MOVIDRIVE® MD_60A Drive Inverters

Addendum to System Manual

Crane Control

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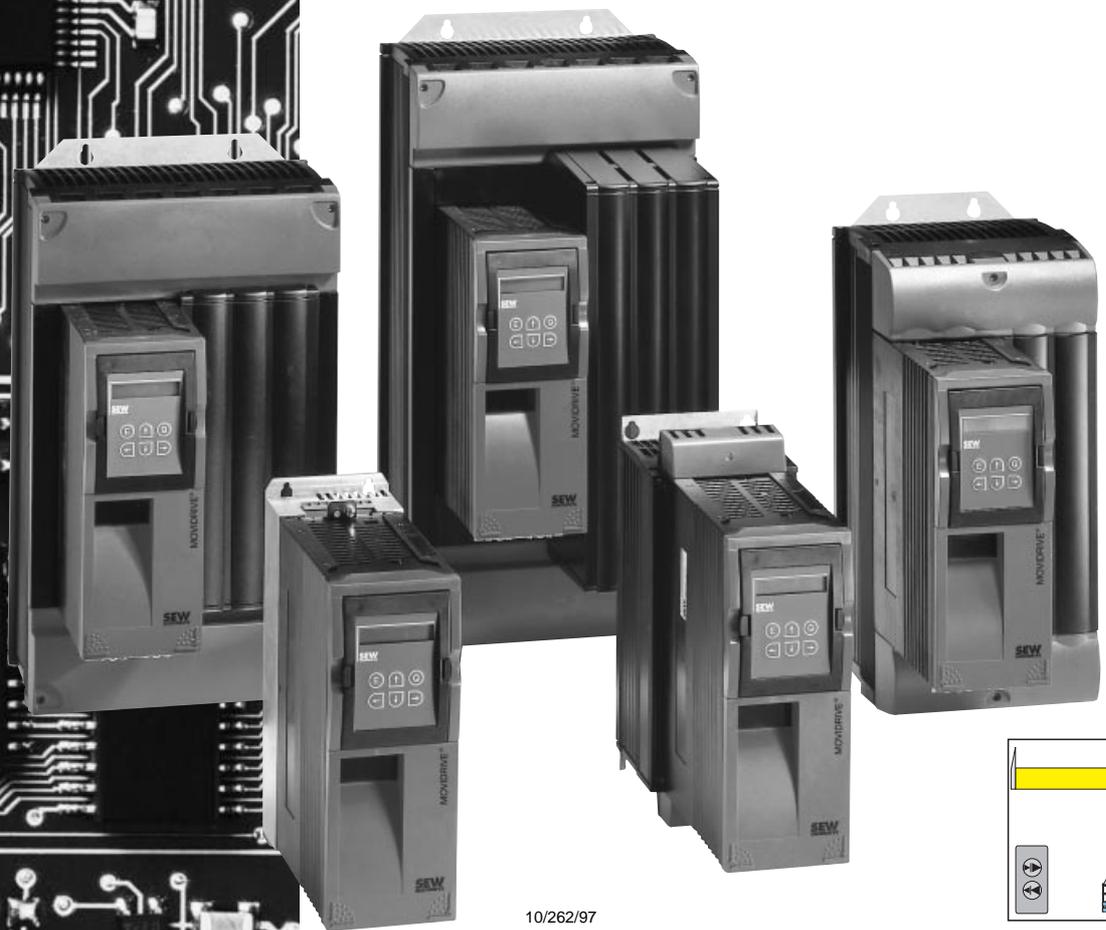
SEW EURODRIVE

- **This supplementary information does not replace the detailed operating instructions!**
- **Installation should only be performed by electrical specialists observing applicable accident prevention regulations and the MOVIDRIVE® operating instructions!**

- **Read through this manual carefully before you commence installation and startup of the crane control with MOVIDRIVE® drive inverters.**
  This manual assumes that the user has access to and is familiar with the documentation on the MOVIDRIVE® system, in particular the MOVIDRIVE® system manual.

- **Safety notes:**
  Always follow the safety and warning instructions contained in this manual!
  Safety notes are marked as follows:

  Electrical hazard, e.g. during live working.

  Mechanical hazard, e.g. when working on hoists.

  Important instructions for safe and fault-free operation of the driven machine/system, e.g. pre-setting before startup.

- In this manual, **cross references** are marked with a →, e.g.:
  (→ MX_SCOPE) means: Please refer to the MX_SCOPE manual for detailed information or information on how to carry out this instruction.
  (→ Sec. X.X) means: Further information can be found in section X.X of this manual.

- Each unit is manufactured and tested to current SEW-EURODRIVE technical standards and specifications.
  A requirement of fault-free operation and fulfillment of any rights to claim under guarantee is that this information is observed.
  This manual contains important information about servicing; as a result, it should be kept in the vicinity of the unit.

1   Project Planning

1.1   Application fields

Crane control is particularly well suited to the materials handling and logistics industries. The following applications represent examples of these:

- Trolleys
- Hoists
- Trolley travelling winches
- Construction cranes

The drives can be operated manually or by remote control.

The crane control offers the following advantages in these applications:

- Wide range of functions
- User-friendly user interface
- You only have to enter the parameters required for the crane control (operating modes, speeds, fixed setpoints, ramps)
- User-friendly application programs guide you through the process of setting parameters, so there is no need for complicated programming
- You do not need any programming experience
- It doesn't take long to get to know the system

1.2   Pre-requisites

1.2.1 PC and software

The crane control is implemented as an IPOS$^{plus\circledR}$ program and forms part of the SEW MOVITOOLS software package. In order to use MOVITOOLS, you must have a PC with one of the following operating systems: Windows 95$^{\circledR}$, Windows 98$^{\circledR}$ or Windows NT$^{\circledR}$ version 4.0.

1.2.2 Inverters, motors and encoders

- **Inverters**

  The crane control function can be implemented with all MOVIDRIVE$^{\circledR}$ MD_60A (MDF60A, MDV60A and MDS60A) drive inverters. MOVIDRIVE$^{\circledR}$ MD_60A must be equipped with the DIO11A input/output interface option (part number 822 726 8) for crane control. Please refer to the MOVIDRIVE$^{\circledR}$ MD_60A operating instructions (Installation section) for information about installing options.

- **Motors**
    - For operation on MOVIDRIVE$^{\circledR}$ MDF60A:

      AC motors DT/DV/D without incremental encoder.
    - For operation on MOVIDRIVE$^{\circledR}$ MDV60A:

      Asynchronous servo motors CT/CV, encoder installed as standard.

      AC motors DT/DV/D with incremental encoder option.
    - For operation on MOVIDRIVE$^{\circledR}$ MDS60A:

      Synchronous servo motors DS/DY, resolver installed as standard.

1.3 Functional description

The crane control provides the following functional characteristics:

- 6 fixed setpoints for multi-stage switching
- Variable speed in motor potentiometer mode
- Monitoring of preliminary and main limit switches
- Speed reduction to n_{min} or n11 (stage 1) when the preliminary limit switch is reached
- Max. speed limitation depending on load (load detection)
- Implementation of crane control in all operating modes (VFC, VFC-n-CONTROL, CFC, SERVO)
- Automatic programming of the input/output terminals required

The functions are implemented with two operating modes:

- **Motor potentiometer mode (floor control)**
  - Drive enable for CW or CCW operation with 2 binary inputs
  - Infinitely variable speed setting with both motor potentiometer up/down buttons
  - Fine positioning of the drive with n_{min}
  - Max. speed limitation depending on load (load detection)

- **Fixed setpoint mode (radio control)**
  - Selection of fixed setpoints n11, n12, n13, n21, n22 or n23 using binary inputs
  - Max. speed limitation depending on load (load detection)

1.4 Limit switches

An extensive limit switch monitoring function monitors the preliminary and main limit switches in the travel range. The limit switches must be low active ("0" = Contact with limit switch, "1" = No contact). You must select the type of preliminary limit switch with the long cams.

- If contact is made with the preliminary limit switch, the speed is reduced to n_{min} (motor potentiometer mode) or n11 (fixed setpoint mode).
- The drive is stopped when contact is made with the main limit switches.
- Limit switch monitoring is active in both operating modes.

2   Installation

2.1   Software

Crane control is a part of the SEW MOVITOOLS software package. Proceed as follows to install MOVITOOLS on your computer:

1. Insert the MOVITOOLS CD into the CD ROM drive of your PC.
2. Select "Start/Run...".
3. Type "{Drive letter of your CD drive}:setup" and press the Enter key.
4. The MOVITOOLS setup menu appears. Follow the instructions of the installation wizard.

Now proceed as follows to install the crane control software:

1. Insert disk 1/2 with the crane control into the disk drive of your PC.
2. Select "Start/Run...".
3. Type "{Drive letter of your floppy disk drive}:setup" and press the Enter key.
4. The crane control setup menu appears. Follow the instructions of the installation wizard.

You can now use Program Manager to start MOVITOOLS. If a MOVIDRIVE® unit is connected to your PC, select the correct port (PC COM port) and set point-to-point connection. Select <Update> to display the inverter in the "Connected Units" window.
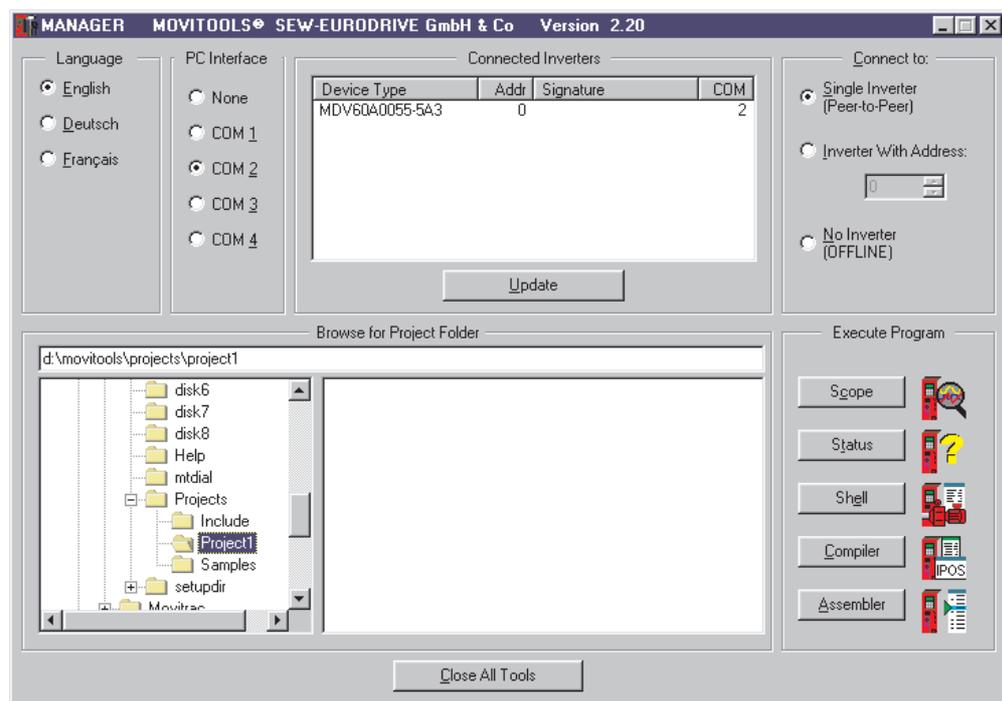

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Fig. 1: MOVITOOLS window

2.2   Terminal assignment and wiring diagrams

The IPOS$^{plus®}$ program automatically programs the binary inputs with the following functions:

Basic unit   X13:2 – X13:6 (DIØ1 – DIØ5)   ⇒   "IPOS input"

DIO11A option   X22:1 (DI1Ø)   ⇒   "/CW LIMIT SWITCH"

                        X22:2 (DI11)   ⇒   "/CCW LIMIT SWITCH"

                        X22:3/X22:4 (DI12/DI13)   ⇒   "IPOS input"

                        X22:5 (DI14)   ⇒   "Reset"

                        X22:6 (DI15)   ⇒   "IPOS input"

                        X22:7 (DI16)   ⇒   "No function"

                        X22:8 (DI17)   ⇒   "Reserved"

Do not reprogram the binary inputs!

Important: Binary input X22:8 (DI17) must have a fixed connection to DGND.

This terminal assignment is the same for either operating mode, motor potentiometer or fixed set-point. The function of the binary inputs programmed with "IPOS input" is defined by the IPOS$^{plus®}$ program. The function is shown in the following wiring diagrams.
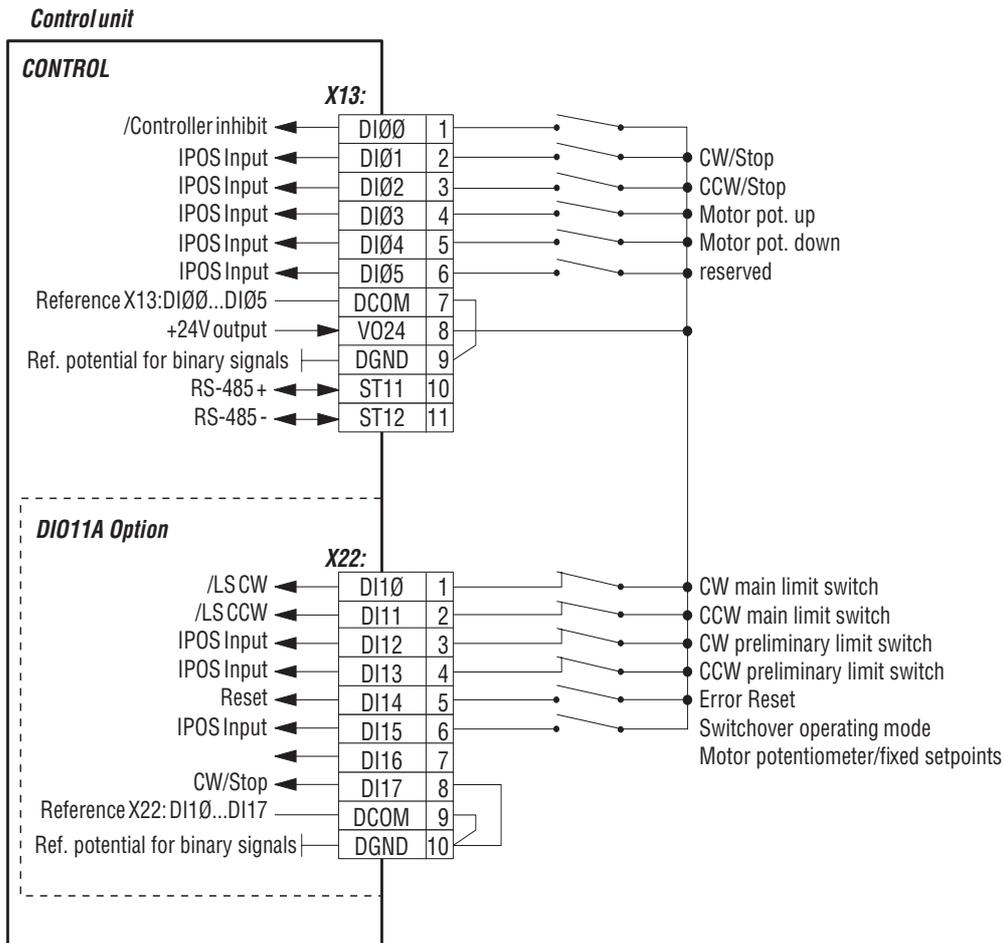
Motor potentiometer mode

Fig. 2: Wiring diagram for motor potentiometer mode
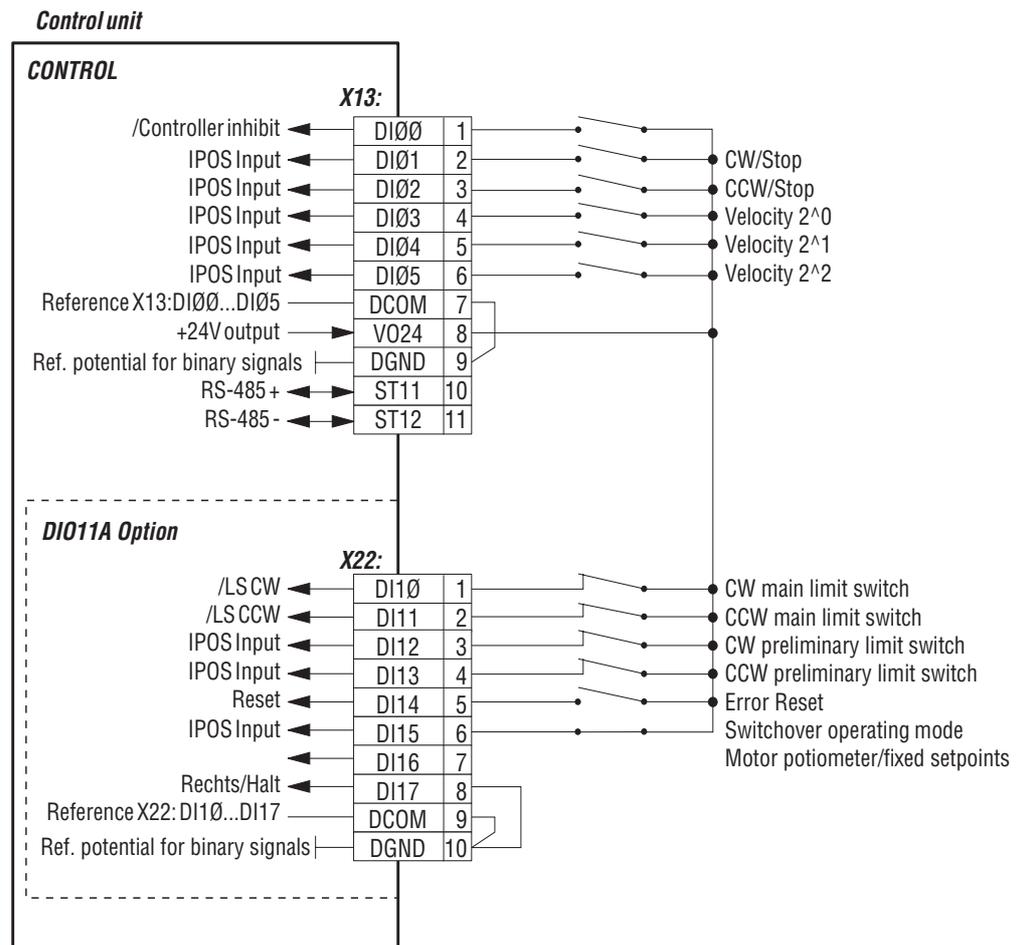
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Fixed setpoint mode

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Fig. 3: Wiring diagram for fixed setpoint mode

The 6 fixed setpoints are selected with binary coding using binary inputs X13:4 (DIØ3) − X13:4 (DIØ5) in fixed setpoint mode.

Fixed setpoint	X13:4 (DIØ3) = Speed 2^0	X13:5 (DIØ4) = Speed 2^1	X13:6 (DIØ5) = Speed 2^2
n11 (stage 1)	"1"	"0"	"0"
n12 (stage 2)	"0"	"1"	"0"
n13 (stage 3)	"1"	"1"	"0"
n14 (stage 4)	"0"	"0"	"1"
n22 (stage 5)	"1"	"0"	"1"
n23 (stage 6)	"0"	"1"	"1"

n_{min} is in effect when the inverter is enabled if no fixed setpoint has been selected, i.e. X13:4, X13:5 and X13:6 = "0".

2.3   Control inputs

It is possible to select between two operating modes for crane control. Binary input X22:6 (DI15) is used for switching between the operating modes:

    X22:6 (DI15) = "0" $\Rightarrow$ Motor potentiometer mode (floor control)

    X22:6 (DI15) = "1" $\Rightarrow$ Fixed setpoint mode (radio control)

Binary inputs X13:4 – X13:6 (DIØ3 – DIØ5) are evaluated differently depending on the operating mode setting.

Binary input X22:5 (DI14) has "Reset" assigned to it and it is not required for crane control. It is provided in the event of a malfunction, to make it possible to perform a reset using the terminals.

The information given in the following tables assumes that ramp set 1 (P130 – P133) in parameter set 1 is used.

Motor potentiometer mode, X22:6 (DI15) = "0":

Binary input	Function	"1" signal	"0" signal
X13:1 (DIØØ)	/Controller inhibit	Output stage not inhibited	Output stage not inhibited
X13:2 (DIØ1)	CW/STOP	CW enable, ramp t11 up CW (P130) until n_{min}	Stop with ramp t11 down CW (P131)
X13:3 (DIØ2)	CCW/STOP	CCW enable, ramp t11 up CCW (P132) until n_{min}	Stop with ramp t11 down CCW (P133)
X13:4 (DIØ3)	Motor potentiometer up	Ramp t3 up (P150) in the direction of rotation specified with X13:2 and X13:3 until max. n_{max}	Current setpoint remains unchanged
X13:5 (DIØ4)	Motor potentiometer down	Ramp t3 down (P151) until n_{min}	Current setpoint remains unchanged
X22:1 (DI1Ø)	CW main limit switch	Status within the travel range	Contact with CW main limit switch $\rightarrow$ Emergency stop *) with ramp t14 (P137)
X22:2 (DI11)	CCW main limit switch		Contact with CCW main limit switch $\rightarrow$ Emergency stop *) with ramp t14 (P137)
X22:3 (DI12)	CW preliminary limit switch		Contact with CW preliminary limit switch $\rightarrow$ Deceleration with ramp t13 (P136) until n_{min}
X22:4 (DI13)	CCW preliminary limit switch		Contact with CCW preliminary limit switch $\rightarrow$ Deceleration with ramp t13 (P136) until n_{min}

*) Emergency stop:

The drive is braked with the emergency ramp t14/t24. Once the stop speed is reached, the brake is applied (DBØØ "/Brake" = "0"). The output stage goes to high-resistance after the brake reaction time has elapsed (P732 / P735).

Fixed setpoint mode, X22:6 (DI15) = "1":

Binary input	Function	"1" signal	"0" signal
X13:1 (DIØØ)	/Controller inhibit	Output stage not inhibited	Output stage not inhibited
X13:2 (DIØ1)	CW/STOP	CW enable, ramp t11 up CW (P130) until n_{min}	Stop with ramp t11 down CW (P131)
X13:3 (DIØ2)	CCW/STOP	CCW enable, ramp t11 up CCW (P132) until n_{min}	Stop with ramp t11 down CCW (P133)
X13:4 (DIØ3)	Speed 2^0	The fixed setpoints n11, n12, n13, n21, n22 and n23 are selected with binary coding ($\rightarrow$ table below).	
X13:5 (DIØ4)	Speed 2^1		
X13:6 (DIØ5)	Speed 2^2		
X22:1 (DI1Ø)	CW main limit switch	Status within the travel range	Contact with CW main limit switch $\rightarrow$ Emergency stop[*] with ramp t14 (P137)
X22:2 (DI11)	CCW main limit switch		Contact with CCW main limit switch $\rightarrow$ Emergency stop[*] with ramp t14 (P137)
X22:3 (DI12)	CW preliminary limit switch		Contact with CW preliminary limit switch $\rightarrow$ Deceleration with ramp t13 (P136) until n_{min}
X22:4 (DI13)	CCW preliminary limit switch		Contact with CCW preliminary limit switch $\rightarrow$ Deceleration with ramp t13 (P136) until n_{min}

[*] Emergency stop:

The drive is braked with the emergency ramp t14/t24. Once the stop speed is reached, the brake is applied (DBØØ "/Brake" = "0"). The output stage goes to high-resistance after the brake reaction time has elapsed (P732 / P735).

Binary coding of the fixed setpoints:

Fixed setpoint	X13:4 (DIØ3) = Speed 2^0	X13:5 (DIØ4) = Speed 2^1	X13:6 (DIØ5) = Speed 2^2
n11 (stage 1)	"1"	"0"	"0"
n12 (stage 2)	"0"	"1"	"0"
n13 (stage 3)	"1"	"1"	"0"
n14 (stage 4)	"0"	"0"	"1"
n22 (stage 5)	"1"	"0"	"1"
n23 (stage 6)	"0"	"1"	"1"

n_{min} is in effect when the inverter is enabled if no fixed setpoint has been selected, i.e. X13:4, X13:5 and X13:6 = "0".

2.4 Limit switch connections

Track limit switch processing for cranes is supported. There is a total of four limit switch inputs for monitoring the travel distance and the travel speed.

Option DIO11A	X22:1 (DI1Ø)	$\Rightarrow$	CW main limit switch
	X22:2 (DI11)	$\Rightarrow$	CCW main limit switch
	X22:3 (DI12)	$\Rightarrow$	CW preliminary limit switch
	X22:4 (DI13)	$\Rightarrow$	CCW preliminary limit switch

The limit switches must be attached to the travel range in accordance with Fig. 4. Only low-active limit switches may be used for reasons of safety. The limit switch monitoring function in the unit checks that both preliminary and main limit switches are connected when the inverter is enabled.

Limit switch inputs which are not in use must be connected to +24 V (X13:8 VO24), otherwise fault message F27 "Limit switches missing" is generated by the limit switch monitoring function.
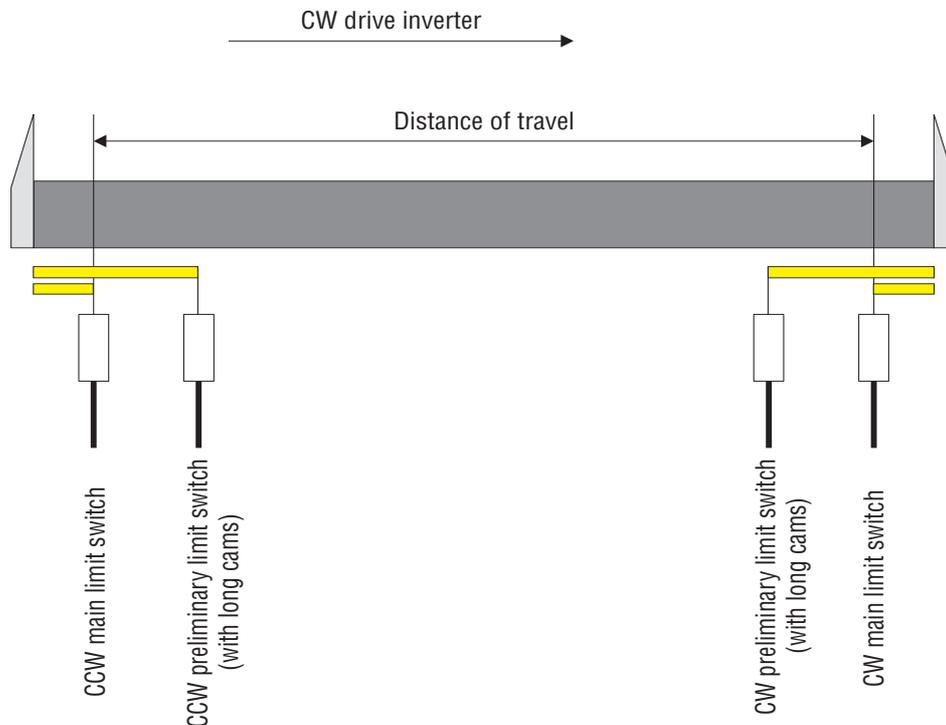
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Fig. 4: Arrangement of limit switches

The cams for the preliminary and main limit switches must overlap (long cams). The cams of the limit switches must cover the travel range up to the stop.

3   Startup

3.1   General information

Correct project planning and installation are the pre-requisites for successful startup. Refer to the MOVIDRIVE®system manual for detailed project planning instructions. The system manual forms part of the MOVIDRIVE® documentation package (publication number 0919 3200).

Check the installation, including the encoder connection and the installation of the input/output interface type DIO11A, by following the installation instructions in the MOVIDRIVE® MD_60A operating instructions and in this manual (Sec. 2, page 6).

3.2   Preliminary work

Perform the following steps before the startup of "crane control":

- Connect the inverter to the PC using the serial port (RS-232, USS21A on PC-COM).
- Install MOVITOOLS on the PC (Sec. 2.1, page 6) and start the program.
- Start up the inverter using <Shell>.
  - With MOVIDRIVE® MDF60A and DT/DV/D motors, in VFC operating mode.
  - With MOVIDRIVE® MDV60A and DT/DV/D motors, in VFC-n-CONTROL operating mode.
  - With MOVIDRIVE® MDV60A and CT/CV motors, in CFC operating mode.
  - With MOVIDRIVE® MDS60A and DS/DY motors, in SERVO operating mode.
- "0" signal at terminal X13:1 (DIØØ, /Controller inhibit).

3.3   Starting the "crane control" program

- Start <Shell>.
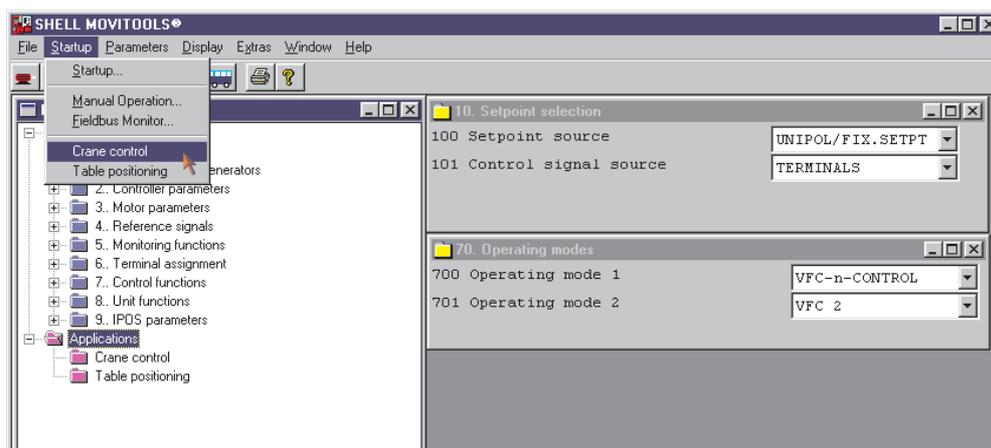- In Shell, start "Startup/Crane control".

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Fig. 5: Starting the "crane control" program

3.3.1 Setting the speed limits and the operating mode

When the crane control starts, the window for setting the speed limits and the operating mode appears.

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Fig. 6: Setting the speed limits and the operating mode

You have to make the following settings in this window:

- Speed limits
- Speeds after contacting a preliminary limit switch

  The slow speed is identical to P301 Minimum speed 1 (n_{min}) and cannot be set at this point.

- Operating mode

  Set the required operating mode. You can also select both operating modes and switch modes during operation using X22:6 DI15 "Fixed setpoint switchover".

Press "Next >>", after which the next startup window appears.

3.3.2 Setting fixed setpoints

This window only appears if you have selected the fixed setpoint operating mode.

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Fig. 7: Setting fixed setpoints

Set the required values for the fixed setpoints. You cannot set the value for stage 1 (n11) because this is defined by the setting for the speed when contact is made with a preliminary limit switch.

Press "Next >>", after which the next startup window appears.

3.3.3 Setting ramps for fixed setpoint operating mode

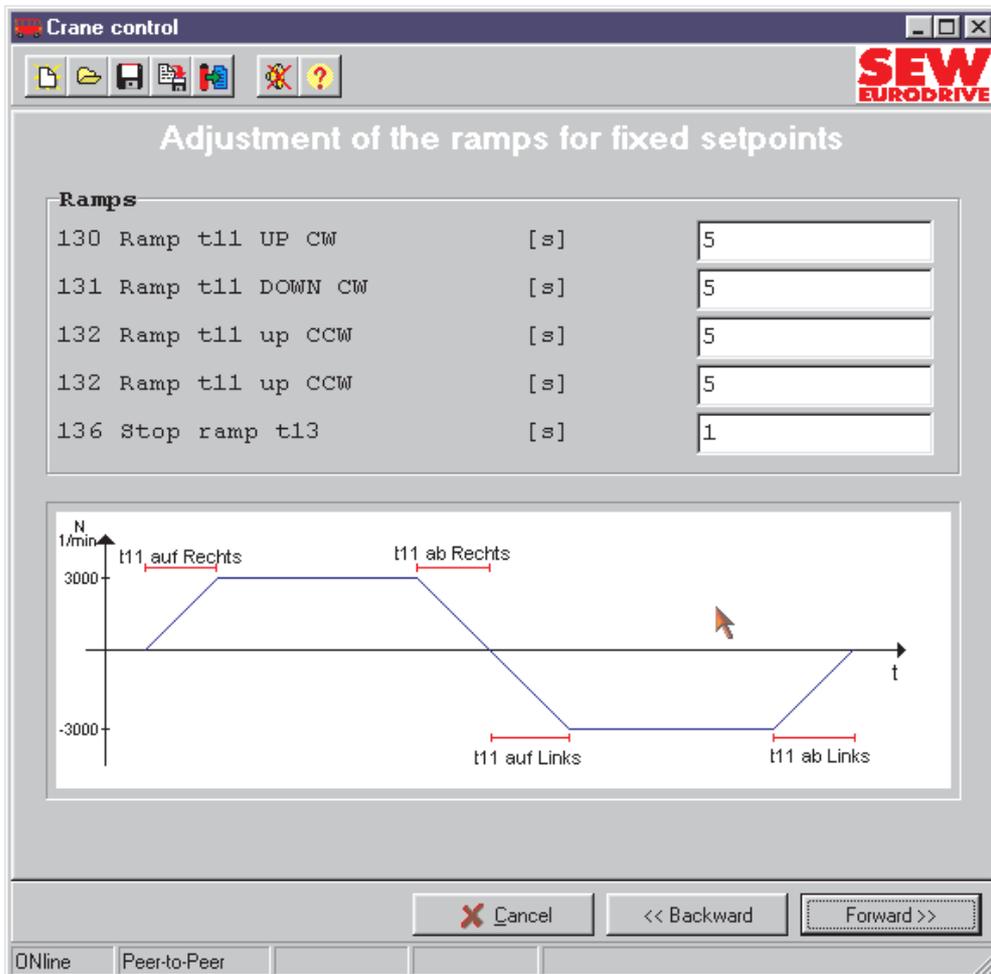This window only appears if you have selected the fixed setpoint operating mode.

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Fig. 8: Setting fixed setpoint ramps

Set the ramps for fixed setpoint operating mode.

Press "Next >>", after which the next startup window appears.

3.3.4 Setting ramps for motor potentiometer operating mode

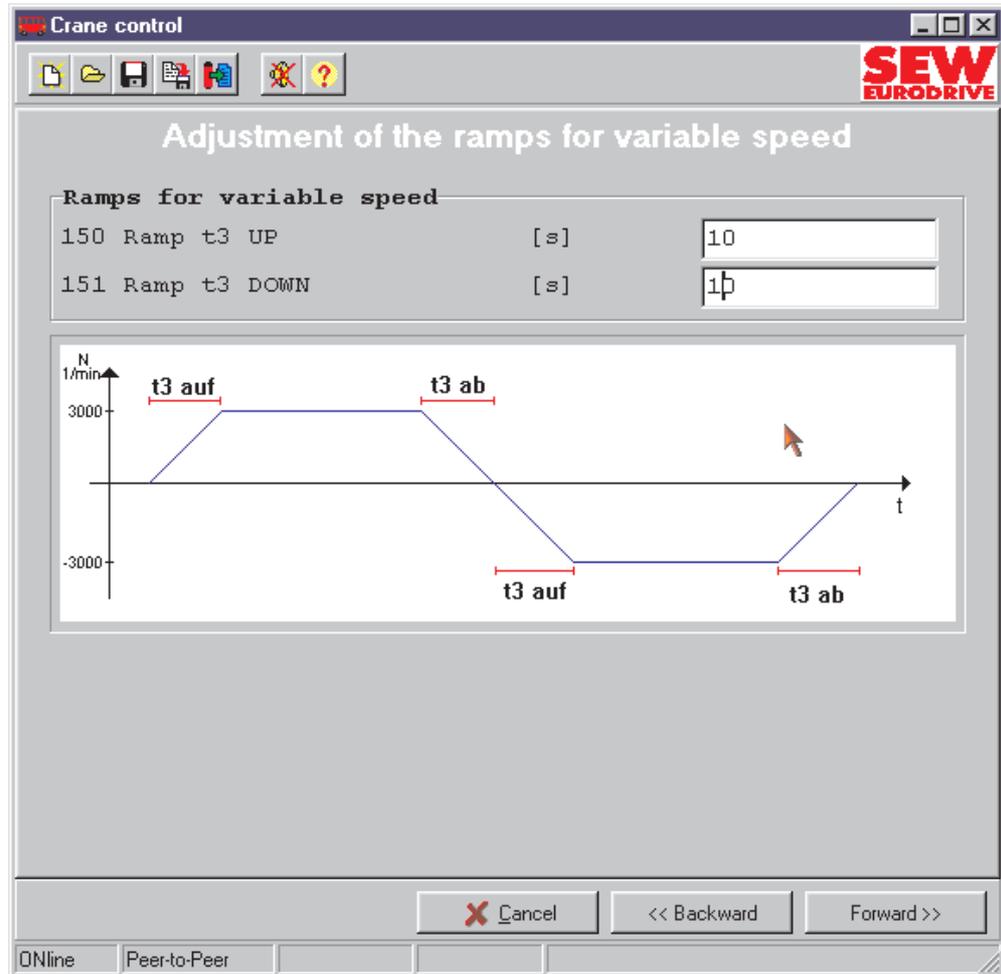This window only appears if you have selected the motor potentiometer operating mode.

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Fig. 9: Setting motor potentiometer ramps

Set the ramps for motor potentiometer operating mode (variable speed preselection).

Press "Next>>" when you have entered the values you want. The program prompts you to save the values you have set. The download window appears after the settings have been saved.

Press <Download>. All necessary settings are automatically made in the inverter and the "Crane control" IPOS program is started.
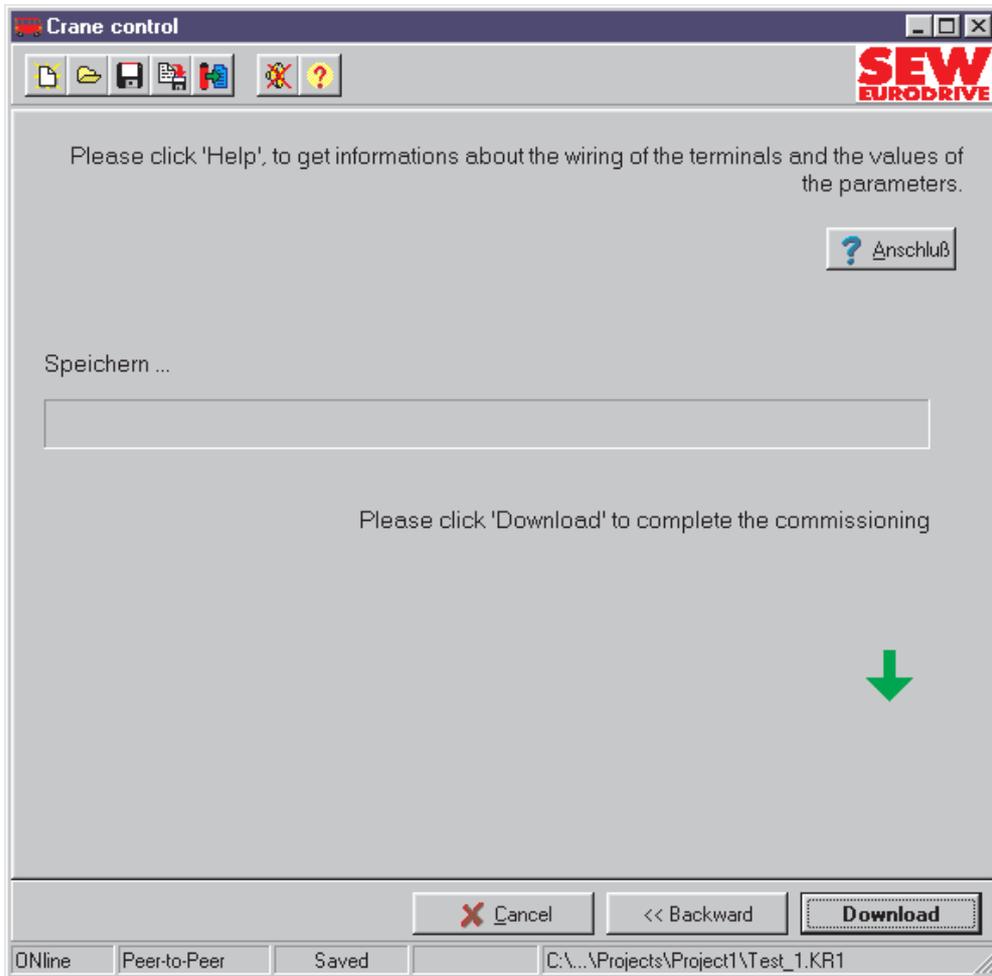
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Fig. 10: Download window

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3.4   Parameter

The crane control startup automatically sets the following parameters:

Parameter number	Parameter	Setting
100	Setpoint source	MOTOR POTENTIOM.
101	Control signal source	TERMINALS
130	t11 up CW	0 – 2000 s
131	t11 down CW	0 – 2000 s
132	t11 up CCW	0 – 2000 s
133	t11 down CCW	0 – 2000 s
136	t13 (STOP ramp)	0 – 20 s
150	t3 up	0.2 – 50 s
151	t3 down	0.2 – 50 s
160	n11	-5000 – 5000 rpm
161	n12	-5000 – 5000 rpm
162	n13	-5000 – 5000 rpm
170	n21	-5000 – 5000 rpm
171	n22	-5000 – 5000 rpm
172	n23	-5000 – 5000 rpm
301	Minimum speed 1	0 – 5500 rpm
302	Maximum speed 1	0 – 5500 rpm
600…604	Binary inputs DIØ1 – DIØ5	IPOS input
610	Binary input DI1Ø	/CW limit switch
611	Binary input DI11	/CCW limit switch
612/613	Binary inputs DI12/DI13	IPOS input
614	Binary input DI14	Reset
615	Binary input DI15	IPOS input
616	Binary input DI16	No function
617	Binary input DI17	Reserved

These parameters must not be altered after startup!

4 Operation and Service

4.1 General information

The crane control operating modes are described using sequence diagrams.

It is permitted to switch over from "motor potentiometer" mode to "fixed setpoint" mode during operation and vice versa. Binary input X22:6 (DI15) is used for switching over:

- X22:6 (DI15) = "0" → Motor potentiometer mode
- X22:6 (DI15) = "1" → Fixed setpoint mode

Speed ramps and fixed setpoints used:

Speed ramps	Parameter set 1
CW/STOP	t11 up CW (P130) t11 down CW (P131)
CCW/STOP	t11 up CCW (P132) t11 down CCW (P133)
Motor potentiometer up	t3 up (P150)
Motor potentiometer down	t3 down (P151)
Stop (preliminary limit switch)	t13 (P136)
Emergency stop (main limit switch)	t14 (P137)

Fixed setpoints	Parameter set 1	Parameter set 2
1st fixed setpoint	n11 (P160)	n21 (P170)
2nd fixed setpoint	n12 (P161)	n22 (P171)
3rd fixed setpoint	n13 (P162)	n23 (P172)

Selecting fixed setpoints:

All 6 fixed setpoints can be selected in "fixed setpoint" operating mode. It is not necessary to change parameter sets in order to do this.

The fixed setpoints are selected using binary code with binary inputs X13:4 (DIØ3) – X13:6 (DIØ5).

Fixed setpoint	X13:4 (DIØ3) = Speed 2^0	X13:5 (DIØ4) = Speed 2^1	X13:6 (DIØ5) = Speed 2^2
n11 (stage 1)	"1"	"0"	"0"
n12 (stage 2)	"0"	"1"	"0"
n13 (stage 3)	"1"	"1"	"0"
n14 (stage 4)	"0"	"0"	"1"
n22 (stage 5)	"1"	"0"	"1"
n23 (stage 6)	"0"	"1"	"1"

Note:

The sequence diagram uses the speed ramps and fixed setpoints of parameter set 1.

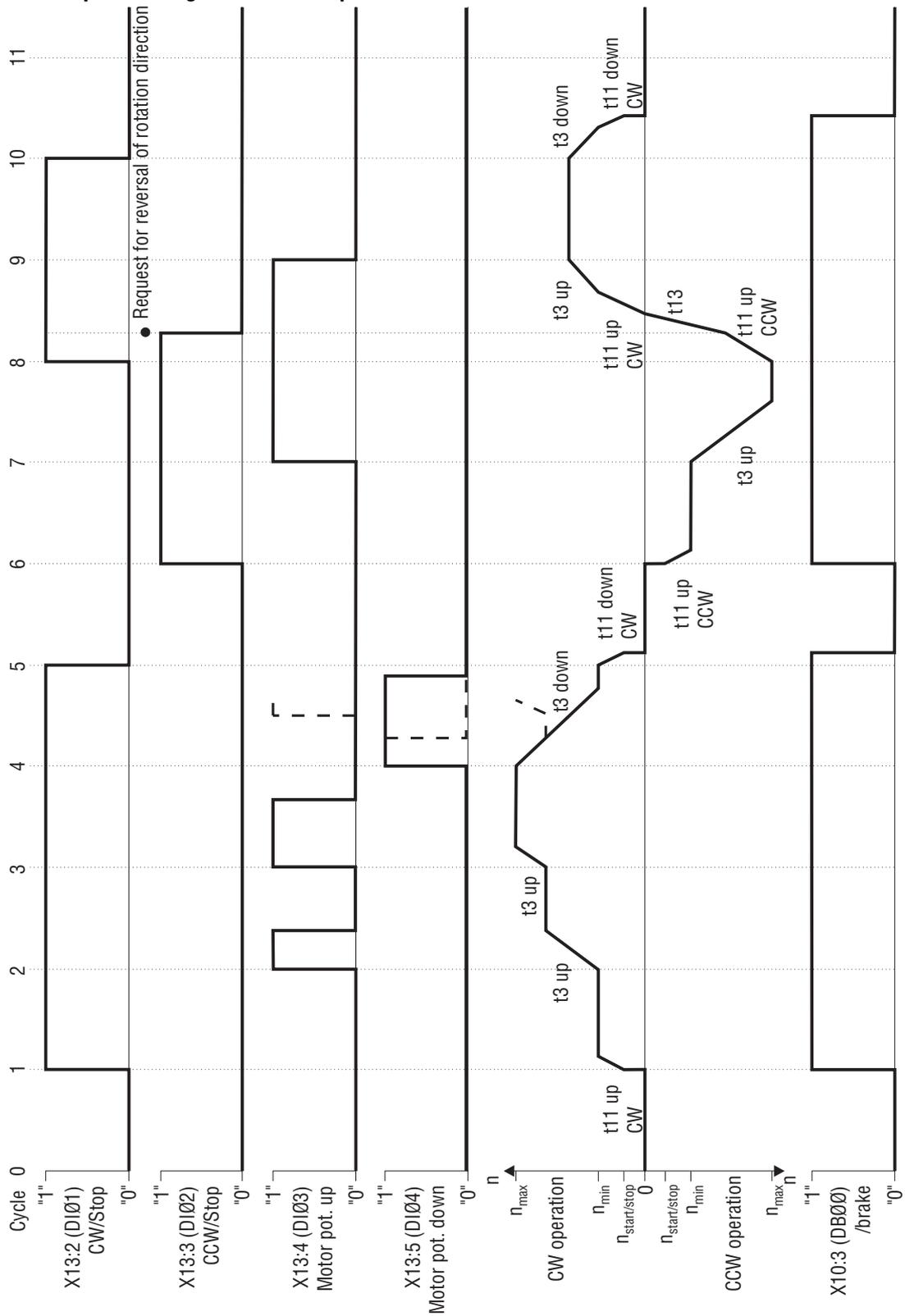## 4.2 Sequence diagram for motor potentiometer

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Fig. 11: Sequence diagram for motor potentiometer

Important:

The drive must be enabled with X13:1 (DIØØ) /CONTROLLER INHIBIT = "1".

Explanation of the sequence diagram for motor potentiometer

- **Tl. X13:1 (DIØØ) /CONTROLLER INHIBIT = "1"**

- Cycle 1: Tl. X13:2 (DIØ1) CW/stop from "0" to "1"
    - Clockwise and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. Acceleration with ramp t11 up CW until n_{min}, n_{min} is then maintained.

- Cycle 2: Tl. X13:4 (DIØ3) motor potentiometer up from "0" to "1"
    - Acceleration with motor potentiometer ramp t3 up as long as there is a "1" signal at X13:4. Current setpoint is maintained with a "0" signal at X13:4 and X13:5 and X13:2 ≠ X13:3.

- Cycle 3: Tl. X13:4 (DIØ3) motor potentiometer up from "0" to "1"
    - Acceleration with motor potentiometer ramp t3 up until n_{max}. n_{max} is maintained when there is a "0" signal at X13:5 and X13:2 ≠ X13:3.

- Cycle 4: Tl. X13:5 (DIØ4) motor potentiometer down from "0" to "1"
    - Deceleration with motor potentiometer ramp t3 down as long as there is a "1" signal at X13:5 or until n_{min} is reached.

- Cycle 5: Tl. X13:2 (DIØ1) CW/stop from "1" to "0"
    - Deceleration with ramp t11 down CW from n_{min} to $n_{start/stop}$, then stop and X10:3 (DBØØ) / Brake from "1" to "0", i.e. the brake is applied.

- Cycle 6: Tl. X13:3 (DIØ2) CCW/stop from "0" to "1"
    - Counterclockwise and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. The drive accelerates with ramp t11 up CCW until n_{min}, n_{min} is then maintained.

- Cycle 7: Tl. X13:4 (DIØ3) motor potentiometer up from "0" to "1"
    - Acceleration with motor potentiometer ramp t3 up until n_{max}. n_{max} is maintained when there is a "0" signal at X13:5 and X13:2 ≠ X13:3.

- Cycle 8: Tl. X13:2 (DIØ1) CW/stop from "0" to "1"
    - Deceleration with motor potentiometer ramp t11 down CCW as long as X13:2 = X13:3. If X13:3 changes from "1" to "0", i.e. X13:2 ≠ X13:3, deceleration with ramp t13 until stop, then change of direction of rotation and acceleration with ramp t11 up CW until n_{min}. If X13:4 = "0", n_{min} is maintained; if X13:4 = "1" acceleration with motor potentiometer ramp t3 up.

- Cycle 9: Tl. X13:4 (DIØ3) motor potentiometer up from "1" to "0"
    - Current setpoint is maintained when "0" signal at X13:4 and X13:5 and X13:2 ≠ X13:3.

- Cycle 10: Tl. X13:2 (DIØ1) CW/stop from "1" to "0"
    - Deceleration with ramp t3 down until n_{min} and ramp t11 down CW from nmin to nstart/stop, then stop and X10:3 (DBØØ) /Brake from "1" to "0", i.e. the brake is applied.

Refer to Sec. 4.4 (page 24) for information about making contact with limit switches.
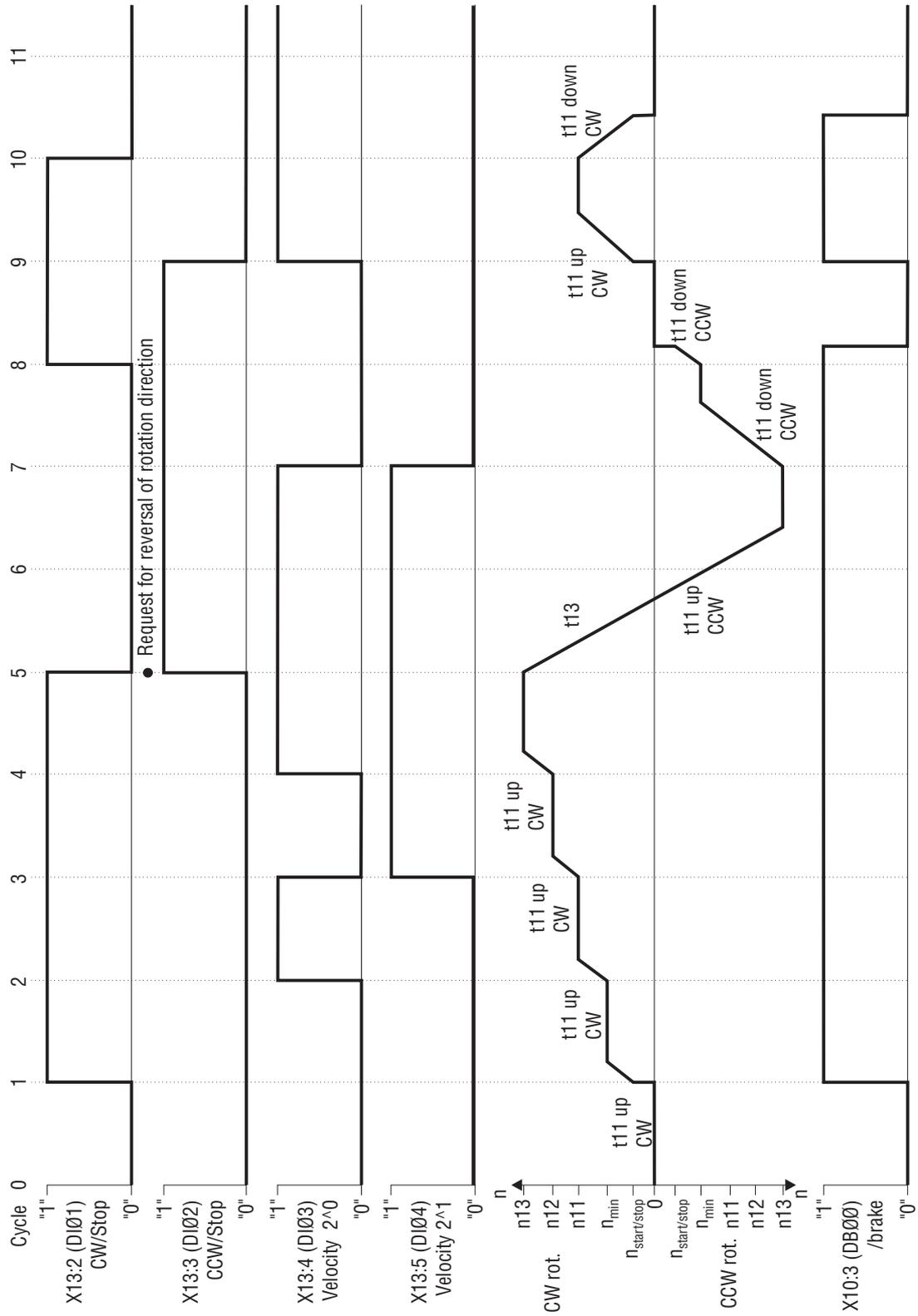
4.3 Sequence diagram for fixed setpoints

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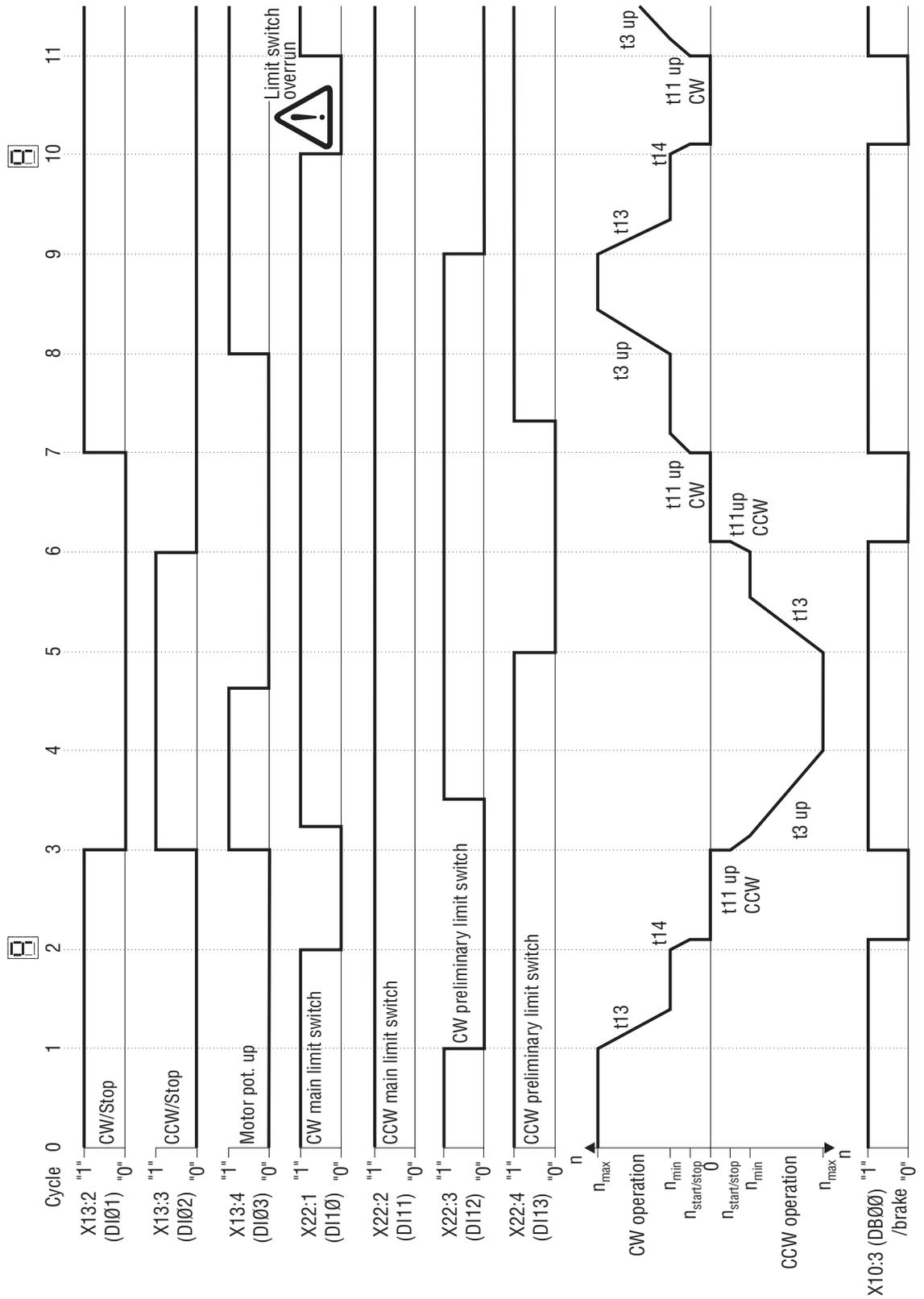*Fig. 12: Sequence diagram for fixed setpoints*

Important:

The drive must be enabled with X13:1 (DIØØ) /CONTROLLER INHIBIT = "1".

Explanation of the sequence diagram for fixed setpoints

- **Tl. X13:1 (DIØØ) /CONTROLLER INHIBIT = "1"**

- Cycle 1: Tl. X13:2 (DIØ1) CW/stop from "0" to "1"
  - Clockwise and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. Acceleration with ramp t11 up CW until n_{min}, n_{min} is then maintained.

- Cycle 2: Tl. X13:4 (DIØ3) speed 2^0 from "0" to "1"
  - Acceleration with ramp t11 up CW to fixed setpoint n11.

- Cycle 3: Tl. X13:4 (DIØ3) speed 2^0 from "1" to "0" and tl. X13:5 (DIØ4) speed 2^1 from "0" to "1"
  - Acceleration with ramp t11 up CW to fixed setpoint n12.

- Cycle 4: Tl. X13:5 (DIØ4) speed 2^1 = "1" and tl. X13:4 (DIØ3) speed 2^0 from "0" to "1"
  - Acceleration with ramp t11 up CW to fixed setpoint n13.

- Cycle 5: Tl. X13:2 (DIØ1) CW/stop from "1" to "0" and tl. X13:3 (DIØ2) CCW/stop from "0" to "1"
  - Deceleration with ramp t13 until stop, then change of direction of rotation and acceleration with ramp t11 up CCW to fixed setpoint n13.

- Cycle 6: Tl. X13:3 (DIØ2) CCW/stop; X13:4 (DIØ3) speed 2^0 and X13:5 (DIØ5) speed 2^1 = "1"
  - Acceleration with ramp t11 up CCW to fixed setpoint n13.

- Cycle 7: Tl. X13:4 (DIØ3) speed 2^0 and X13:5 (DIØ4) speed 2^1 from "1" to "0"
  - Deceleration with ramp t11 down CCW until n_{min}.

- Cycle 8: Tl. X13:3 (DIØ2) CCW/stop = "1" and X13:2 (DIØ1) CW/stop from "0" to "1"
  - Deceleration with ramp t11 down CCW from n_{min} to $n_{start/stop}$, then stop and X10:3 (DBØØ) / Brake from "1" to "0", i.e. the brake is applied.

- Cycle 9: Tl. X13:3 (DIØ2) CCW/stop from "1" to "0" and X13:4 (DIØ3) speed 2^0 from "0" to "1"
  - Clockwise and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. Acceleration with ramp t11 up CW to fixed setpoint n11.

- Cycle 10: Tl. X13:2 (DIØ1) CW/stop from "1" to "0"
  - Deceleration with ramp t11 down CW until $n_{start/stop}$, then stop and X10:3 (DBØØ) /Brake from "1" to "0", i.e. the brake is applied.

4.4 Making contact with limit switches (in "motor potentiometer" mode)

Fig. 13: Sequence diagram for making contact with limit switches

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Important:

The drive must be enabled with X13:1 (DIØØ) /CONTROLLER INHIBIT = "1".

Explanation of the sequence diagram for making contact with limit switches
(in motor potentiometer mode, also applies to fixed setpoint mode)

- **Tl. X13:1 (DIØØ) /CONTROLLER INHIBIT = "1"**

- Cycle 1: Tl. X13:2 (DIØ1) CW/stop = "1", X13:3 (DIØ2) CCW/stop = "0"
  and X22:3 (DI12) CW preliminary limit switch from "1" to "0"
  - Contact made with CW preliminary limit switch, so deceleration with ramp t13 until n_{min}.

- Cycle 2: Tl. X22:1 (DI1Ø) from "1" to "0"
  - Contact made with CW main limit switch, so deceleration with ramp t14 from n_{min} to $n_{start/stop}$, then stop and X10:3 (DBØØ) /Brake from "1" to "0", i.e. the brake is applied.
    The 7-segment display of the inverter shows "9" (contact made with limit switch).

- Cycle 3: Tl. X13:2 (DIØ1) CW/stop from "1" to "0", X13:3 (DIØ2) CCW/stop from "0" to "1"
  and X13:4 (DIØ3) motor potentiometer up from "0" to "1"
  - CCW and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. Drive accelerates
    with ramp t11 up CCW/until n_{min} and continues with ramp t3 up while as X13:4 = "1".

- Cycle 4: Tl. X13:3 (DIØ2) CCW/stop = "1" and X13:4 (DIØ3) motor potentiometer up = "1"
  - n_{max} is reached, the drive is running at n_{max}.

- Cycle 5: Tl. X13:2 (DIØ1) CW/stop = "0", X13:3 (DIØ2) CCW/stop = "1"
  and X22:4 (DI13) CCW preliminary limit switch from "1" to "0"
  - Contact made with CCW preliminary limit switch, so deceleration with ramp t13 until n_{min}.

- Cycle 6: Tl. X13:3 (DIØ2) CCW/stop from "1" to "0"
  - Deceleration with ramp t11 down CCW from n_{min} to $n_{start/stop}$, then stop and X10:3 (DBØØ) /
    Brake from "1" to "0", i.e. the brake is applied.

- Cycle 7: Tl. X13:2 (DIØ1) CW/stop from "0" to "1"
  - Clockwise and tl. X10:3 (DBØØ) /Brake from "0" to "1", i.e. the brake is released. Acceleration
    with ramp t11 up CW until n_{min}.

- Cycle 8: Tl. X13:2 (DIØ1) CW/stop = "1" and X13:4 (DIØ3) motor pot. up from "0" to "1"
  - Acceleration with motor potentiometer ramp t3 up as long as there is a "1" signal at X13:4.

- Cycle 9: X22:3 (DI12) CW preliminary limit switch from "1" to "0"
  - Contact made with CW preliminary limit switch, so deceleration with ramp t13 until n_{min}

- Cycle 10: Tl. X22:1 (DI1Ø) from "1" to "0"
  - Contact made with CW main limit switch, so deceleration with ramp t14 from n_{min} to $n_{start/stop}$, then stop and X10:3 (DBØØ) /Brake from "1" to "0", i.e. the brake is applied.
    The 7-segment display of the inverter shows "9" (contact made with limit switch).

- Cycle 11: **Drive past limit switch** → tl. X22:1 (DI1Ø) CW main limit switch from "0" to "1"
  - **Important:** Not an operational state. Drive moves past main limit switch and accelerates with
    ramp t11 up CW until n_{min} and continues with ramp t3 up for as long as X13:4 = "1".

4.5 Fault messages

The limit switch monitoring function in the unit is active when the inverter is enabled, i.e. X13:1 (DIØØ) /Controller inhibit = "1". It checks that both preliminary and main limit switches are connected according to the wiring diagram (Fig. 2 on page 7 or Fig. 3 on page 8).

Limit switch inputs which are not in use must be connected to +24 V (X13:8 VO24), otherwise fault message F27 "Limit switches missing" is generated by the limit switch monitoring function.

The inverter is braked with the emergency stop ramp t14 if the main limit switches are missing or there is an open circuit. Once the stop speed is reached, the brake is applied (DBØØ "/Brake" from "1" to "0"). The output stage goes to high-resistance after the brake reaction time has elapsed (P732 / P735). Error F27 is displayed on the 7-segment display. The plain text message "F27 Limit switches missing" appears on the DBG11A keypad and in MX_SHELL.

Fault code	Name	Response	P	Possible cause	Action
27	Limit switches missing	Emergency stop		- Open circuit/both limit switches missing. - Main limit switches swapped over in relation to motor sense of rotation	- Check wiring of limit switches. - Swap over main limit switch connections.

Fault messages which occur are stored in fault memory P08_.

RESET: A fault message can be acknowledged by:

- Switching the mains power off and on again.
  Recommendation: Observe a minimum switch-off time of 10 s for the main contactor K11.
- Reset via input terminal, i.e. via an appropriately assigned binary input. The IPOS$^{plus®}$program automatically programs X22:5 (DI14) to the "RESET" function in the case of the crane control.
- Manual reset in MX_SHELL (P840 = "YES" or [Parameter] / [Manual reset])
- Manual reset using the DBG11A (pressing the <E> key in the event of a fault gives direct access to parameter P840)

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