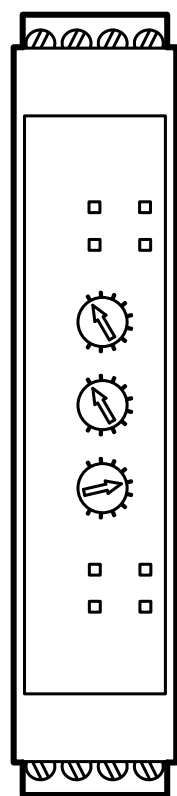


Original Installation Instructions
Safety speed monitor

DD110S
DD111S

UK

80005256 / 00 08 / 2020



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1 Preliminary note

The instructions are part of the unit. They are intended for authorised persons according to the EMC and Machinery 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.

Instructions, technical data, approvals, accessories and further information at www.ifm.com.

1.1 Symbols used

▶ Instruction

> Reaction, result

[...] Designation of keys, buttons or indications

→ Cross-reference



Important note

Non-compliance may result in malfunction or interference.



Information

Supplementary note.

● LED on

○ LED off

⊗ 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.

ATTENTION!

Warning of damage to property.

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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

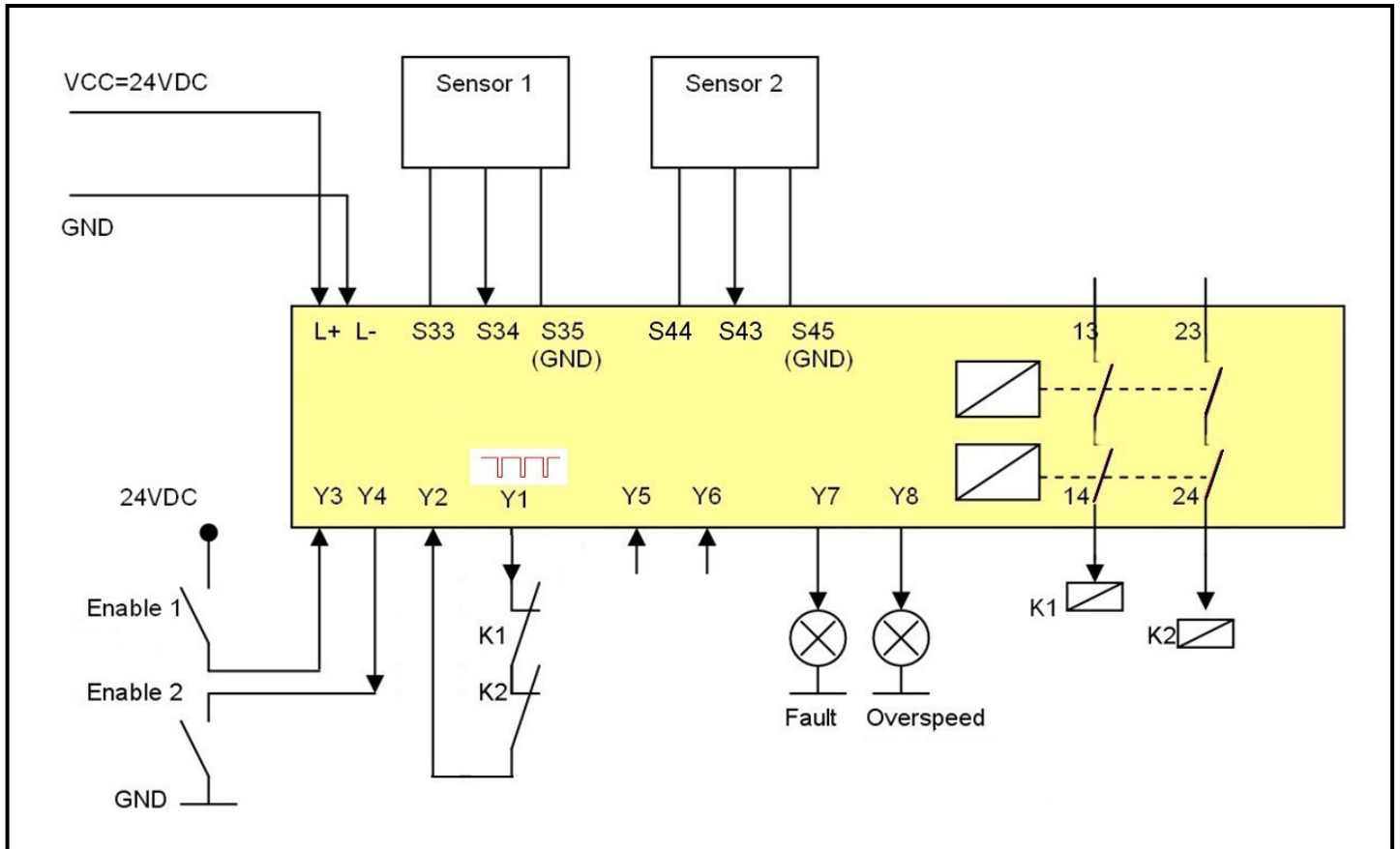
3.1 General function description

The device is a two-channel pulse evaluation system for safe overspeed 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 overspeed of the set switch point.

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

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Block diagram

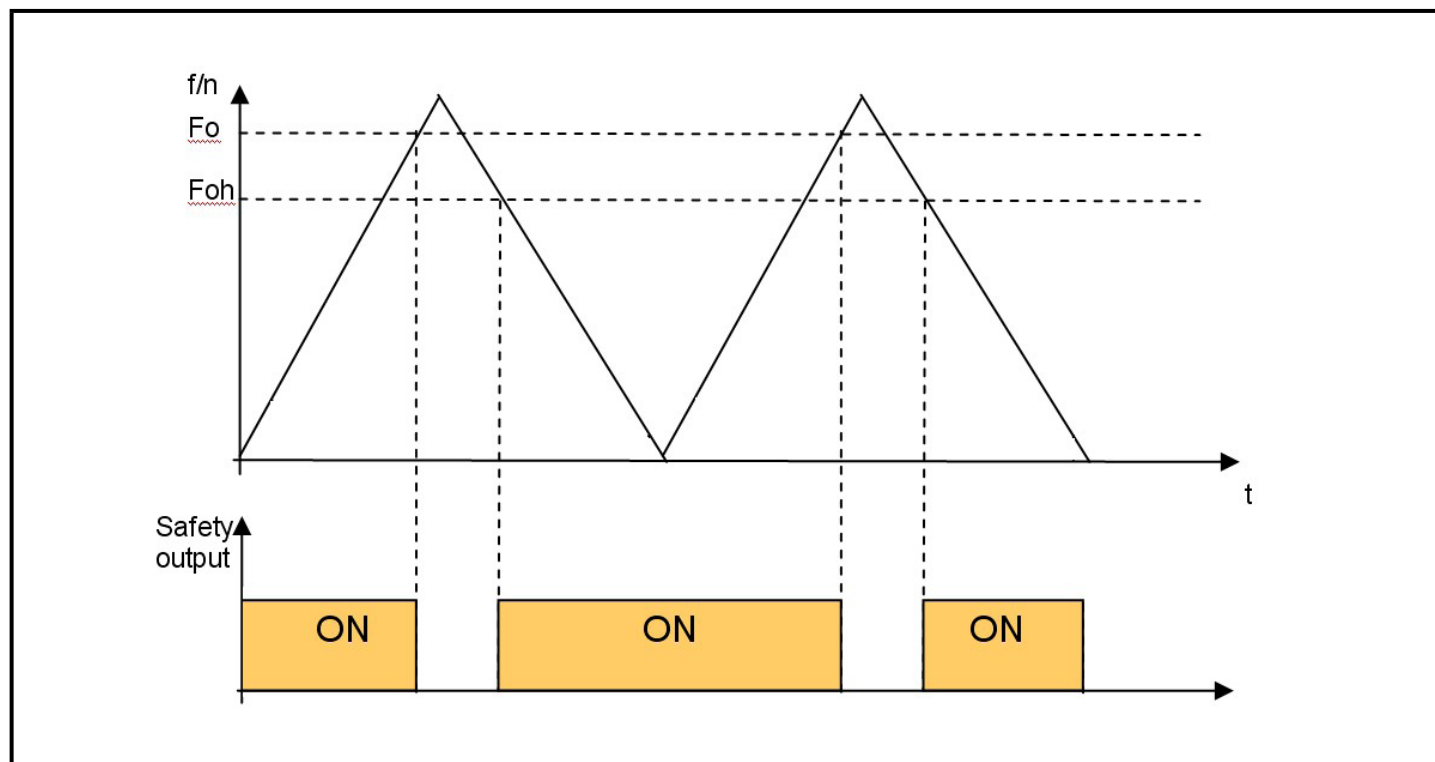
The target value is set via 3 switches on the front of the device. The value can be set in "rpm"/"Hz" (DD110S) or "Hz" (DD111S).

3.2 Safe state of the output relays

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

3.3 Switching function "Overspeed"

The output relays de-energise when the event occurs (selected frequency F_o reached). The relays switch on again when the value falls below the preset value reduced by hysteresis (F_{oh}).



Characteristics of the safety outputs (current paths)

The NO contacts of the internal relays are connected in series and connected to the terminals. If both relays are energised, the current paths are closed so that, for example, a power contactor can be controlled.

If the switch point is exceeded, the current paths open.

3.4 Hysteresis

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

The hysteresis value is fixed at 5 %.

If the input frequency falls below the set switch point by 5 %, the relays energise again and the current paths are closed.

Example switch point $F_o = 10$ (Hz):

- The current paths open when F_o has been exceeded (rising frequency).

- Current paths close when the measured value is lower than F_{oh} (in this case 9.5 Hz, falling frequency).

3.5 Initialisation

Directly after power on, the device carries out an initialisation comprising a complete self-test. After approx. 3 s the device is ready for operation.

3.6 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.

UK

3.7 Overspeed output (Y8)

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

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

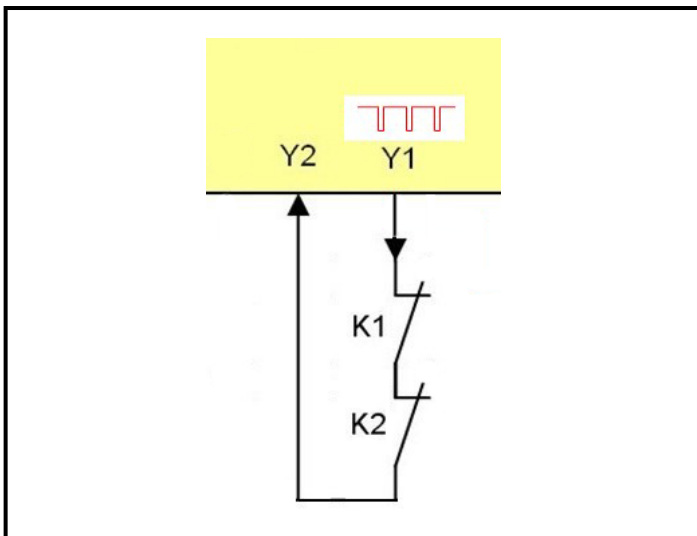
If overspeed is detected, the current paths open and the external relays are de-energised.

If the feedback circuit does not close within 1 s, an error message is provided. LED [FAULT] flashes 3 times.

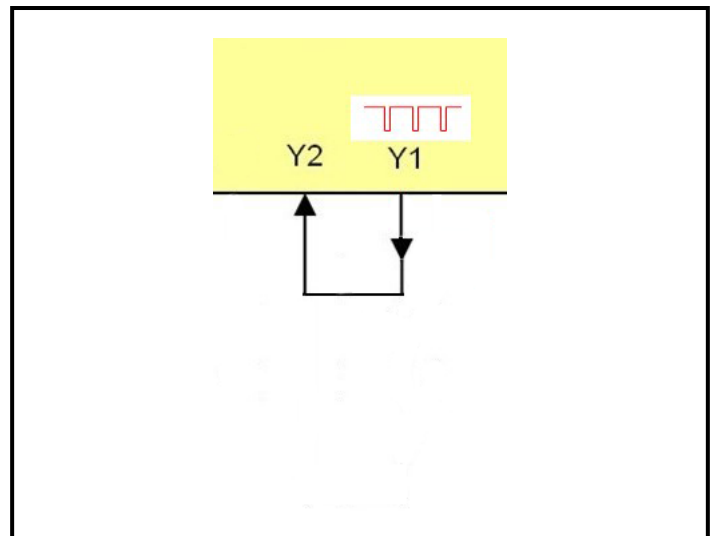
Also see (→ 6.1 LEDs).



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)

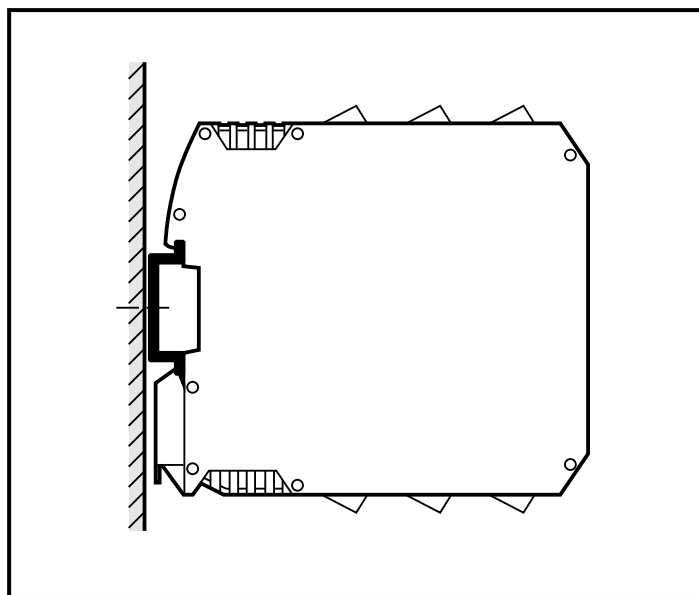
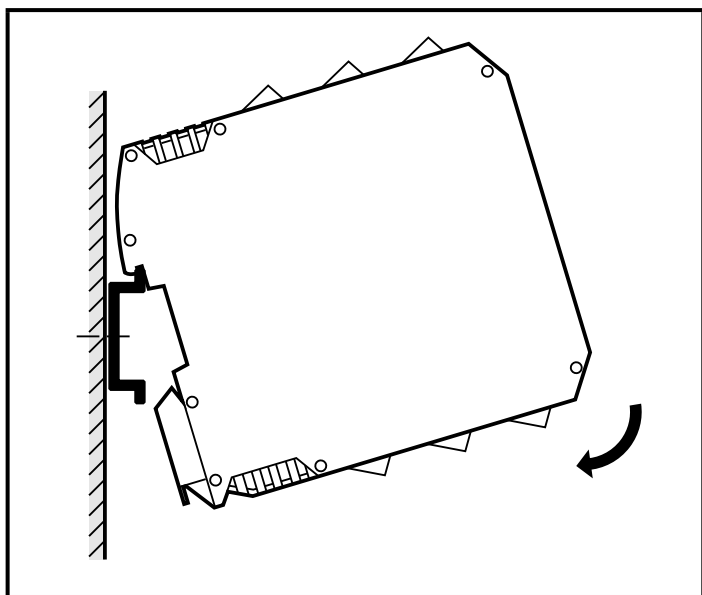


Without feedback function with bridge

4 Installation

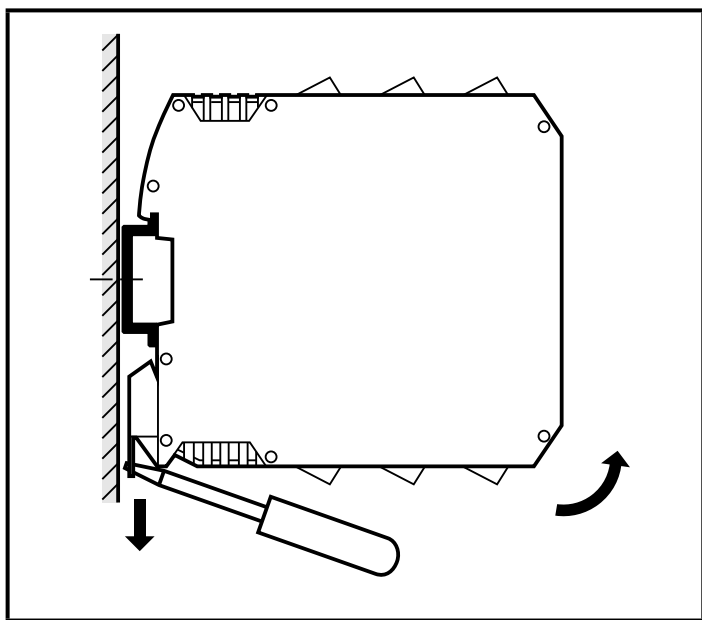
4.1 Mechanical installation of the device

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



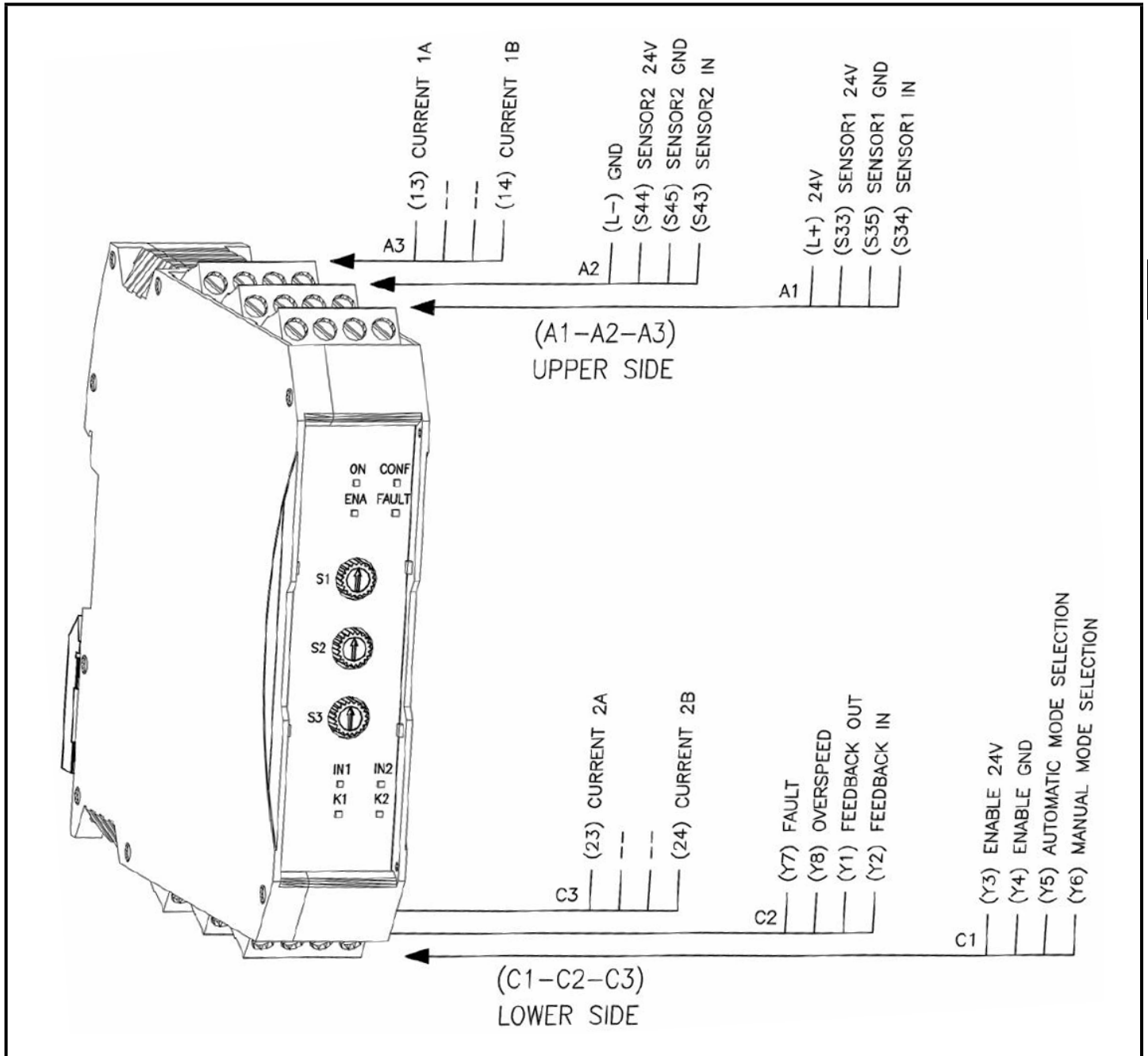
- ⚠ Leave enough space between the device and the top and bottom of the housing to enable air circulation and to avoid excessive heating.
- ⚠ Take into account the internal heating of all devices when mounting several devices side by side. The environmental conditions must be observed for every device 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

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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	Transistor output "Fault"	(→ 3.6)
	Y8	Transistor output "Overspeed"	(→ 3.7)
	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)	



The relay contacts of the device must be supplied from the same voltage source.



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.



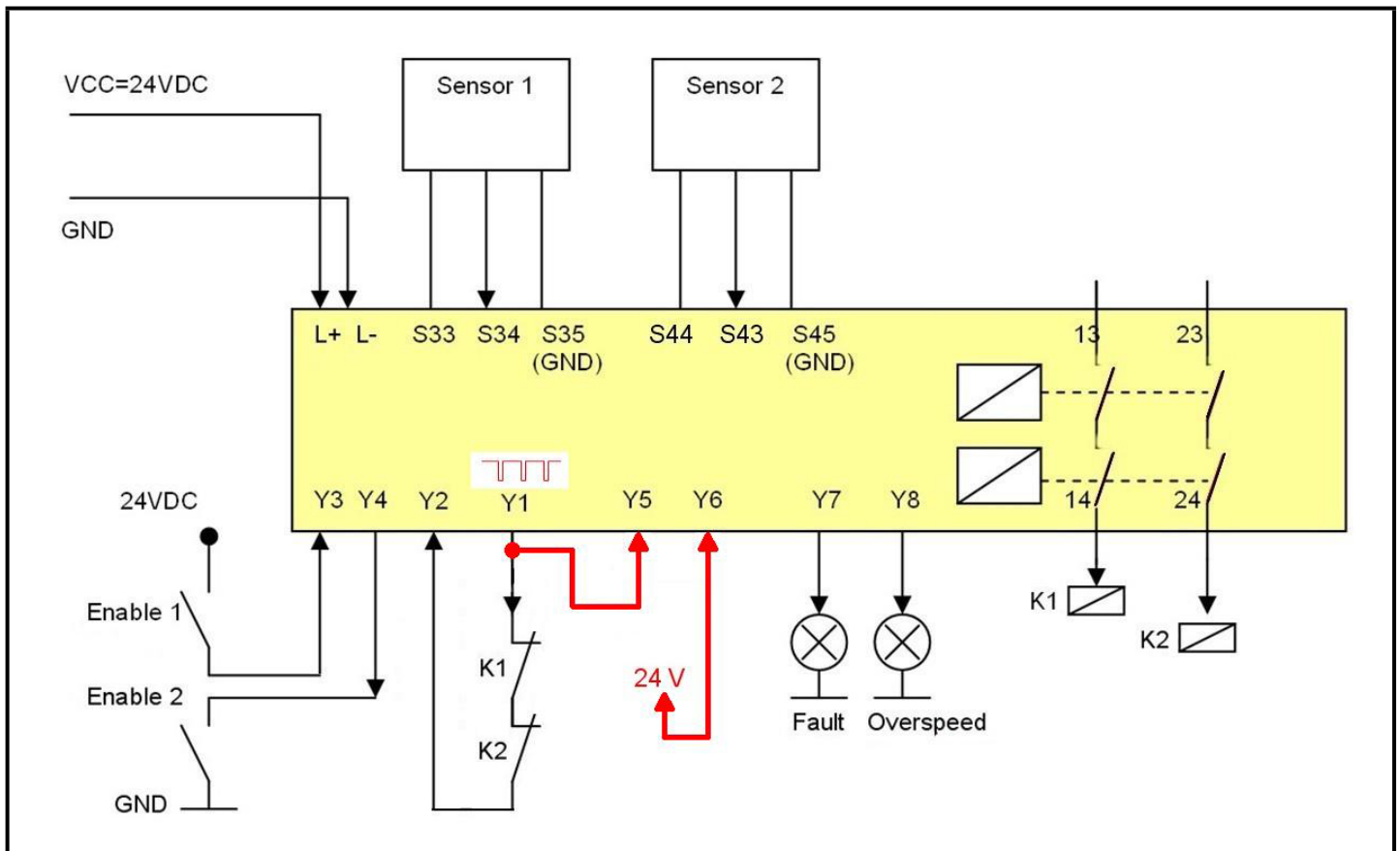
Terminal tightening torque: 0.6...0.7 Nm (5...7 lb-in).

5.2 Automatic/manual mode selection

If overspeed is detected, the current paths open and the drive is switched off. As a result the input frequency falls below the switch point and the current paths close (below F_{oh}).

By means of the automatic/manual function it can be prevented that the current paths close automatically when the input frequency drops below the F_{oh} value. The selection of the operating mode is made via two input terminals Y5 and Y6.

5.2.1 Automatic mode



Automatic mode

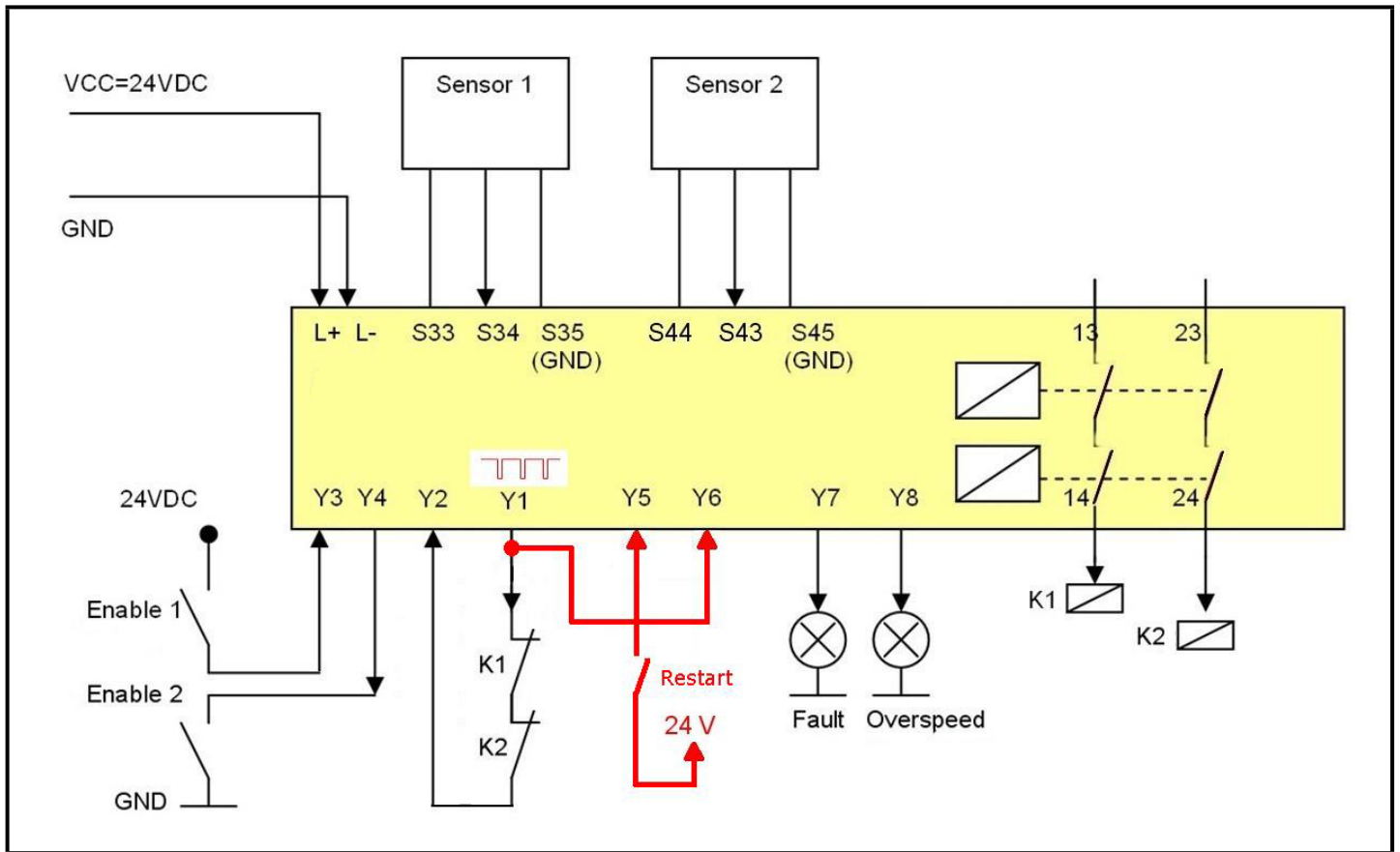
In this operating mode the device compares the input frequency with the set target value.

- If the input frequency is below the target value, the relay outputs are switched.
- If the input frequency exceeds the target value, the relay outputs are not switched.

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

The device goes into the failsafe state as soon as an error has been detected (short circuit at 0 V DC or + 24 V DC or separated connections).

5.2.2 Manual mode



Manual mode

In this operating mode, the outputs of the device are only activated if the input frequency is below the target value and after the restart signal has been sent to the device via an external restart command (terminal Y5).

Once the overspeed has been detected, the relay outputs are not switched.

The sequence described above must be repeated in order to re-activate them.

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

In this case the current path remains open until there is a restart signal on input Y5. The restart signal on input Y5 responds after the falling edge (a complete transition 0 V DC → + 24 V DC → 0 V DC) of this input. This signal is only active if the frequency is below the Foh value.



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. It is not required to operate it from outside the hazardous area.



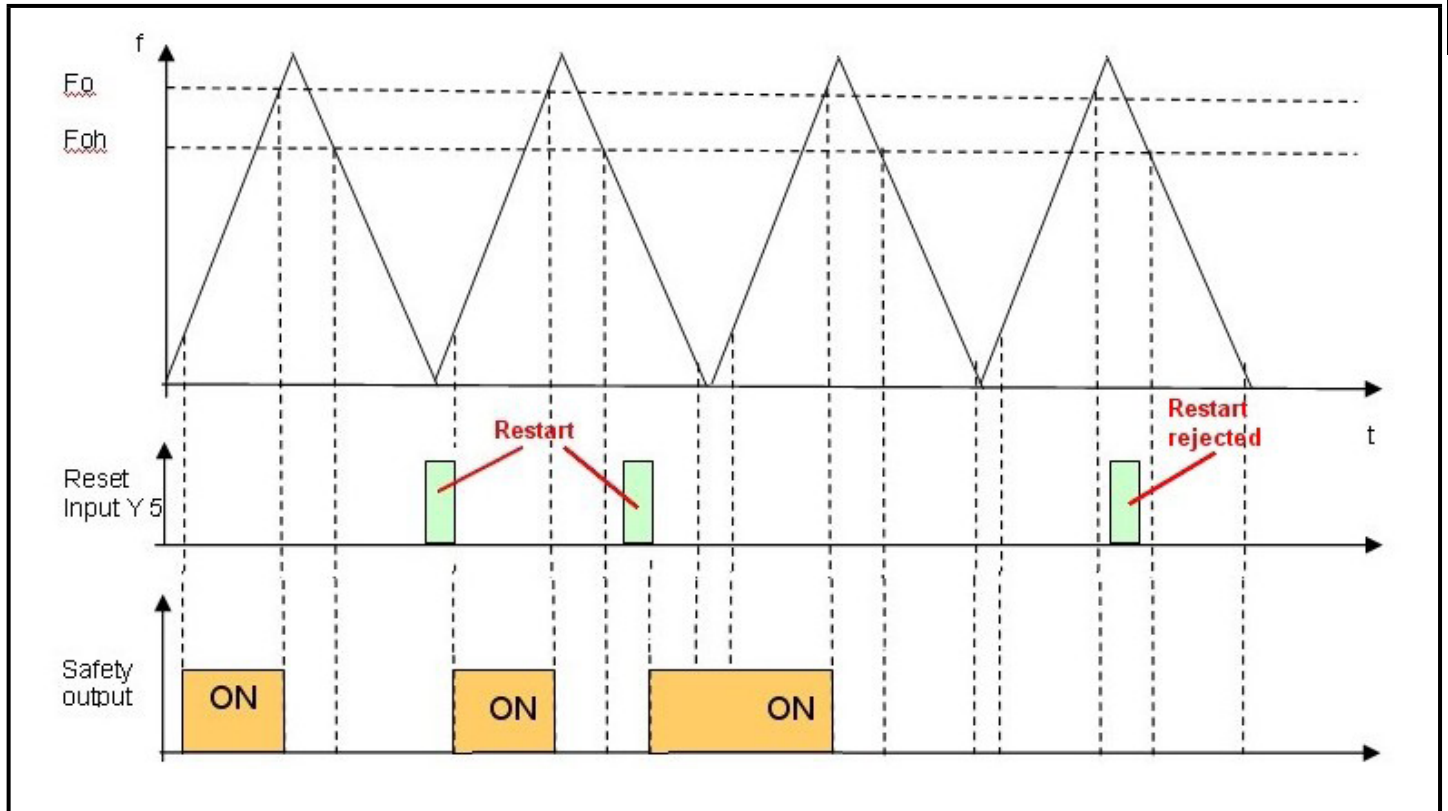
The restart signal must be applied for 0.3...5 s. Otherwise the command is rejected.



If the restart command is activated (rising edge or falling edge or both) when the frequency is between F_o and F_{oh} , the command is also rejected.

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

The figure below shows the restart options in the manual mode.



Manual mode / restart diagram

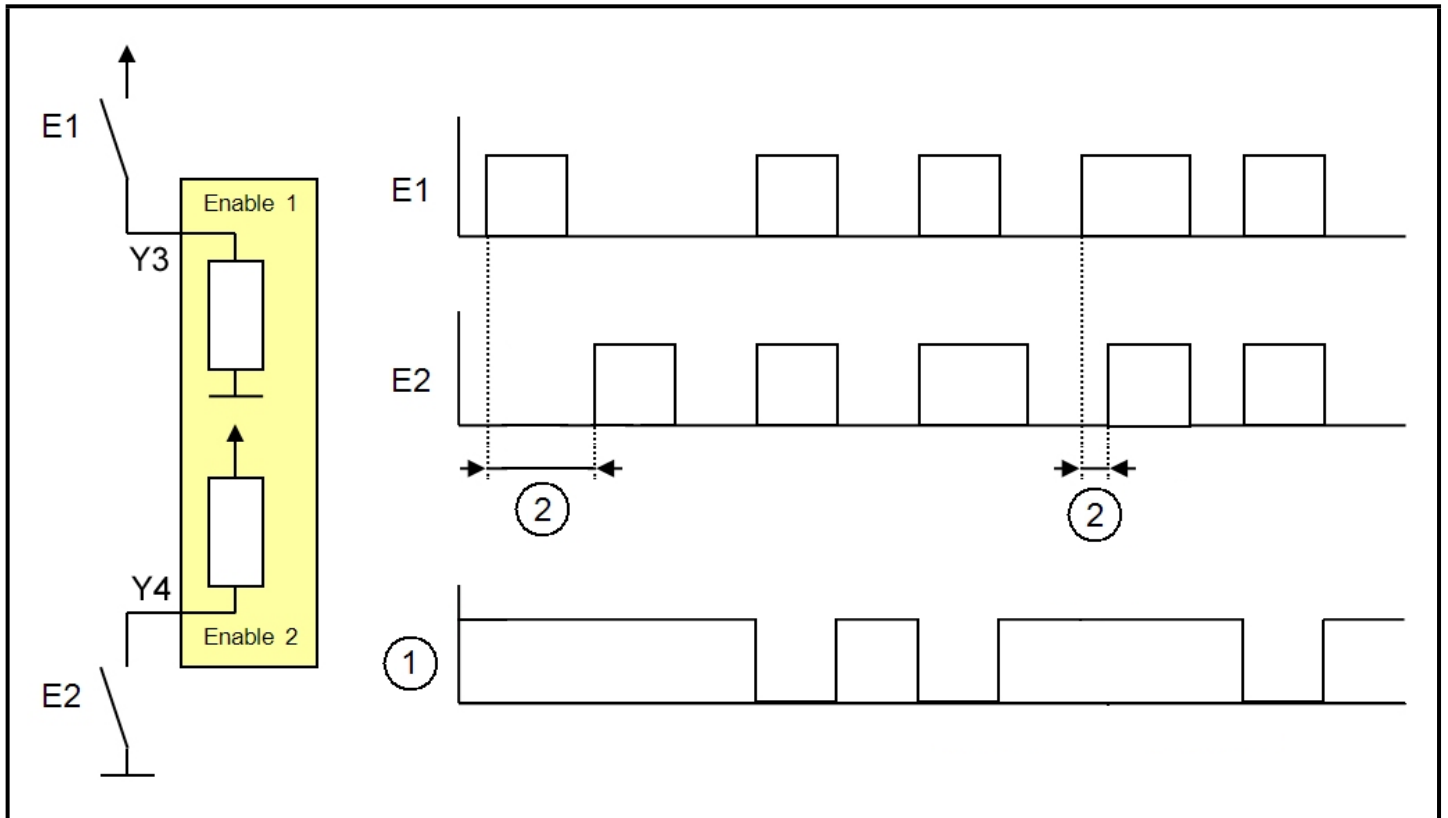
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5.3 Enable input

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

In this way the relay status can be controlled via the enable input after power-on of the device.

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



Time-dependent behaviour of the enable inputs

1: Monitoring function active/not active

2: Enable inputs not in the right time

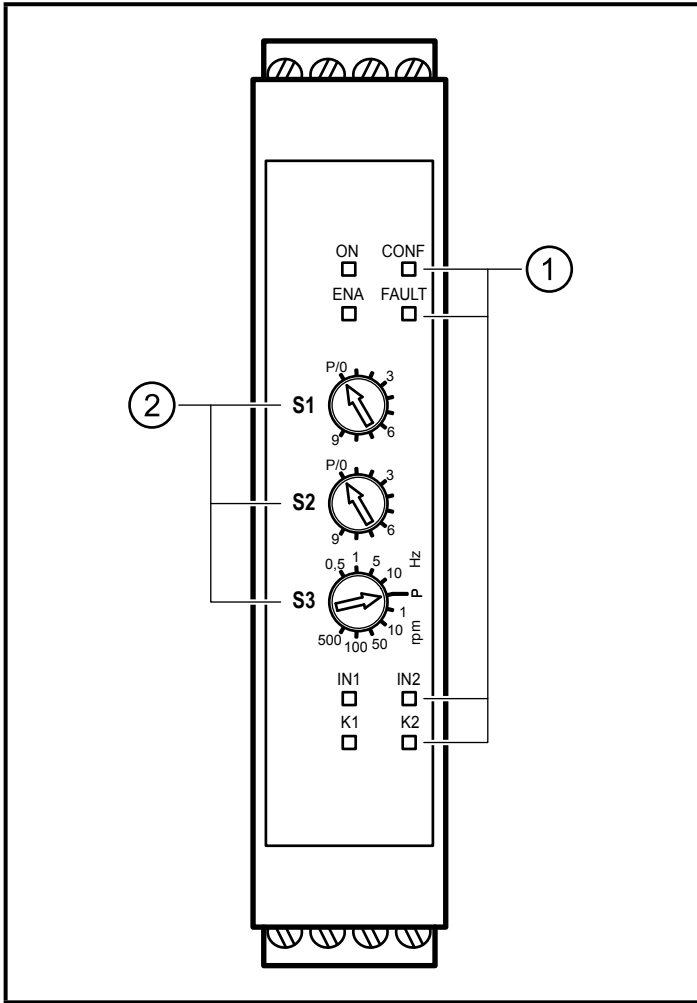


The monitoring function is only deactivated if both input signals E1 and E2 are provided almost simultaneously. The maximum time interval of both input signals must not exceed 0.5 s.

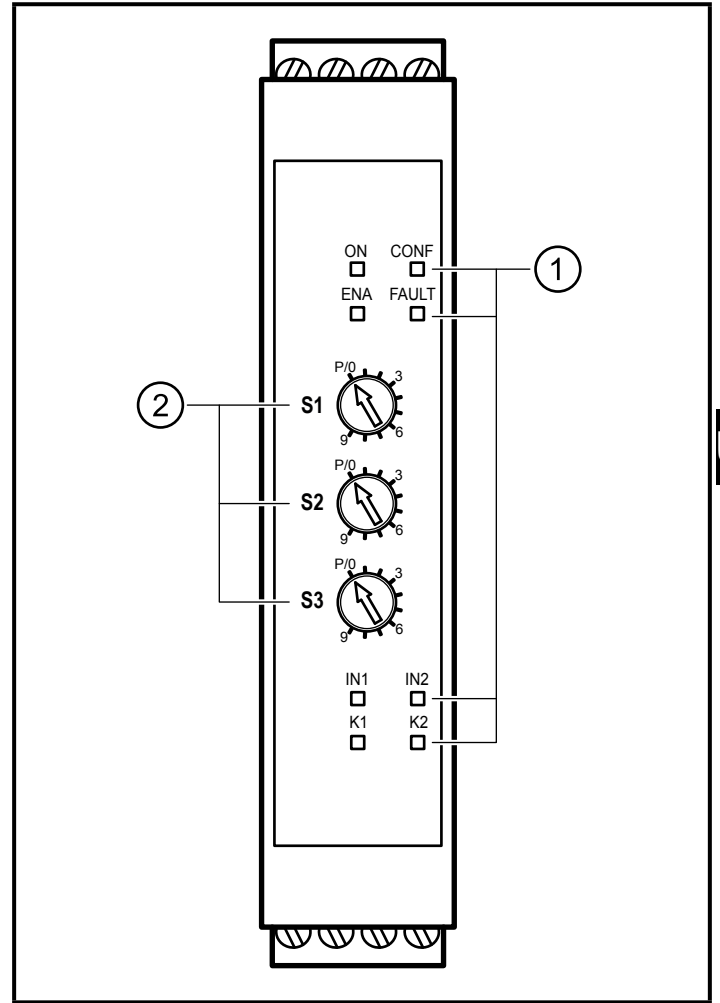


The signal can be applied via mechanical switches.

6 Indicators and operating elements



DD110S



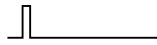
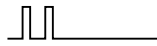



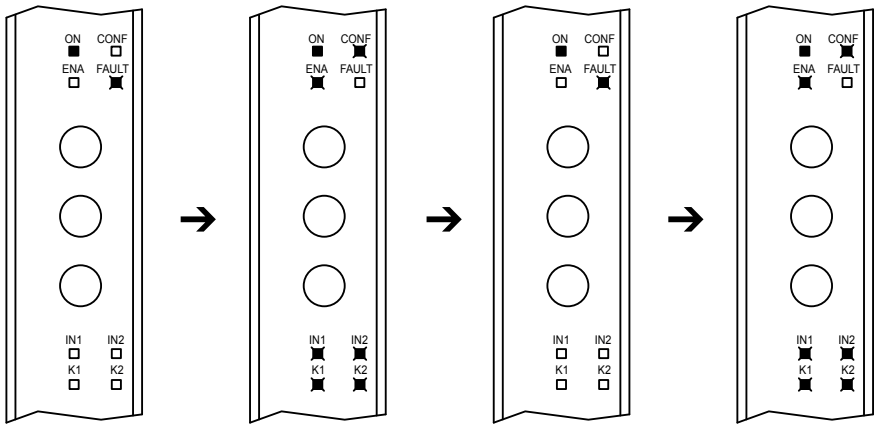
DD111S

- 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).

UK

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

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	DD110S	SP multi
	DD111S	SP x 0.1



To select the switch point, the 3 switches must be in the "P" (DD110S) or "P/0" (DD111S) position before the device is switched on.

7 Set-up

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

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

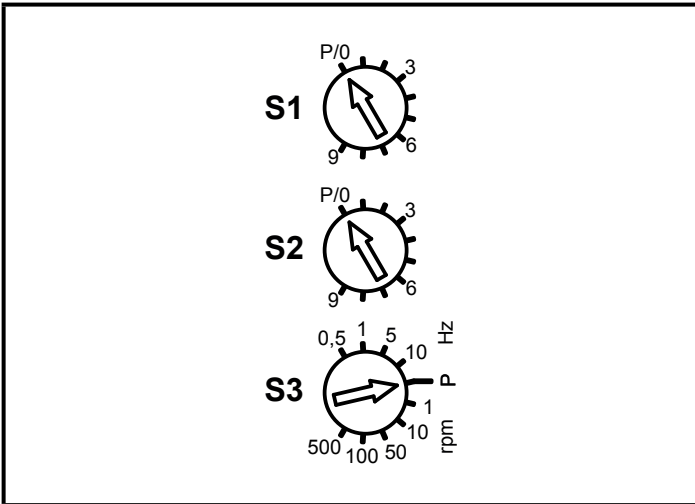
- With S1 and S2 switches numerical values from 1 to 99 can be set (S1 with increments of 10, S2 with increments of 1).
- DD110S: The multiplier is set using switch S3. The numerical values are multiplied with these factors and thus provide the actual switch point value. The multipliers have the unit "rpm" or "Hz".
- DD111S: The decimal values can be set with switch S3.

UK

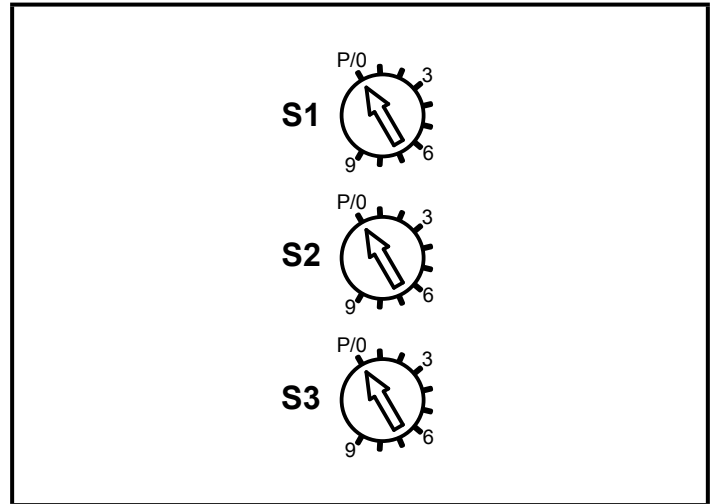
7.1 Configuration position (factory setting)



The switch point value can only be set when the operating voltage is connected to the device and the 3 switches are set as indicated (factory setting).



DD110S



DD111S

- S1 in position P/0
- S2 in position P/0
- S3 in position P (DD110S) or P/0 (DD111S)

ATTENTION!

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.
The flashing of the LED is a visual feedback of each step executed.
- > 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 (DD110S) or P/0 (DD111S) 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.
- > LED [CONF] remains permanently on.

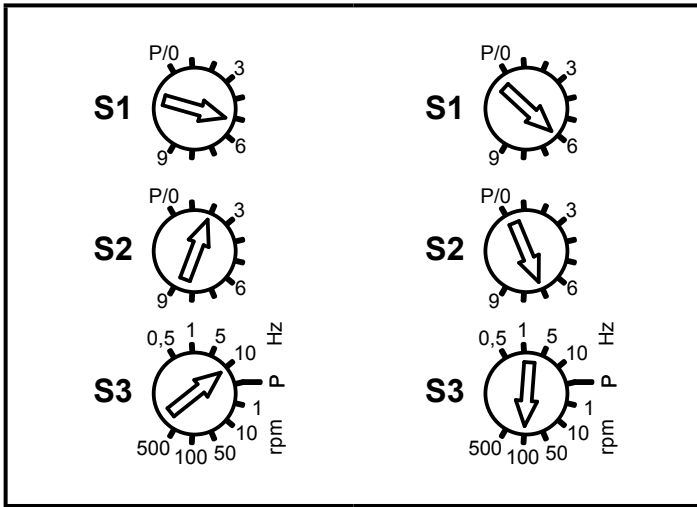
Step 5:

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

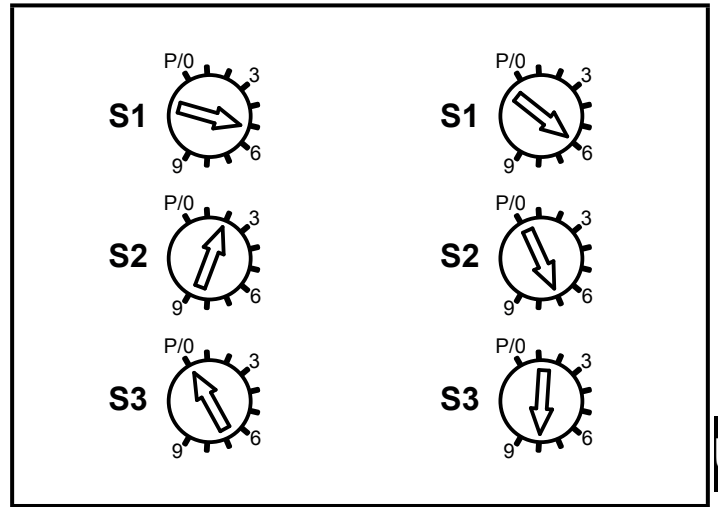


To ensure that a value can be set all 3 switches have to be moved at least once. This also applies if the required value is "0" (corresponds to the "P" position).

7.3 Examples of switch point settings



DD110S: 520 Hz | 6700 rpm



DD111S: 52.0 Hz | 67.8 Hz



DD110S:

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



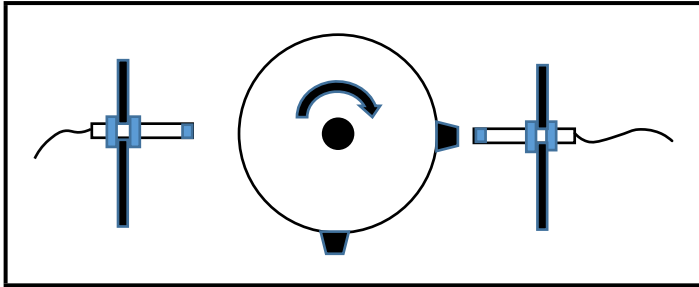
Directly after power on, the device carries out an initialisation comprising a complete self-test.

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.

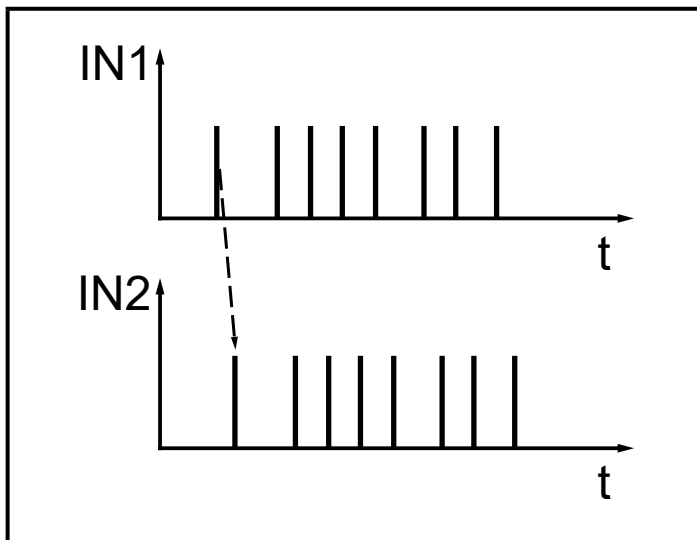
7.5 Notes on the positioning of the sensors / damping elements

The device checks whether the frequencies at both inputs are identical (within the corresponding tolerances). If the direction of movement remains unchanged, the sensors can be positioned anywhere within the damping zone.



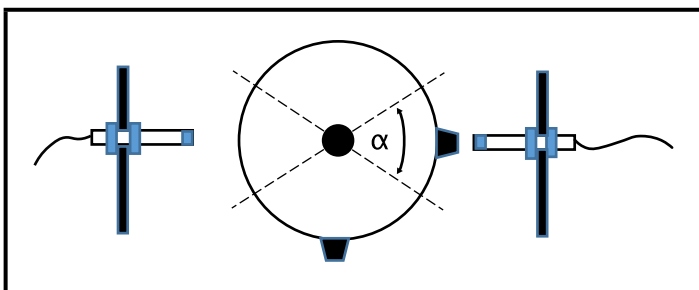
Example: 1 direction of movement

The input signals may look like this:



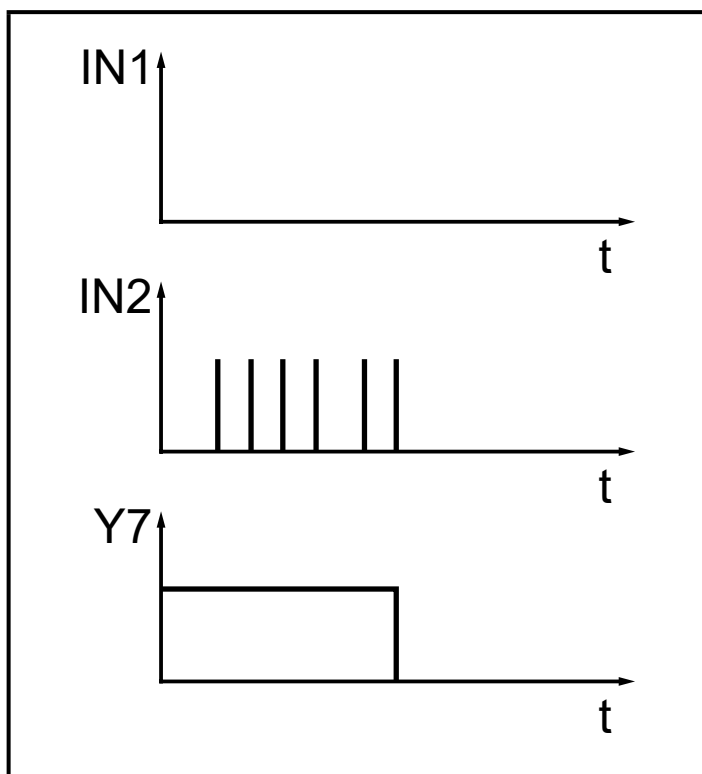
same frequency, time lag

In other cases, the position of the sensors / damping elements is essential for correct functioning. If the direction of movement changes, one of the sensors may not be damped correctly, leading to an error.



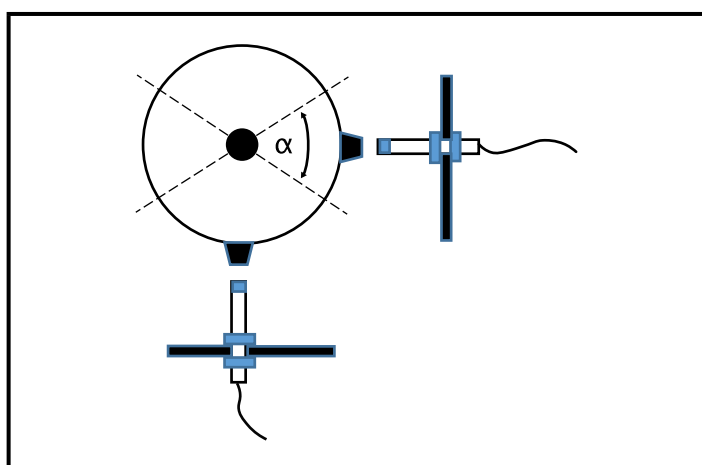
Example: changing direction of movement
wrong sensor position

In case of repeated movements within the indicated angle, the two sensors will detect different frequencies and the device will signal an error. The error will be signalled by the LEDs FAULT, IN1 and IN2 flashing four times.



no signal at IN1, error message at Y7

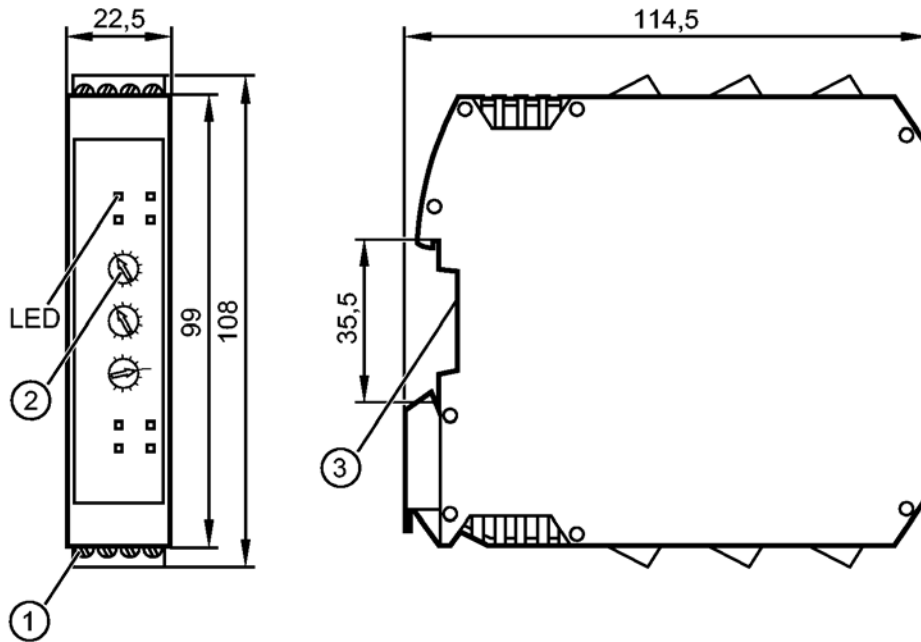
The problem can be solved by positioning the sensors / damping elements differently, so that the pulses are detected correctly by both sensors.



Example: changing direction of movement
correct sensor position

8 Technical data

8.1 DD110S



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



Product characteristics

Safety speed monitor
 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: 2015 category 4 PL e
 IEC 61508: SIL 3

Application

Application: Monitoring of rotational or linear movements for adherence to a maximum setpoint (overspeed)

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
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

Output data	Fault output "Fault" Y7 and diagnostic output "Overspeed" 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 above switch point Transistor output "Fault" Y7 open (LOW) in case of device fault or external fault Transistor output "Overspeed" Y8 open (LOW) when the switching outputs 13-14 and 23-24 are opened.

Accuracy / deviations

Hysteresis [%]	5
Permitted frequency difference between the inputs [%]	≤ 10 (f > 100 Hz) / ≤ 20 (f < 100 Hz)

Response times

Power-on delay time [ms]	≤ 3000
Risk time (response time for safety [ms]-related faults)	5.5
Response time [ms]	[f _{sel} ≥ 30 Hz]: t = 8.5 + 400 × (f _{sel} + f _{in}) [f _{sel} < 30 Hz]: t = 8.5 + (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 [h]	≤ 175200, (20 years)
Safety-related reliability PFHd [1/h] (1000/y)	8.33E-09 (DC13 (2A), 24VDC) / 8.89E-09 (AC15 (1A), 230VAC) / 9.80E-09 (AC15 (3A), 230VAC)
Safety-related reliability PFHd [1/h] (10000/y)	8.74E-09 (DC13 (2A), 24VDC) / 1.43E-08 (AC15 (1A), 230VAC) / 2.34E-08 (AC15 (3A), 230VAC)
Hardware fault tolerance HFT	1, type B
MTTFd [years] (1000/y)	441.84 (DC13 (2A), 24VDC) / 419.01 (AC15 (1A), 230VAC) / 386,61 (AC15 (3A), 230VAC)
MTTFd [years] (10000/y)	424.94 (DC13 (2A), 24VDC) / 278.82 (AC15 (1A), 230VAC) / 179,00 (AC15 (3A), 230VAC)
SFF	> 99.0 %
DC/CCF/Cat.	99.0 % / - / -

Mechanical data

Housing materials	PA (polyamide)
Installation	rail TH35 (to EN 60715)
Weight [kg]	0.309

Displays / operating elements

Display	Voltage	green
	Release	yellow
	Configuration	blue
	Fault	Red
	Switching status	2x green
	Input pulses	2x yellow

Electrical connection

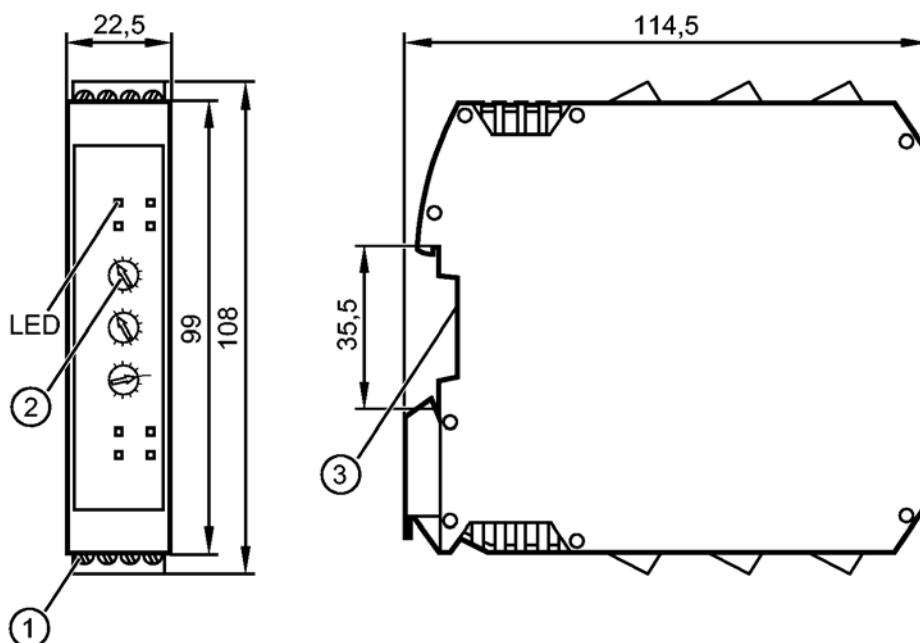
Connection	screw terminals; 0.5...2.5 mm ² (AWG 30...12)
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Remarks

Remarks	Safety classification considering 1000/10000 relay operations/year DC13 (2A), 24VDC / AC15 (1A), 230VAC / AC15 (3A), 230VAC f sel = selected frequency (by potentiometer) f in = input frequency (sensors) RoHS compliant
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Pack quantity [piece]	1
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8.2 DD111S



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



Product characteristics

Safety speed monitor

Evaluation system for safe speed monitoring

for 2 pnp switching sensors

Diagnostic and fault output

Adjustable frequency range 0.1...99.9 Hz

Complies with the requirements:

EN ISO 13849-1: 2015 category 4 PL e

IEC 61508: SIL 3

Application

Application

Monitoring of rotational or linear movements for adherence to a maximum setpoint (overspeed)

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

Sensor supply

24 V DC / ≤ 70 mA

Inputs

Input characteristics

Pulse inputs S34, S43:
 "1": 6 mA / 24 V DC

Adjustable frequency range [Hz]

0.1...99.9

Input frequency [Hz]

≤ 2000

Output data	Fault output "Fault" Y7 and diagnostic output "Overspeed" 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 above switch point Transistor output "Fault" Y7 open (LOW) in case of device fault or external fault Transistor output "Overspeed" Y8 open (LOW) when the switching outputs 13-14 and 23-24 are opened.

Accuracy / deviations	
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Hysteresis [%]	5
Permitted frequency difference between the inputs [%]	≤ 10 (f > 100 Hz) / ≤ 20 (f < 100 Hz)

Response times	
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Power-on delay time [ms]	≤ 3000
Risk time (response time for safety [ms]-related faults)	5.5
Response time [ms]	[f _{sel} ≥ 30 Hz]: t = 8.5 + 400 × (f _{sel} + f _{in}) [f _{sel} < 30 Hz]: t = 8.5 + (4500 + f _{in})

Environment	
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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	
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Mission Time [h]	≤ 175200, (20 years)
Safety-related reliability PFHd [1/h] (1000/y)	8.33E-09 (DC13 (2A), 24VDC) / 8.89E-09 (AC15 (1A), 230VAC) / 9.80E-09 (AC15 (3A), 230VAC)
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SFF	> 99.0 %
DC/CCF/Cat.	99.0 % / - / -

Mechanical data	
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Housing materials	PA (polyamide)
Installation	rail TH35 (to EN 60715)
Weight [kg]	0.307

Displays / operating elements	
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Display	Voltage green Release yellow Configuration blue Fault Red Switching status 2x green Input pulses 2x yellow
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Electrical connection	
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Connection	screw terminals; 0.5...2.5 mm ² (AWG 30...12)
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Remarks	
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Remarks	Safety classification considering 1000/10000 relay operations/year DC13 (2A), 24VDC / AC15 (1A), 230VAC / AC15 (3A), 230VAC f sel = selected frequency (by potentiometer) f in = input frequency (sensors) RoHS compliant
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Pack quantity [piece]	1
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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!

Malfunction due to tampering with the unit

Deterioration of the safety function

- ▶ Do not open the housing.
- ▶ In case of malfunction of the device or uncertainties contact the manufacturer.
- ▶ The device must only be repaired by 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:

- EN 60204-1: 2006 (where applicable) Electrical equipment of machines
- UL 508
- you can find information about further applied standards in the EU declaration of conformity



The EU declaration of conformity and approvals can be found at:
www.ifm.com

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	

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