to prevent uncontrolled behaviour by the load, e.g. dropping.

Disconnecting the crane option board

CAUTION: Always deactivate the crane option board in menu [3A0] before disconnecting it.

Hoisting drives

CAUTION: Make sure the encoder function, menu [22B] and the deviation function (jumper j 101) are activated. The function Motor lost menu [423] must be set to Trip.

Check these functions carefully. They are safety related and prevent the load from falling down.

Contents

1 Introduction

This document is a complement to the instruction manual for the variable speed drive. Here we describe how to mount and connect the crane option. You will also find descriptions of crane applications and functions.

The crane option board is an option for the variable speed drives, which offers the inputs and outputs necessary for operating cranes. It can be extended with a crane interface option that provides mains isolated I/O when long control leads are used or to solve EMC problems.

Read this instruction manual carefully before commencing installation, or connecting or working with the variable speed drive with crane option board (and crane interface).

1.1 Crane option board

The crane option contains:

- Crane option board
- Flat cable control board (X5) - crane option board (X5)
- Mounting material
- This manual

1.2 Encoder option board

The Encoder option contains

- Encoder option board
- Flat cable control board (X5) - option board (X5)
- Mounting material
- Manual

NOTE: This option is only needed for hoisting drives with encoder feedback.

1.3 Crane interface

The crane interface is an interface that provides galvanic isolation, 24 VDC or 230 VAC, and signal adjustment when connecting control equipment to the crane option board.

When the crane option board is mounted inside the variable speed drive, the crane interface extension contains:

- Crane interface (suitable for DIN-rail mounting)
- Cable 20p header - 2x D-Sub (bottom of inverter)
- 2x Cable D-Sub -D-Sub

1.4 Notes, cautions, warnings and danger signs

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

NOTE: Additional information to avoid problems.

CAUTION: Failure to follow these instructions can result in malfunction or damage to the variable speed drive.

WARNING: Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the variable speed drive.

1.5 Standards

See the instruction manual for the variable speed drive.

2. Installation

This chapter describes how to mount the option mounting plate and an option board in the main product. Up to three different option boards and one communication board can be mounted.

2.1 Polarisation of flat cables

The flat cable is marked with colour on one side and has a tap on the micromatch male contact. This side must be matched to the female micromatch contact on the control board and option board respectively, where a small hole in the board is located.

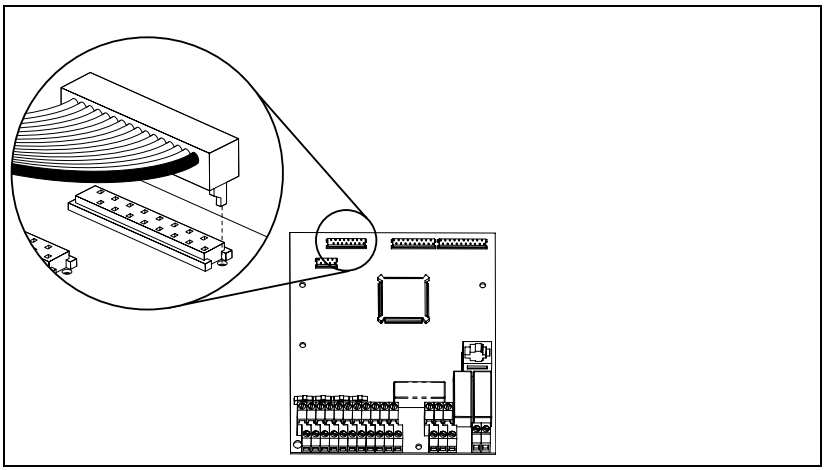


Fig. 1 Polarisation of flat cable

CAUTION: Incorrect connection might cause damage to both the option and to the control board/external equipment.

2.2 Mechanical mounting

Make sure that the main product has been switched off for at least five minutes to ensure that the capacitor bank is discharged before continuing with installation! Also make sure that no external equipment connected to the drive's interface is switched on.

NOTE: Correct installation is essential for fulfilling the EMC requirements and for proper operation of the module.

2.3 Mounting the first option board

The first option board is always mounted on the slot marked 1 on the mounting plate. In this example we assume that no other option board is installed.

Delivered with the option board kit

- Option board and four screws.
- 20-pole flat cable for connection to crane interface.

Mounting

1. Connect the 16-pole flat cable to the X5 connector on the control board with the cable downwards as in Fig. 2.

NOTE: The polarisation of the flat cable, see section 2.1 on page 5.

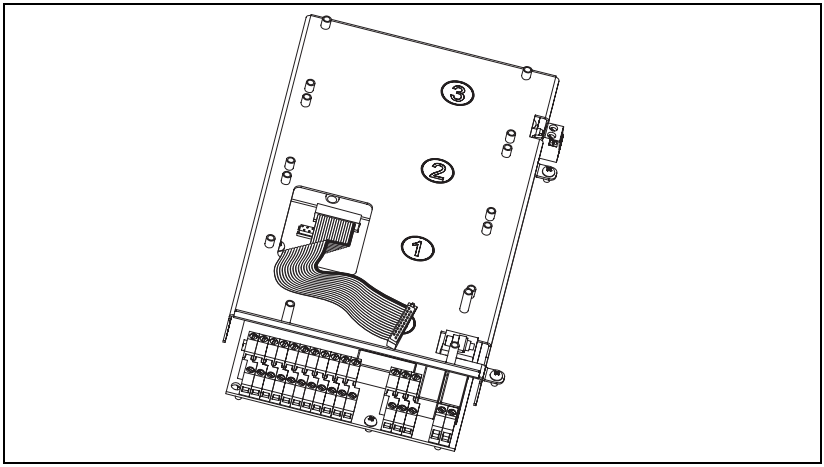


Fig. 2 Flat cable connected to the control board

2. Place the insulating sheet over the short spacers on the slot marked 1 on the mounting plate. Make sure the edge bent upwards is mounted towards the control board interface as in the figure below.

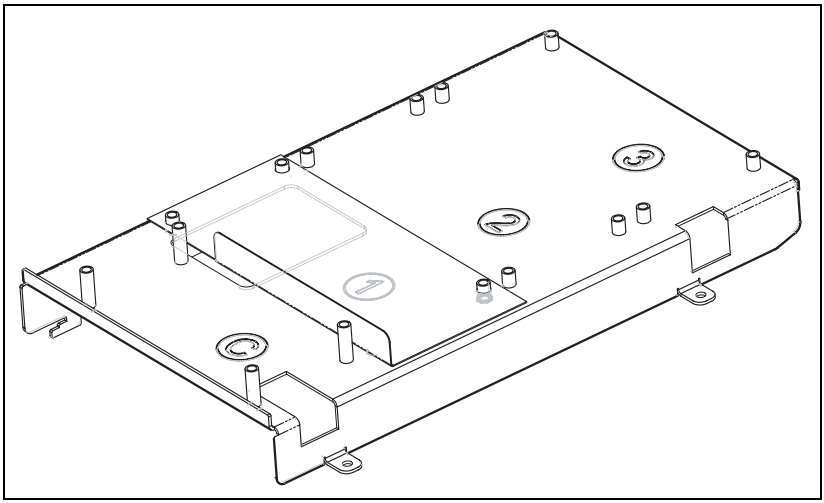


Fig. 3 Mounted insulating sheet

3. Connect the other end of the 16-pole flat cable to the X5A connector on the option board. Make sure that the polarisation is correct as in section 2.1 on page 5.

NOTE: Connect the micro match male contact to the option in the same manner as on the control board, i.e. the tap on the micro match contact must be fitted into the hole in the PCB.

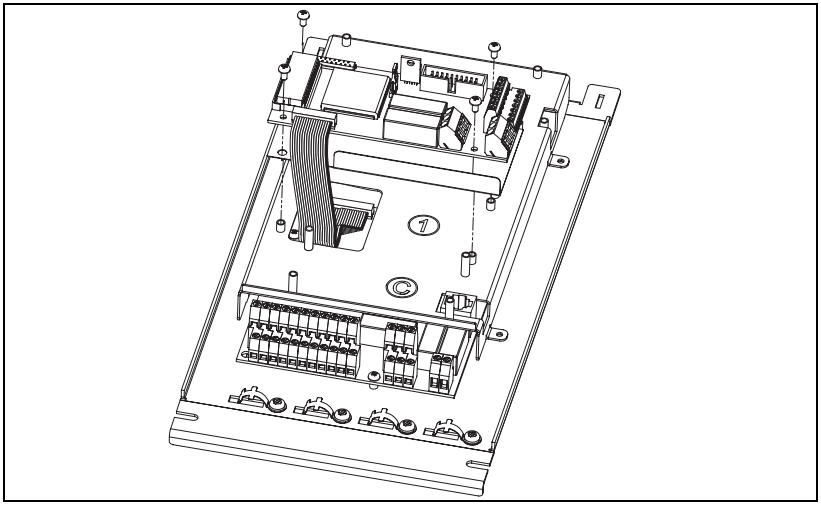


Fig. 4 Flat cable connected to the option board

4. Put the option board on the spacers.
5. Fasten the board using the four screws

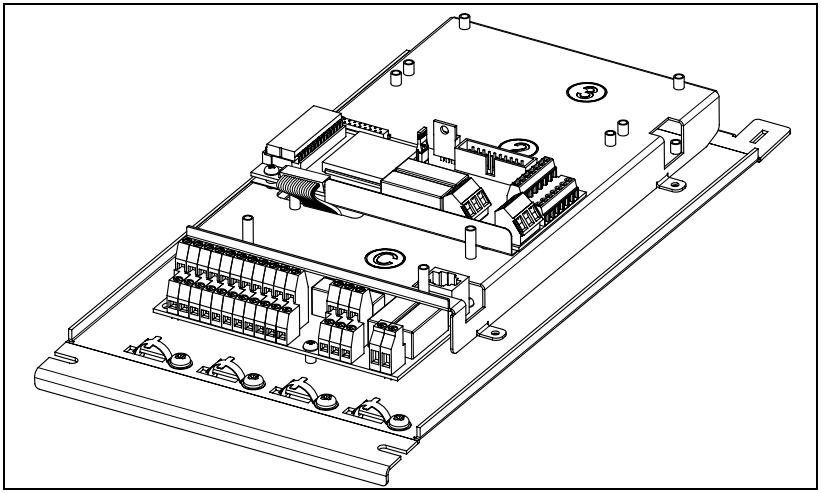


Fig. 5 Mounted option board

2.4 Mounting another option board

1. Place the insulating sheet on the spacers on the option board slot marked 2 or 3. It is necessary to select the slot closest to the already mounted option board.

NOTE: Place the insulating sheet with the turned up edge facing the interface of the control board to achieve proper insulation between the option boards.

2. Put the option board on the spacers.
3. Fasten the option board on the spacers using the four screws.
4. Connect the short flat cable between the X5B connector on the first option board and the X5A connector on the option board you have just mounted.

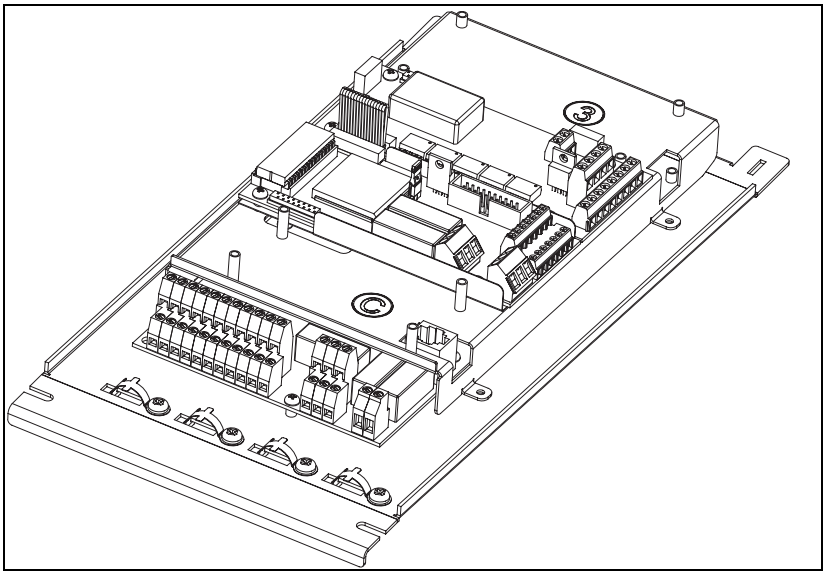


Fig. 6 Two option boards mounted on the option mounting plate

3. Control Connections for Crane Option

This chapter describes the control connections on the crane option board and the crane interface.

NOTE: All menu numbers refer to the setup menu as described in the VSD manual.

3.1 Crane option board control signals

3.1.1 Relays CR1 & 2

Specification: 2A/250 VAC/AC1

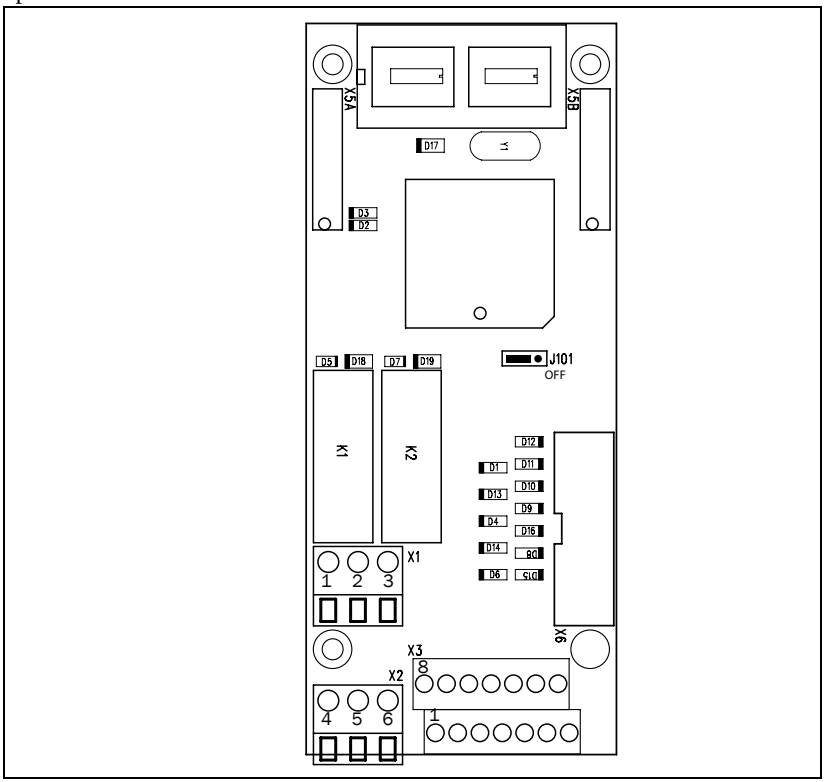


Fig. 7 Crane option board layout

Table 1 Function of terminals X1 and X2

Terminal		Name	Function
X1	1	CR1 P	Crane Relay CR1: central contact
	2	CR1 NC	Crane Relay CR1: normally closed contact; opens when CR1 is activated.
	3	CR1 NO	Crane Relay CR1: normally open contact; closes when CR1 is activated.
X2	4	CR2 P	Crane Relay CR2: central contact
	5	CR2 NC	Crane Relay CR2: normally closed contact; opens when CR2 is activated.
	6	CR2 NO	Crane Relay CR2: normally open contact; closes when CR2 is activated.

3.1.2 User interface

Specification:

All inputs are active high up to 24 V.

Voltage range: 8 - 24 VDC type

Max. input voltage: 30 VDC

Switching levels: HIGH >8 V min
LOW <4 V max

Input current: 1 mA type @8 VDC
5 mA type @24 VDC

Table 2 Function of terminal X3

Terminal	Name	Function
1	A1	Crawl Right/Hoist
2	B1	Preset Speed 2
3	E1	Limit Switch Right/Hoist
4	V2	Prelimit Switch Left/Lower
5	E2	Limit Switch Left/Lower
6	V1	Prelimit Switch Right/Hoist
7	A2	Crawl Left/Lower
8	N	Null Position
9	B2	Preset Speed 3
10	B3	Preset Speed 4
11	R1	2nd Acc/Dec Time via Parameter Set B
12	R2	Run: 1= Start, 0= Stop
13	Gnd	Signal Ground

NOTE: The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24 VDC.

3.2 Crane interface control signals

The LEDs indicate the status of the inputs and relays. F1 is the mains supply fuse and F2 the transformer secondary fuse.

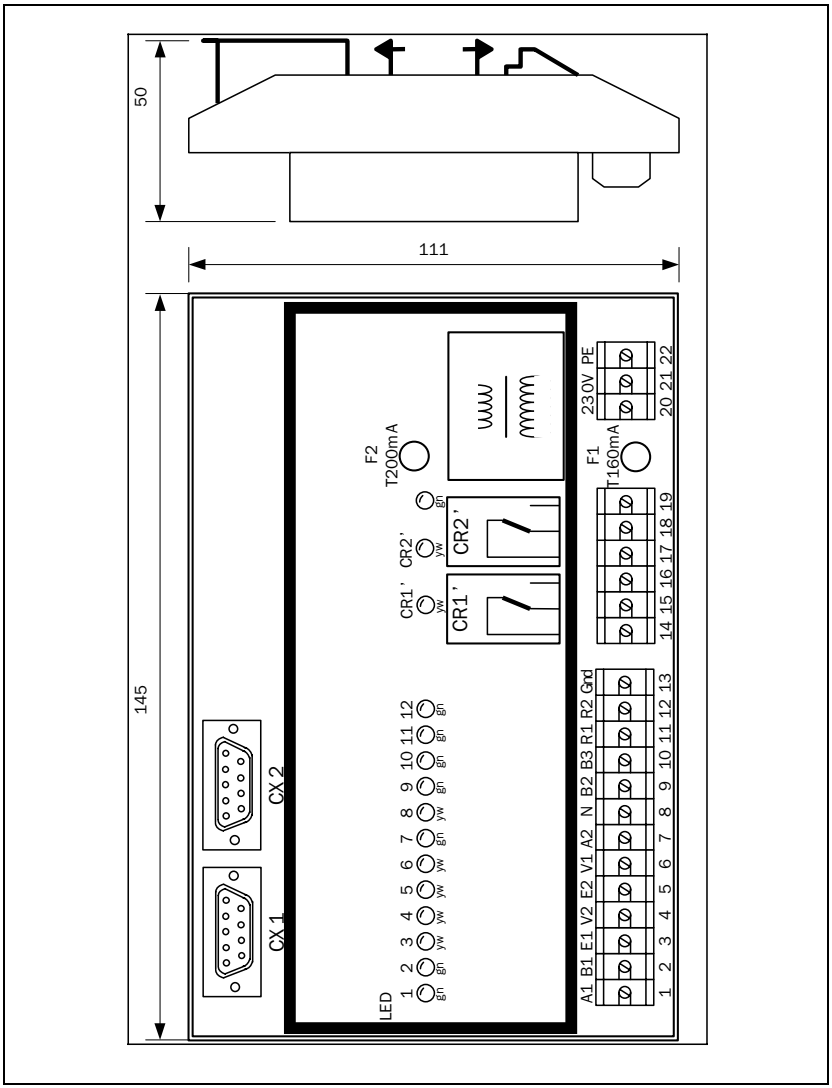


Fig. 8 Crane interface layout

3.2.1 Crane interface connections

All control inputs 1-12 are active high.

24 VDC version:

Input voltage 15-36 V type

Input resistance 2.7 kΩ

Input current 7 mA type @ 24 VDC

230 VAC version:

Input voltage 120-250 VAC type

Input resistance 27 kΩ

Input current 5 mA type @ 230 VAC

Table 3 Function of crane interface terminal strip

No.	Name	Function
1	A1	Crawl Speed H/R
2	B1	Preset Speed 2
3	E1	Limit Switch H/R
4	V2	Prelimit Switch L/L
5	E2	Limit Switch L/L
6	V1	Prelimit Switch H/R
7	A2	Crawl Speed L/L
8	Null	Null Position
9	B2	Preset Speed 3
10	B3	Preset Speed 4
11	R1	2nd Acc/Dec Rampvia Parameter Set B
12	R2	Run: 1= Start, 0= Stop
13	Gnd	Ground connection for control signals

Table 3 Function of crane interface terminal strip

No.	Name	Function
14	CR1 P	Identical function as crane relay 1. 250 VAC 1 A max.
15	CR1 NC	
16	CR1 NO	
17	CR2 P	Identical function as crane relay 2. 250 VAC 1 A max.
18	CR2 NC	
19	CR2 NO	
20	230V	Mains supply for the crane interface. 30 mA type.
21		
22	PE	Protective earth

NOTE: The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24VDC (or 230V for crane interface) when not in use.

3.2.2 Connector to crane interface

Connector X6 has the same signals as terminal X3 as well as signals describing the relays.

NOTE: Only used to connect the crane interface.

Table 4 Function of crane option terminal X6

Terminal	Name	Function
9	A1	Crawl Right/Hoist
8	B1	Preset Speed 2
7	E1	Limit Switch Right/Hoist
6	V2	Prelimit Switch Left/Lower
4	E2	Limit Switch Left/Lower
3	V1	Prelimit Switch Right/Hoist
2	A2	Crawl Left/Lower
1	N	Null Position
12	B2	Preset Speed 3
14	B3	Preset Speed 4
16	R1	2nd Ramp via Parameter Set B
18	R2	Run: 1= Start, 0= Stop
13	Gnd	Signal Ground
15	Gnd	Signal Ground
5	Gnd	Signal Ground
10		Unused
11		Unused
17		Unused
19	CR2	'High (24V/4.7 kΩ) when Crane Relay CR2 activated
20	CR1	'High (24V/4.7 kΩ) when Crane Relay CR1 activated

3.2.3 Programming inverter for riding applications

NOTE: If more than one motor is connected to the inverter for riding applications, set menu [213] Drive Mode = V/Hz.

- For riding applications the deviation function is not necessary. Switch off the mains supply. Set Jumper J101 on the crane option board to "Deviation off".
- Set in menu [3A1] Crane = On.
- Execute Load Defaults - Factory in menu [243]. This instruction activates crane specific default values for menus [214], [215] and [241].
- After initialising, the inverter operates in Parameter Set B, because it always starts at 0 rpm with the 2nd Acc/Dec Time.
- Enter the motor data according to menu [220] and execute a short ID-run without rotating the motor (menu [229]=short) for optimum performance.

WARNING: It is dangerous to perform an extended ID-run with the motor coupled to the cable drum, because the motor will then run at high speeds in both directions.

- Set the control selection in menu [3A2], Control, according to the controller used.
- Set all parameters in menu [300] and all I/O in menu [500] as required by the application. For example [343] Max Speed, [331] Acceleration Time, [332] Deceleration Time, [33C] to [33F] brake settings.
- Set all the other parameters/functions to their required settings. The Menu List in the manual for the main product can be used as a guideline and filled in by the user for later reference.
- Copy in menu [242] Parameter Set B to A (B>A).

- When an encoder is used check if the encoder is correctly installed by verifying that the speed direction shown in menu [22D] and [100] is the same. If the direction is not the same, change the signals, A with B and A' with B' on terminal X1 on the Encoder option board.
- Set Encoder = On in menu [22B], if encoder is used.
- Copy in menu [242] Parameter Set B to A (B>A).
- Change menu [331] B:Acc Time and menu [332] B:Dec Time to the required values.

3.2.4 Programming inverter for hoisting applications

WARNING: Contact your supplier if multi-motor operation occurs in hoisting applications.

- For hoisting applications the deviation function is needed. Switch off the mains supply. Temporaily set jumper J101 on the crane option board to "Deviation off". The function is activated later.
- Set in menu [3A1] Crane = On
- Execute Load Defaults - Factory in menu [243]. This instruction activates crane specific default values for menus [214], [215] and [241].
- After initialising, the inverter operates in Parameter Set B, because it always starts at 0 rpm with the 2nd Acc/Dec Time.
- Enter the motor data acc. to menu [220] and execute a short ID-run without rotating the motor, menu [229]=short, for optimum performance.

WARNING: It is dangerous to perform an extended ID-run with the motor coupled to the cable drum, because the motor will then run at high speeds in both directions.

- Set the control selection in menu [3A2], Control, according to the controller used.

- Set all parameters in menu [300] and all I/O in menu [500] as required by the application. For example [343] Max Speed, [331] Acceleration Time, [332] Deceleration Time, [33C] to [33F] brake settings.
- Set all the other parameters/functions to their required settings. The Menu List in the manual for the main product can be used as a guideline and filled in by the user for later reference.
- Copy in menu [242] Parameter Set B to A (B>A).
- When an encoder is used check if the encoder is correctly installed by verifying that the speed direction shown in menu [22D] and [100] is the same. If the direction is not the same, change the signals, A with B and A' with B' on terminal X1 on the Encoder option board.
- Set Encoder = On in menu [22B], if encoder is used.
- Copy in menu [242] Parameter Set B to A (B>A).
- Switch off the mains supply. Set the jumper J101 on the crane option board to "Deviation on".
- Change menu [3AB] and [3AC] (Deviation settings) to the required values.
- Copy in menu [242] Parameter Set B to A (B>A).
- Change menu [331] B:Acc Time and [332] B:Dec Time to the required values.

WARNING! Make sure the deviation function, Jumper J 101 is activated. The function Motor lost, menu [423] must be set to Trip. Check these functions carefully. They are safety related and prevent the load from falling down.

4. Control connections on Encoder option board

4.1 Board layout

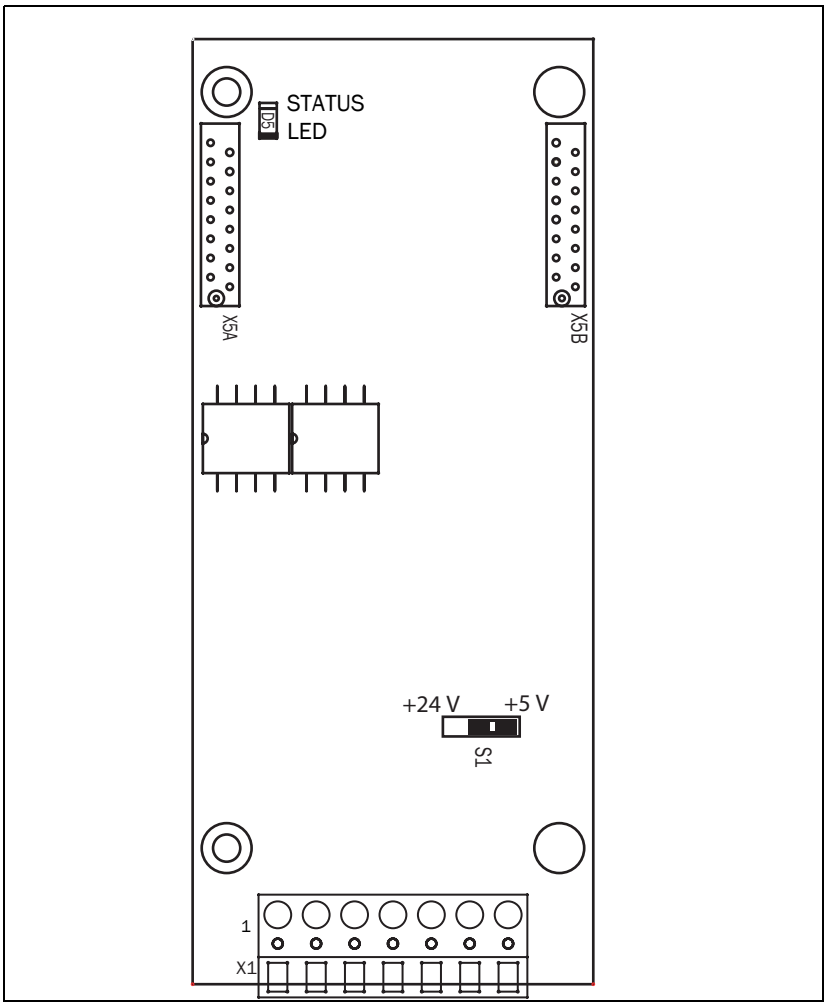


Fig. 9 Encoder option board layout

4.2 General information

4.2.1 Menus

The following menus are available when the Encoder option board is mounted in the main product.

All menus are described in the manual for the main product.

Table 5 Menus available with the Encoder option board installed

Menu	Function	Default	Range/Selection
22B	Encoder	Off	On = Encoder enabled Off = Encoder disabled
22C	Enc Pulse	1024	5-16384 pulse/rev
22D	Enc Speed		Measured motor speed

4.2.2 Status LED

Table 6 Specification of status LED

LED	Specification
D5	Flashing slow (1 Hz) = OK On = communication error Off = no power supply

4.2.3 Cable recommendations and shielding

Shielded twisted pair cables are recommended. Connect the cable shield firmly (low ohmic connection) to the mounting plate (PE) according to picture below.

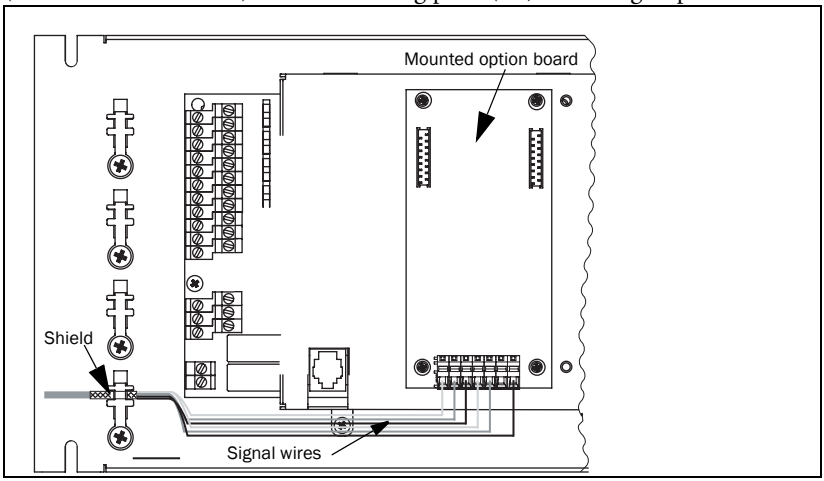


Fig. 10 General shielding

The shield must end at the clamp. Only the signal wires should continue to the terminals of the Encoder option board.

In most cases it is recommended that both ends of the shield are connected to PE. This will give a good attenuation of high frequency interference. Shield connection should be made with the largest possible area.

Make sure that you select a cable of material appropriate for your environment. Consider ambient temperature, humidity and occurrence of chemical substances such as oil. Standard copper wire with crossing area of approximately 0.14 - 1.5 mm^2 will be sufficient in most cases.

4.2.4 Isolation

The encoder circuit on this option board is separated from the control board SELV circuit with functional insulation only. It is therefore important that the encoder and encoder connections are separated from live parts with double or reinforced insulation for the relevant voltage.

WARNING: It is mandatory to use an external encoder with double or reinforced insulation towards live parts.

4.3 Encoder interface

WARNING: Before connecting the Encoder to the Encoder option board, check the voltage rating of the encoder and make sure that the S1 switch on the Encoder option board is set to the correct position.

Terminal X1 has the following terminal configuration starting from the left:

Table 7 Encoder interface, terminal X1

X1	Name	Function	Remarks
1	Gnd	Signal ground	
2	A	Signal A	See the specification Table 9.
3	A'	Signal A' (inverted)	
4	B	Signal B	
5	B'	Signal B' (inverted)	
6	½ V_{sup}	Half power supply voltage	Used for non-differential encoder inputs
7	V_{sup}	Supply voltage to encoder; +24 VDC or +5 VDC.	Correct supply voltage must be set with S1 on the option board

NOTE: When the encoder is powered by an external supply (i.e. not by the Encoder option board itself) a +5V or +24V voltage source should be used.

NOTE: Only incremental encoder types can be used.

NOTE: This Encoder option board can handle both TTL and HTL type of incremental encoders by selecting the corresponding supply voltage with switch S1.

4.3.1 Using differential signals

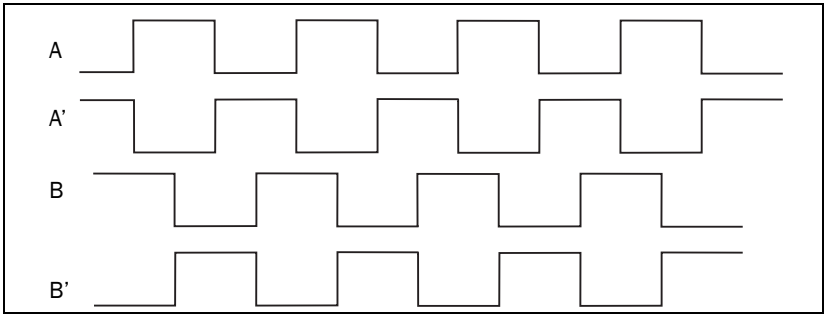


Fig. 11 Example of two differential channels which are 90 degrees out of phase.

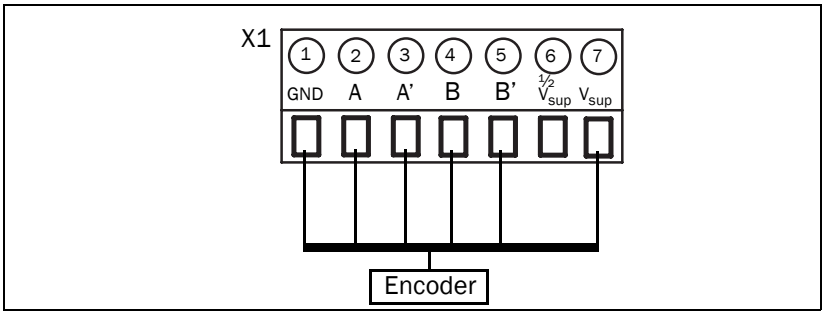


Fig. 12 Connection on terminal.

4.3.2 Using non-differential signals

In this case the two inverted input terminals A' and B' should be connected to half of the power supply (X1:6).

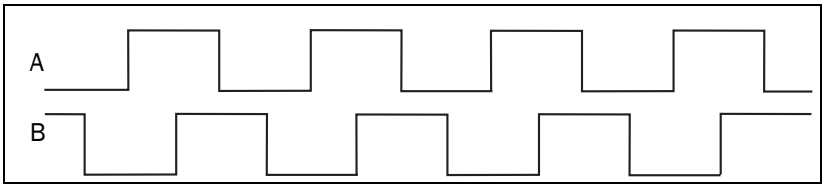


Fig. 13 Example of two non-differential channels which are 90 degrees out of phase.

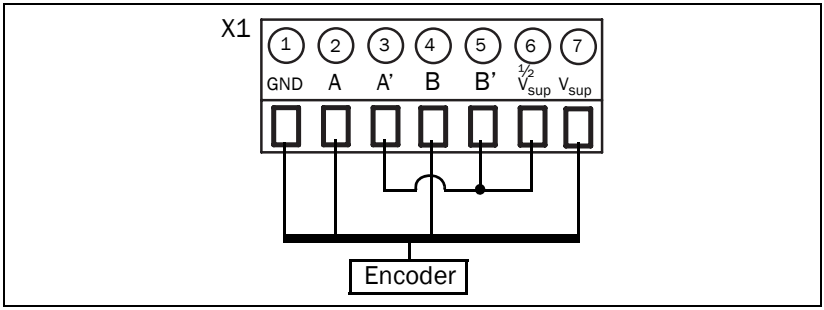


Fig. 14 Connection on terminal

4.3.3 Electrical specification encoder power output interface

Table 8 Setting of switch S1

Position	Description
+24	Power supply on terminal X1:7 is +24 VDC
+5	Power supply on terminal X1:7 is +5 VDC

Table 9

Allowed voltage amplitude input	+5 - 24 VDC
Input impedance	min 9 kΩ
Supply to encoder	+5/24 VDC - 100 mA max selected by switch S1
Pulse range (adjustable in inverter)	5 – 16384 pulse/rev
Max input frequency	100 kHz
Differential input sensitivity	±200 mV

5. Applications and Functions

5.1 Crane applications

The crane option board is especially developed for crane applications. Apart from the three possible controller configurations (4-0-4, 3-pos or analogue controllers) it has inputs for prelimit and limit switches. For hoisting applications an encoder can be connected, which is mandatory when the deviation function is used. Crane specific functions are fast reversing, parameter set B, pre-magnetised motor for fast starting and special brake functions. For retrofitting the crane interface can be used. It has 230 VAC control inputs (other voltages on request) and provides galvanic isolation. LED status indication makes the commissioning easier.

Crane option board

- 12 digital input connections for controller (4-0-4, 3-pos or analogue) (pre)limit switches, null position, parameter set B, inverter stage deactivation
- Relays for brake control and deviation function

Crane interface

- Externally mounted on DIN-rail
- Connected to the crane option board via the 20-pole flat cable connector
- Control inputs 230 VAC (other voltages on request)
- LED status indication
- Galvanic isolation

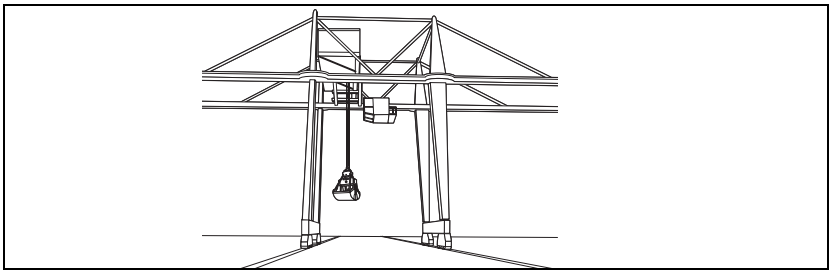


Fig. 15

5.2 Hoist application

This section describes the functions that can be used in a hoist application.

Several functions are available when using crane option, such as:

- Simultaneous operation of the hoisting movement and the opening and closing of the grabber to shorten cycle time.
- Fast yet smooth start thanks to matching rapid direct torque control, fast pre-magnetization of the motor and precise brake control.
- Fast yet smooth stop by using the VFX rapid vector brake and brake chopper, together with direct torque control.

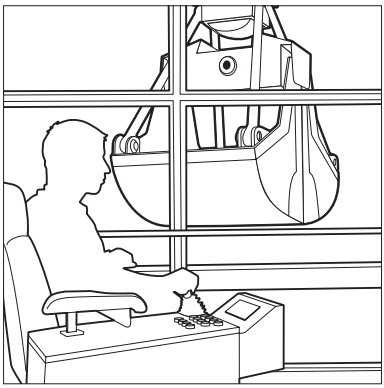


Fig. 16

5.3 Riding application

This section describes the functions that can be used in a riding application.

For riding applications the variable speed drive offers high end functionality such as:

- Fast and safe movement to end position of the crane can be programmed for safe, automatic stopping. The crane can be moved at full speed to the end position without jerky movements that may jeopardize the load.
- With an additional option you can maintain a fully synchronous ride that makes the crane ride fully parallel to the rail. This means much less wear on the wheels, resulting in less maintenance being required. the wheels need to be changed approximately every 5 years with normal wear, compared to as often as every 3 months with asynchronized riding.

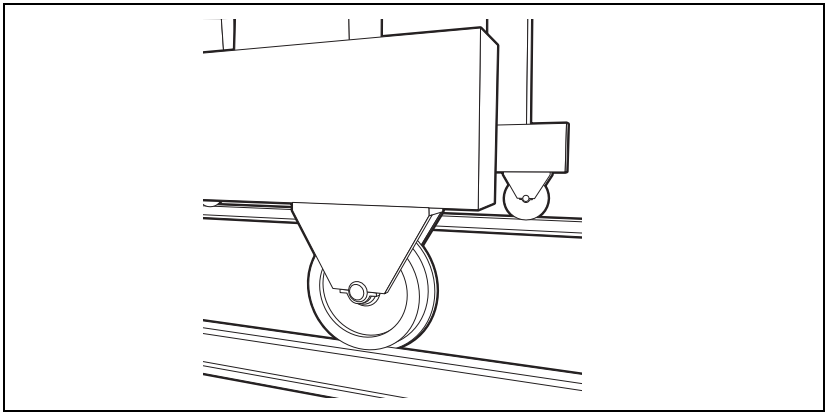


Fig. 17

5.4 Control functions

5.4.1 4-speed controller operation

Connection example for 4-speed controller operation

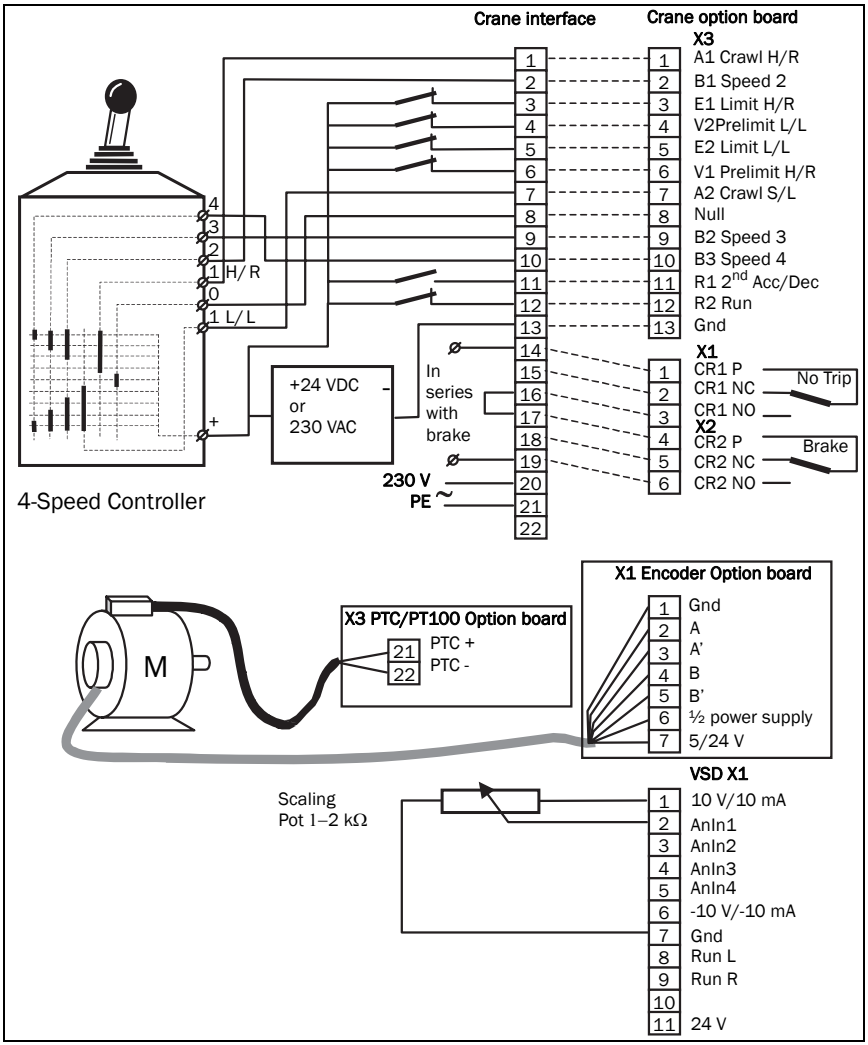


Fig. 18 Connection diagram for 4-Speed controller operation

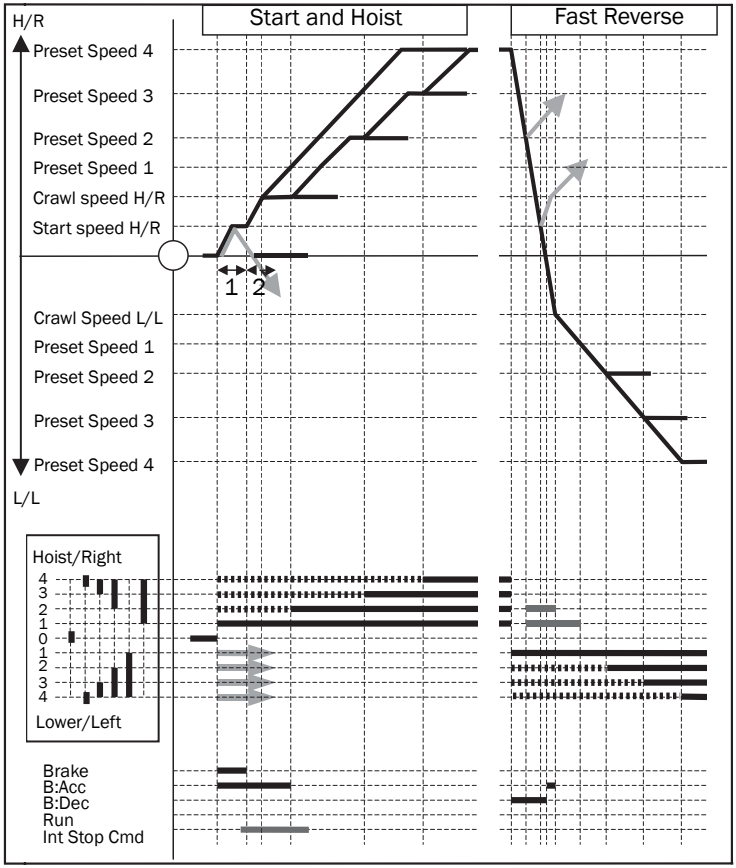
Setting the speeds for 4-speed controller operation

Menu no.	Menu name	Function/Value
3A1	Crane enable	On
3A2	Control	4-speed
3A3	Crane Relay1	No trip
3A4	Crane Relay2	Brake
3A5	PreLimSwSpd	Pre Limit sw
3A6	CrawlSpd H/R	Crawl H/R
3A7	CrawlSpd L/L	Crawl L/L
3A8	Speed 2	Speed 2
3A9	Speed 3	Speed 3
3AA	Speed 4	Speed 4
3AB	Dev Bandwidt	Deviation Bandwidth
3AC	Dev Time	Deviation Time
3AD	LAFS Load	Set Load

Setting the brake functions

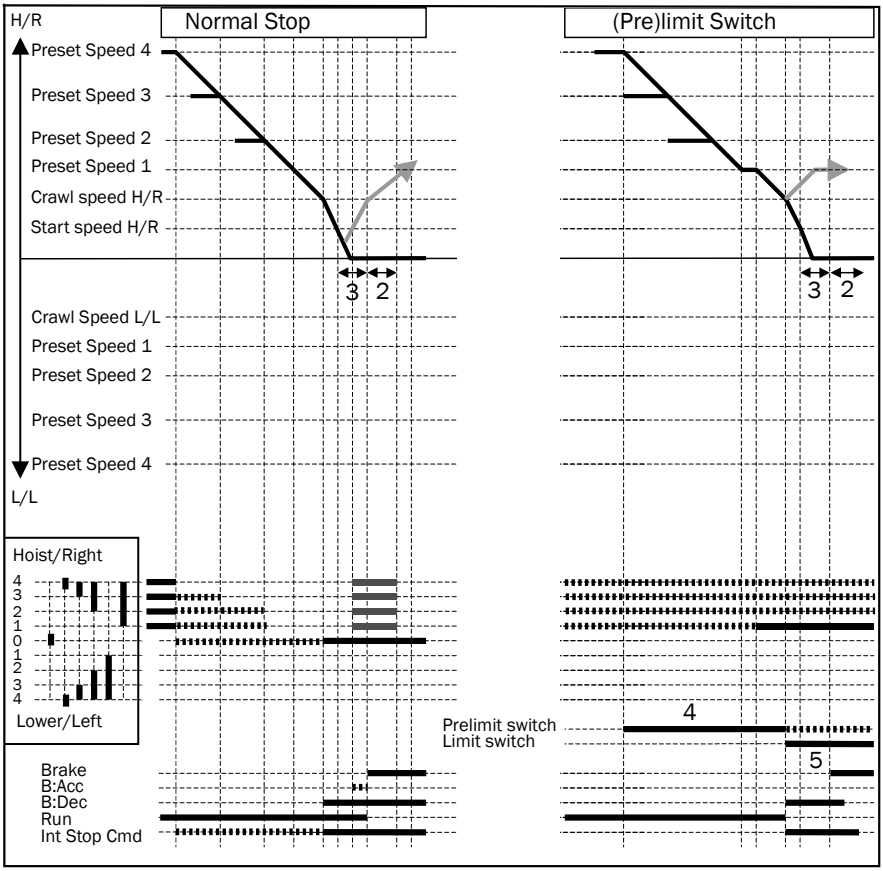
Menu no.	Menu name	Function/Selection
33C	Brk Release	Brake Release time
33D	Brk Spd	Release Speed
33E	Brk Engage	Brake Engage time
33F	Brk Wait	Brake Wait time

NOTE: The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24 VDC (or 230V for crane interface) when not in use.



1. Brake release
2. Brake engage

Fig. 19 General diagram for 4-speed controller operation



2. Brake engage
3. Brake wait
4. When prelimit switch active only speed between Crawl Speed and Preset Speed 1 in moving direction or reverse speeds possible.
5. When limit switch active only reverse speeds possible.

Fig. 20 General diagram for 4-speed controller operation

5.4.2 3-pos switch operation

Connection example for 3-position switch operation

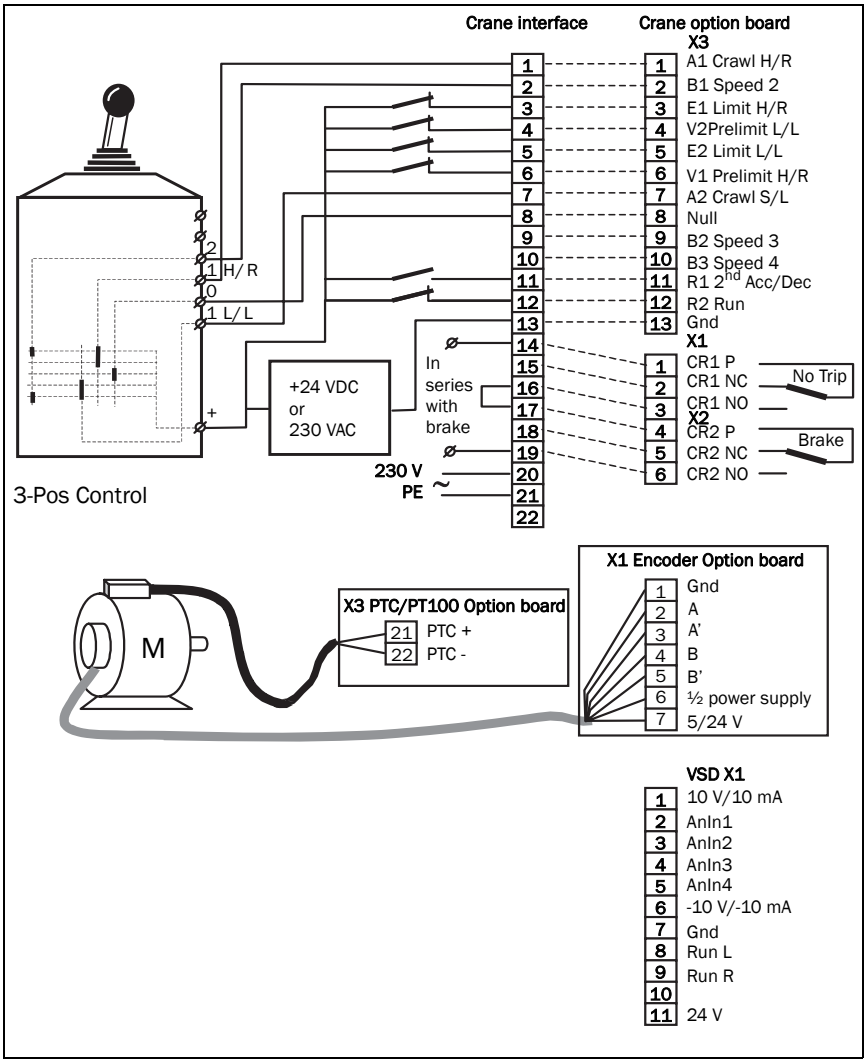


Fig. 21 Connection diagram for 3-position switch operation

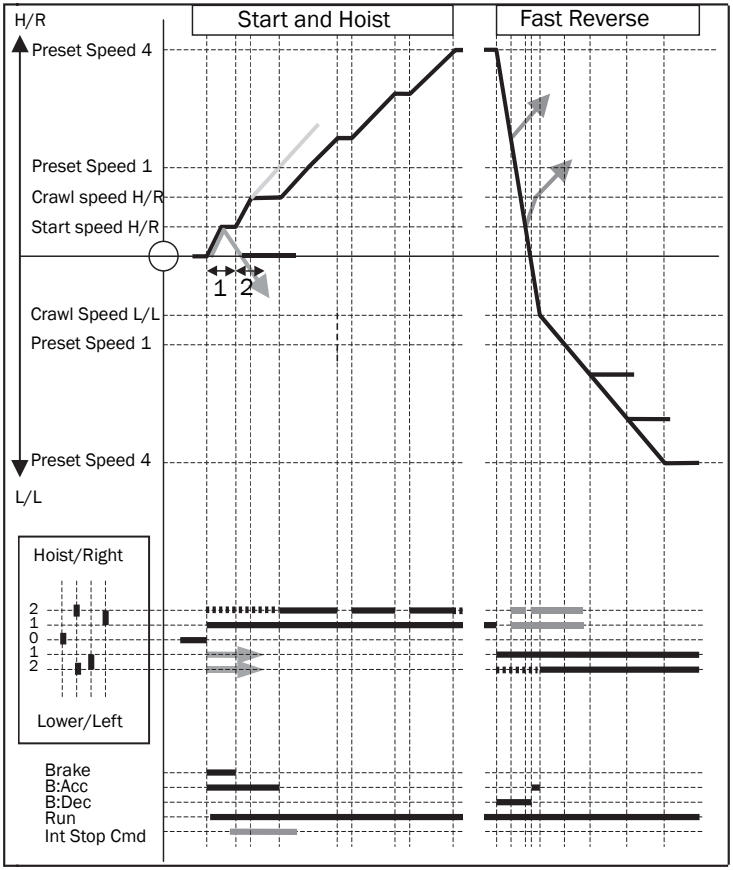
Setting the speeds for 3-position switch operation

Menu no.	Menu name	Function
3A1	Crane Enable	On
3A2	Control	3-pos
3A3	Crane Relay1	No trip
3A4	Crane Relay2	Brake
3A5	PreLimSwSpd	Pre Limit sw
3A6	CrawlSpd H/R	Crawl H/R
3A7	CrawlSpd L/L	Crawl L/L
3AA	Speed 4	Speed 4
3AB	Dev Bandwidt	Deviation Bandwidth
3AC	Dev Time	Deviation Time
3AD	LAFS Load	Set Load

Setting the brake functions

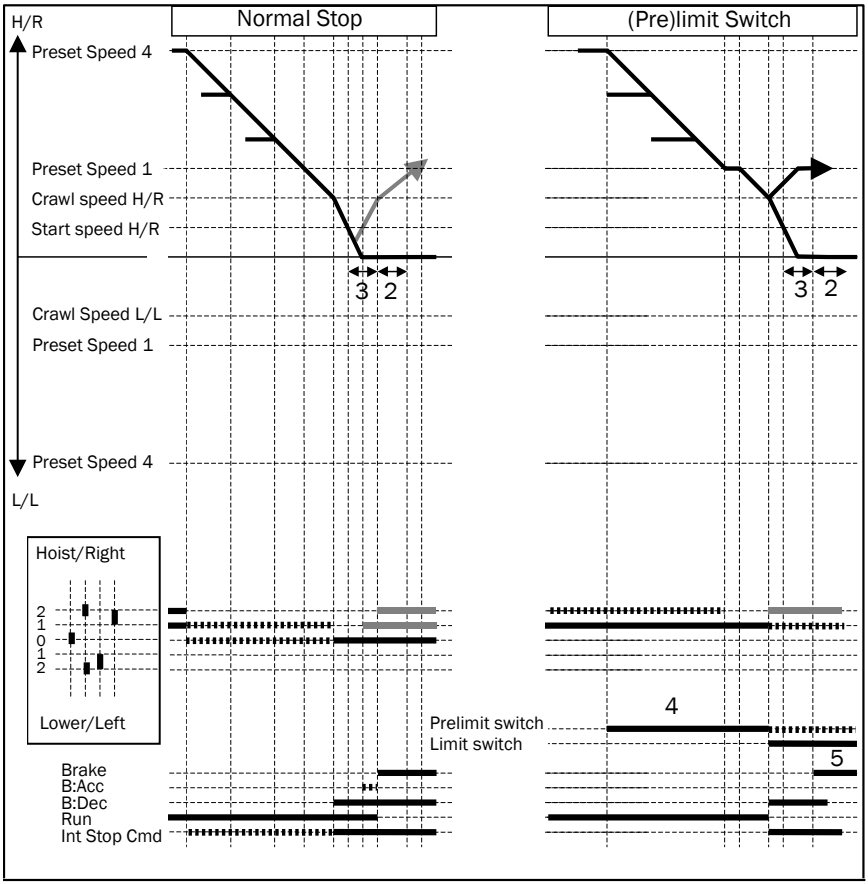
Menu no.	Menu name	Function/Selection
33C	Brk Release	Brake Release time
33D	Brk Spd	Release Speed
33E	Brk Engage	Brake Engage time
33F	Brk Wait	Brake Wait time

NOTE! The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24 VDC (or 230V for crane interface) when not in use.



1. Brake release
2. Brake engage

Fig. 22 General diagram for 3-position switch operation



2. Brake engage
3. Brake wait
4. When prelimit switch active only speed between Crawl Speed and Preset Speed 1 in moving direction or reverse speeds possible.
5. When limit switch active only reverse speeds possible.

Fig. 23 General diagram for 3-position switch operation

5.4.3 Analogue control

Connection example for 4-20 mA analogue control operation

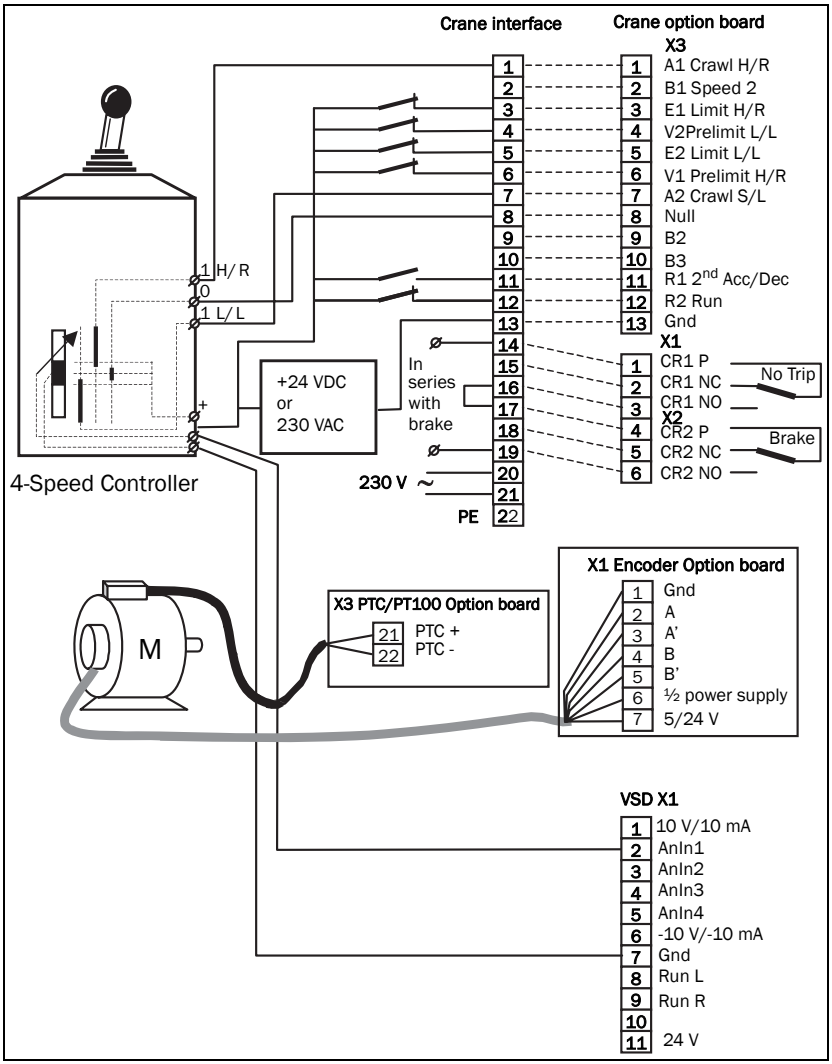


Fig. 24 Connection diagram for 4-20 mA analogue control operation

Setting up analogue control operation

Menu no.	Menu name	Function
3A1	Crane Enable	On
3A2	Control	Analogue
3A3	Crane Relay1	No trip
3A4	Crane Relay2	Brake
3A5	PreLimSwSpd	Pre Limit sw
3A6	CrawlSpd H/R	Crawl H/R
3A7	CrawlSpd L/L	Crawl L/L
3AA	Speed 4	Speed 4
3AB	Dev Bandwidt	Deviation Bandwidth
3AC	Dev Time	Deviation Time
3AD	LAFS Load	Set Load

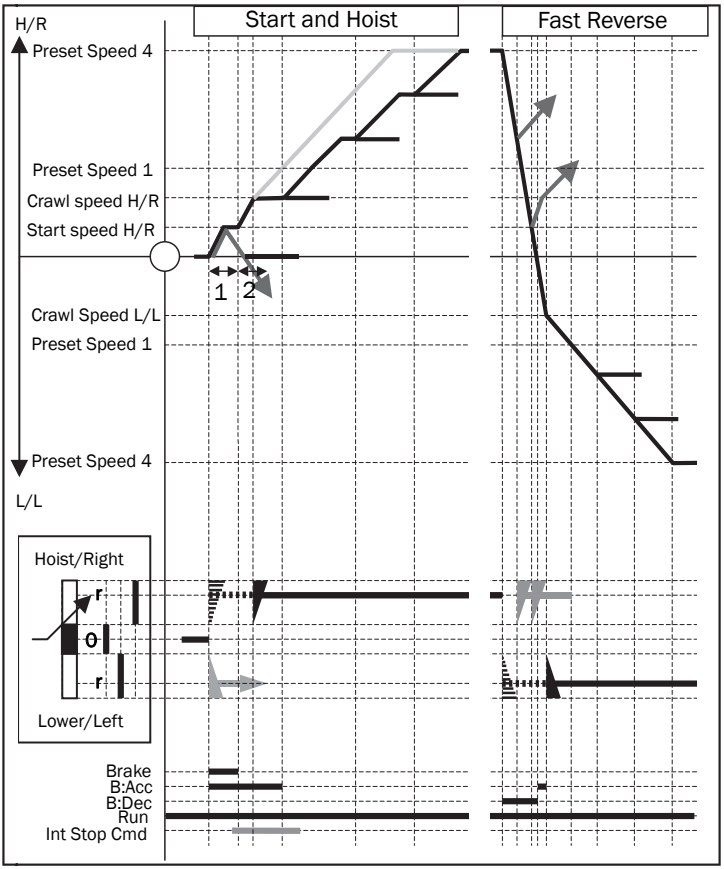
Setting the brake functions

Menu no.	Menu name	Function/Selection
33C	Brk Release	Brake Release time
33D	Brk Spd	Release Speed
33E	Brk Engage	Brake Engage time
33F	Brk Wait	Brake Wait time

Setting the AnIn1 Setup

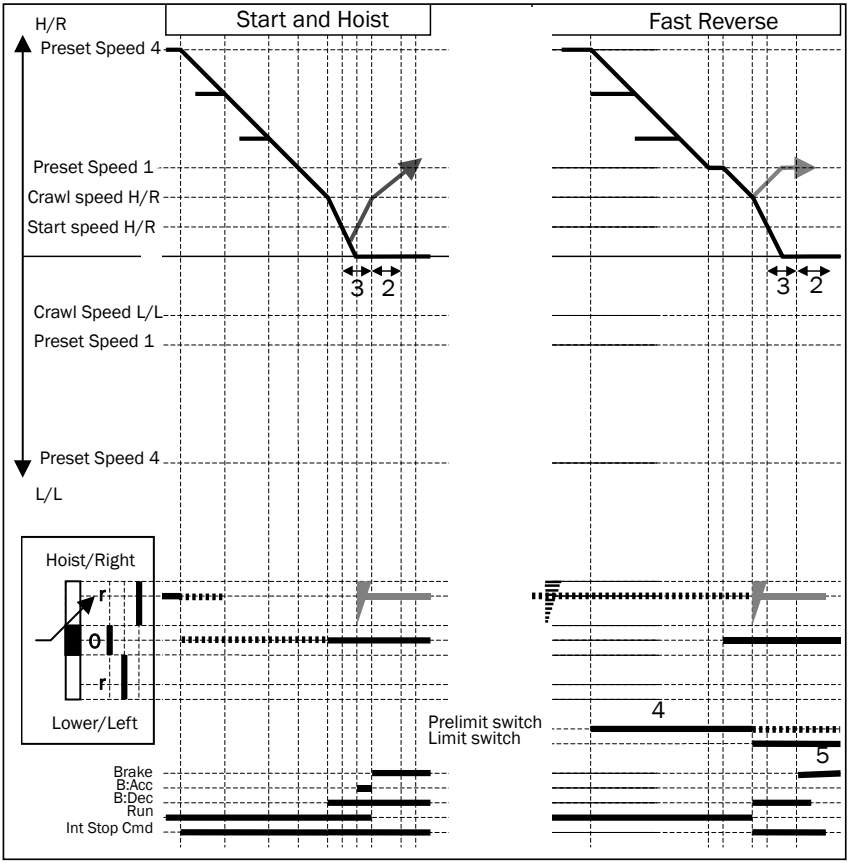
Menu no.	Menu name	Function/Selection
512	AnIn1 Setup	2-10 V/4-20 mA (if 4-20 mA to be selected)

NOTE: The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24 VDC (or 230V for crane interface) when not in use.



1. Brake release
2. Brake engage

Fig. 25 General diagram for analogue control operation



2. Brake engage
3. Brake wait
4. When prelimit switch active only speed between Crawl Speed and Preset Speed 1 in moving direction or reverse speeds possible.
5. When limit switch active only reverse speeds possible.

Fig. 26 General diagram for analogue control operation

5.5 Functions

5.5.1 Deviation

Deviation is a special safeguard function for a crane's hoisting function that prevents the load from falling. For safety reasons it cannot be performed by the inverter itself but must be performed by an independent unit, in this case the crane option board. This is because it functions independently after it has been initialised, although it uses information from the inverter.

WARNING: Depending on local regulations it may be necessary to install a fully independent safety system, including control of the mechanical brake.

Deviation function

The deviation function compares the actual reference speed on the inverter's internal ramp signal with the motor speed from the encoder and determines whether they match or not, with the direction also being taken into account. If they do not match, the load is assumed to be "lost", the crane board switches Relay CR1 (Deviation) and the inverter activates the relay output for the mechanical brake and trips. Also the communication between crane board and inverter is monitored. After a communication time-out of approx. 600 ms the crane board relays activate accordingly. This condition automatically ends when the communication is restored.

CAUTION: When menu [3A2] Control = Analogue the inverter reference speed does not come from the crane board but from an analogue input (AnIn1 to AnIn4).

If the difference between the reference speed and encoder speed, set in menu [3AB], Deviation Band (rpm), is exceeded, the deviation function will be activated.

The minimum duration for the difference to exceed the bandwidth before the deviation function is activated is set in menu [3AC], Deviation Time.

NOTE: An encoder is mandatory for the deviation function.

(De)activating deviation function

For riding movements the deviation function is switched off by the jumper on the crane option board.

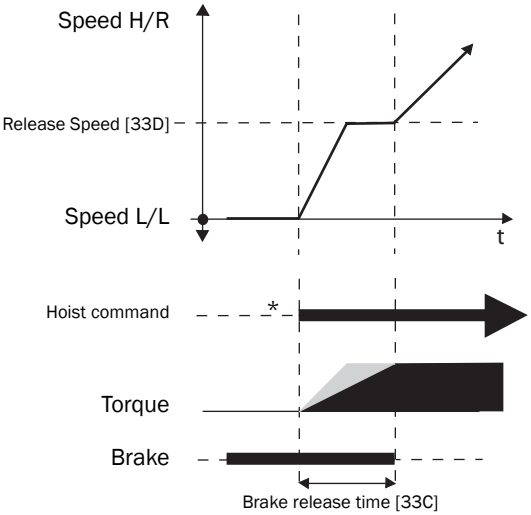
Jumper J101 setting	
	Deviation function activated
	Deviation function deactivated

5.5.2 Mechanical brake

The mechanical brake is used to achieve a smooth change-over from run to stop and vice versa. The mechanical brake can be controlled by selecting the “Brake” function for the relays R1 and R2 on the control board or the relay CR2. This is the default setting of relay CR2.

Mechanical brake function at start

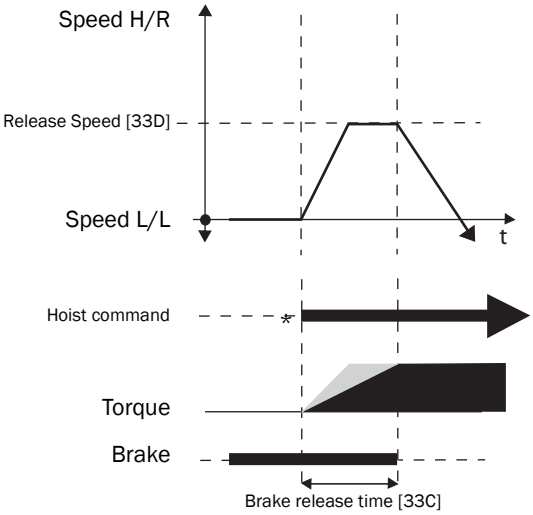
After a start hoisting command, also see Fig.27 below, the speed increases up to the Release Speed H/R. After the brake release time the speed is allowed to increase further, depending on the speed reference of course. The brake should be released within the brake release time, or the brake release time must be set to a value greater than the actual release time of the brake. Only then it is ensured that the load will be held when the brake is released.



* The torque **must** be present once the brake release time elapses. The shaded area indicates that the torque may build-up before the end of the brake release time.

Fig. 27 Diagram of brake function at start of hoisting

After a start lowering command, also see Fig. 28 below, the speed increases up to the Release Speed to build up torque to hold the load. After the brake release time the speed is allowed to increase in the opposite direction, depending on the speed reference of course. The brake should be released within the brake release time, or the brake release time must be set to a value greater than the actual release time of the brake. Only then it is ensured that the load will be held when the brake is released.

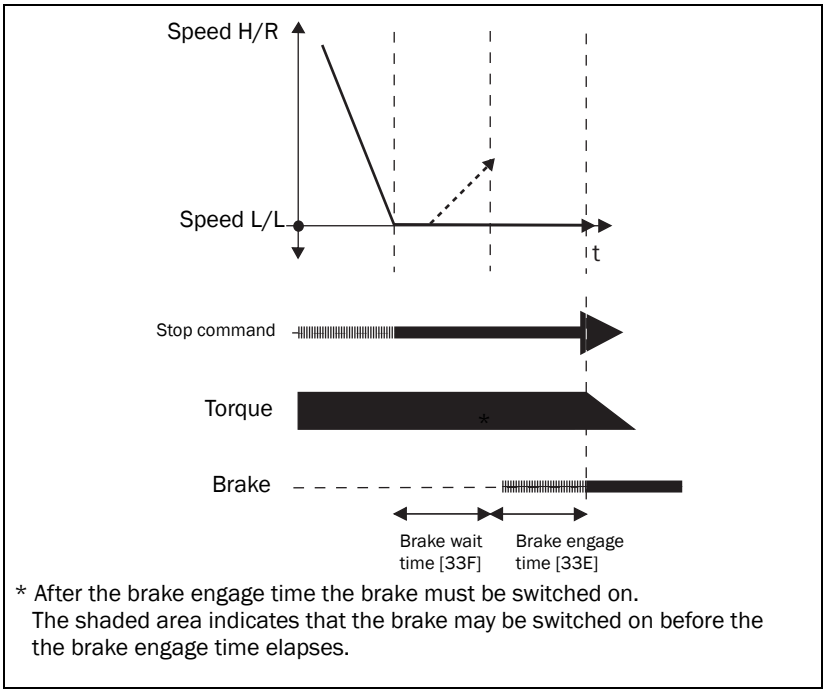


* The torque **must** be present once the brake release time elapses. The shaded area indicates that the torque may build up before the end of the brake release time.

Fig. 28 Diagram of brake function at start of lowering

Mechanical brake function at stop

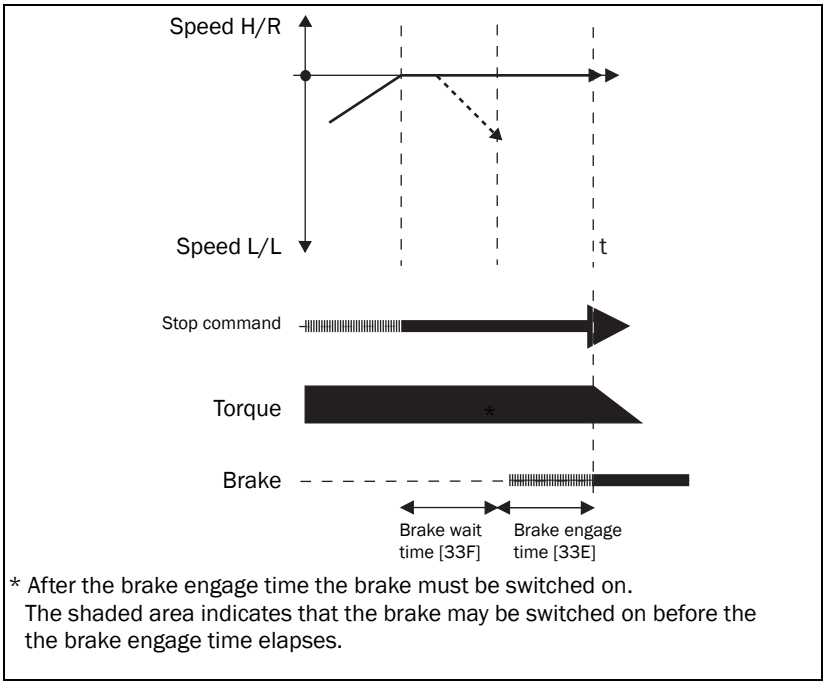
When a stop command is issued during hoisting the hoisting, also see Fig. 29 below, speed is decreased down to 0 rpm. During the brake wait time the load is held and it is possible to increase the hoisting speed again. During the brake engage time the brake is engaged and the brake engage time must be set to a value greater than the actual brake engage time of the brake to ensure the brake is on when the torque is finally reduced to zero.



* After the brake engage time the brake must be switched on.
The shaded area indicates that the brake may be switched on before the the brake engage time elapses.

Fig. 29 Diagram of brake function at stop hoisting

When a stop command is issued during lowering, also see Fig. 30, the speed is decreased to 0 rpm. During the brake wait time the load is held and it is once more possible to lower or hoist. During the brake engage time the brake is engaged and the brake engage time must be set to a value greater than the actual brake engage time of the brake to ensure the brake is on when the torque is finally reduced to zero.



* After the brake engage time the brake must be switched on.
The shaded area indicates that the brake may be switched on before the the brake engage time elapses.

Fig. 30 Diagram of brake function at stop lowering

Coordination of brake and deviation function

To get the fastest response to a deviation condition, it is recommended that the crane board Relay 1 N/O contact (No Trip/Deviation) be put in series with the N/O contacts of the brake relay (either crane board Relay 2 or one of the relays on the control board, depending on the programming). This series connection should be put in the brake circuit.

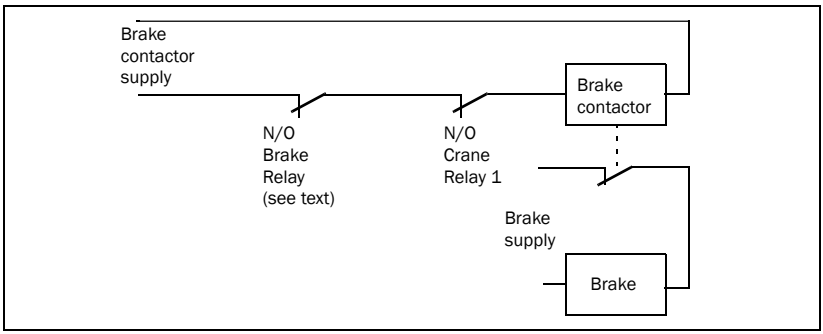


Fig. 31 Recommended brake circuitry

Fig. 31 shows the recommended connection for deviation (crane board Relay 1) and the brake relay. When the deviation function is activated, the brake is activated and the inverter stops. When the joystick is put in the null position within 3 s, a restart can be performed, otherwise the inverter trips with the trip message "Deviation".

As a restart will generally be prevented following the activation of the deviation function, crane board Relay 1 will operate the mains contactor.

5.5.3 (Pre)limit switches

This function is used to achieve a smoother and more secure run to the end points. The (pre)limit switches are connected to the inputs E1, E2, V1, V2, see Fig. 18, Fig. 21 and Fig. 24, and should open when active. The following diagram illustrates their effect:

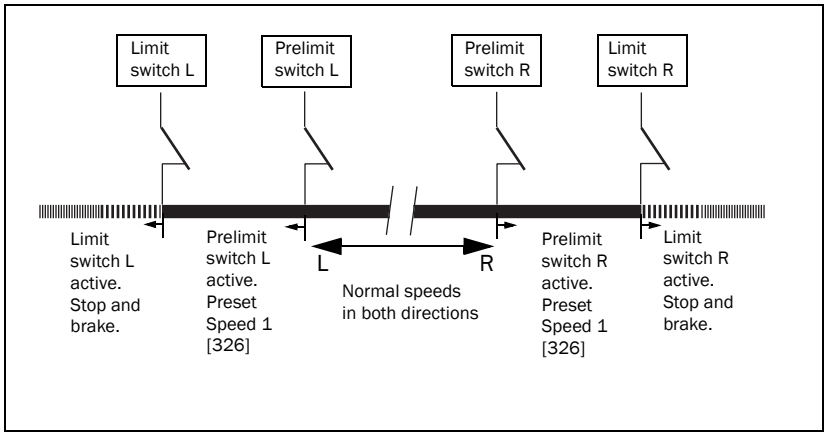


Fig. 32 Effect of (pre)limit switches

The VSD operates normally between the two prelimit switches.

When only a prelimit switch is active, the inverter is allowed to move with the prevailing Crawl Speed or Preset Speed 1 (or a speed in between these values if a 3-position switch or analogue control is used) in the direction of the limit switch or is allowed to move in the opposite direction at any speed.

When a limit switch is active, the inverter stops (and the brake is activated) and is only allowed to move in the opposite direction at any speed.

NOTE: The inputs E1, E2, V1, V2, R2 and NULL must be connected to +24 VDC (or 230V for crane interface) when not in use.

Operation of limit switch without activated prelimit switch

Sometimes the limit switch can be activated without an activated prelimit switch, e.g. when two traverses ride over the same rail with a limit switch on each cable reel or as an anti-collision mechanism.

The traverse is stopped upon activation. Contrary to normal limit switch operation, the traverse can be moved again in both directions after the controller has been in the null position, provided the limit switch concerned is deactivated.

5.5.4 Fast reverse

When the controller is moved in the opposite speed direction during hoisting, the inverter reverses fast and decelerates with the 2nd Dec Time.

It keeps decelerating with the 2nd Dec Time until 0 rpm, after which it accelerates in the opposite speed direction with the 2nd Acc Time to Crawl Speed. Then, depending on the controller position, it accelerates further to the desired speed. See diagrams in § 5.4, page 30.

NOTE: The 2nd Dec Time and 2nd Acc Time are set in Parameter Set B.

5.5.5 Scaling

This function is used if you want to decrease the speeds and retain the ratio between the speeds.

NOTE: Only applicable when controlled by a 4-speed controller.

When menu [3A2] Control = 4-Speed, the inverter speed is scaled by AnIn1. If scaling is not required, AnIn1 must be connected to +10 V (or +20 mA).

The scaling works according to the diagram in Fig. 33:

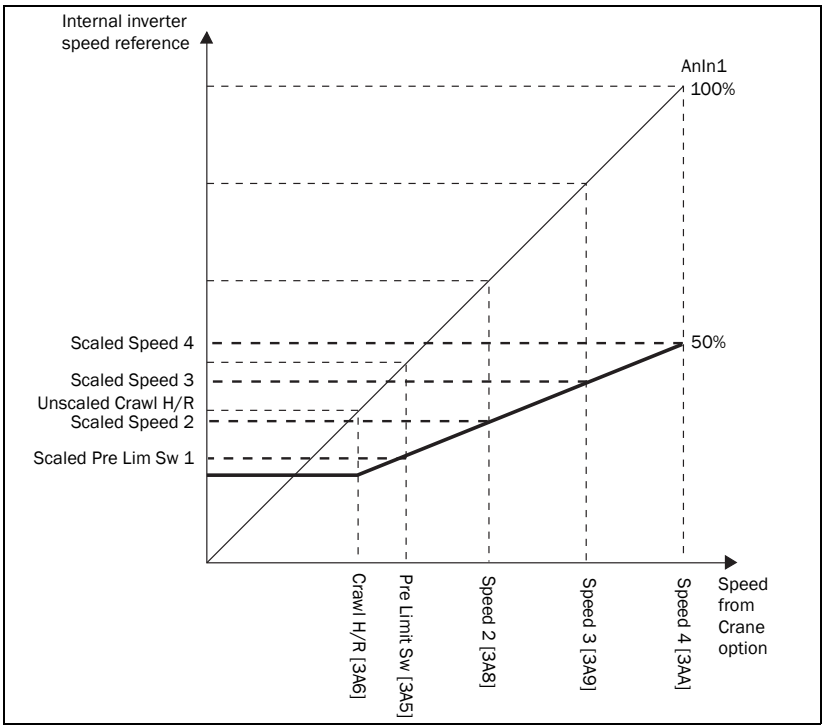


Fig. 33 Effect of scaling the speed reference from the crane option board

NOTE: If no scaling is used when 4-speed control is selected, AnIn 1 has to be connected to +10 V by a jumper, see Fig. 33.

5.5.6 Crane option board relay CR1

This relay has a fixed "No Trip" function.

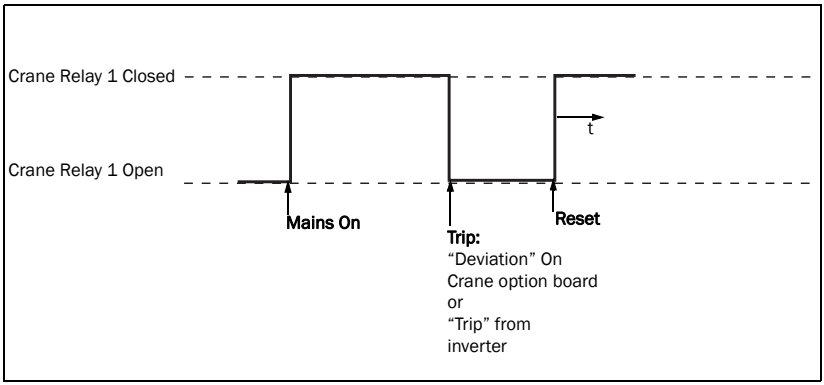


Fig. 34 Crane relay CR1 function

NOTE: When the inverter is switched off, crane option board relay CR1 is open and indicates a "Trip" condition where there is none. This must be dealt with by the user to prevent a false trip warning.

5.5.7 Magnetizing the motor

In order to get the fastest motor response to a Run command (derived from the controller action), the motor maybe kept magnetized during stop. When Start Mode=Normal DC is selected in menu [339], the motor is magnetized before each run command is executed. In many crane applications this takes too long. It is therefore possible to set a digital input to the function Motor PreMag. By making this specific digital input high, it will be possible to keep the motor magnetized when it is stopped. The current level is approx. 0.4 I_{NOM}. This means that heat is dissipated in the rotor and the motor must be dimensioned for this use. Forced external cooling is recommended.

NOTE: When the motor is permanently magnetized, it needs to be dimensioned correspondingly. Forced external cooling is recommended.

5.5.8 Load dependent field weakening operation

Load dependent field weakening operation allows hoisting/lowering at speeds above sync speed when the load is low or zero (empty hook).

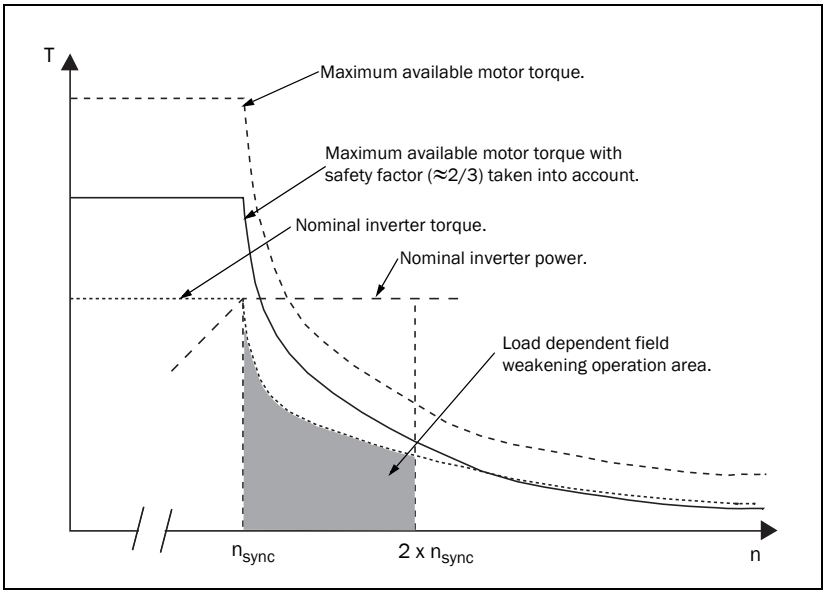


Fig. 35 Theoretical load dependent field weakening operation

The maximum over synchronous speed can be set between Sync. Speed and 4*Sync. Speed via Speed 4 in menu [3AA]. If Speed 4 is set to a value <Sync Speed, then load dependent field weakening operation is not active.

Set menu [343], Max Speed at least 200 rpm higher than Preset Speed 4, to give the internal speed PI controller room for regulation. The load above which the load dependent field weakening operation is active can be set in menu [3AD]. Read in menu [100] or [713] the torque indication in % with the max. load used in practice at sync speed and set this value in menu [3AD] accordingly. For more information about field weakening operation, contact your sales representative.

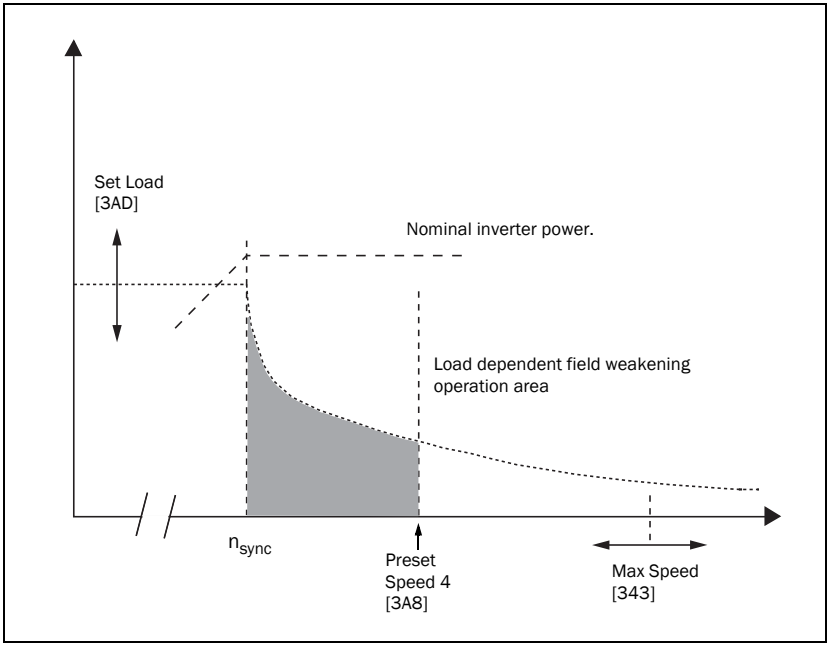


Fig. 36 Settings for load dependent field weakening operation

6. Functional Description

In the variable speed drive a number of menus appear when the crane option board is connected and automatically recognised.

In certain menus a different selection, compared with the standard settings, has to be made.

6.1 Programming the variable speed drive

The starting point is the default setting for all functions and parameters.

6.1.1 General

When the menu [241], Select Set=Option and the crane option board is activated the inverter starts in parameter set B because of the 2nd Acc Time. Therefore it is best to program parameter set B first and then copy B into A (menu [242]). Subsequently the Acc Time and Dec Time in parameter set B can be set to their required values (menus [331] and [332]).

6.2 Changed defaults when crane option board is activated

Activate the crane option board by setting menu [3A1] crane option board = On.

After executing Load Default Values in menu [243] a number of defaults will change from the standard default settings.

The changed inverter defaults are:

Menu	Function	Changed default
214	Reference control	Option
215	Run/Stop control	Option
241	Select set	Option

See § 5.5.2, page 43.

Menu	Function	Changed default
33C	Brake release time	0.5 s
33E	Brake engage time	0.5 s
33F	Brake wait time	0.5 s

See the Process Protection section in the manual for the main product.

Menu	Function	Changed default
423	Motor lost	Trip
424	Overvolt control	Off

6.3 Menu descriptions

All menus are described in the instruction manual for the variable speed drive.

Index

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U

V

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