MOVITRAC® 31C...-503-4-01 Frequency Inverters

Manual
Special Version for Crane Control

Edition 11/96

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TÜV CERT DIN EN ISO 9001

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1 Inverter data and installation

1.1 General information and part numbers

- This supplementary information does not replace the comprehensive Operating Instructions!
- Equipment may only be installed by qualified electrical personnel in compliance with the applicable accident prevention regulations and the MOVITRAC® Operating Instructions.

The power ratings of the MOVITRAC®31C...-503-4-01 special version for crane control are the same as those of the standard version and can be taken from the MOVITRAC® 31C Operating Instructions.

Part numbers of the special version for crane control:

MOVITRAC® type	Part number	MOVITRAC® type	Part number
31C008-503-4-01	826 339 6	31C110-503-4-01	826 399 X
31C015-503-4-01	826 340 X	31C150-503-4-01	826 400 7
31C022-503-4-01	826 341 8	31C220-503-4-01	826 401 5
31C030-503-4-01	826 342 6	31C300-503-4-01	826 402 3
31C040-503-4-01	826 343 4	31C370-503-4-01	826 403 1
31C055-503-4-01	826 344 2	31C450-503-4-01	826 404 X
31C075-503-4-01	826 345 0		

The special versions for crane control are fitted with the FEA 31C input/output expansion pcb. This option pcb carries the system EPROMs for crane control.

The system EPROMs for the crane control option have the part numbers: 822 246 0.XX LOW
822 247 9.XX HIGH

Functions like hoist and speed control etc. continue to be available without any restrictions.

1.2 Differences to the MOVITRAC® 31C basic version

MOVITRAC® 31C...-503-4-01 inverters are especially equipped for applications such as **trolleys for bridge cranes** and **hoists**.

- **Two operating modes** are implemented.
  The signal level on input TL. 34/35 determines which of the two operating modes is active:

TL. 34	0...5 V	= “0"	motorized potentiometer mode	(ground control)
	7.5...30 V	= ”1"	fixed setpoint mode	(radio control)
TL. 35	jumper with TL. 30 (0V24)			

- A comprehensive **limit switch control** monitors the preliminary and ultimate (operational) limit switches along the distance of travel of the bridge crane or trolley. To this end, the binary inputs TL. 48/49/50/51 are permanently assigned to limit switch monitoring (low active). Parameters P603...P606 are therefore ineffective.

- **External fault detection** via TL. 36/37:
  The analogue input is used for an “external fault” binary input signal, which is active when low.

TL. 36	0...5 V	= “0"	external fault
	7.5...30 V	= ”1"	no fault
TL. 37	jumper to TL. 30		
Note:	If this signal input is not used, then TL. 36 - TL. 44 (+24V) and TL. 37 - TL. 30 must be jumpered		

- The **following functions** of the standard version **are no longer available**:
  - manual operation (P 87_)
  - master/slave operation (P 88_)
  - setpoint n1 TL. 32/33 with standard function
  - setpoint n2 TL. 34/35
  - external current limit TL. 36/37
  - programming capability of the binary inputs TL. 42-51 (P 60_)
  - all functions, activated through binary inputs
    Exception: fixed setpoints
    parameter set selection
  - reset via binary input

1.3 Wiring of crane control pushbuttons

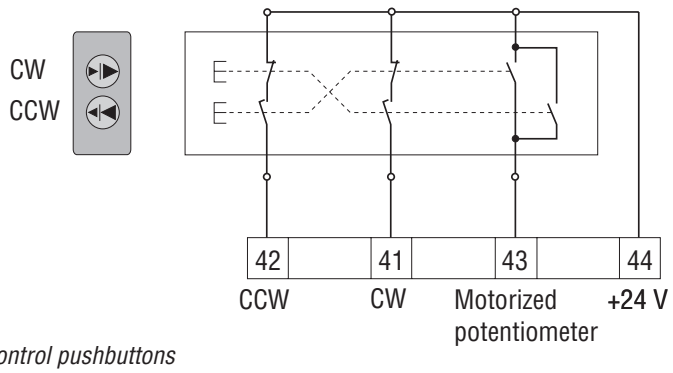

Fig. 1: Wiring of crane control pushbuttons

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1.4 Wiring diagram

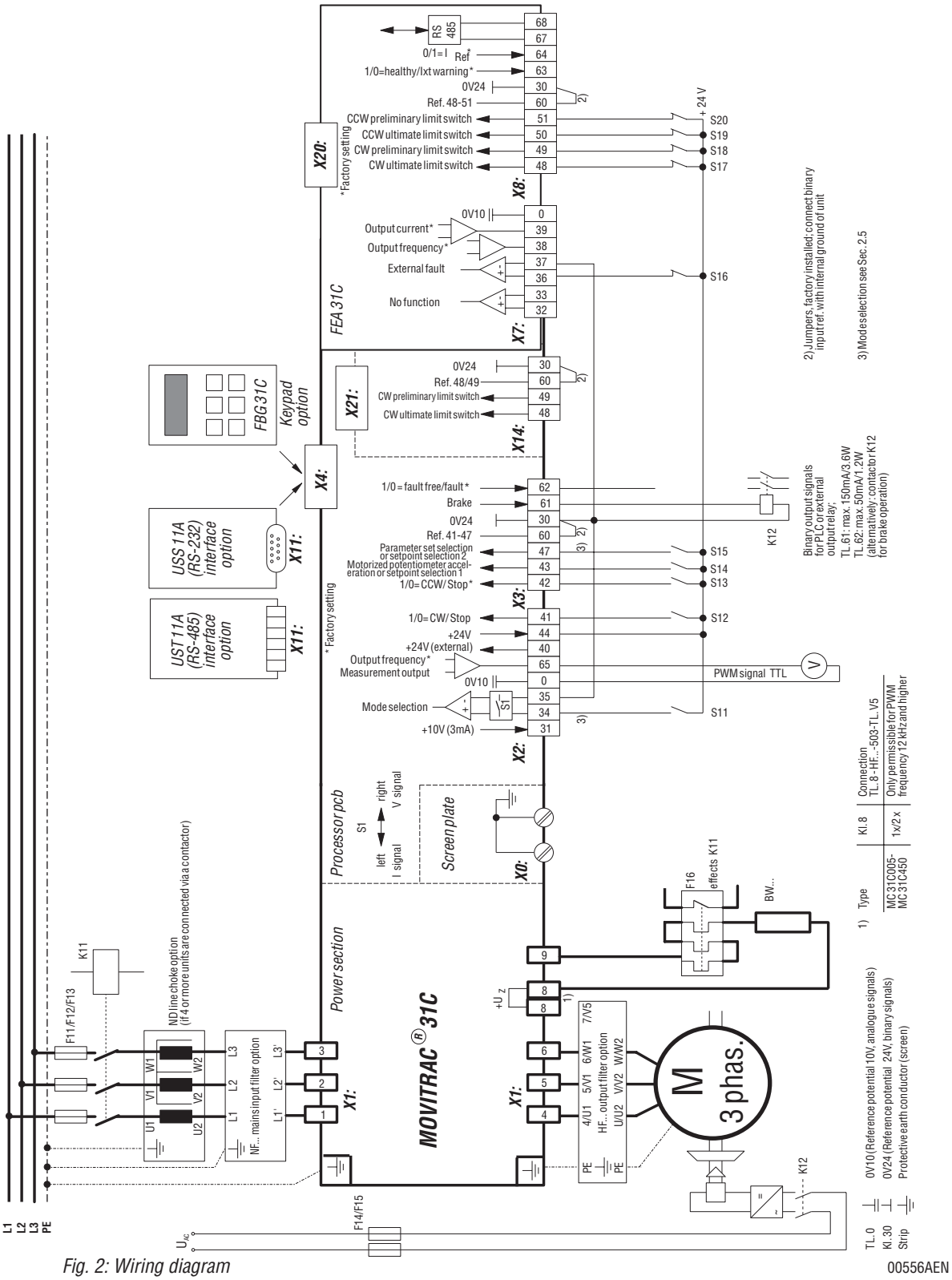

Fig. 2: Wiring diagram

Terminals X14:48 - X8:48 and X14:49 - X8:49 are OR'd internally, allowing terminals X14:48-49 or X8:48-49 to be used alternatively.

An external voltage +24V can be applied directly to analogue inputs X2:34 and X7:36. The negative output of the external power supply must be connected to 0V24 (TL. 30).

1.5 Control inputs

1. **Motorized potentiometer mode (for ground control)** = control by modified motorized potentiometer function. The motorized potentiometer function (P15_) of the MOVITRAC® is automatically activated

Terminal	Function	Signal status "1"	Signal status "0"
TL. 34/35	Mode selection	Fixed setpoint mode	Motorized potentiometer mode
TL. 36/37	External fault detection (e.g. TF thermistor)	No fault	External fault
TL. 41	Enable + CW	Ramp UP t11* (P120) to f_{min}	Ramp DOWN t4 (P 152) to f_{min} Ramp DOWN t11* (P 121) to $f_{start/stop}$
TL. 42	Enable + CCW	Ramp UP t11* (P 120) to f_{min}	Ramp DOWN t4 (P 152) to f_{min} Ramp DOWN t11* (P 121) to $f_{start/stop}$
TL. 43	Acceleration motorized potentiometer	Ramp UP t4 (P 151) to f_{max}	Setpoint stays at present value
TL. 47	Parameter selection*	Parameter set 2	Parameter set 1
TL. 48	CW ultimate limit switch	Status during travel	CW ultimate limit switch reached → rapid stop ramp t13* (P140), output stage inhibited, brake applied
TL. 49	CW preliminary limit switch		CW preliminary limit switch reached → rapid stop ramp t13* to f_{min}
TL. 50	CCW ultimate limit switchtravel		CCW ultimate limit switch reached → rapid stop ramp t13*, output stage inhibited, brake applied
TL.51	CCW preliminary limit switch		CCW preliminary limit switch reached → rapid stop ramp t13* to f_{min}

* The parameters of the 2nd parameter set are activated through the parameter set selection parameter.

2. Fixed setpoint mode (for radio control) = control by internal fixed setpoints

Terminal	Function	Signal status "1"	Signal status "0"
TL. 34/35	Mode selection	Fixed setpoint mode	Motorized potentiometer mode
TL. 36/37	External fault detection (e.g. TF thermistor)	No fault	External fault
TL. 41	Enable + CW	Ramp UP t11 (P 120) to f_{min}	Ramp DOWN t11 (P 121) to f_{min} Ramp DOWN t13 (P 140) to f_{stop}
TL. 42	Enable + CCW	Ramp UP t11 (P 120) to f_{min}	Ramp DOWN t11 (P 121) to f_{min} Ramp DOWN t13 (P 140) to f_{stop}
TL. 43	Internal fixed setpoint n11	n11 active	n11 ineffective
TL. 47	Internal fixed setpoint n12	n12 active	n12 ineffective
TL. 43+47	Internal fixed setpoint n13	n13 active	n13 ineffective
TL. 48-51	Ultimate and preliminary limit switches	See table above	

If not all limit switch inputs (TL. 48/49/50/51) are used, the open inputs must be connected to +24V (TL. 44) as otherwise the limit switch monitoring will signal a fault (→ Sec. 2.6 Fault signals).

1.6 Limit switch connection

The use of end-of-track limit switches for crane control is supported. Altogether four limit switch inputs are available for monitoring the travel and the travel speed. (→ Sec. 1.4 Wiring diagram and Sec. 1.5 Control inputs).

- CW ultimate limit switch TL. 48
- CW preliminary limit switch TL. 49
- CCW ultimate limit switch TL. 50
- CCW preliminary limit switch TL. 51

The limit switches must be installed along the distance of travel in accordance with Fig. 4. For safety reasons the limit switches must be implemented as “low active”. When the inverter is enabled the internal limit switch monitoring feature monitors whether both preliminary and ultimate limit switches are connected in accordance with the wiring diagram (→ Sec. 1.4). If only one of the two preliminary or ultimate limit switches is missing no fault signal is issued. The limit switches are not monitored for correct connection.

If not all limit switch inputs (TL. 48/49/50/51) are used, the open inputs must be connected to +24V (TL. 44) otherwise the limit switch monitoring will issue a fault signal (→ Sec. 2.6 Fault signals).

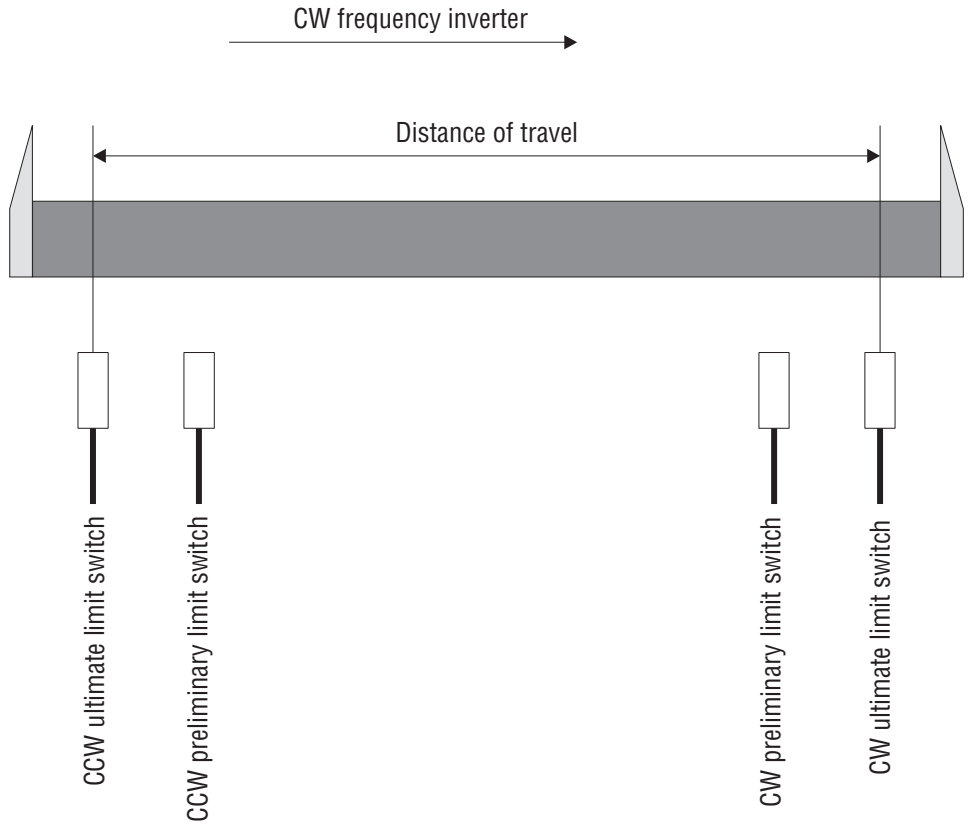

Fig. 3: Limit switch installation 00557AEN

2 Operating instructions

2.1 General

Two operating modes can be distinguished in crane control:
1. Setpoint control by the motorized potentiometer function (ground control)
2. Setpoint control by selecting a fixed setpoint (radio control)

Input X2:34 is used to change between the operating modes. It is also possible to change between operating modes when then the inverter is running. This means that the 2nd set of fixed setpoints can also be used (→ Sec. 2.5).

The operating modes are characterized by "operational sequence charts".

The following acceleration and deceleration ramps are used for crane control:
- Ramp UP — 1st ramp t11 UP (P 120) set 1 or 1st ramp t21 UP (P 123) set 2
- Ramp DOWN — 1st ramp t11 DOWN (P 121) set 1 or 1st ramp t21 DOWN (P 124) set 2
- Motorized potentiometer ramp UP — t4 UP (P 151)
- Motorized potentiometer ramp DOWN — t4 DOWN (P 152)
- Rapid stop ramp — t13 (P 140) set 1 or t23 (P 142) set 2

The following fixed setpoints are used for crane control:
- n11 (P 160) set 1 or n21 (P 170) set 2
- n12 (P 161) set 1 or n22 (P 171) set 2
- n13 (P 162) set 1 or n23 (P 172) set 2

The following frequency characteristics are used for crane control:
- $f_{min}1$ (P 200) set 1 or $f_{min}2$ (P 210) set 2
- $f_{base}1$ (P 201) set 1 or $f_{base}2$ (P 211) set 2
- $f_{max}1$ (P 202) set 1 or $f_{max}2$ (P 212) set 2
- $f_{start/stop}1$ (P 260) set 1 or $f_{start/stop}2$ (P 261) set 2

Notes on the operational sequence charts:

- The operational sequence charts show the ramp generators, fixed setpoints and frequency characteristics of set 1.
- The figures in the "status" line refer to the state graph (→ Sec. 3).

2.2 Motorized potentiometer mode

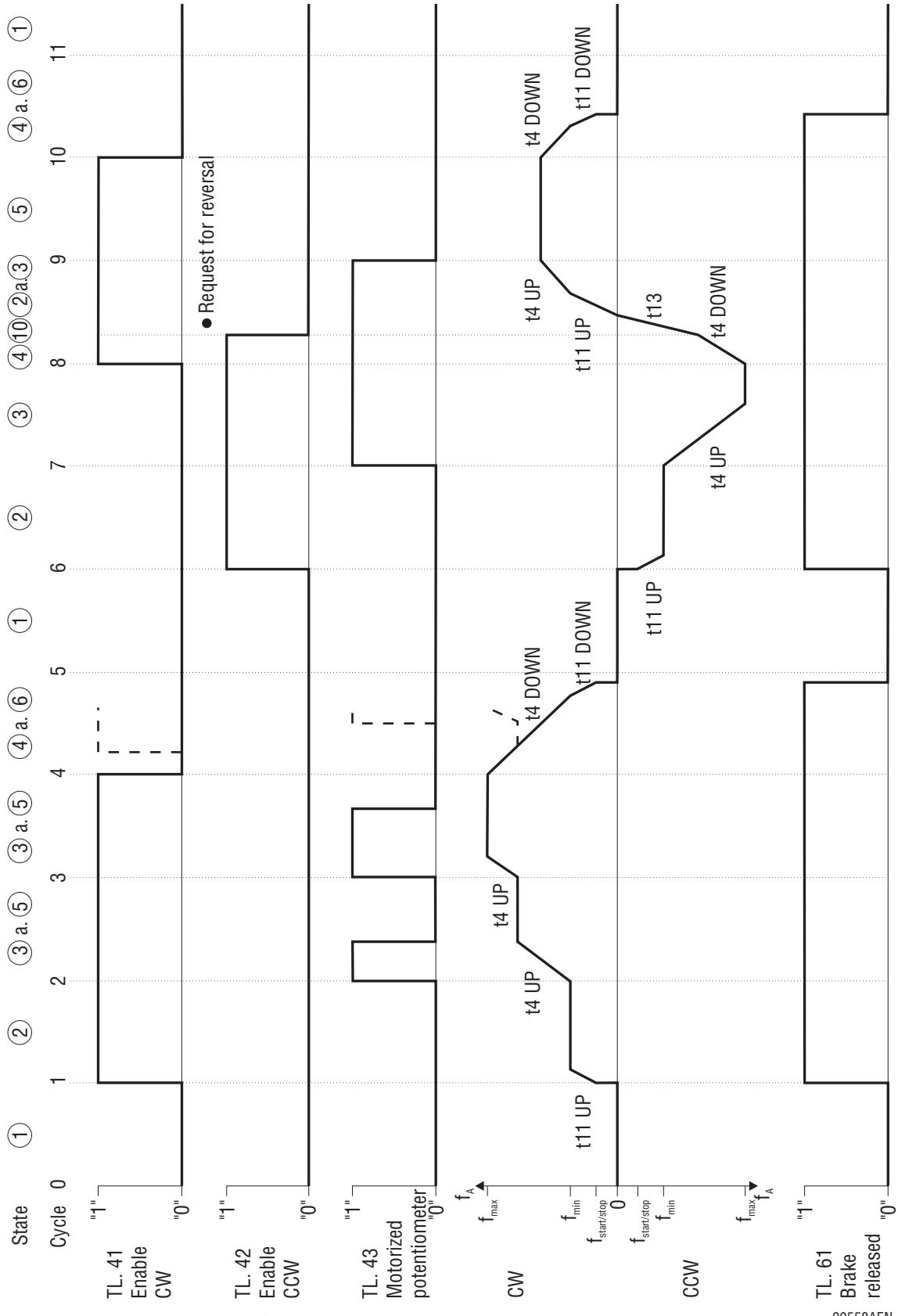

Fig. 4: Operational sequence chart for the motorized potentiometer mode

Explanation of the operational sequence chart for the motorized potentiometer mode

- Cycle 1: TL. 41 signal transition from “0" to ”1".
  → CW, brake RELEASED (TL. 61) signal transition from “0" to ”1" and acceleration with ramp UP (t11) to f_{min}, f_{min} is then held.

- Cycle 2: TL. 43 signal transition from “0" to ”1".
  → Acceleration with motorized potentiometer ramp UP (t4) while TL. 43 = “1".
  Setpoint is held while TL. 41 ≠ TL. 42 and TL. 43 = ”0".

- Cycle 3: TL. 43 signal transition from “0" to ”1".
  → Acceleration with motorized potentiometer ramp UP (t4) to max. f_{max}.
  Setpoint is held while TL. 41 ≠ TLI. 42.

- Cycle 4: TL. 41 signal transition from “1" to ”0".
  → Deceleration with motorized potentiometer ramp DOWN (t4), then ramp DOWN (t11) to $f_{start/stop}$.
  Brake RELEASED (TL. 61) signal transition from “1" to ”0", drive stops.

- Cycle 6: TL. 42 from “0" to ”1".
  → CCW, brake RELEASED (TL. 61) signal transition “0" to ”1" and acceleration with ramp UP (t11) to f_{min}, f_{min} is then held.

- Cycle 7: TL. 43 signal transition from “0" to ”1".
  → Acceleration with motorized potentiometer ramp UP (t4) to max. f_{max}, setpoint is held while TL.41 ≠ TL. 42 and TL. 43 = “0".

- Cycle 8: TL. 41 signal transition from “0" to ”1" and TL. 42 from “1" to ”0" (delayed or simultaneous, in any case before reaching $f_{start/stop}$).
  → Deceleration with motorized potentiometer ramp DOWN (t4) while TL. 41 = TL. 42.
  If TL. 41 ≠ TL. 42 then deceleration with rapid stop ramp (t13) to f = 0 Hz, then reversal and acceleration with ramp UP (t11) to f_{min}, then acceleration with motorized potentiometer ramp UP (t4) while TL. 43 = “1".

- Cycle 9: TL. 41 = “1" and TL. 43 signal transition from ”1" to “0".
  → Setpoint is held while TL. 41 ≠ TL. 42.

- Cycle 10: TL. 41 signal transition from “1" to ”0".
  → Deceleration with motorized potentiometer ramp DOWN (t4) to f_{min}, then ramp DOWN (t11) to $f_{start/stop}$, when $f_{start/stop}$ reached, then brake RELEASED (TL. 61) signal transition from “1" to ”0", drive stops.

Approach to the preliminary and ultimate (operational) limit switches is discussed in Sec. 2.4.

2.3 Fixed setpoint mode

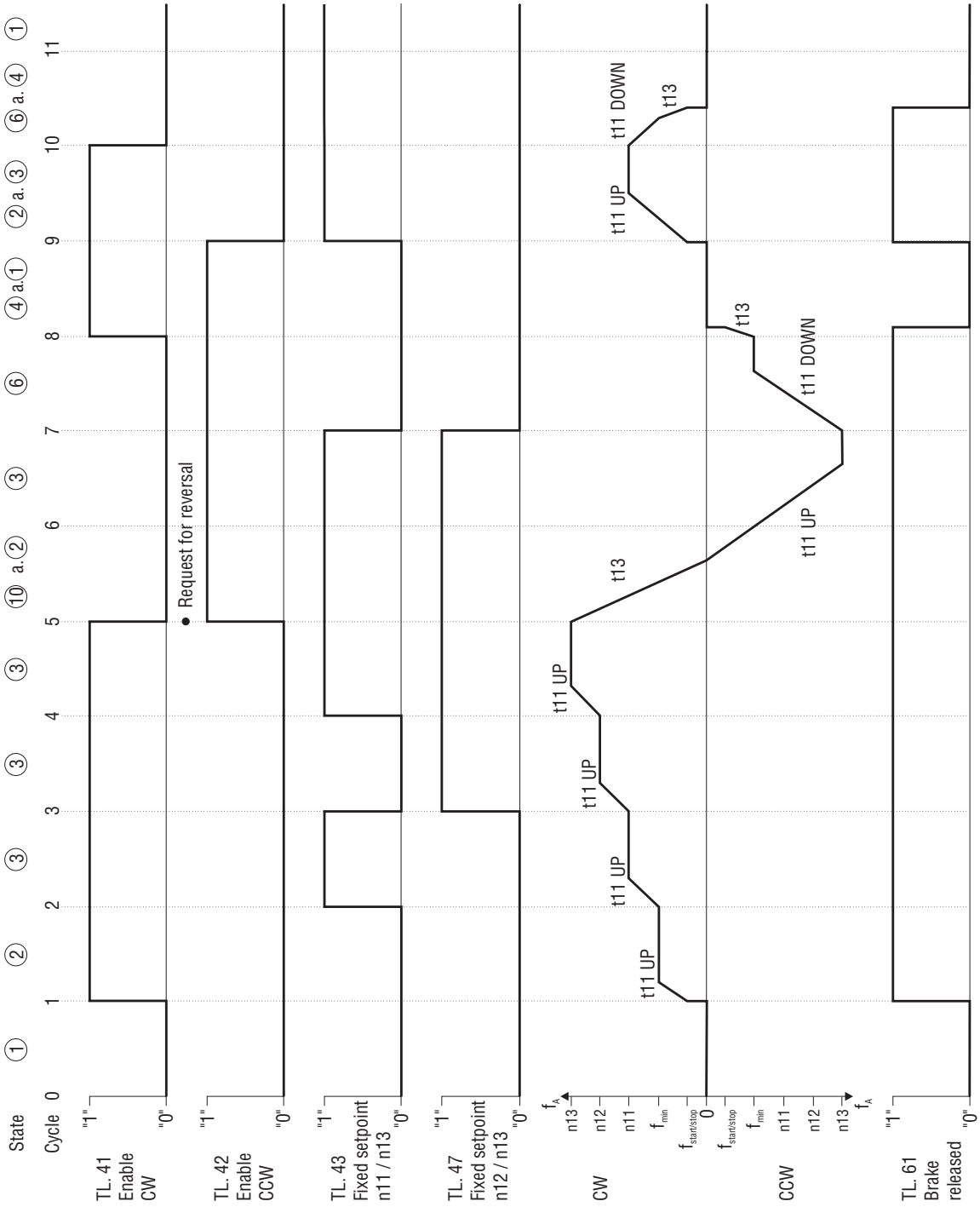

Fig. 5: Operational sequence chart for the fixed setpoint mode

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Explanation of the operational sequence chart for the fixed setpoint mode

- Cycle 1: TL. 41 signal transition from “0" to ”1".
  → CW, brake RELEASED (TL. 61) signal transition from “0" to ”1" and acceleration with ramp UP (t11) to f_{min}, f_{min} is then held.

- Cycle 2: TL. 43 signal transition from “0" to ”1".
  → Acceleration with ramp UP (t11) to n11.

- Cycle 3: TL. 43 signal transition from “1" to ”0" and TL. 47 from “0" to ”1".
  → Acceleration with ramp UP (t11) to n12.

- Cycle 4: TL. 47 = “1" and TL. 43 signal transition from ”0" to “1".
  → Acceleration with ramp UP (t11) to n13.

- Cycle 5: TL. 41 signal transition from “1" to ”0" and TL. 42 from “0" to ”1".
  → Deceleration with rapid stop ramp (t13), to f = 0 Hz,
  then reversal and acceleration with ramp UP (t11) to n13.

- Cycle 7: TL. 43 and TL. 47 signal transition from “1" to ”0".
  → Deceleration with ramp DOWN (t11) to f_{min}.

- Cycle 8: TL. 42 = “1" and TL. 41 signal transition from ”0" to “1".
  → Deceleration with rapid stop ramp (t13) to $f_{start/stop}$,
  when $f_{start/stop}$ reached, then brake RELEASED = ”0", drive stops.

- Cycle 9: TL. 42 signal transition from “1" to ”0" and TL. 43 signal transition from “0" to ”1".
  → Brake RELEASED (TL. 61) from “0" to ”1" and acceleration with ramp UP (t11) to n11.

- Cycle 10: TL. 41 and TL. 43 signal transition from “1" to ”0".
  → Deceleration with ramp DOWN (t11) to fmin, then with rapid stop ramp (t13) to $f_{start/stop}$,
  when $f_{start/stop}$ reached, then brake RELEASED (TL. 61) signal transition from “1" to ”0",
  drive stops.

Approach to the preliminary and ultimate (operational) limit switches is discussed in Sec. 2.4.

2.4 Approach to limit switches (in “motorized potentiometer” mode)

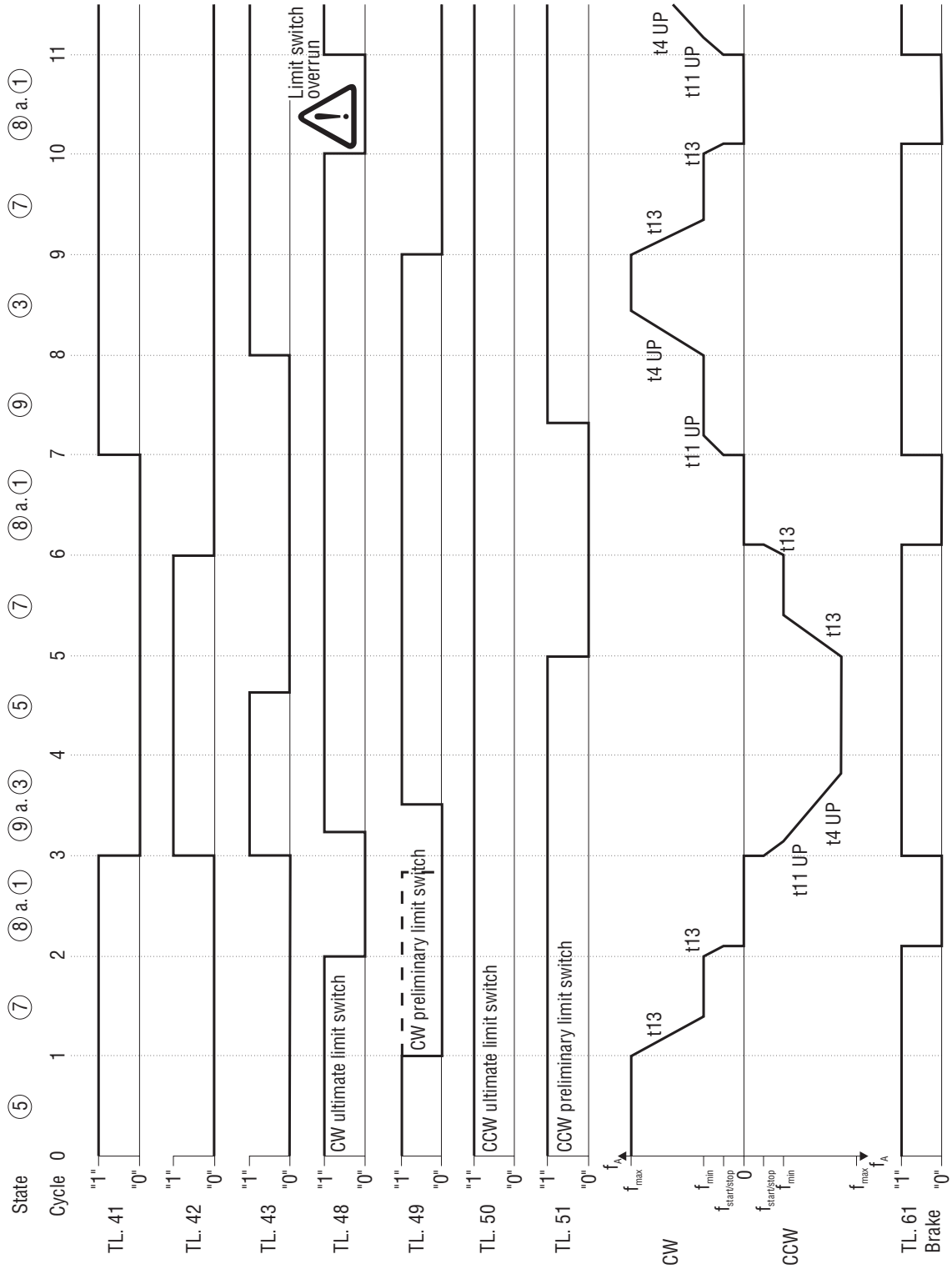

Fig. 6: Operational sequence chart for approach to limit switches

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Explanation of the operational sequence chart for the approach to the limit switches (in "motorized potentiometer" mode, the same applies to "fixed setpoint" mode)

- Cycle 1: TL. 41 = "1", TL. 42 = "0" and TL. 49 signal transition from "1" to "0".
  → CW preliminary limit switch is reached, initiating deceleration with rapid stop ramp (t13) to f_{min}.

- Cycle 2: TL. 48 signal transition from "1" to "0".
  → CW ultimate limit switch is reached, initiating deceleration with rapid stop ramp (t13) to $f_{start/stop}$. Brake RELEASED (TL. 61) signal transition from "1" to "0", drive stops.

- Cycle 3: TL. 41 signal transition from "1" to "0", TL. 42 from "0" to "1" and TL. 43 from "0" to "1", → CCW, brake RELEASED (TL. 61) signal transition from "0" to "1" and acceleration with ramp UP (t11) to f_{min} and ramp UP (t4) to f_{max}.
  TL. 48 and TL 49 signal transition from "0" to "1", as drive travels clear of limit switches.

- Cycle 5: TL. 51 signal transition from "1" to "0".
  → CCW preliminary limit switch is reached, initiating deceleration with rapid stop ramp (t13) to f_{min}.

- Cycle 6: TL. 41 = "0" and TL. 42 signal transition from "1" to "0".
  → Deceleration with rapid stop ramp (t13) to $f_{start/stop}$.
  Brake RELEASED (TL. 61) from "1" to "0", drive remains stopped.

- Cycle 7: TL. 41 signal transition from "0" to "1".
  → Acceleration with ramp UP (t11) to f_{min}.
  TL. 51 signal transition from "0" to "1", as drive travels clear of limit switch.

- Cycle 8: TL. 43 signal transition from "0" to "1".
  → Acceleration with ramp UP (t4) to max. f_{max}.

- Cycle 9: TL. 49 signal transition from "1" to "0".
  → CW preliminary limit switch is reached, initiating deceleration with rapid stop ramp (t13) to f_{min}.

- Cycle 10: TL. 48 signal transition from "1" to "0."
  → CW ultimate limit switch is reached, initiating deceleration with rapid stop ramp (t13) to $f_{start/stop}$. Brake RELEASED (TL. 61) from "1" to "0", drive remains stopped.

- Cycle 11: Limit switch is run onto, initiating a signal transition on TL. 48 from "0" to "1".
  → **Caution:** Not an operational state. Drive runs onto ultimate limit switch and accelerates with ramp UP (t11) to f_{min} and then with ramp UP (t4) to f_{max}.

2.5 Mode selection while the inverter is running

The following steps must be carried out to select the 2nd fixed setpoint set when in the “fixed setpoint” mode.

- Change to “motorized potentiometer” mode.
- To select the 2nd parameter set, only while the inverter is not enabled (TL. 41 = TL. 42), i.e. parameter set selection “1" (TL. 47).
- Enable the inverter, i.e. TL. 41 ≠ TL. 42.
- Change to “fixed setpoint” mode.

The 2nd set of fixed setpoints will remain active while the unit is enabled. When the enable signal is removed the 1st set of fixed setpoints will automatically become active again.

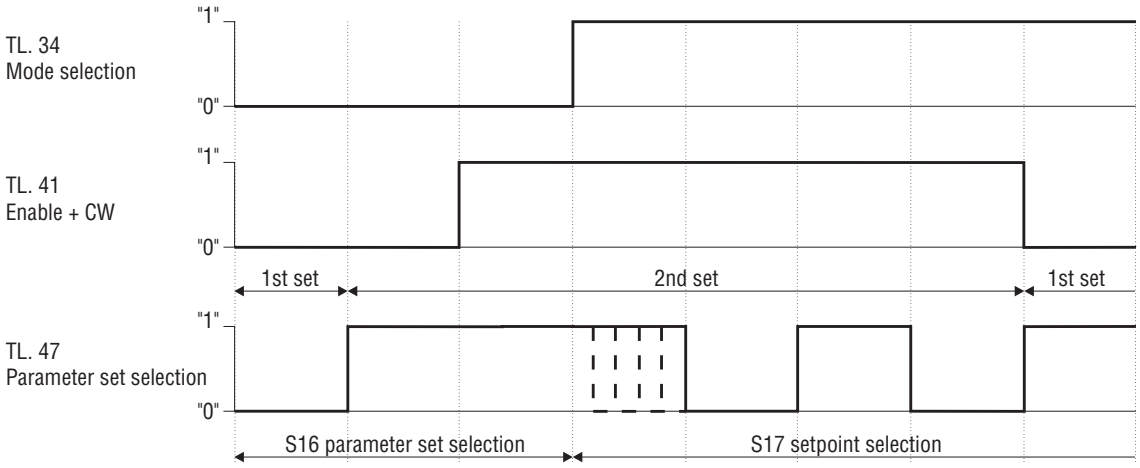

Fig. 7: Selection of 2nd fixed setpoint set 00585AEN

In addition to the details in the wiring diagram, the parameter set selection can be implemented with the following circuit (relay K14 requires a free-wheeling diode).

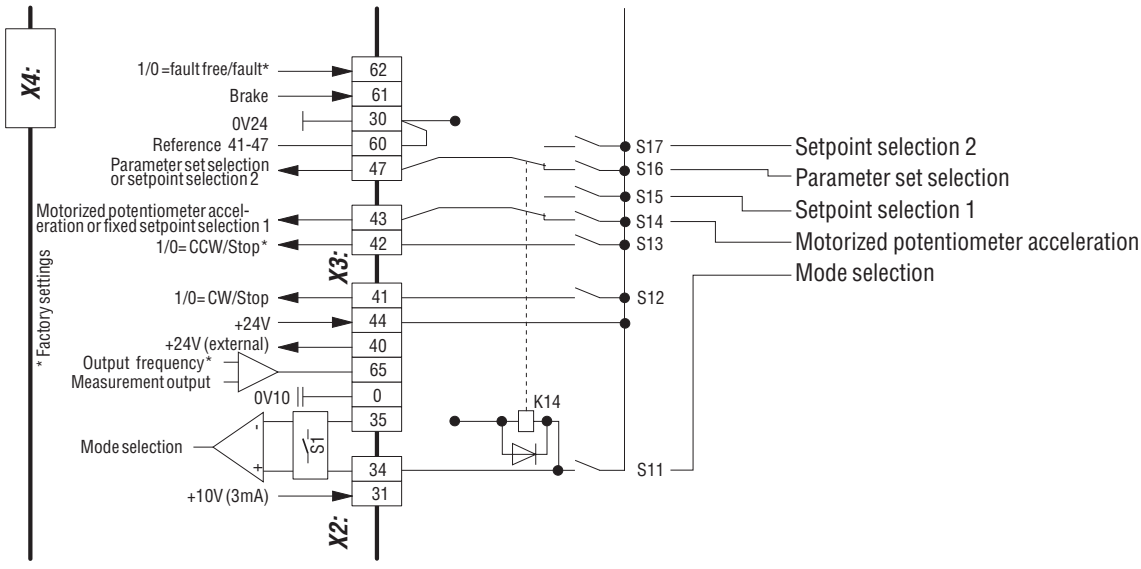

Fig. 8: Parameter set selection 00586AEN

If control of the drive system is by PLC, relay K14 can be dispensed with.

2.6 Fault signals

When the inverter is enabled, the internal limit switch monitoring feature monitors whether both preliminary and ultimate limit switches are connected in accordance with the wiring diagram (→ Sec. 1.4). If only one of the two preliminary and ultimate limit switches is missing, no fault signal is issued. The limit switches are not monitored for correct connection.

Operational approach to the limit switches does not cause a fault signal to be issued.

If not all limit switch inputs (TL. 48/49/50/51) are used, the open inputs must be connected to +24V (TL. 44), otherwise the limit switch monitoring will issue a fault signal.

If the ultimate limit switches are not installed or wire break is detected, the inverter is inhibited. The signals brake released = “0" (TL. 1) and fault ”1" (TL. 62) are issued. The red LED V1 lights up and the fault message is indicated in plain text on the FBG 31C or the PC (MC_SHELL user interface).

The following additional fault messages are issued by the limit switch monitoring:

No	FAULT SIGNAL	Switch-off	Reset	Cause
46	**ULTIMATE LIMIT SWITCHES MISSING**	Immediate switch-off	•	Limit switches missing or wire break
47	**PRELIMINARY LIMIT SWITCHES MISSING**			

Fault messages are stored in the fault memory (P 060...P 064).

In addition, the standard fault signals (→ MOVITRAC® 31C Operating Instructions, Sec. Fault information and Sec. Fault signals and fault causes) apply.

Fault clearance is by:

- powering the inverter down and then up again
- Pushbutton reset (P 862)
- Autoreset (P 860)
- PC (MC_SHELL)

It is not possible to reset the special version for crane control via the input terminals.

3 Additional information (state graphs)

3.1 State graph for the motorized potentiometer mode

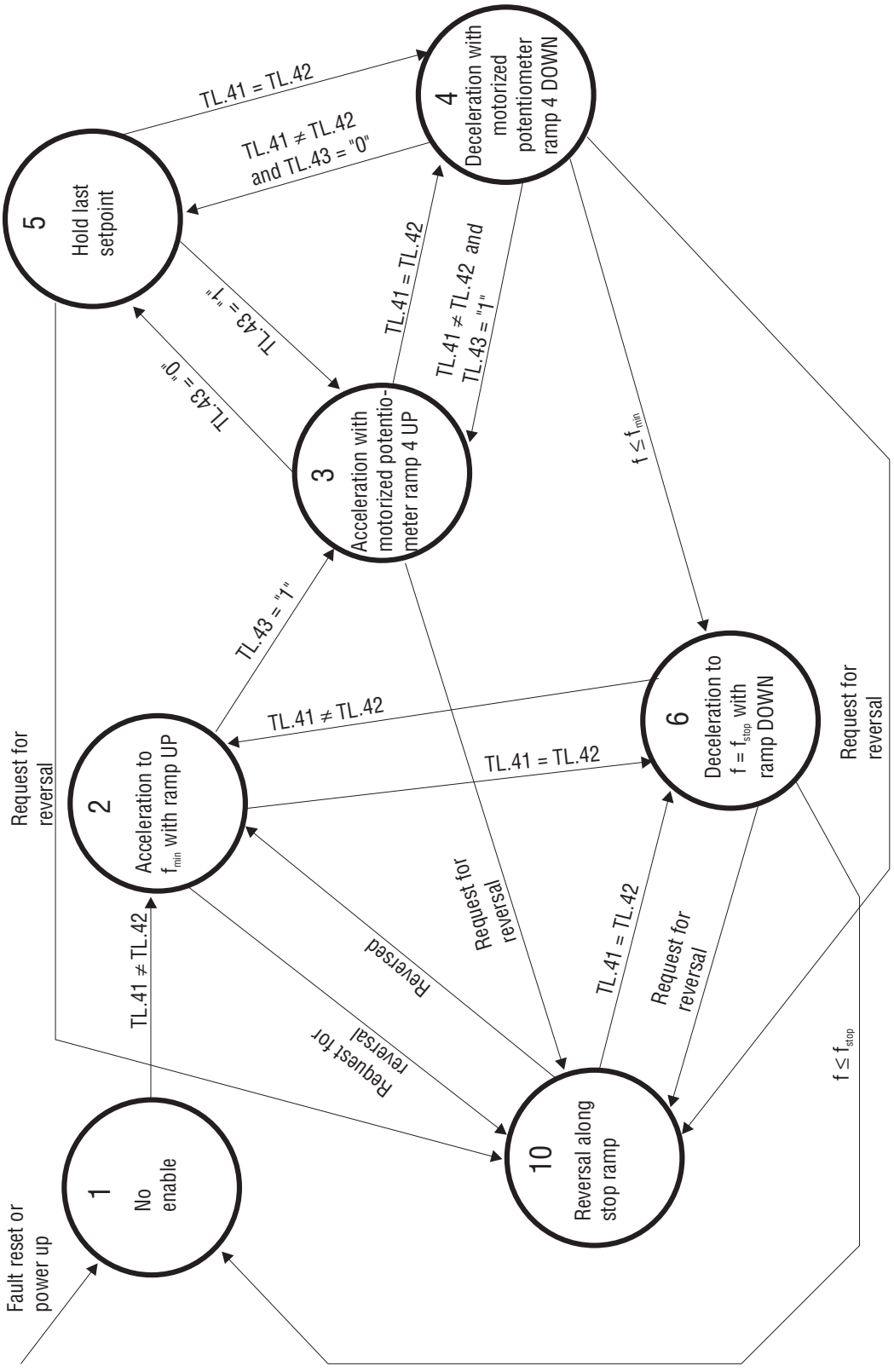

Fig. 9: State graph for the motorized potentiometer mode

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Description of operating states in the "motorized potentiometer" mode

State no. 1:

Description:
- Rotating field is stationary.
- Brake (if fitted) is applied.
- Limit switch monitoring is deactivated.

Activation:
- Switch on the power supply.
- Fault reset.
- Reaching the start/stop frequency from state no. 6 after a stop command has been applied.
- Remove both limit switch signals (corresponding to the direction of rotation) from state no. 8.

Deactivation:
- Enable by setting TL. 41 ≠ TL. 42 → state no. 2.

State no. 2:

Description: Acceleration up to the preset f_{min} with the "Ramp UP" ramp of the selected parameter set.

Activation:
- Enable (TL. 41 ≠ TL. 42) from state no. 1.
- Enable from state no. 6.
- After reversal from state no. 10.

Deactivation:
- Continue acceleration with motorized potentiometer ramp 4 UP if TL. 43 = "1" → state no. 3.
- Initiate a stop by setting TL. 41 = TL. 42 → state no. 6.
- Initiate a reversal → state no. 10.

State no. 3:

Description: Acceleration with motorized potentiometer ramp 4 UP to max. the preset f_{max}.

Activation: Apply acceleration command by setting TL. 43 = 1 during CW or CCW rotation from state nos. 2, 4, 5.

Deactivation:
- Remove the signal on TL. 43 while TL. 41 ≠ TL. 42.
  → State no. 5 for holding the present setpoint.
- Remove the signals on TL. 41, TL. 42, TL. 43 to reduce the setpoint value using motorized potentiometer ramp 4 DOWN → state no. 4.
- Initiate a reversal → state no. 10.

State no. 4:

Description: - Deceleration with the motorized potentiometer ramp 4 DOWN, until the output frequency has reached the preset f_{min}

Activation: - Set TL. 41 = TL. 42, regardless of the state of TL. 43 to produce the deceleration down motorized potentiometer ramp 4 DOWN from state nos. 3, 5.

Deactivation: - Set TL. 43 = "1" while TL. 42 ≠ TL. 42, to increase the setpoint value → state no. 3.
TL. 41 ≠ 42 and TL. 43 = 0 for holding the setpoint value → state no. 5.
The present output frequency has reached the value f_{min} → state no. 6.
Request for reversal → state 10.

State no. 5:

Description: When the signal on TL. is removed, and while TL. 41 ≠ TL. 42, the setpoint value reached when the signal on TL. 43 was removed, is held.

Activation: Remove the signal on TL. 43 while TL. 41 ≠ TL. 42 from state nos. 3, 4.

Deactivation: - Set TL. 43 again while TL. 41 ≠ TL. 42 to further increase the setpoint value with motorized potentiometer ramp 4 UP → state no. 3.
- Remove the enable signal by setting TL. 41 = TL. 42 → state no. 4.
Request for reversal → state no. 10.

State no. 6:

Description: Deceleration down the "ramp DOWN" ramp which is activated by the selected parameter set, to the preset stop frequency

Activation: - Reaching the limit frequency f_{min} when decelerating down the motorized potentiometer ramp 4 DOWN from state 4.
- Stop command by setting TL. 41 = TL. 42 from state nos. 2, 10.

Deactivation: - The start/stop frequency is reached during the deceleration phase → state no. 1.
- A request for reversal is initiated during the deceleration phase → state no. 10.
- A renewed enable is given during the deceleration phase by setting TL. 41 ≠ TL. 42 without reversal → state no. 2.

State no. 10:

Description: - Carries out a reversal along the rapid stop ramp DOWN.

Activation: - Request for a reversal by selecting the opposite direction of rotation to the present one via TL. 41 and TL. 42.

Deactivation: - Reversal carried out → state no. 2
- Stop command by setting TL. 41 = TL. 42 → state no. 6

3.2 State graph for the fixed setpoint mode

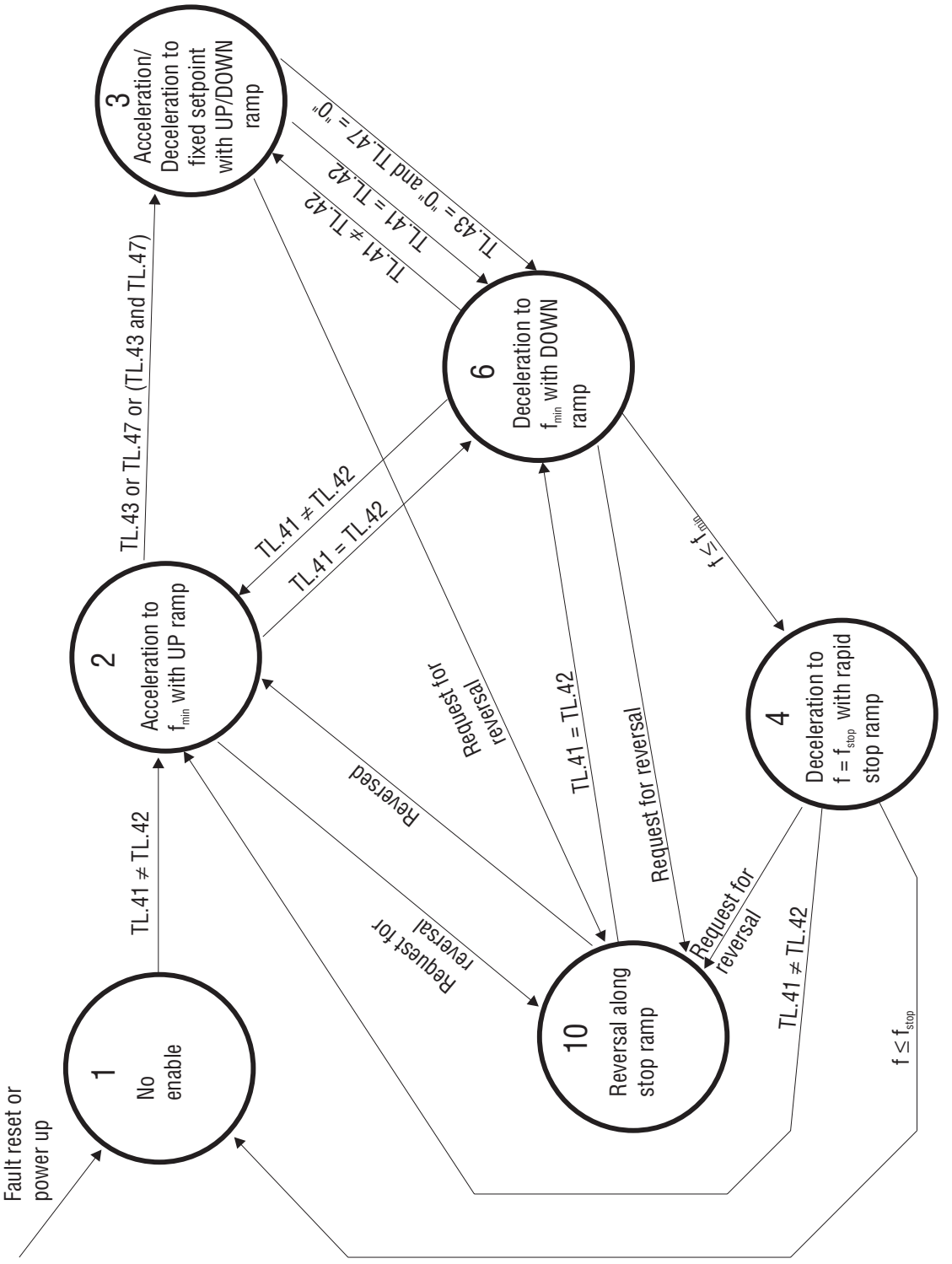

Fig. 10: State graph for the fixed setpoint mode

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Description of operating states in the "fixed setpoint" mode

State no. 1:

Description:
- Rotating field is stationary.
- Brake (if fitted) is activated.
- Limit switch monitoring is deactivated.

Activation:
- Switch on the power supply.
- Fault reset.
- Reaching the start/stop frequency from state no. 4 after a stop command has been applied.

Deactivation: Enable by setting TL. 41 ≠ TL. 42 → state no. 2.

State no. 2:

Description: Acceleration to the preset f_{min} with the "ramp UP" ramp of parameter set 1. This state remains in force until one of the internal setpoints is selected.

Activation:
- Enable by setting TL. 41 ≠ TL. 42 from state no. 1.
- Reversal in state no. 10.
- Renewed enable during stop from state nos. 4 and 6.
- No internal setpoint selected from state no. 3.

Deactivation:
- Select one of the internal setpoints of parameter set 1 → state no. 3.
- Reversal → state no. 10.
- Inverter stop request by setting TL. 41 = TL. 42 → state no. 6.

State no. 3:

Description: Acceleration or deceleration with the up or down ramp of parameter set 1 to the internal fixed setpoint selected by TL. 43 and 47.

Activation:
- Select one of the internal setpoints by combining TL. 43 and TL. 47.
- Enable from state 6.

Deactivation:
- No internal setpoint currently selected (TL. 43 = TL. 47 = "0") → state no. 2.
- Request for reversal → state no. 10.
- Inverter stop request by setting TL. 41 = TL. 42 → state no. 6.

State no. 4:

Description: After reaching the frequency limit f_{min} on an inverter stop request from state no. 6, deceleration takes place with the rapid stop ramp of parameter set 1 to the frequency limit of the start/stop frequency. When this frequency is reached the brake is activated.

Activation: - Reaching frequency limit f_{min} after an inverter stop request from state no. 6.

Deactivation:
- Reaching the start/stop frequency → state no. 1.
- Enable during the deceleration phase by setting TL. 41 ≠ TL. 42 → state no. 2.
- Request for reversal → state no. 10.

State no. 6:

Description: After an inverter stop request by setting TL. 41 = TL. 42, deceleration with DOWN ramp 1 of parameter set 1 until the frequency limit f_{min} is reached.

Activation: - Request for an inverter stop command by setting TL. 41 = TL. 42 → state nos. 2, 3, 10.

Deactivation:
- Enable by setting TL. 41 ≠ TL. 42 → state no. 2, 3.
- Request for reversal during deceleration → state no. 10.
- Reaching the frequency limit f_{min} → state no. 4.

State no. 10:

Description: - Carries out a reversal along rapid stop ramp down.

Activation: - Request for reversal by selecting the opposite direction of rotation to the present one via TL. 41 and TL. 42.

Deactivation:
- Reversal carried out → state no. 2.
- Inverter stop command by setting TL. 41 = TL. 42 → state no. 6.

3.3 State graph for the preliminary and ultimate limit switches

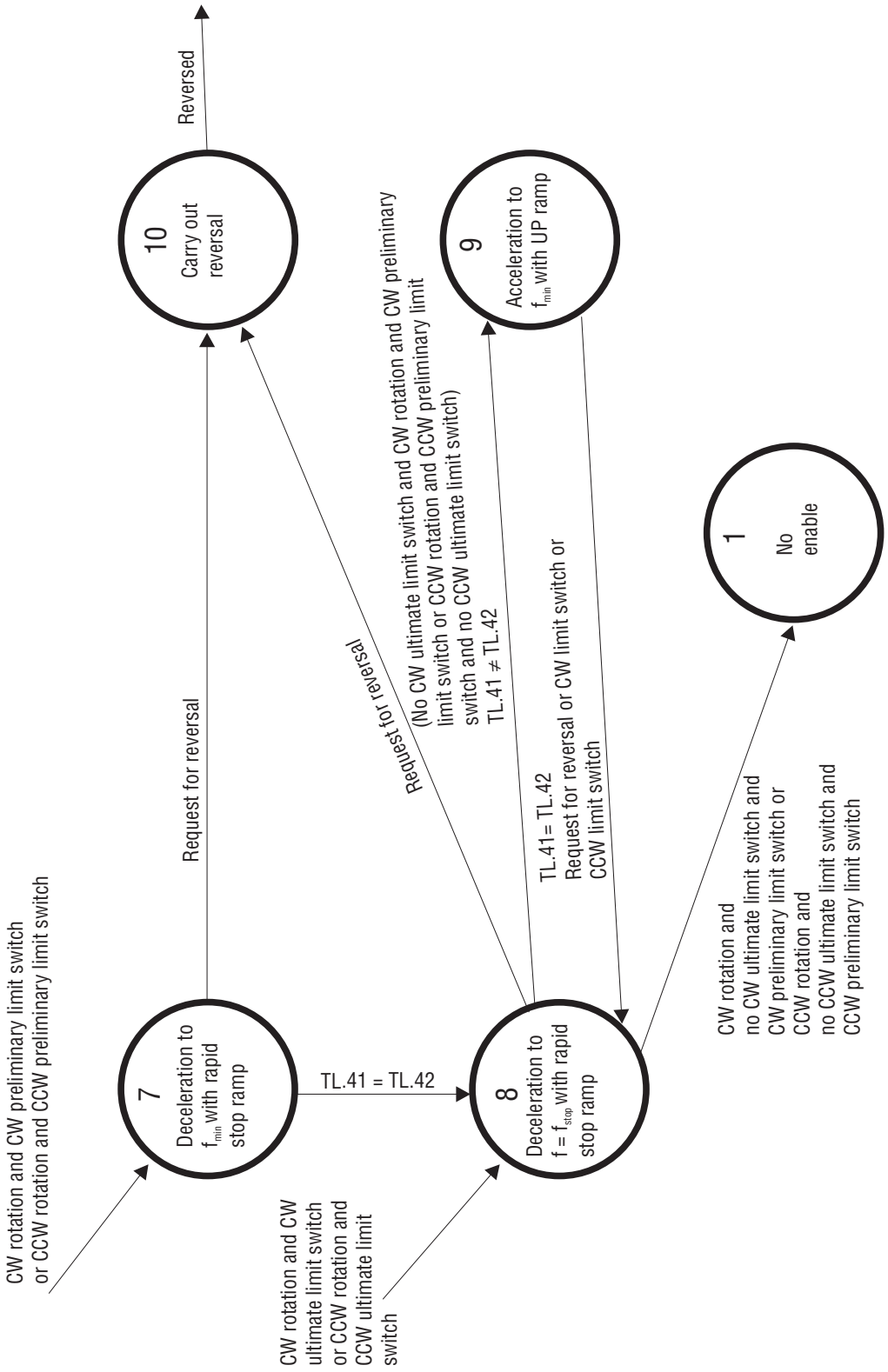

Fig. 11: State graph for the preliminary and ultimate limit switches

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Description of operating states for the preliminary and ultimate limit switches

State no. 7:

Description: After reaching the CW preliminary limit switch (for clockwise rotation) or the CCW preliminary switch (for counterclockwise rotation) the system branches into this state. An immediate deceleration follows, with the selected rapid stop ramp down to the preset frequency limit f_{min}. This state remains in force until either the direction of rotation is reversed or the inverter is stopped. The reversal allows the drive to accelerate in the opposite direction again, although the limit switch is actuated.

Activation:
- Reaching the CW preliminary limit switch for CW rotation.
- Reaching the CCW preliminary limit switch for CCW rotation.

Deactivation:
- Request for reversal → state no. 10
- Inverter stop command → state no. 8
- The ultimate limit switch position is reached → state no. 8

State no. 8:

Description: After reaching the ultimate limit switch (operational limit switch) the system will branch to this state in any case. A stop is carried out with the rapid stop ramp and the inverter is then inhibited. This state can be left by requesting a reversal, or by traveling clear of all the limit switches.

Activation:
- Actuation of a CW or CCW ultimate limit switch.

Deactivation:
- Request for reversal → state no. 10
- Removal of all the limit switch signals → state no. 1

State no. 9:

Description: If a preliminary limit switch is activated and evaluated via state nos. 7 and 8, it is possible to continue, with the preliminary limit switch activated, in the same direction with a maximum frequency of f_{min} until the ultimate limit switch is reached. This state is ended when the enable signal is removed or reversal is requested.

Activation: Enable in state no. 8, as long as only the preliminary limit switch in the direction of travel is actuated.

Deactivation:
- Removal of the enable signal.
- Request for reversal.
- Actuation of an ultimate limit switch.
  → All of these conditions lead to state no. 8.

State no. 10:

See description of operating states for the “motorized potentiometer mode”.

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