ifm electronic

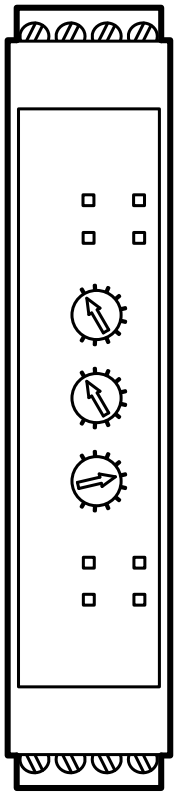
CE

Original Installation Instructions
Safety Underspeed Monitor

UK

ecomat200®

DU110S



80227414 / 00 04 / 2015

Contents

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This document is the original instructions.

1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC and Low Voltage Directive and safety regulations.
The instructions contain information about the correct handling of the product.
Read the instructions before use to familiarise yourself with operating conditions, installation and operation.
Adhere to the safety instructions.

1.1 Symbols used

▶ Instructions
> Reaction, result
→ Cross-reference


Important note
Non-compliance may result in malfunction or interference.


Information
Supplementary note

○ LED off
● LED on
✱ LED flashes

1.2 Warnings used

⚠ WARNING
Warning of serious personal injury.
Death or serious irreversible injuries may result.

⚠ CAUTION
Warning of personal injury.
Slight reversible injuries may result.

NOTE
Warning of damage to property.

2 Safety instructions

- Follow the operating instructions.
- Improper use may result in malfunctions of the unit. This can lead to personal injury and/or damage to property during operation of the machine. For this reason note all remarks on installation and handling given in this document. Also adhere to the safety instructions for the operation of the whole installation.
- In case of non-observance of notes or standards, especially when tampering with and/or modifying the unit, any liability and warranty is excluded.
- The unit must be installed, connected and put into operation by a qualified electrician trained in safety technology.
- The applicable technical standards for the corresponding application must be complied with.
- For installation the requirements according to EN 60204 must be observed.
- Connect and lay all cables according to EN ISO 13849-2 D.5.2 (Safety of machinery - Safety-related parts of control systems).
- In case of malfunction of the unit please contact the manufacturer. Tampering with the unit is not allowed.
- Disconnect the unit externally before handling it. Also disconnect any independently supplied relay load circuits.
- After setup the system has to be subjected to a complete function check.
- Use the unit only in specified environmental conditions (→ 8 Technical data). In case of special operating conditions please contact the manufacturer.
- Use only as described below (→ 3 Functions and features).

2.1 General requirements on the safety-related functions

The device complies with the functional and organisational requirements of EN ISO 13849-1 Performance-Level "e" and EN 62061 SIL "3".

To maintain Safety Integrity Level (SIL) "3" requirements the two input sensors should not be of the exact same type and independent of each other.
Common cause failures between input sensors must be excluded by observing an appropriate cable installation (i.e. separate cable paths). Input sensors must be mounted separately from each other.

To maintain the category 4 requirements during longer periods of standstill the machine operator has to ensure that the machine to be monitored is operated once a day (t < 24 h).

3 Functions and features

3.1 General function description

The device is a two-channel pulse evaluation system for safe underspeed detection.

To do so, it receives the pulse sequences from the pulse pick-ups connected to the inputs. The device calculates the resulting frequency.

By continuously comparing the input frequency (actual value) and the switch point (target value) the device promptly detects underspeed of the set switch point.

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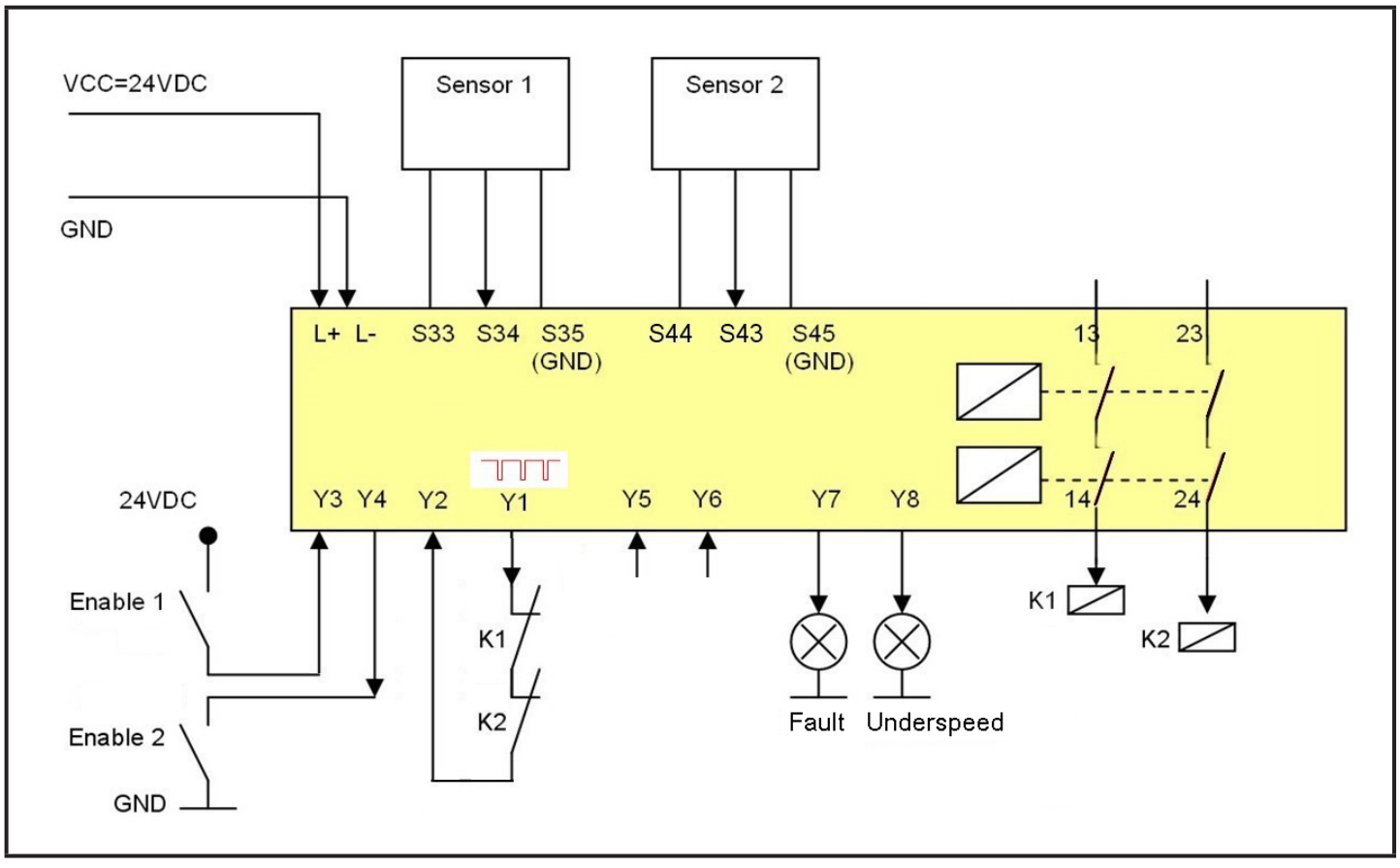
The NO contacts of the internal relays are connected in series so that the current paths are not closed before both relays have switched.

By means of the current paths a door guard locking system can, for example, be controlled.



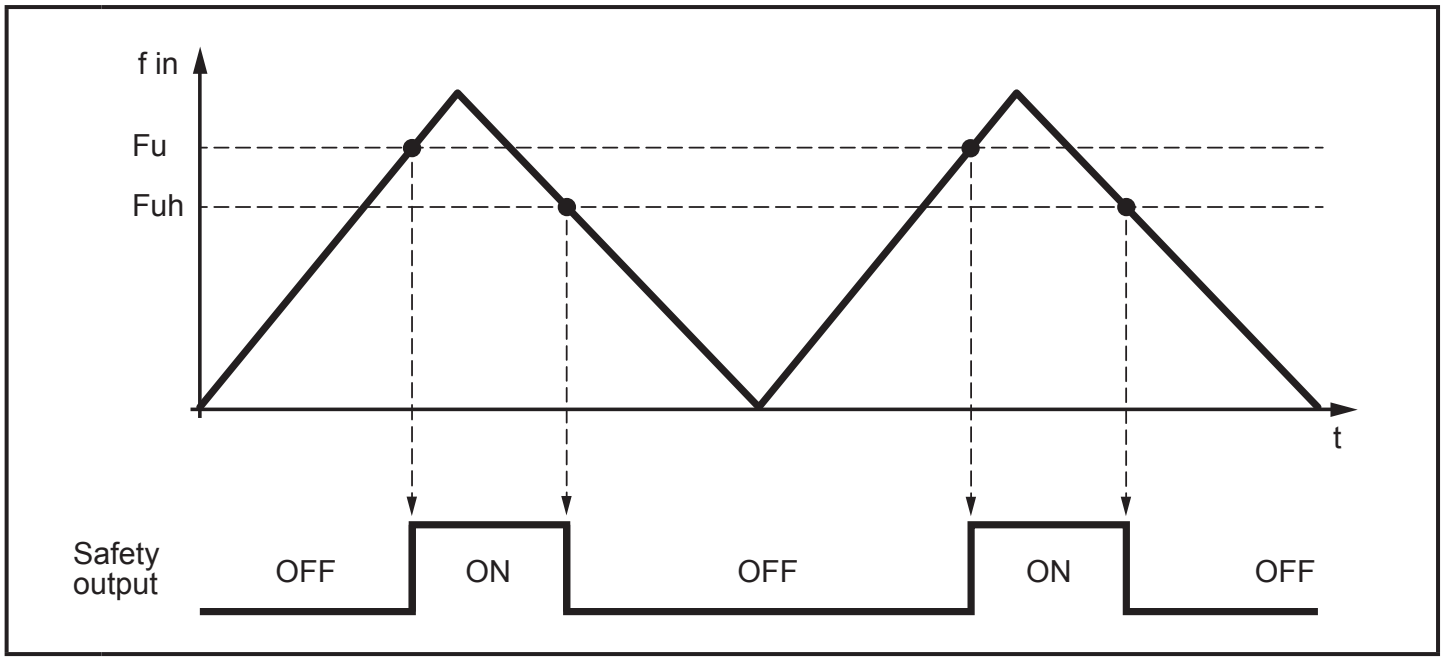
Block diagram

3.2 Safe state of the output relays (failsafe state)

Output relays are de-energised. Current paths are open.

3.3 Switching function "underspeed"

The output relays de-energise when underspeed occurs (frequency FuH has been reached). The relays energise again when the input frequency exceeds the set switch point Fu.



Switching characteristics of the current paths (safety-related outputs)

Fu: Frequency underspeed (= set switch point)
Fuh: Frequency underspeed – hysteresis

3.4 Hysteresis

The hysteresis determines the distance between the switch point (current paths close) and the switch-off point (current paths open).

The hysteresis value is fixed at 5 %.

If the input frequency decreases by 5% below the set switch point Fu, the output relays de-energise and the current paths are open.

Example switch point Fu = 10 Hz:

- Current paths close if Fu is exceeded (rising frequency)
- Current paths open if Fuh is not reached (here 9.5 Hz, falling frequency).

3.5 Initialisation

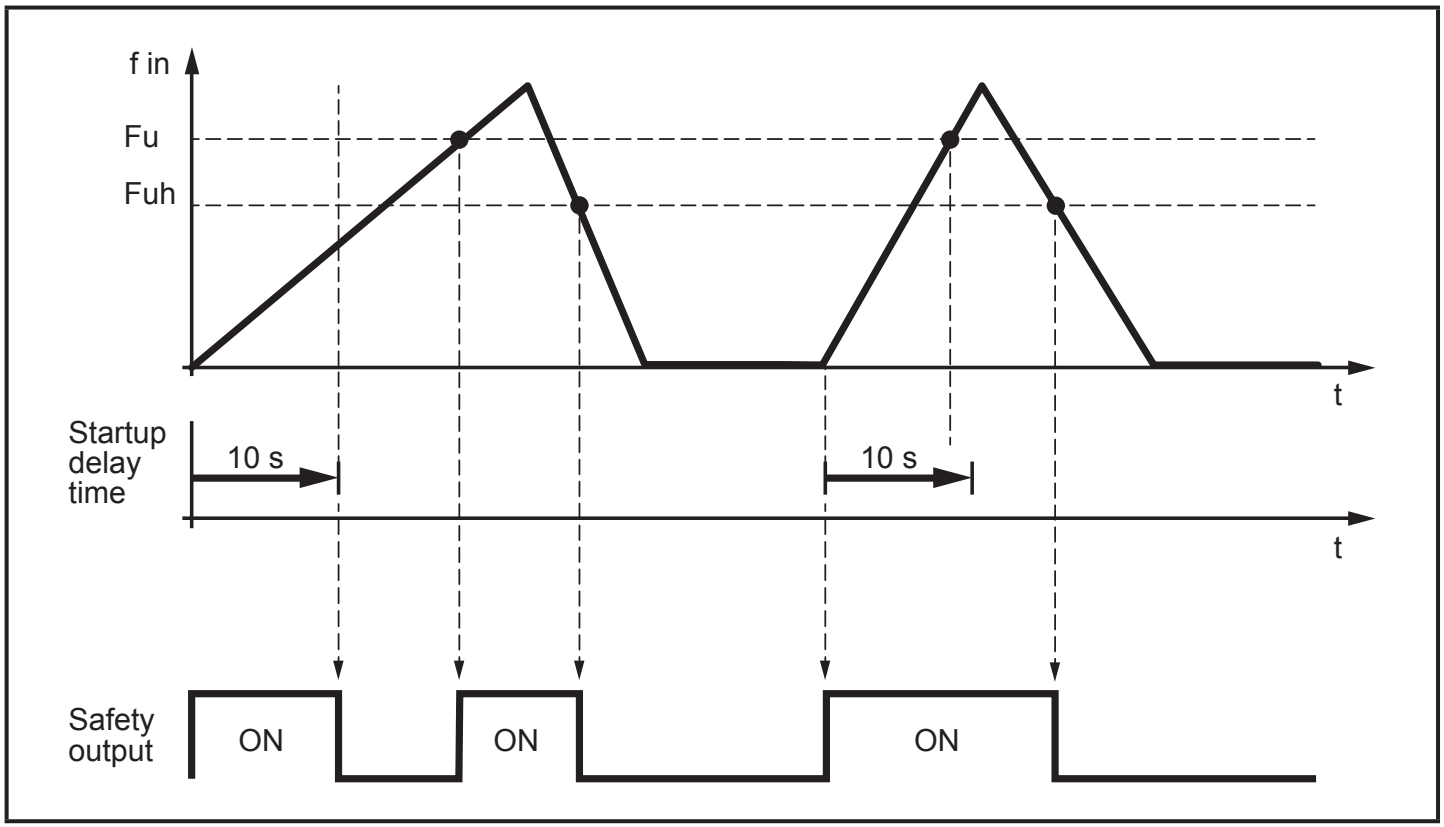
Directly after power on, the device carries out a complete self-test. This initialisation phase takes approx. 3 s.

3.6 Start-up delay

To suppress unintended switch-off of the current paths during the start-up of the machine the device has a fixed start-up delay of 10 seconds.

⚠ WARNING

During these 10 seconds the protective function is temporarily suspended. Carefully check your risk analysis in order to assess whether this function is compatible with your application and what additional measures have to be taken (i.e. guard lock, protective fence, etc.)



Current paths (safety-related outputs) in dependence of the start-up delay

When the operating voltage has been switched on, the current paths are switched off for max. 10 seconds because of the underspeed.
If after this period the input frequency Fu has not been reached, the current paths are switched off.

The start-up delay includes the initialisation phase (→ 3.5 Initialisation).

3.7 Fault output (Y7)

The transistor output "Fault" (Y7) opens when an internal or external error occurs.

The error message is reset by interrupting the voltage supply.

3.8 Underspeed output (Y8)

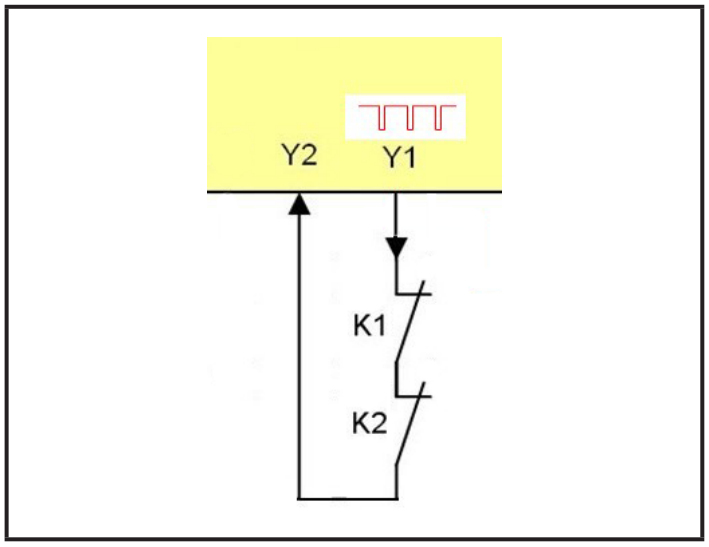
The underspeed output (Y8) is "HIGH" when the current paths are closed and "LOW" when the current paths are opened.

3.9 Feedback circuit for external device monitoring (Y1-Y2)

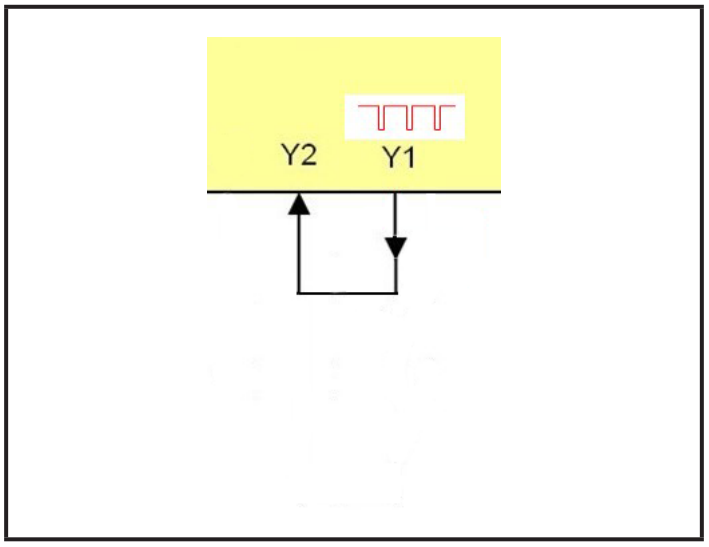
If underspeed is detected, the current paths open and the external relays are de-energised.

If the feedback circuit does not close within 1 s, an error message is provided. LED [FAULT] flashes 3 times.
Also see (→ 6.1 LEDs).

If the feedback function is not required, the terminals Y1-Y2 must be permanently bridged.



Feedback contacts (NC contacts of the external relays in series)

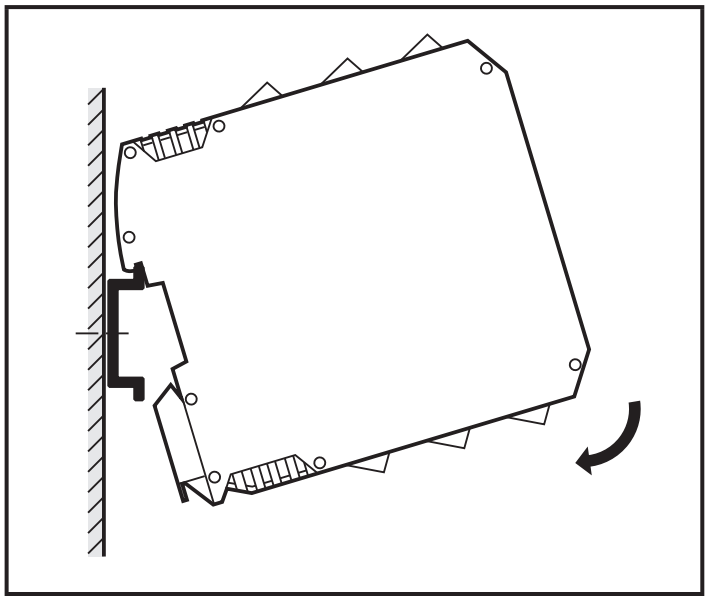


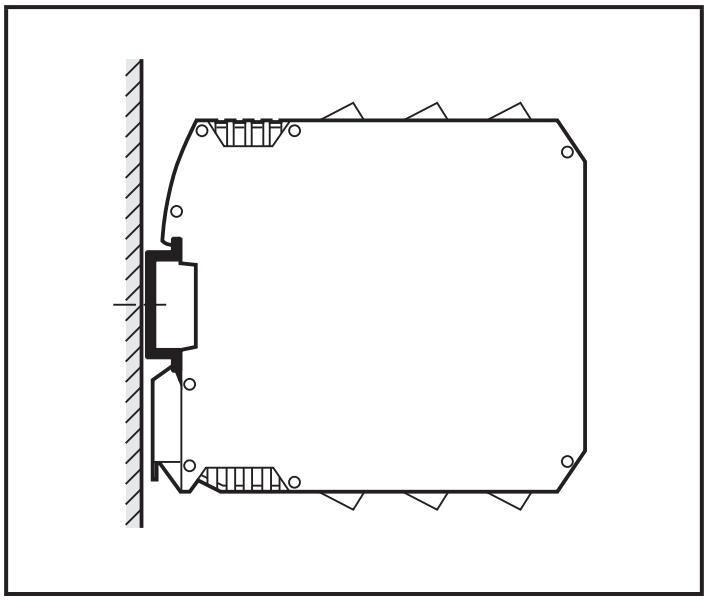
Without feedback function with bridge

4 Installation

4.1 Mechanical installation of the device

▶ Mount the device on a 35 mm DIN rail in a housing protected against dust and humidity (min. IP 54).

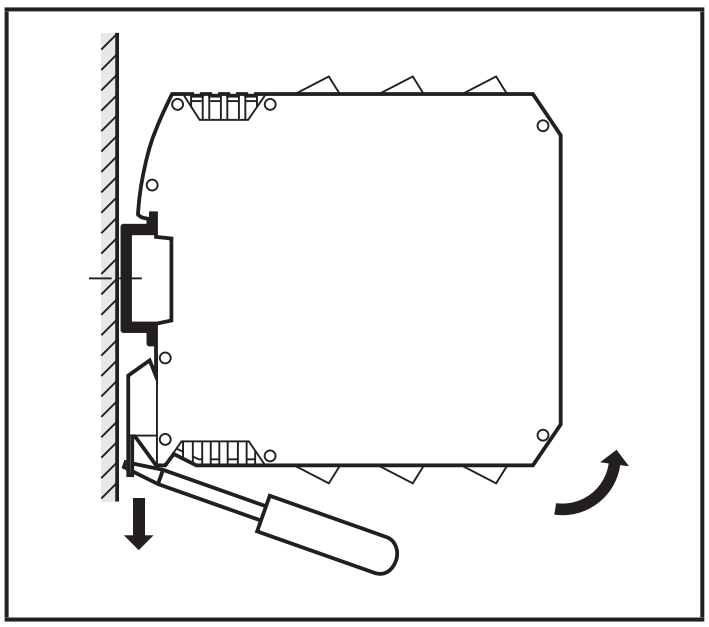




Leave enough space between the device and the top and bottom of the housing to enable air circulation and to avoid excessive heating.

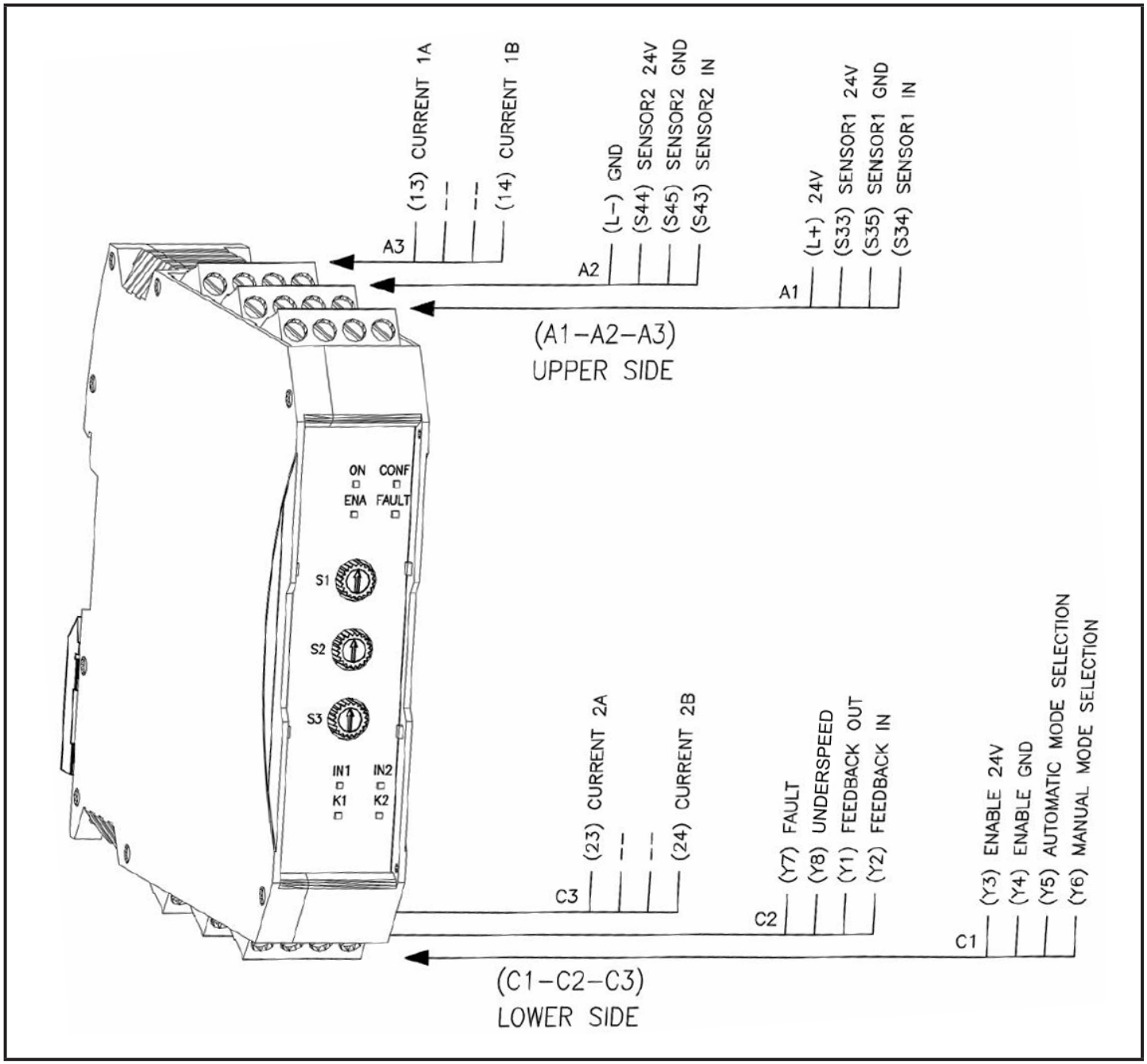
Take into account the internal heating of all devices when mounting several devices side by side. The environmental conditions must be observed for every device and, in order to avoid overheating, maintain between them a minimum distance of 20 mm.

4.2 Remove the device



5 Electrical connection

5.1 Terminals



Terminals

Plug	Terminal	Connection
A1	L+	Supply voltage (+ 24 V DC) protected by a resettable fuse short-circuit proof, not monitored
	S33	Sensor 1 supply (+ 24 V DC)
	S35	Sensor 1 GND (0 V DC)
	S34	Sensor 1 input

Plug	Terminal	Connection	
A2	L-	Supply voltage (GND) directly connected to the device ground	
	S44	Sensor 2 supply (+ 24 V DC)	
	S45	Sensor 2 GND (0 V DC)	
	S43	Sensor 2 input	
A3	13	Current path 1A (relay contacts)	
		(not connected)	
		(not connected)	
	14	Current path 1B (relay contacts)	
C1	Y3	Deactivation of the monitoring function (P)	(→ 5.3)
	Y4	Deactivation of the monitoring function (N)	(→ 5.3)
	Y5	Automatic mode selection	
	Y6	Manual mode selection	
C2	Y7	"Fault" transistor output	(→ 3.7)
	Y8	"Underspeed" transistor output	(→ 3.8)
	Y1	Feedback circuit output	
	Y2	Feedback circuit input	
C3	23	Current path 2A (relay contacts)	
		(not connected)	
		(not connected)	
	24	Current path 2B (relay contacts)	

Observe the technical data of the electrical connections.
(→ 8 Technical data)

PELV power supplies are to be used according to EN 60204-1.
The electrical input signals meet the requirements to EN 61131, type 2.

Do not use unconnected terminals as support point terminal.

Terminal tightening torque: 0.6...0.7 Nm (5...7 lb-in).

5.2 Automatic/manual mode selection

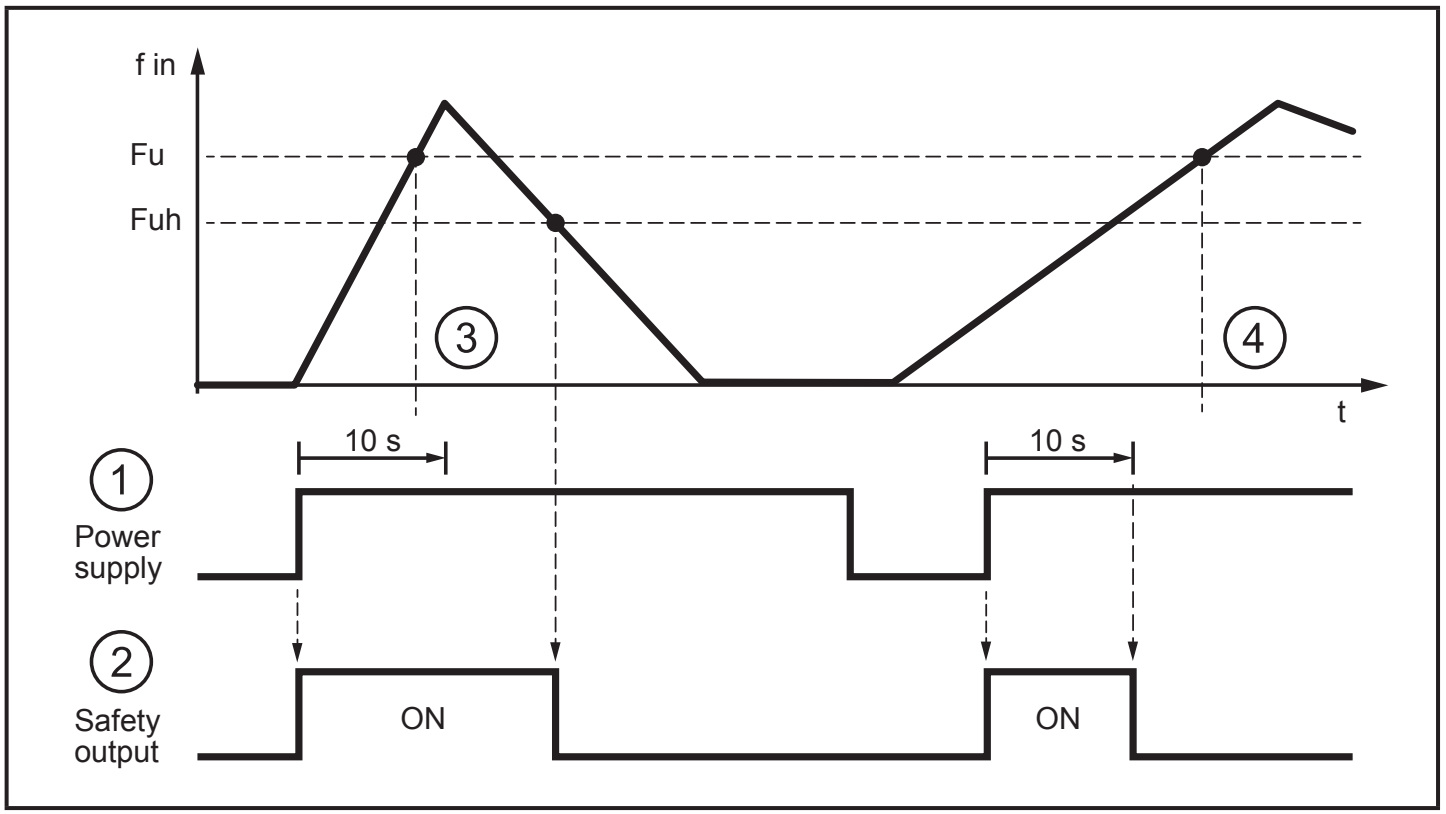
If underspeed is detected, the current paths open and the drive is switched off. The manual operation can prevent the current paths closing automatically as soon as the input frequency exceeds the Fu value again.

The operating mode is selected via the circuitry of two input terminals Y5 and Y6.

5.2.1 Automatic operation

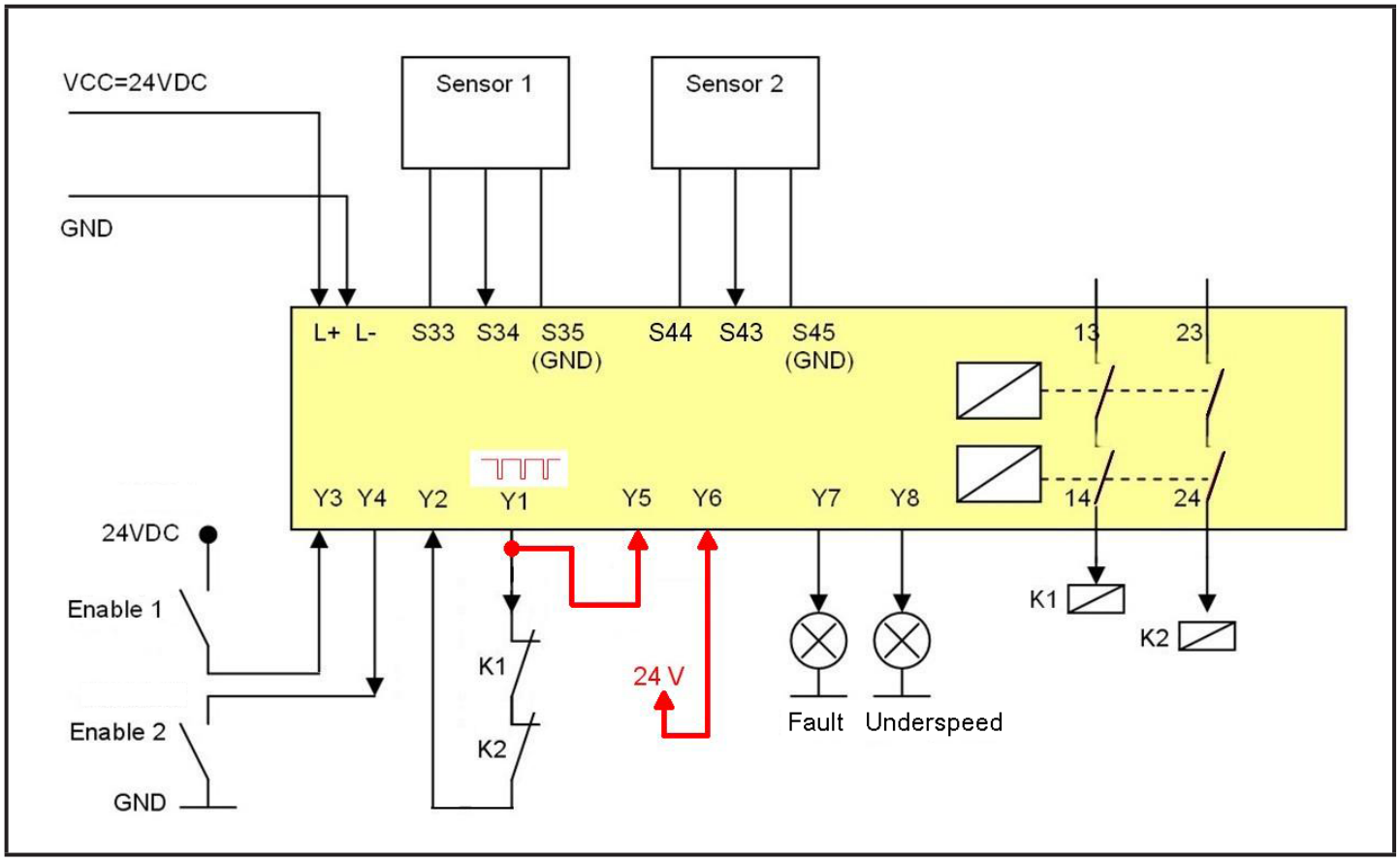
In this operating mode the device compares the input frequency with the set switch point.

- If the input frequency is above the switch point Fu, the current paths are closed.
- If the input frequency is below the switch point Fu minus hysteresis, the current paths are open.



Automatic operation

1: Voltage supply of the unit
2: Current paths (safety-related outputs)
3: Switch point Fu is reached during the start-up delay
4: Switch point Fu is not reached during the start-up delay



Automatic operation (circuitry of the inputs Y5 and Y6)

The automatic operation mode is implemented by connecting input Y5 to Y1 (pulsed test signal) and input Y6 to + 24 V DC.

If the device detects an error, it returns to the safe state (→ 3.2 Safe state of the output relays (failsafe state)).
Detected errors are short circuit on 0 V DC or + 24 V DC or separated connections.

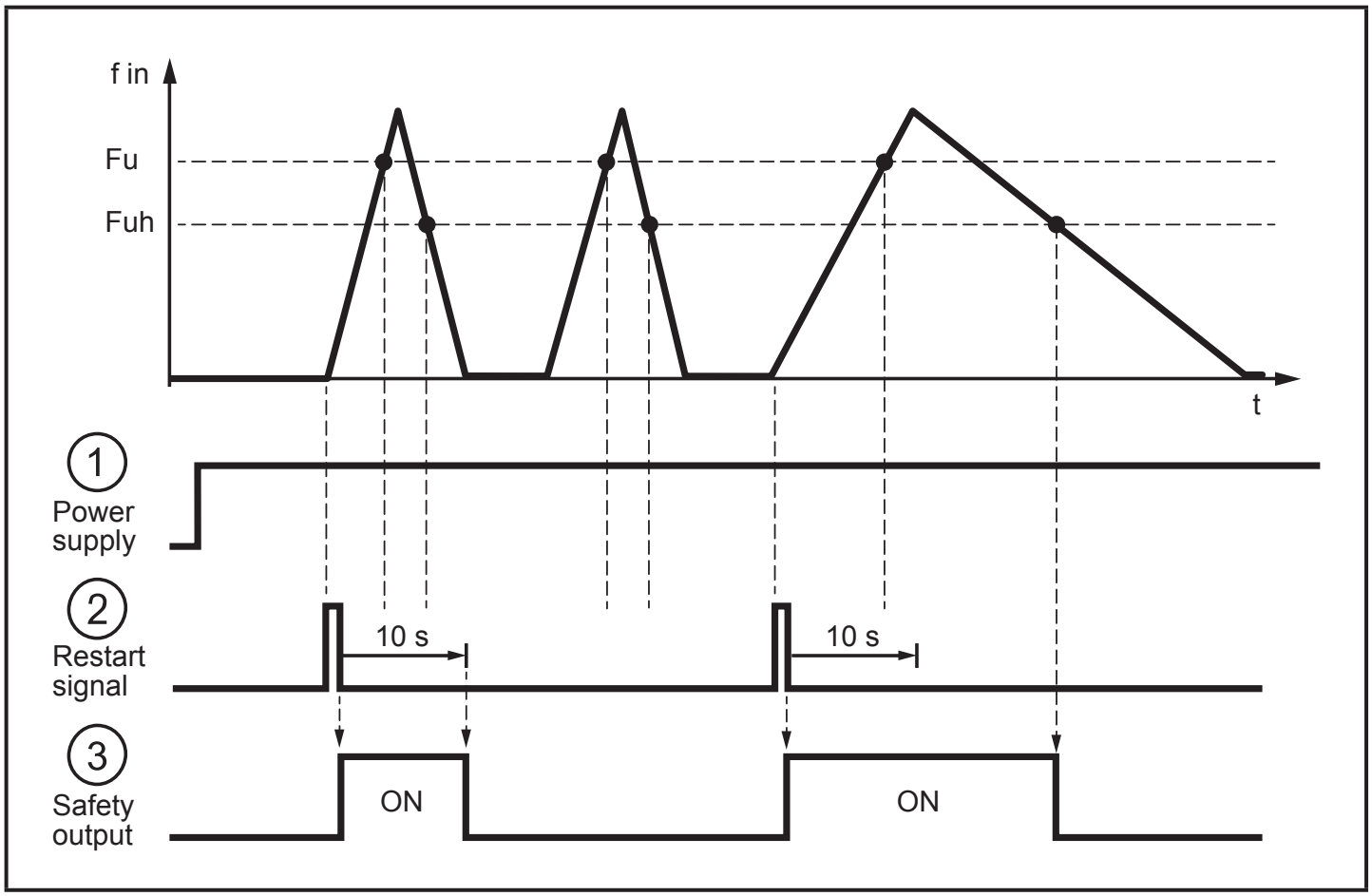
⚠ WARNING

Carefully check if the automatic operating mode can be used when the current paths (safety-related outputs) directly drive a motor.
In some applications an uncontrolled restart may be dangerous.
In these cases the device must be used only as a speed monitor and not for the direct control of a machine.

5.2.2 Manual operation

In this operating mode, the outputs of the device are only switched if the input frequency is above the switch point Fu and after the restart signal has been sent to the device via an external restart command element.

When the underspeed has been detected, the current paths are open.



Manual operation

1: Voltage supply of the unit
2: Restart signal
3: Current paths (safety-related outputs)

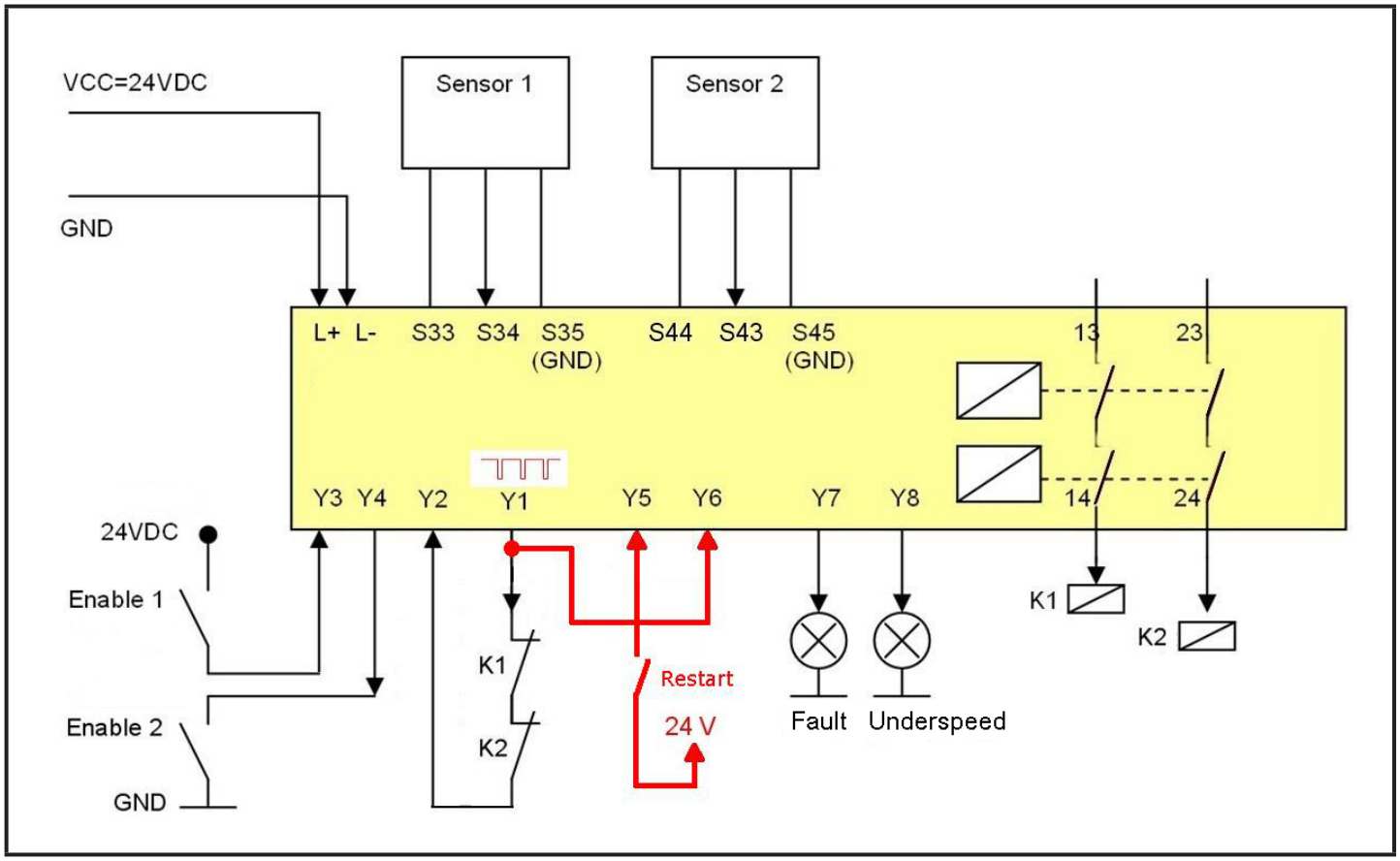
In manual operation the current path remains open until there is a restart signal on input Y5. The restart signal is activated via a falling edge on input Y5 (a complete transition 0 V DC → + 24 V DC → 0 V DC).
This signal is only active if the frequency exceeds the Fuh value.

The restart signal must be applied for 0.3...5 s. Otherwise the command is rejected.

If the restart command is activated while the frequency is between Fu and FuH, the command is rejected. This applies both to the rising and the falling edge.

The restart command element must be installed outside the hazardous area in a position where the hazardous area and the entire work area concerned are clearly visible.
The device may also be installed within the hazardous area since handling is not required during operation.

When the device is waiting for the restart command, the yellow LED [ENA] flashes.



Manual operation (circuitry of the inputs Y5 and Y6)

Manual operation is implemented when during initialisation input Y6 is on the pulsed test signal of Y1 and input Y5 is open.

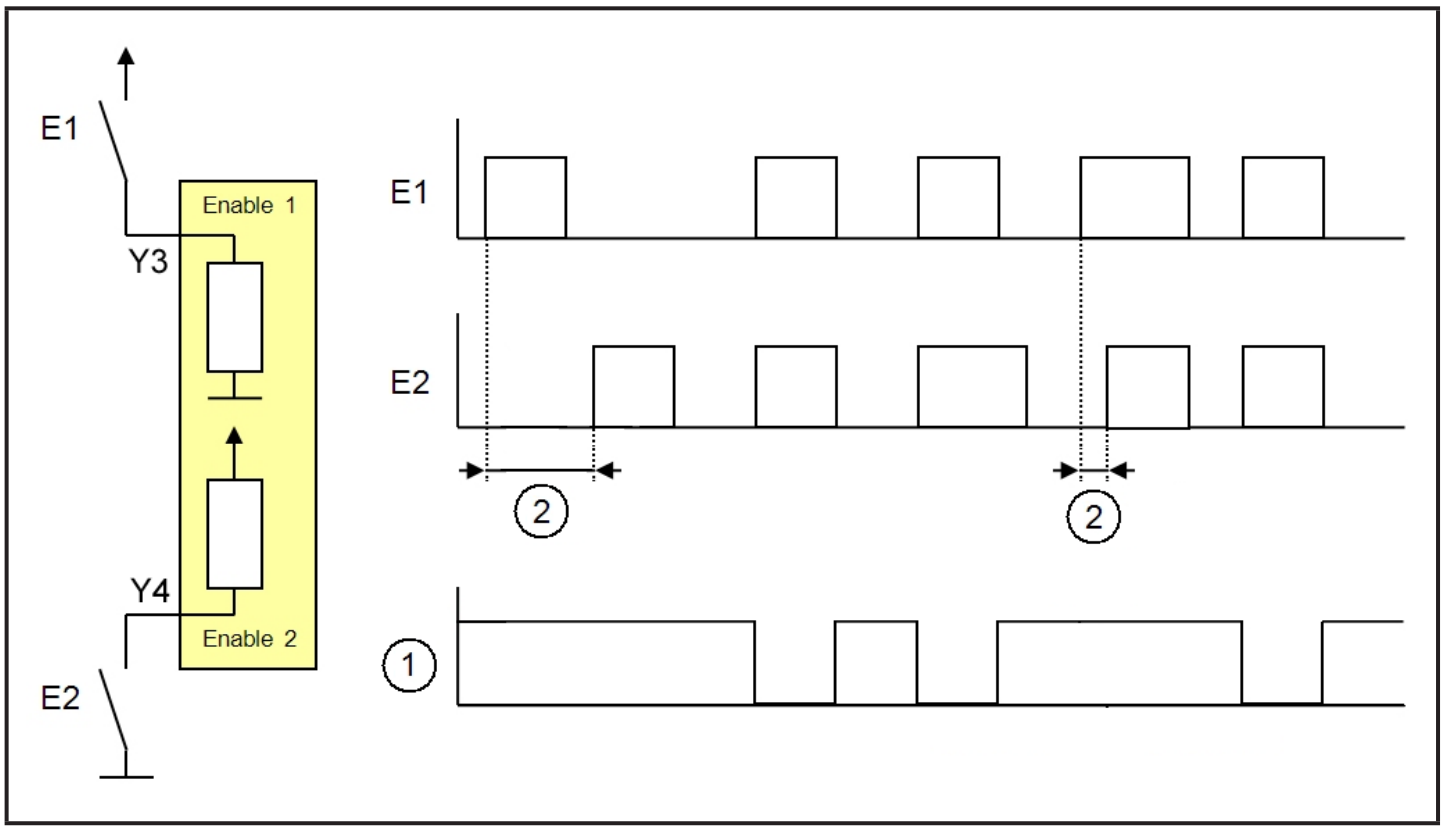
The start-up delay of 10 seconds is active after each restart command (→ 3.6 Start-up delay).

5.3 Enable inputs

If several devices with different switch points are used for underspeed monitoring of a drive, devices whose switch point value is not relevant can be "switched off" by means of the two enable inputs.

The monitoring function of these devices is then deactivated; the current paths are closed.

The monitoring function of a device is activated or deactivated by means of a complementary signal to both enable inputs.



Enable inputs E1 and E2

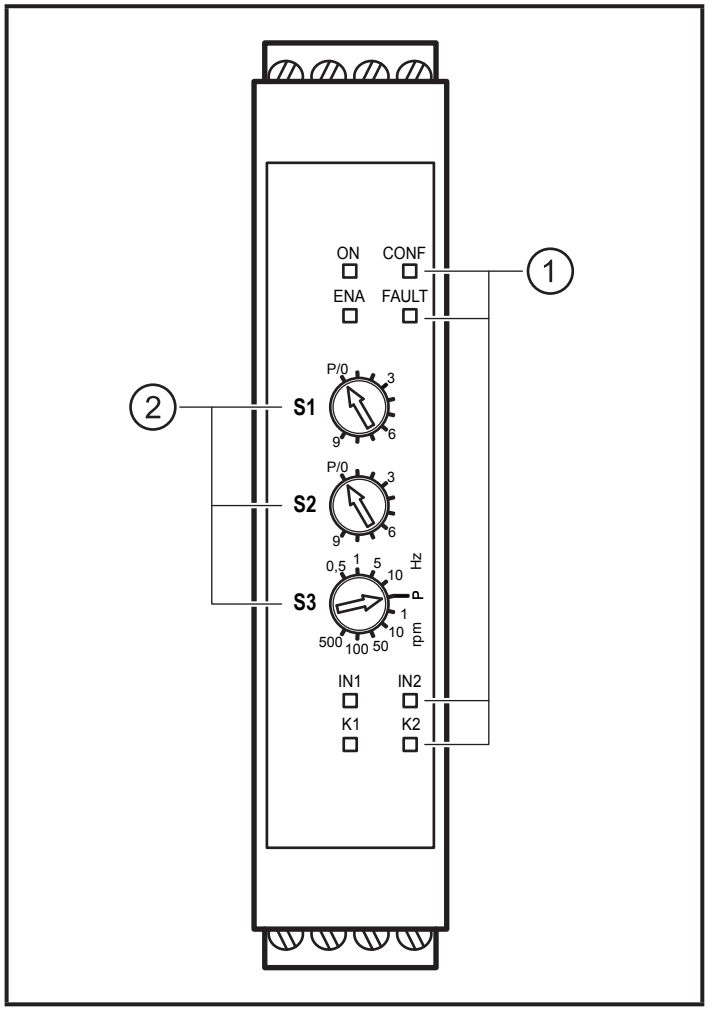
1: The monitoring function of the device is active/not active
2: Enable signals not simultaneous

To deactivate the monitoring function of a device 2 conditions must be met:

- The enable signals E1 and E2 have to be activated almost simultaneously. Max. time interval of the enable signals: 0.5 s
- The device must be switched on when the enable signals are activated.

The enable signals can be activated by means of mechanical switches.

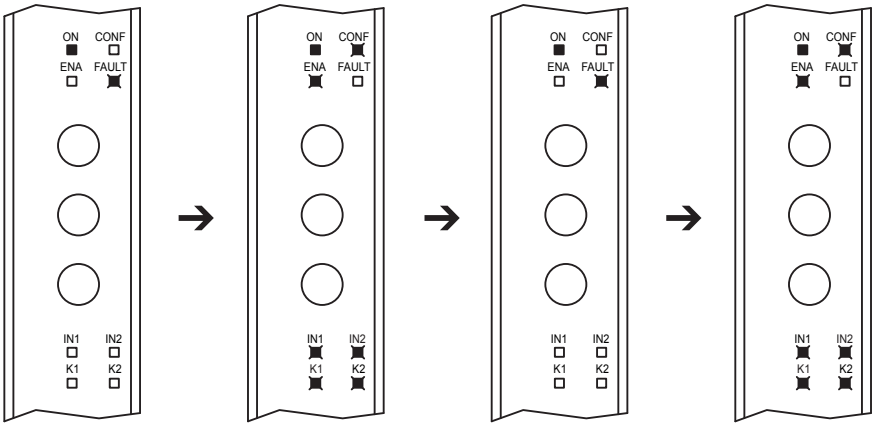
6 Indicators and operating elements



1: LEDs
2: Switches (270° potentiometer, 10 positions, locking)

6.1 LEDs

LED	Colour	Description
ON	Green	Power ON when device is switched on.
CONF	Blue	Configuration ON when device in configuration mode. Flashing when switches are in P position.
ENA	Yellow	Enable ON when the enable inputs are logically on. Flashing in configuration mode when the position of a switch is changed (one flash for each step). Flashing when the device is waiting for a restart command (→ 5.2.2).

LED	Colour	Description
FAULT	Red	Error ON when an internal fault was detected. Flashing when an external fault was detected. 1 x ⎍‾‾‾‾ Manual/automatic configuration error 2 x ⎍⎍‾‾‾ Switches in incorrect position (frequency selectors) 3 x ⎍⎍⎍‾‾ Feedback circuit error 4 x ⎍⎍⎍⎍‾ Sensor error (function or wiring) 5 x ⎍⎍⎍⎍⎍ Current > 500 mA on output S33, S44, Y1, Y7 or Y8 Flashing alternately with ENA, CONF, IN1/2 and K1/2 when a sensor is not connected. 
IN1/2	Yellow	Input IN1/2 ON when a HIGH signal was detected on the input IN1 or IN2.
K1/2	Green	Relay K1/2 ON when the safety output relay K1 or K2 is switched on.

6.2 Switches

Switches		Description
S1	SP x 10	Switch point selection (increments of 10)
S2	SP x 1	Switch point selection (increments of 1)
S3	SP multi	Unit (rpm/Hz) and multiplier of the selected switch point

7 Set-up

When the device is switched on for the first time, it is necessary to configure the underspeed frequency (Fu) using the three switches.

The 3 switches allow the user to enter the value of the desired preset frequency.

- The numerical values 1 to 99 can be set with S1 and S2.
  S1 with a step increment of 10, S2 with a step increment of 1.
- The multiplier is set with S3.
  The numerical values are multiplied with these factors and thus provide the actual switch point value. The multipliers have the unit "rpm" or Hz".

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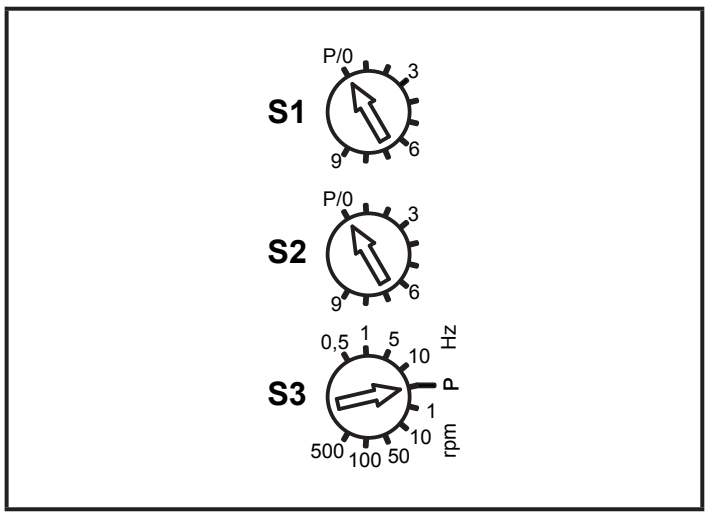
7.1 Configuration position (factory setting)

Before the device is switched on for switch-point setting, the 3 switches must be in position "P" (factory setting).

The switch-point setting is only possible when the device is switched on.



S1 in position P/0
S2 in position P/0
S3 in position P

NOTE

To prevent damage to the switches use a screwdriver of the appropriate size.

7.2 Setting the switch point

Step 1:

▶ Switch off power supply of the device.
▶ Set the 3 switches to configuration position P or P/0 (→ 7.1).
▶ Switch on power supply of the device.
> Device is in the configuration mode.
> LED [CONF] flashes.

Step 2:

▶ Set switch S1 from the position P/0 to the required value.
> During the rotation, the LED [ENA] flashes with every step.
The flashing of the LED is a visual feedback of each step executed.
> Device remains in the configuration mode and waits for S2 to be set.
> LED [CONF] is still flashing.

Step 3:

▶ Set switch S2 from the position P/0 to the required value.
> During the rotation, the LED [ENA] flashes with every step.
> Device remains in the configuration mode and waits for S3 to be set.
> LED [CONF] is still flashing.

Step 4:

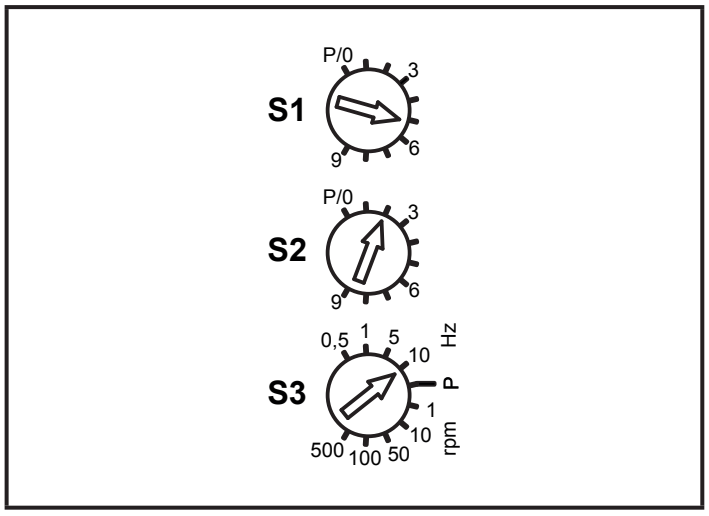
▶ Set switch S3 from the position P to the required value.
> During the rotation, the LED [ENA] flashes with every step.
> LED [CONF] remains permanently on.

Step 5:

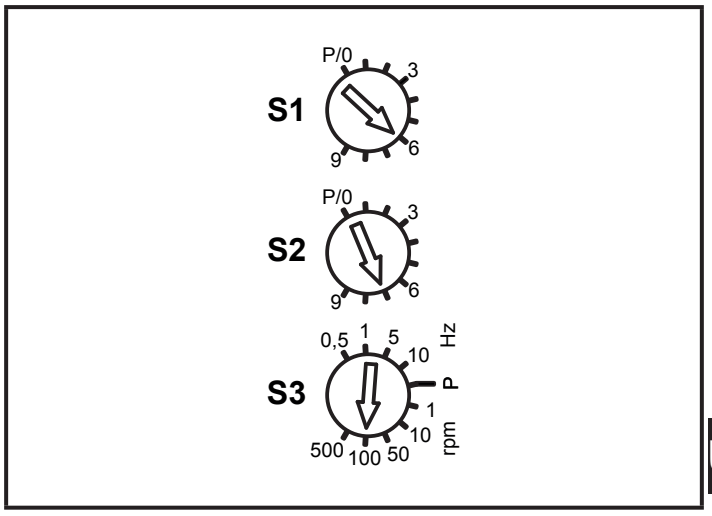
▶ Wait until LED [CONF] flashes twice (settings are saved).
▶ Switch off power supply of the device.
> Configuration is completed.

All 3 switches must be moved at least once. This also applies if the required value is "0" (corresponds to the "P" position).

7.3 Examples of switch point settings



520 Hz



6700 rpm

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The unit rpm is only applicable when 1 cam/revolution is present.
For several cams: Multiply the required switch point by the number of cams.

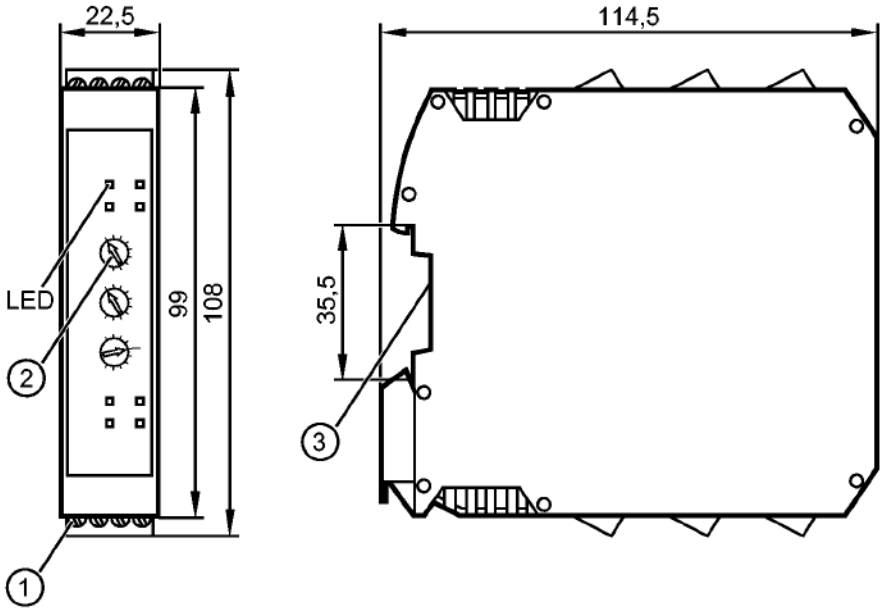
Example	Required switch point:	1000 rpm
	Number of cams:	4
	Setting value:	4 x 1000 rpm = 4000 rpm

7.4 Checklist after installation and set-up

Directly after power on, the device carries out an initialisation comprising a complete self-test.
To ensure reliable operation of the device the following checks have to be performed on start-up and then at least once a year:

1. Verify that all cables are correctly connected and the terminal blocks well screwed.
2. Verify that all LEDs (indicators) light correctly.
3. Verify the positioning of all connected sensors.
4. Verify the correct fixing of the device to the DIN rail.
5. Verify that all external indicators work correctly.
6. Verify that the switches work correctly.

8 Technical data



1: screw terminals
2: Rotary switch
3: Mounting on DIN rail

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Product characteristics		
Safe speed monitor for underspeed detection		
Evaluation system for safe speed monitoring		
for 2 pnp switching sensors		
Diagnostic and fault output		
Adjustable frequency range 0.5...990 Hz / speed range 1...49500 rpm		
Complies with the requirements: EN ISO 13849-1: category 4 PL e IEC 61508: SIL 3		
Application		
Application		Monitoring rotational or linear movements for minimum switch point not reached (underspeed)
Electrical data		
Electrical design		Relay
Operating voltage	[V]	19.2...28.8 DC; incl. 5 % residual ripple
Nominal voltage	[V]	24 DC
Current consumption	[mA]	≤ 125
Protection class		II
Power-on delay time	[ms]	≤ 3000
Sensor supply		24 V DC / ≤ 70 mA
Inputs		
Input characteristics		Pulse inputs S34, S43: "1": 6 mA / 24 V DC
Adjustable speed range [rpm]		1...49500
Adjustable frequency range [Hz]		0.5...990
Input frequency [Hz]		≤ 2000

Outputs		
Output function		2 safety-related switching outputs (floating contacts) 1 fault output "Fault" (positive switching) 1 diagnostic output "Underspeed" (positive switching)
Output data		Fault output "Fault" Y7 and diagnostic output "Underspeed" Y8 ≤ 20 mA, 24 V DC, voltage drop ≤ 2 V DC, short-circuit proof, non safe
Contact rating		6 A, 250 V AC / 24 V DC (≥ 6 mA); resistive load
Short-circuit protection		The contacts are to be protected by means of fuses with a nominal current of < 3.6 A.
Switching function		Switching outputs 13-14 and 23-24 open if input frequency/speed below switch point Transistor output "Fault" Y7 open (LOW) in case of device fault or external fault Transistor output "Underspeed" Y8 open (LOW) if switching outputs 13-14 and 23-24 open
Accuracy / deviations		
Hysteresis	[%]	5
Permitted frequency difference between the inputs [%]		≤ 10 (f > 100 Hz) / ≤ 20 (f < 100 Hz)
Reaction times		
Risk time (response time for safety-related faults)	[ms]	5.5
Response time [ms]		[f sel ≥ 100 Hz]: t = 10.7 + 400 x (f sel ÷ f in) [f sel < 100 Hz]: t = 14 + (4500 ÷ f in)
Environment		
Ambient temperature	[°C]	-40...55, observe the free space for convection (see operating instructions)
Storage temperature [°C]		-40...70
Max. relative air humidity	[%]	10...95
Height above sea level	[m]	≤ 2000
Protection		IP 20
Safety classification		
Mission time TM	[h]	≤ 175200, (20 years)
Safety-related reliability PFHd	[1/h]	7.69E-09 / 8.25E-09 / 9.15E-09
Hardware Failure Tolerance HFT		1, type B
MTTFd	[Years]	528.73 / 496.36 / 451.51
DC/CCF/Cat.		99.0 % / - / -
Mechanical data		
Housing materials		PA (polyamide)
Installation		rail TH35 (to EN 60715)
Displays / operating elements		
Display		Voltage green Release yellow Configuration blue Fault Red Switching status 2x green Input pulses 2x yellow
Electrical connection		
Connection		screw terminals; 0.5...2.5 mm² (AWG 30...12)
Remarks		
Remarks		Safety classification considering 1000 relay operations/year DC13 (2A), 24VDC / AC15 (1A), 220VAC / AC15 (3A), 220VAC f sel = selected frequency (by potentiometer) f in = input frequency (from sensors) RoHS compliant
Pack quantity	[piece]	1

9 Maintenance, repair and disposal

The device is maintenance-free and does not contain any components that need to be maintained by the user.

⚠ WARNING

Tampering with the device can affect the safety of operators and machinery. The device must only be repaired by the manufacturer.

- ▶ Do not open the housing.
- ▶ In case of malfunction of the device or uncertainties contact the manufacturer.

▶ Dispose of the device in accordance with the national environmental regulations.

10 Approvals/standards

The device was tested and certified by TÜV-Süd.

The device was developed and tested in accordance with the following directives and standards:

- 2006/42/EC Machinery Directive
- 2004/108/EC EMC Directive
- 73/23/EEC or 93/68 Low voltage directive
- EN ISO 13849-1: 2008 Safety of machines - safety-related parts of control systems
- IEC 61508: 2011 Functional safety of electrical/electronic/programmable electronic safety-related systems
- EN 60204-1: (1997) (where applicable) Electrical equipment of machines
- UL 508.

The EC declaration of conformity and approvals can be found at:
www.ifm.com → Data sheet search → DU110S → More information

11 Terms and abbreviations

Cat.	Classification of the safety-related parts of a controller as regards their resistance to failures.	
CCF	Common Cause Failure	
DC	Diagnostic Coverage	
MTTF	Mean Time to Failure	
$MTTF_d$	Mean Time To Dangerous Failure	
PFH	Probability of Failure per Hour	
PFH_D	Probability of Dangerous Failure per Hour	
PL	Performance Level	PL to EN ISO 13849-1
SIL	Safety Integrity Level	SIL 1-4 to IEC 61508
HFT	Hardware Failure Tolerance	HFT 0-2 to IEC 61508
PLC	Programmable Logic Controller	