wieland

SNS 40x4K

Zero Speed Monitor

Manual

Product and Object Description
Doc. no. BA000507
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1 About This Manual

1.1 What Does This Manual Describe?

This manual describes the Standstill Monitor SNS 40x4K and its functions. In addition to the specific configurations on switches and terminals, the basic mode of operation of the functions are explained in detail. Installation instructions, measures and regulations to be observed, technical data with interface description, error messages and error handling complete the manual.

The symbol "ATTENTION" is used in this manual as follows:

"ATTENTION" indicates a potentially hazardous situation or state which, if not avoided, could result in minor or moderate injuries. "ATTENTION" is also used to warn against unsafe practices or obvious misuse, as well as for situations which can result in material damage or personal injury.

ATTENTION

1.2 For Whom is This Manual Intended?

This manual contains the information required for proper usage of the products it describes. The products must only be installed by skilled personnel and the corresponding VDE regulations (German Association for Electrical, Electronic & Information Technologies) or the applicable standard in the respective country must be observed. Therefore, this manual is aimed at technically qualified personnel such as mechanical and electrical engineers, safety representatives, PLC programmers, switch cabinet constructors, electricians, machine/system operators, commissioning engineers, service and maintenance personnel.

1.3 Safety Notices

Degree of protection according to DIN EN 60529.
Limited contact protection.
Case / terminals: IP 40 / IP 20.
Finger-proof according to DIN EN 50274.

Please observe the following safety instructions:

Note

- The installation, commissioning, modification and retrofitting must only be performed by a qualified electrician.
- Disconnect the device / the system from the power supply before starting work. In the case of installation and system errors, mains voltage can be present on the control circuit in the case of non-galvanically isolated devices.
- Observe the electrotechnical and professional trade association safety regulations for the installation of the equipment.
- Opening the case or other manipulation voids any warranty.
- In the case of improper use or any use other than for the intended purpose, the device must no longer be used and any warranty claim is void. Invalidating causes can be: strong mechanical loading of the device such as, e.g. in the case of falling or voltages, currents, temperatures, humidity outside the specification.

- Always check all safety functions in accordance with the applicable regulations during initial commissioning of your machine / system and observe the specified inspection cycles for safety devices.
- In applications with low safety function requirements, a proof-test has to be performed once a year (power-cycling the device, triggering the safety functions, e.g. by means of exceeding the frequency).

1.4 Intended Use

The device described in this manual is used for the protection of people, the environment, the machine and the material in accordance with the framework Directive 89/391/EEC, the Machinery Directive 2006/42/EC, the Use of Work Equipment Directive 89/655/EEC applicable in the EU and applicable legal regulations and standards in other countries (e.g. USA with the safety standards according to OSHA 29 CFR 1910.xxx, the concepts and technologies for machine safety according to OSHA 3067, product liability according to NPFA 70, NFPA 79, ANSI B11).

If used as prescribed and properly maintained, the device normally poses no risks either to property or to the health of personnel. However, hazards may arise from connected actuating elements such as motors, hydraulic equipment etc., if the entire system or machine is improperly configured, installed, serviced or operated, if the instructions in this operating manual are not observed, or in the case of interventions by insufficiently qualified personnel.

The device has been constructed using state-of-the-art-technology and according to recognised safety regulations. Nevertheless, during use it may still present risks to the life and limb of the user or third parties and the possibility of damage to machines, systems or other property.

The device must only be used when in proper working condition, as well as according to its prescribed usage, with due regard given to safety, awareness of any hazards and following the instructions enclosed with the equipment and contained in this operating manual. Reliable and safe operation of the system requires proper transport, storage and installation as well as careful operation and maintenance. In particular, faults which can adversely affect the safety must be rectified immediately.

2 General Description

2.1 Type Overview

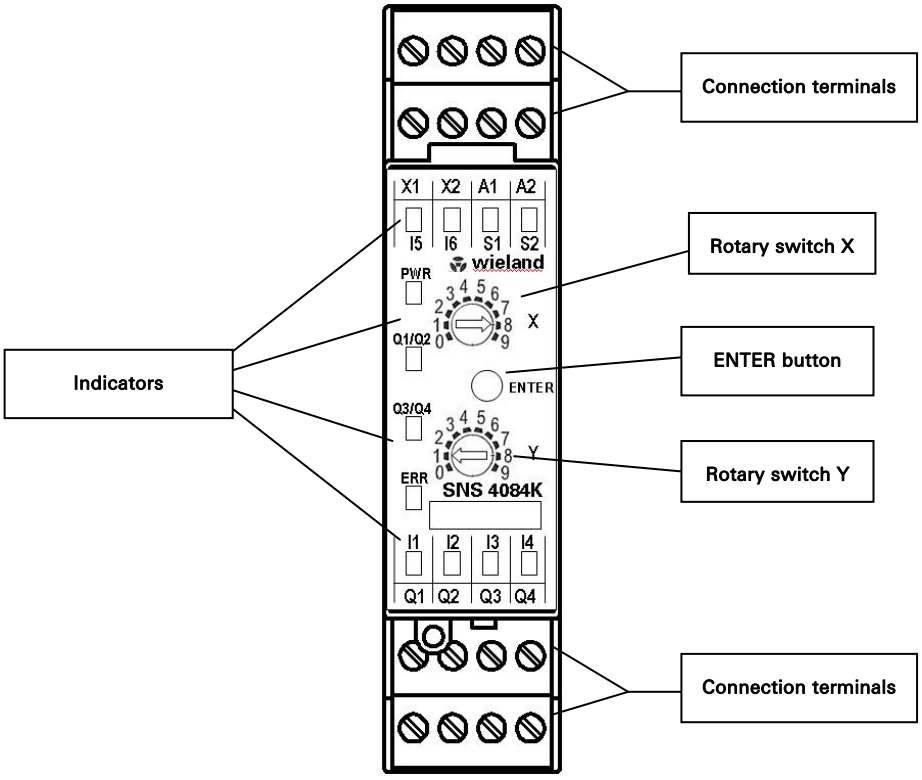
- Designation: Standstill Monitor
- Type

SNS 4074K-A, 0.1 - 9.9 Hz	R1.188.3620.0 (pluggable screw terminals)
SNS 4074K-C, 0.1 - 9.9 Hz	R1.188.3630.0 (pluggable spring-loaded terminals)
SNS 4074K-A, 0.5 - 99 Hz	R1.188.3640.0 (pluggable screw terminals)
SNS 4074K-C, 0.5 - 99 Hz	R1.188.3650.0 (pluggable spring-loaded terminals)
SNS 4,084K-A, 0.1 - 9.9 Hz	R1.188.3660.0 (pluggable screw terminals)
SNS 4084K-C, 0.1 - 9.9 Hz	R1.188.3670.0 (pluggable spring-loaded terminals)
SNS 4,084K-A, 0.5 - 99 Hz	R1.188.3480.0 (pluggable screw terminals)
SNS 4084K-C, 0.5 - 99 Hz	R1.188.3490.0 (pluggable spring-loaded terminals)

- Design: 22.5 mm case width

2.2 Description

The device SNS 4074K / 4084K provides the reliable monitoring of an input signal frequency of signal transmitters or sensors connected to the device and switches outputs on or off depending on a frequency limit value set on the device.



2.2.1 Controls and connection terminals

Control	Use
X	10-stage rotary switch for setting the frequency to be monitored (10th position)
Y	10-stage rotary switch for setting the frequency to be monitored (1st position)
ENTER	Button for application of the system configuration
Connection terminals	**Use**
A1	Operating voltage U_B
A2	Ground
I1	Sensor input
I2	Sensor input or configuration input (depending on the operating mode group)
I3	Sensor input or configuration input (depending on the operating mode group)
I4	Sensor input or configuration input (depending on the operating mode group)
I5	Restart lock input (RESET signal) or configuration input RESET
I6	Startup Bridging input (SNS 4084K)
	Bypass input (SNS 4074K)
S1	Configuration input, operating mode group
S2	Configuration input, operating mode group
Q1	Safe output
Q2	Safe output
Q3	Safe output (inverted)
Q4	Safe output (inverted)
X1	Signal output
X2	Signal output

2.2.2 Indicators

Status information of the inputs, outputs, power supply and error states is displayed using optical indicators (LEDs) on the front panel of the module. The rotary switch indicates the specified frequency to be monitored.

Name	Colour	Normal operation		in the case of error
PWR	green	+24V	flashes (for finding the old switch position after change)	
Q1/Q2	green	HIGH → on	LOW → off	-
Q3/Q4	green	HIGH → on	LOW → off	-
ERR	red	off		See Chapter 2.7, "Error Behaviour and Diagnosis"
I1	green	HIGH → on	LOW → off	
I2	green	HIGH → on	LOW → off	
I3	green	HIGH → on	LOW → off	
I4	green	HIGH → on	LOW → off	
I5	green	HIGH → on	LOW → off	
I6	green	HIGH → on	LOW → off	
S1	green	HIGH → on	LOW → off	
S2	green	HIGH → on	LOW → off	

2.3 Device Function

The device is used for standstill monitoring, for example of drives, in order to enable users to safely access machine or system parts where dangerous movements can occur.

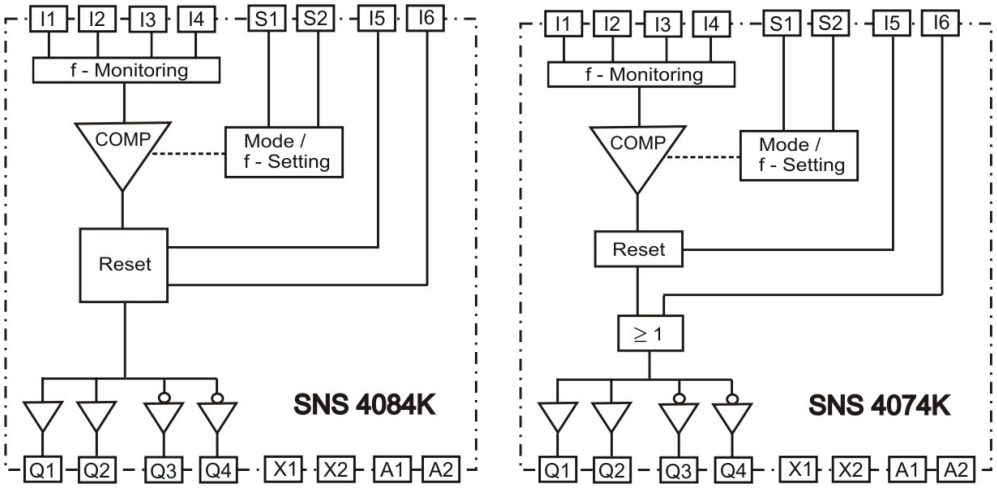
Using the device, a speed is monitored for exceeding the specified limit value, i.e. the safe speed range is below the specified limit value. Applications can be, for example, the unlocking of interlocks or the monitoring of slowly rotating axes in setting up/maintenance mode.

Before the device is put into operation, it must be configured accordingly for its use, i.e. the frequency to be monitored, the operating mode (A, V, C or D) and the type of restart lock (RESET) must be set and saved.

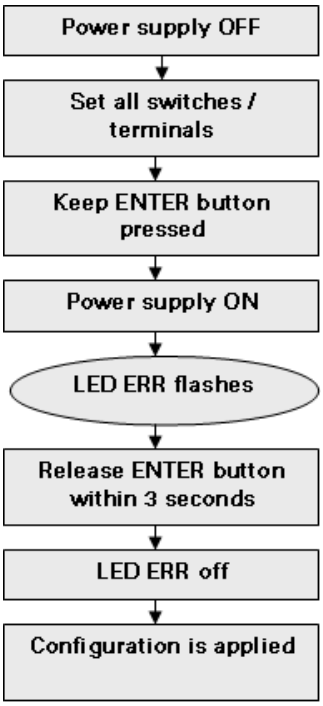
During operation, the device monitors the frequency of the signals at the inputs I1-I4 and compares this with the frequency set at the rotary switches. If the measured frequency is smaller than the specified frequency, output signals are produced which are transmitted to the outputs Q1 - Q4 depending on the status of the restart lock (RESET) (see Block Diagram 1). In order to prevent constant activation and deactivation of the output signals close to the specified frequency, switching hysteresis is installed (see Point 2.5). The response time of the device and its outputs is dependent on the frequency measured at the inputs.

If an error occurs on the device or there is a power failure, all safety-related outputs Q1 - Q4 deactivate (LOW level at the terminals). This must be strictly observed during the consideration of the safety function on a machine or system.

Block Diagram



2.4 Device Configuration



The setting or modification of a configuration at the switches and terminals must only be performed when the complete system is switched off, i.e. without application of an operating voltage at the terminals A1/A2.

After the required functions/operating modes have been set by external wiring of the terminals I5 (RESET), S1, S2 and optionally I2, I3, I4 (depending on the selected operating mode group) and the speed to be monitored has been set at the rotary switches, the operating voltage must be applied while the ENTER button is pressed.

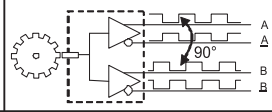
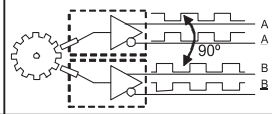
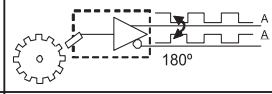
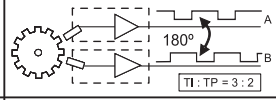
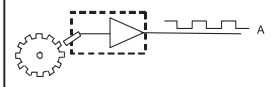
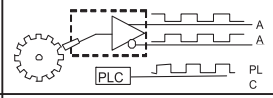
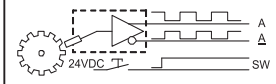
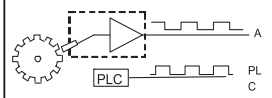
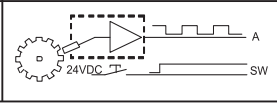
As soon as the ERR indicator starts flashing, the ENTER button must be released again within three seconds. Afterwards, the selected operating mode is saved and active.
If the ENTER button is pressed for longer than 5 seconds after the LED has started flashing, an error is displayed at the ERR indicator (internal system error).

2.5 Device Operation

There is a number of different operating groups (A, B, C or D) for the realisation of the function of standstill monitoring. Which operating mode is set or active is dependent on the levels at the configuration inputs S1 and S2 and if necessary on the input wiring at the inputs I2-I4 (depending on the selected operating mode group, see Table 1).

2.5.1 Operating Modes

Table 1 (operating modes)

Operating mode	Sensor signals	I1	I2	I3	I4	S1	S2	Cable break-detection	Stuck-at-high-detection	Crossover	Maximum achievable safety level of the application
A-1		A	B	A	B	0	0	yes	yes	yes	SIL 3 PL e Cat 4
A-2		A	B	A	B	0	0	yes	yes	yes	SIL 3 PL e Cat 4
B-1		A	A	0	0	0	1	yes	yes	yes	SIL 1 PL c Cat 2
B-2 [1)]		A	B	0	1	0	1	yes	yes	no	SIL 2 PL d Cat 3
B-3		A	0	1	0	0	1	no	no	no	SIL 1 PL c Cat 1
C-1		A	PLC	A	0	1	0	yes	yes	yes	SIL 2 PL d Cat 3
C-2		A	SW	A	1	1	0	yes	yes	yes	SIL 2 PL c Cat 2
D-1		A	PLC	0	0	1	1	Process error	Process error	no	SIL 2 PL d Cat 3
D-2		A	SW	0	1	1	1	Process error	Process error	no	SIL 1 PL c Cat 2

[1)] In operating mode B-2 the indicated safety level can only be maintained if the sensor lines are single jacket cables and laid in protected or secured enclosures.

Table 1 shows which error detection options are possible for connection of the sensor concerned using the device. The maximum achievable safety levels shown in the table are guide values for users and are also determined definitively by the sensors used and their safety characteristics as well as their line routing.

ATTENTION

2.5.2 Selection of the Operating Mode (S1, S2)

The different operating modes (sensor connection variants) can be subdivided into 4 operating mode groups A, B, C and D.
Operating Mode Group A (S1 = 0, S2 = 0):
Monitoring of one or two incremental encoders (HTL output) or two independent sensor signals with inverted outputs and a 90° phase shift against each other.
Operating Mode Group B (S1 = 0, S2 = 1):
Monitoring of one or two independent sensor signals, optionally with or without inverted outputs.
Operating Mode Group C (S1 = 1, S2 = 0):
Monitoring of one independent sensor signal with inverted outputs in combination with another enabling signal (static)
Operating Mode Group D (S1 = 1, S2 = 1):
Monitoring of a single sensor signal in combination with another enabling signal (static).

2.5.3 Setting of the frequency to be monitored

The speed to be monitored results from the setting at the two rotary switches on the device and the available "translation" of the speed into a frequency. For example, a gear wheel with 10 teeth installed on an axis produces a frequency of 10 Hz at one revolution per second.

The number of revolutions is monitored indirectly by, for example, measuring and evaluating the frequency produced by a gear and the proximity switches.

The monitoring frequency is set at the two rotary switches X and Y. The value at the rotary switch X represents the first, higher significant digit while the value at the rotary switch Y stands for the second, lower significant digit of the specified frequency.

The setting 00 at the rotary switches X and Y produces a monitoring frequency of 0.5 Hz for the devices with 99 Hz maximum setting and is 0.1 Hz for the devices with 9.9 Hz maximum setting.

Example

The speed to be monitored is 5.2 Hz:
A device with an adjustable frequency range 0.1 - 9.9 Hz is selected for this and the value 5 is set at the rotary switch X and the value 2 at the rotary switch Y.

2.5.4 Operation with low demand mode of the safety function

If the safety function of the device is seldom required (PFD Application, see IEC 61508), a proof test interval of 1 year must be defined. For example, this can be necessary when monitoring for a speed for overspeed if the speed set at the device is never exceeded in normal operation of the machine.

2.5.5 Error Detection

Error detection (e.g. cable break detection) as shown in Table 1 is performed depending on the selected operating mode. Such an error is indicated at the signal output X1 using an error code.

2.5.6 Sensor Inputs (I1 - I4)

The actuation of the inputs I1, I2, I3 and I4 for the frequency measurement is performed using proximity switches with PNP output or incremental encoders with HTL output. (e.g. programmable incremental encoder Type DKS40 (SICK)).

Depending on the set operating mode, the inputs I2 - I4 are also used if necessary for the configuration of the device (see Table 1).

The proximity switches / incremental encoders are not supplied with power by the device. However, the GND connections must be connected with each other with low resistance. Proximity switches can either be connected singly or in pairs.

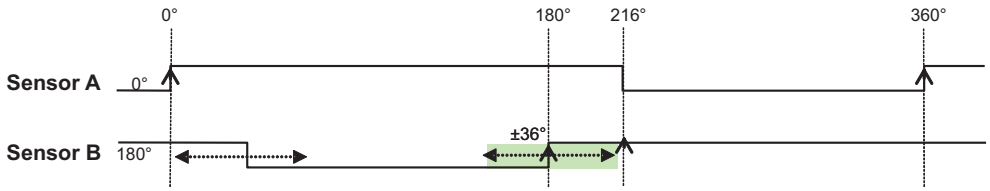
The connection of two proximity switches offset by 180° in the operating mode B-2 (e.g. on a gear disc/toothed rack) must be made so that at least one initiator is activated in any position of the disc, i.e. a HIGH level is provided. In order to guarantee this, the asymmetry between tooth and depression on the gear disc must show a duty cycle of 1 : 1.5.
Thereby, the initiators must each be exactly aligned with the middle of a tooth or a depression.
The spacing of a depression on the gear disc must be greater than the switching distance of the initiator used. In contrast, the spacing of a tooth must be selected so that it is maximum half the switching distance of the initiator. The entries 0°-360° refer to a segment (tooth + gap).

NOTE

The minimum requirements of the signal must strictly be observed. LOW or HIGH time must be greater than 200 µs.

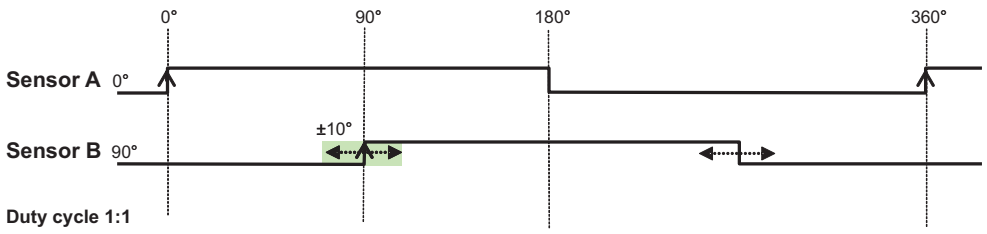
2.5.6.1 Duty cycle and phase offset of the sensor signals

The following duty cycles and phase offsets of the sensor signals must be complied with:
Operating modes A-1 and A-2: Duty cycle 1 : 1 / phase offset 90°
Operating mode B-2: Duty cycle 1 : 1,5 / phase offset 180°
Other operating modes: Duty cycle 1 : 1…1,5 / phase offset according to the operating mode



Duty cycle 3:2

Measurement tolerance: for 180° sensor arrangement → ±36° → Cutoff frequency = 2 kHz



Duty cycle 1:1

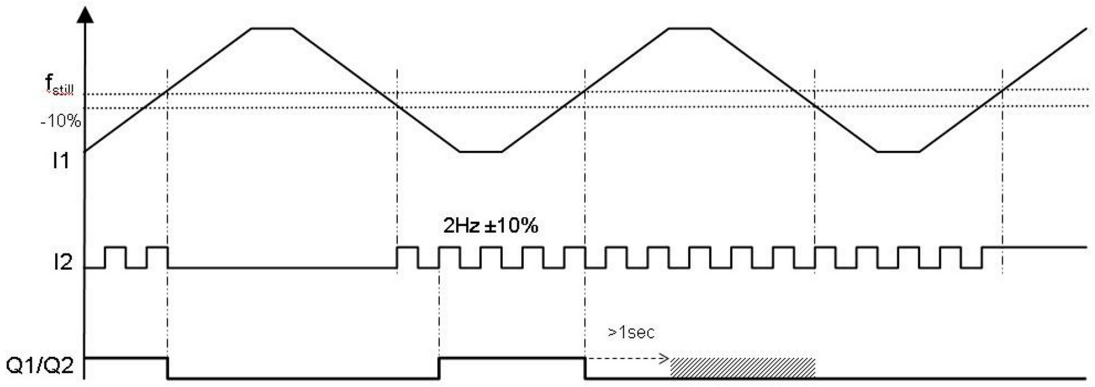
Measurement tolerance: for 90° sensor arrangement → ± 10° → Cutoff frequency = 2 kHz

2.5.6.2 Pulse form of the dynamic enable signal (I2) for the operating modes C-1 and D-1

A dynamic signal with f = 2 Hz at I2 is deemed as enable signal and can together with the standstill at I1(I3) produce an output signal at Q1, Q2. If the enable signal I2 and standstill I1(13) are different, no output signal is produced at Q1, Q2.

NOTE

For a smooth process of this operating mode, it is mandatory that both the standstill I1(I3) as well as the enable signal I2 have been granted simultaneously before restarting the machine. If this is not the case, a process error is produced which is not reset again until standstill and enable signal are present at the same time.



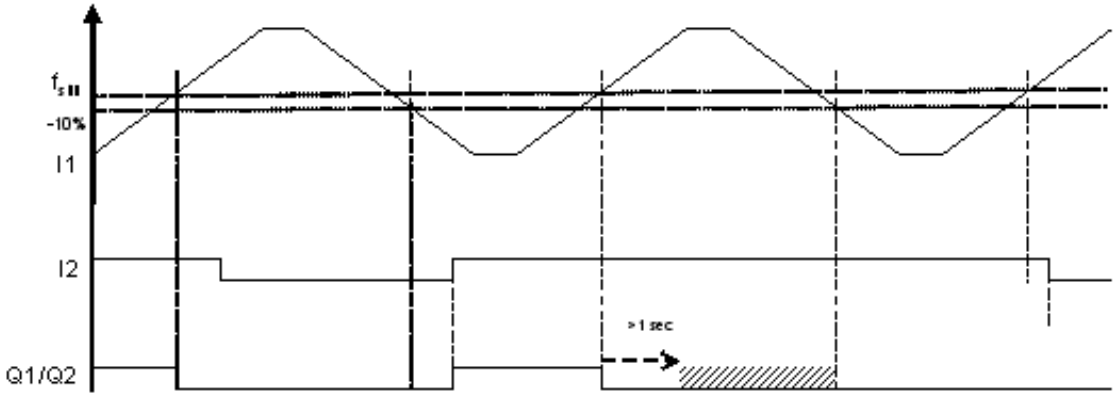
Process error for dynamic input

2.5.6.3 Pulse form of the static enable signal (I2) for the operating modes C-2 and D-2

A static signal at I2 is deemed as enable signal and can together with the standstill at I1(I3) produce an output signal at Q1, Q2. If the enable signal I2 and standstill I1(13) are different, no output signal is produced at Q1, Q2.

NOTE

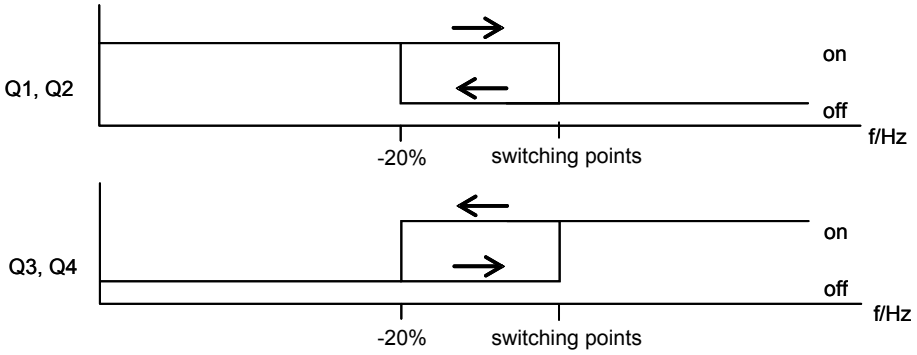
For a smooth process of this operating mode, it is mandatory that both the standstill I1(I3) as well as the enable signal I2 have been granted simultaneously before restarting the machine. If this is not the case, a process error is produced which is not reset again until standstill and enable signal are present at the same time.



Process error for static input

2.5.6.4 Hysteresis

The hysteresis prevents the enable being constantly activated and deactivated if the measured frequency value fluctuates around the frequency to be monitored. Therefore, a frequency range in which no switching action is performed is kept in every measuring range. If the measured frequency exceeds the frequency to be monitored, the enable is deactivated immediately. If the measured frequency is less than the frequency to be monitored minus the hysteresis, the enable is activated again.



This produces switching points at 40 Hz and 32 Hz for a monitored frequency of 40 Hz.

2.5.6.5 Cutoff frequency

The cutoff frequency for the sensor inputs I1-I4 is 2 kHz. Exceeding this frequency is detected and the outputs are switched off in a safe state.

2.5.6.6 Vibration during standstill

It can happen during standstill that a transmitter is exactly on the edge of a tooth of the gear disc and produces a frequency due to vibrations in the system while the other transmitter is permanently HIGH or LOW. In this case, the enable is not deactivated for two-channel monitoring while the vibration frequency is below the set frequency. The status "Vibration during standstill" is detected and indicated at the signal output X1 using an error code.

2.5.6.7 Requirements for the sensors and signal transmitters

The connected sensors and signal generating equipment should comply with the relevant technical standards.
For example, these are EN 60947-5-2 or EN 60947-5-3 for proximity switches and IEC 61131 for programmable logic controllers.

2.5.7 RESET – Function (I5)

2.5.7.1 Configuration of the RESET function

The RESET behaviour of the device (with or without restart lock) is defined during the device configuration. If HIGH is present at input I5 during the configuration process, automatic operation without restart lock (Automatic RESET) is set; if LOW (open input) is present at the input I5, a manual, monitored RESET (operation with restart lock) is set.
At every Power Up during later operation, the state of the input I5 must correspond to the state which has been configured. Differences are signalled as configuration errors.

2.5.7.2 Manual Reset

For operation with manual reset (operation with restart lock), a transfer of the internal output signal of the comparator is made to the outputs Q1-Q4 if the input I5 is activated (HIGH) and then deactivated again (LOW) (pulse duration 0.1 - 5 s) whereby the output signal with the falling flank is transmitted to I5.

2.5.7.3 Automatic Reset

In the case of **automatic RESET** (operation without restart lock), the internal output signal of the comparator is transferred directly to the outputs if the input I5 is activated (HIGH signal). An open input I5 during operation does not result in a system error for the automatic RESET function.

2.5.7.4 External Device Monitoring (EDM)

The input I5 is also used for external device monitoring (EDM) The positively driven normally closed contacts (NC contacts) of contactors or relays which are actuated by Q1/Q2 (or Q3/Q4 for interlocks locked by magnetic force) must (connected in series) be connected to the input I5 irrespective of whether a manual or automatic reset is used.

2.5.8 Bypass Function (only for SNS 4074K)

Using the Bypass input I6 of the SNS 4074K, the Reset function (which influences transmission of the signals to the outputs Q1 - Q4) can be bridged (ODER function). If the input I6 is not wired (LOW), the outputs Q1 - Q4 are activated in accordance with the selected RESET function. If the input I6 is wired (HIGH), the outputs Q1 and Q2 are permanently HIGH and Q3 and Q4 permanently LOW irrespective of the status at the inputs I1 - I4.

ATTENTION

The generation of the bypass signal must meet at least the same safety requirements as the operating mode and the designated safety function.

2.5.8.1 Bypass in the case of manual reset (only for SNS 4074K)

If input I6 is activated, the outputs Q1-Q2 are activated irrespective of the status at the sensor inputs I1 - I4 and irrespective of whether there is a manual Reset pulse at I5.
After ending the Bypass function at I6 (LOW), the outputs are not activated again until the measured frequency is below the set cutoff frequency and a manual Reset signal has been sent to I5.

2.5.8.2 Bypass in the case of automatic reset (only for SNS 4074K)

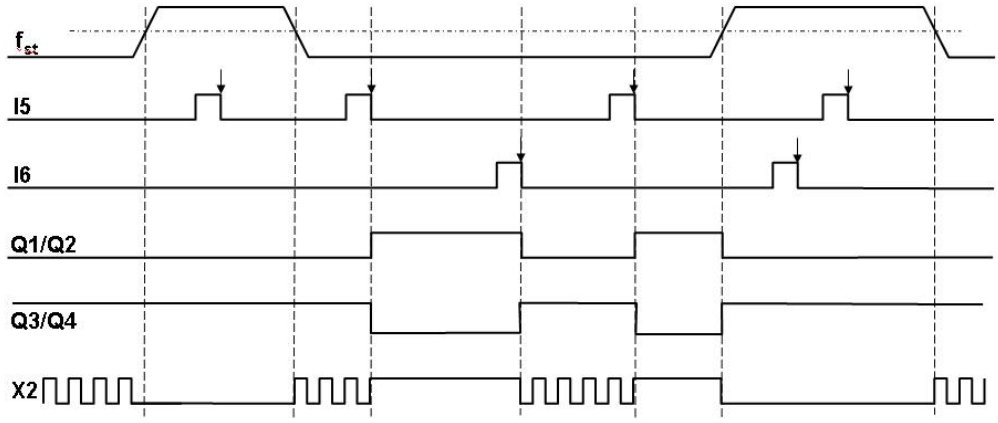
If input I6 is activated, the outputs Q1-Q2 are activated irrespective of the status at the sensor inputs I1 - I4 and irrespective of whether there is an automatic Reset signal (HIGH) at I5.
After ending the Bypass function at I6 (LOW), the outputs are not activated again until the measured frequency is below the set cutoff frequency and a HIGH signal is present at I5.

2.5.9 Startup Bridging Function (only for SNS 4084K)

A transfer of the output signals to the outputs Q1 to Q4 can be influenced using Startup Bridging (SB) at the input I6 of the SNS 4084K. If the input I6 is not wired (LOW), the Startup Bridging function is not active and the outputs Q1 and Q2 are permanently LOW and the outputs Q3 and Q4 are permanently HIGH.

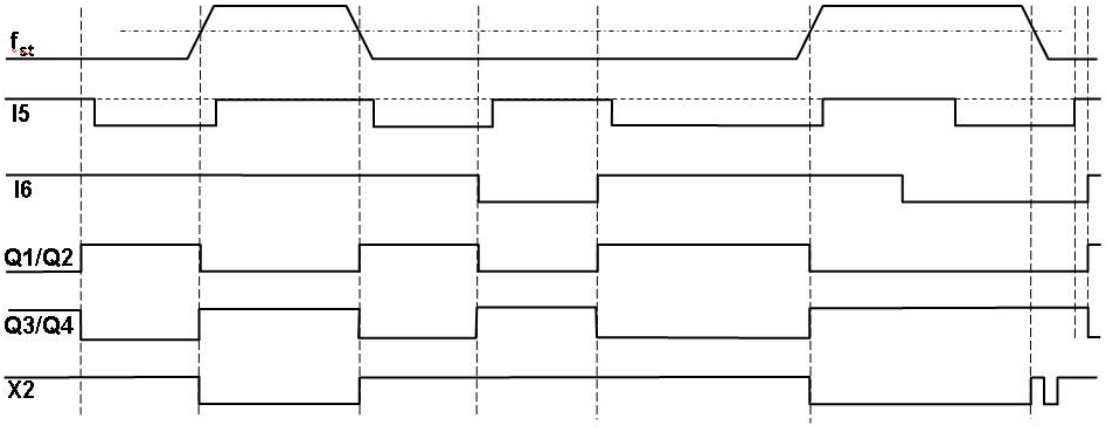
2.5.9.1 Startup Bridging in the case of manual reset (only for SNS 4084K)

For operation with manual RESET, an output signal to the outputs caused by the RESET signal at I5 can be reset by a pulse at I6 (pulse duration 0.1 - 5 s), e.g. for locking a safety device during the standstill of a machine.



2.5.9.2 Startup Bridging in the case of automatic reset (only for SNS 4084K)

In the case of operation with automatic RESET, an output signal sent to the outputs can be reset by removal of the signal at I6 (pulse duration 0.1 - 5 s).



NOTE

The input I5 is shown with active External Device Monitoring (monitoring of the normally closed contact of a contact extension connected to Q1/Q2). Without External Device Monitoring, a permanent HIGH signal would be present at I5.

A process error at I5 is shown on the far right in the diagram and is signalled by a flashing code at X2 (see also Chapter 2.7).

2.6 Outputs

2.6.1 Safety-related Outputs (Q1 - Q4)

Q1, Q2 HL output, safety-related
Q3, Q4 HL output, (inverted to Q1 or Q2)

The safety-related semiconductor outputs Q1 - Q4 of the module can be loaded up to 2 A (ohmic load) and have permanent short-circuit protection. The switching capability of the outputs is continuously monitored. The outputs are periodically switched off individually for a short time and checked in doing so. In the case of an error, all the outputs Q1 - Q4 are switched to LOW.

In the case of single-channel actuation of an actor, it must be noted that the switch-off path in the case of an external short circuit (Stuck-at-HIGH) is not effective due to the operating principle. Such types of errors must be ruled out using suitable design measures (e.g. protected cable routing, installation in the switch cabinet).

Q1/Q2 can be used, for example, for the actuation of locks maintained by spring force.
Q3/Q4 can be used, for example, for the actuation of locks maintained by magnetic force.

ATTENTION

If an error occurs on the device or there is a power failure, all safety-related outputs Q1 - Q4 are switched off (LOW level at the terminals). This must be strictly observed during the consideration of the safety function on a machine or system.
Outputs Q1/Q2 can be used up to SIL 3.
Outputs Q3/Q4 cann be used for the activation of locks maintained by magnetic force up to SIL 1.

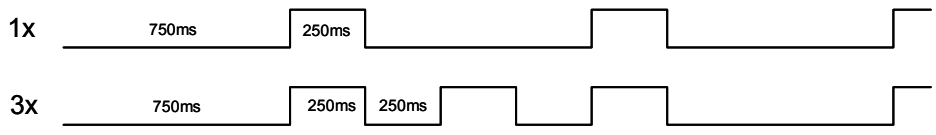
In case of single-channel actuation of an actor: If an internal error occurs, upon request there may be an 20 ms delay (approx.) in the respective output switching off. An output in safe state can falsely switch on for about 20 ms before the error is detected and the device finally shuts down. Whether this behaviour is acceptable has to be evaluated for each application individually.

2.6.2 Signal Outputs (X1, X2)

X1 / X2 are not safety-related semiconductor outputs for signal purposes.

The signal output X1 produces a pulse code which gives information about the error status of the device and can be used for diagnostics purposes (e.g. by a PLC) (see also Table 1, Chapter 2.7).

Example Output of an error code at X1:



Flashing pulse = 250 ms, pause in between = 750 ms

The output status of the safety-related outputs Q1 - Q4 can be diagnosed using the signal output X2.

Level at X2	Output status Q1/Q3	Comment
LOW	Output Q1/Q2 => LOW Output Q3/Q4 => HIGH	The outputs Q1 and Q2 are switched off. The outputs Q3 and Q4 are switched on.
HIGH	Output Q1/Q2 => HIGH Output Q3/Q4 => LOW	The outputs Q1 and Q2 are switched on. The outputs Q3 and Q4 are switched off.
Pulse code 1 x	Output Q1/Q2 => LOW Output Q3/Q4 => HIGH	The outputs Q1 and Q2 are switched off and the outputs Q3 and Q4 are switched on; however the outputs change their status as soon as there is a manual RESET signal (input I5).

Table 2 (signal output X2)

Pulse code at X2:

The corresponding types of errors are indicated using the various LEDs of the device in the case of an error (see also Table 1, Chapter 2.7).

2.7 Error Behaviour and Diagnosis

The detection of errors inside the device or in its actuation results in switching off the safety-related outputs Q1 - Q4 of the device (LOW level).
In addition, the ERR LED displays an error code (flashing every 2 seconds). The deactivation can be revoked if necessary by the user by elimination of an error (e.g. in the control) and by switching off the operating voltage and then switching it on again.

2.7.1 Error classes

Error Behaviour and Diagnosis					
	Error type	Pulse code and displays			Device status
		X1	ERR	LED	
1.	Error cannot be rectified	Switch device off/on → Error persists → Device defective			
1.1	Internal system error	HIGH	On	-	Outputs Q1, Q2, Q3, Q4 → LOW
2.	Serious error	Rectify error → Switch device off/on → OK			
2.1	Cutoff frequency	14 x	flashing	-	Outputs Q1, Q2, Q3, Q4 → LOW
2.2	Operating voltage	13 x	flashing	-	Outputs Q1, Q2, Q3, Q4 → LOW
2.3	Power On configuration	12 x	flashing	PWR /S2	Outputs Q1, Q2, Q3, Q4 → LOW
2.4	Rotary switch configuration error	12 x	flashing	PWR	Outputs Q1, Q2, Q3, Q4 → LOW
2.5	Operating mode configuration error	12 x	flashing	S2	Outputs Q1, Q2, Q3, Q4 → LOW
2.6	Discrepancy error	11 x	flashing	S1	Outputs Q1, Q2, Q3, Q4 → LOW
2.7	Sensor error I1, I2, I3, I4	10 x	flashing	I1,I2, I3,I4	Outputs Q1, Q2, Q3, Q4 → LOW
3.	Minor errors	Correct error → OK			
3.1	Process error, operating mode C or D	1 x	off	---	no effect
3.2	Process error, RESET	2 x	off	---	no effect
3.3	Process error, Startup Bridging	3 x	off	---	no effect
3.4	Vibration	4 x	off	---	no effect
3.5	90° phase shift in operating mode A could not be tested	5 x	off	—	no effect
	No error	OK			
		LOW	off	---	

Table 3

2.7.2 Types of errors and causes

Table 4

Error type	Description of a possible error cause / troubleshooting
Internal system error	Internal device error ➝ Device faulty, please replace
Cutoff frequency	The upper cutoff frequency of the device has been exceeded ➝ Check input frequency, see chapter 7, "Technical Data"
Operating voltage	The operating voltage limits are not complied with ➝ Check operating voltage, see chapter 7, "Technical Data"
Power On configuration	Any of the configuration elements has been changed in the switched off condition. ➝ Restore original operating mode, or apply changed configuration.
Rotary switch configuration error	The configured standstill speed on the two rotary switches has been changed ➝ Restore original monitoring speed or apply changed monitoring speed
Operating mode configuration error	The operating mode configured at S1, S2 and I2, I3, I4, I5 has been changed ➝ Restore original operating mode, or apply changed configuration.
Sensor error I1, I2, I3, I4	The sensor signal at the inputs I1 - I4 is not present/invalid ➝ Check sensors and sensor cables for possible defects (breaks, short circuits,…)
Process error, operating mode C or D	A signal (e.g. PLC) has failed in the operating mode B ➝ Check sensors and sensor cables for possible defects (breaks, short circuits,…)
Process error, RESET	The signal for the manual RESET at I5 was too long ➝ Check RESET button, check RESET button cable for short circuit
Process error, Startup Bridging	The signal for the Startup Bridging at I6 was too long ➝ Check source of signal for startup bridging, check cable at I6 for short circuit
Discrepancy error	The input frequency at I1/ I3 was different for longer than 30 seconds in comparison with the input frequency I2 / I4 ➝ Check sensors and sensor cables for possible defects (breaks, short circuits,…)
Vibration	Changing signals occur at the sensor inputs I1 – I4, triggered, for example, by vibrations of the machine. ➝ dampen vibrations of sensor(s)
Phase shift test	90° phase shift of sensors could not be tested ➝ constant speed for measuring is required

2.7.3 Change of the configuration of the device

A change of the configuration elements (rotary switches X, Y, S1 and S2 (and, if applicable, also I2, I3 and I4 depending on the operating mode group) in the switched-off condition is only detected by the device when an operating voltage is applied.

During operation, a change of the rotary switches X and Y or a change of the logical level at the inputs S1 and S2 (if applicable also I2, I3 and I4) results in immediate removal of all safety-related output signals and lighting the Error indicator of the module concerned. A restart of the program process is not possible again until either the original operating mode has been set or a new operating mode has been defined and confirmed (new configuration).

Note

Pressing the Enter button during operation is ignored.

2.7.4 Short circuit of input circuits to U_B

A short circuit on the cables of the input circuits to U_B can result in incorrect generation of safety-related output signals.

2.7.5 Earth fault of input circuits (I1 – I4)

Earth fault of input circuits is detected as cable break and thus as sensor error. The outputs are switched off.

2.7.6 Short circuit of input circuit to input circuit (I1 – I4)

A short circuit on the cables of the input circuits between each other is detected as a sensor error (crossover). In this case, the outputs are switched off. In operating mode B-2 the crossover will not be detected.

2.7.7 Removal or addition of output wiring while operating voltage is present.

- Short circuit of output circuits to A2 (earth fault, only applies for HL outputs):
  A short circuit to A2 potential (earth fault) is detected in all output circuits either immediately or on request of the function.
- Short circuit of output circuits to A1 (earth fault, only applies for HL outputs):
  A short circuit to A1 potential (earth fault) is detected in all output circuits immediately.

2.7.8 Error at I5 (RESET)

- Not opening at the terminal I5 in the case of manual RESET
  - during operation: No enable, because a pulse signal is expected.
  - during Power Up: Configuration error (system error)
- Not closing at the terminal I5 in the case of manual RESET
  - No enable, because a pulse signal is expected.
- Not opening at the terminal I5 in the case of automatic RESET
  - No detection as this can occur in normal operation.
- Not closing at the terminal I5 in the case of automatic RESET
  - during operation: No enable because RESET signal is not present.
  - during Power Up: Configuration error (system error)

2.7.9 Error at I6 (Bypass or Startup Bridging)

SNS 4084K (Startup Bridging function)

- Not opening at the terminal I6 in the case of manual RESET
  - No enable, because a pulse signal is expected
- Not closing at the terminal I6 in the case of manual RESET
  - No enable, because a pulse signal is expected
- Not opening at the terminal I6 in the case of automatic RESET
  - No error
- Not closing at the terminal I6 in the case of automatic RESET
  - No enable.

SNS 4074K (Bypass function)

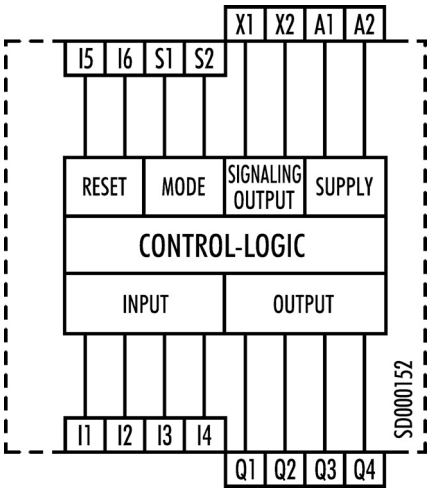
- Not opening at the terminal I6 in the case of manual RESET
  - Enable persists because ODER link switches on.
- Not closing at the terminal I6 in the case of manual RESET
  - no enable using Bypass I6
- Not opening at the terminal I6 in the case of automatic RESET
  - Enable persists because ODER link switches on.
- Not closing at the terminal I6 in the case of automatic RESET
  - no enable using Bypass I6

3 Installation

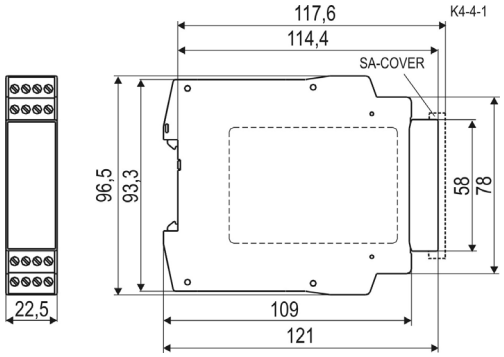
3.1 Installation Conditions

- The system must be installed in a switch cabinet with a protection class of at least IP54.
- The module is mounted on a standard rail according to EN 50022.
- The standard rail must be connected to protective earth (PE).
- The system and the system inputs must always be supplied with power from a power supply.
- The external power supply must comply with the regulations for low voltages with safe separation (SELV, PELV according to IEC 60536) and DIN EN 50178 (Electrical equipment for use in power installations).

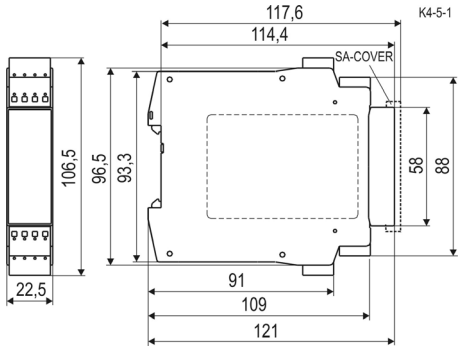
3.2 Connection Diagram



3.3 Dimensions



SNS 40x4K-A



SNS 40x4K-C

3.4 Safety precautions before starting installation/dismantling

Take the following safety precautions before starting installation / assembly or dismantling:

- Disconnect the device / the system from the power supply before starting work.
- Secure the machine / system against being switched on again.
- Confirm that no voltage is present.
- Ground the phases and short to ground briefly.
- Cover and shield neighbouring live parts.

3.5 Mounting

- The module must be attached to the standard rail and latched.
- The wiring of the system is performed afterwards.

3.6 Dismantling

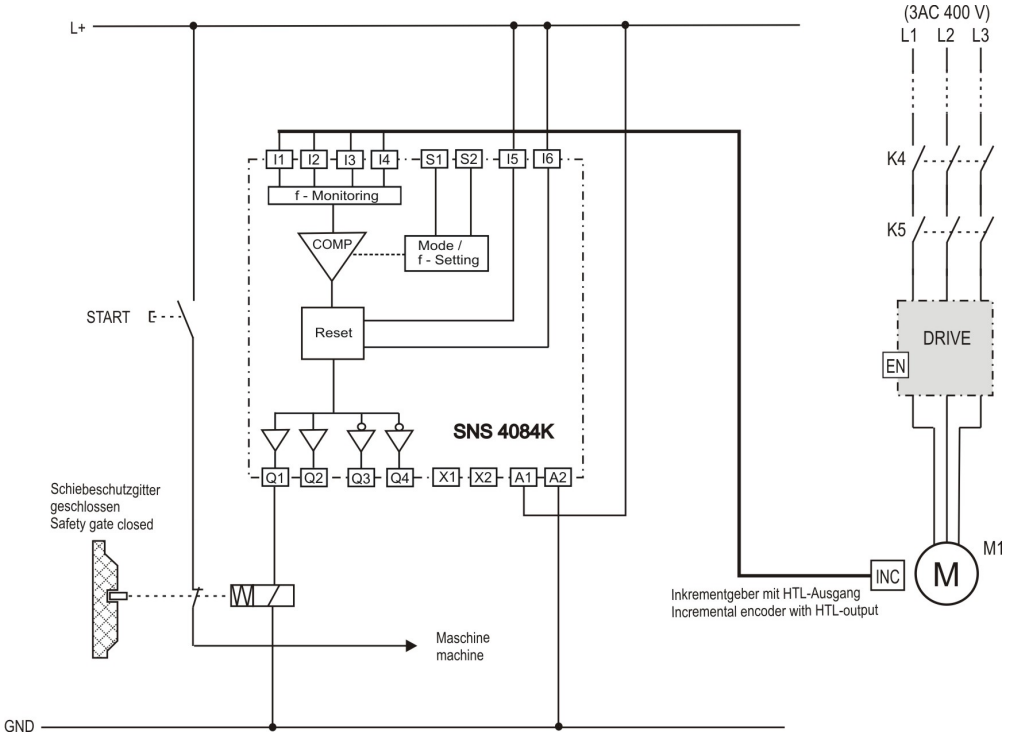
- The wiring of the system must be detached first.
- The module can be removed after unlocking the standard rail latching on the underside of the device.

3.7 Protection Circuit

External loads must be equipped with a suitable protection circuit for the load (e.g. RC elements, varistors, suppressors) in order to reduce EMC interference and to increase the service life of the output switching elements.

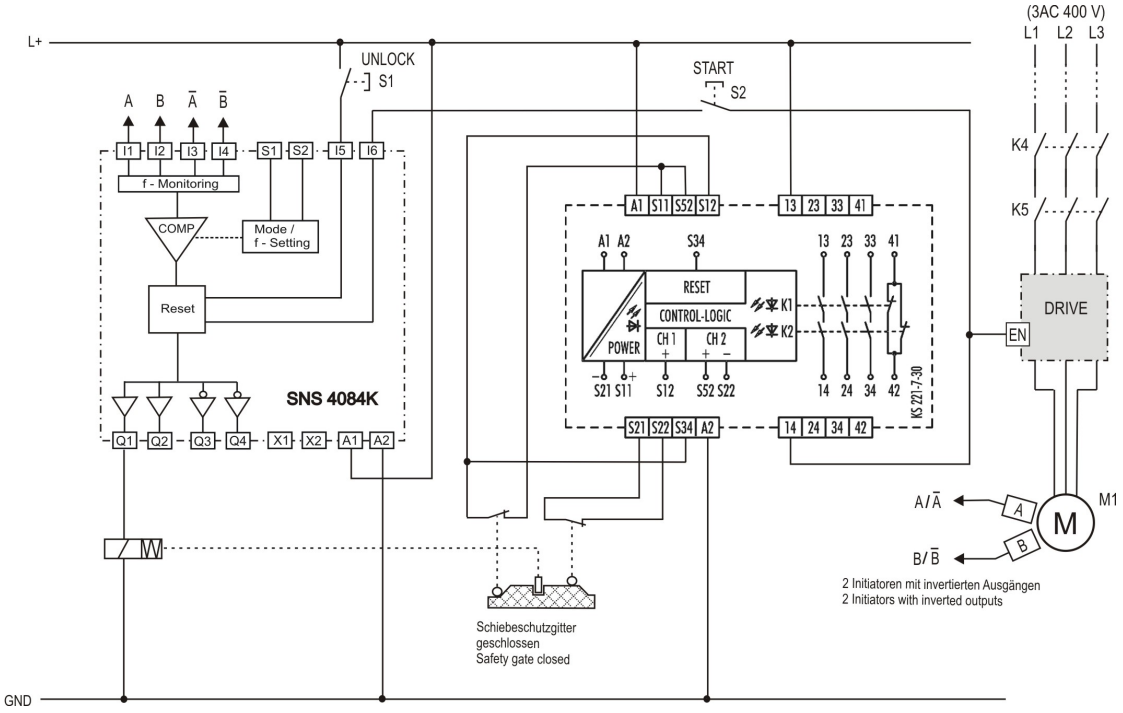
4 Application Examples

4.1 Zero speed monitor with incremental encoder (operating mode A-1)



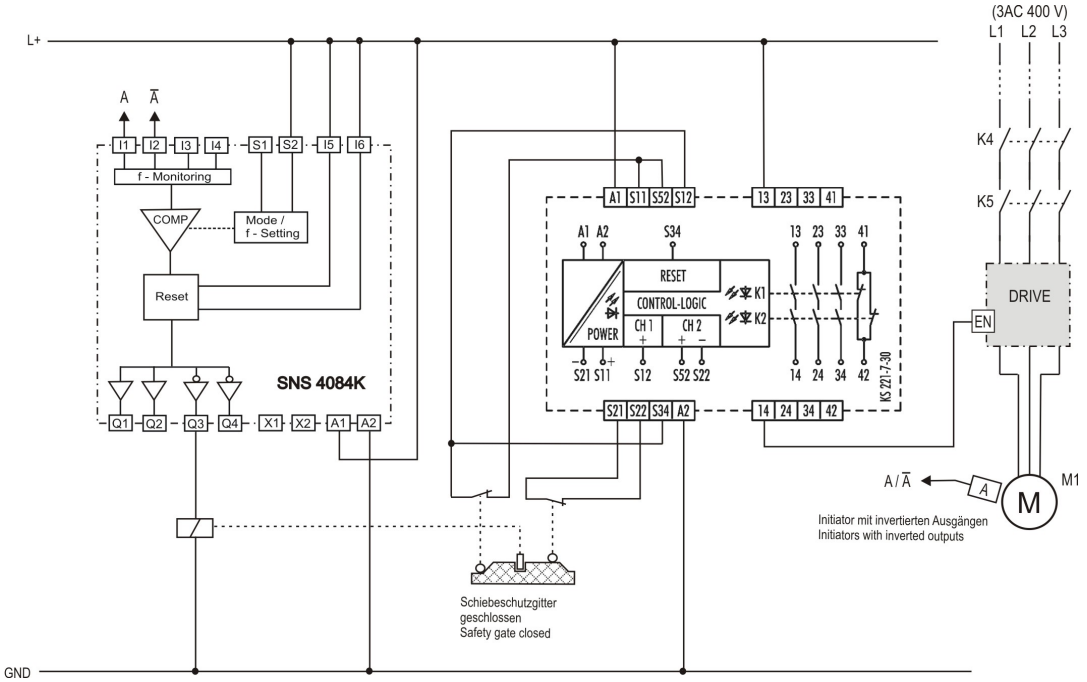
When the actual speed is less than the standstill speed, the lock maintained by spring force of the safety door is opened and the access to the machine during standstill can be automatic.
The machine cannot be restarted until the safety door is locked again.

4.2 Zero speed monitor with initiators (operating mode A-2)



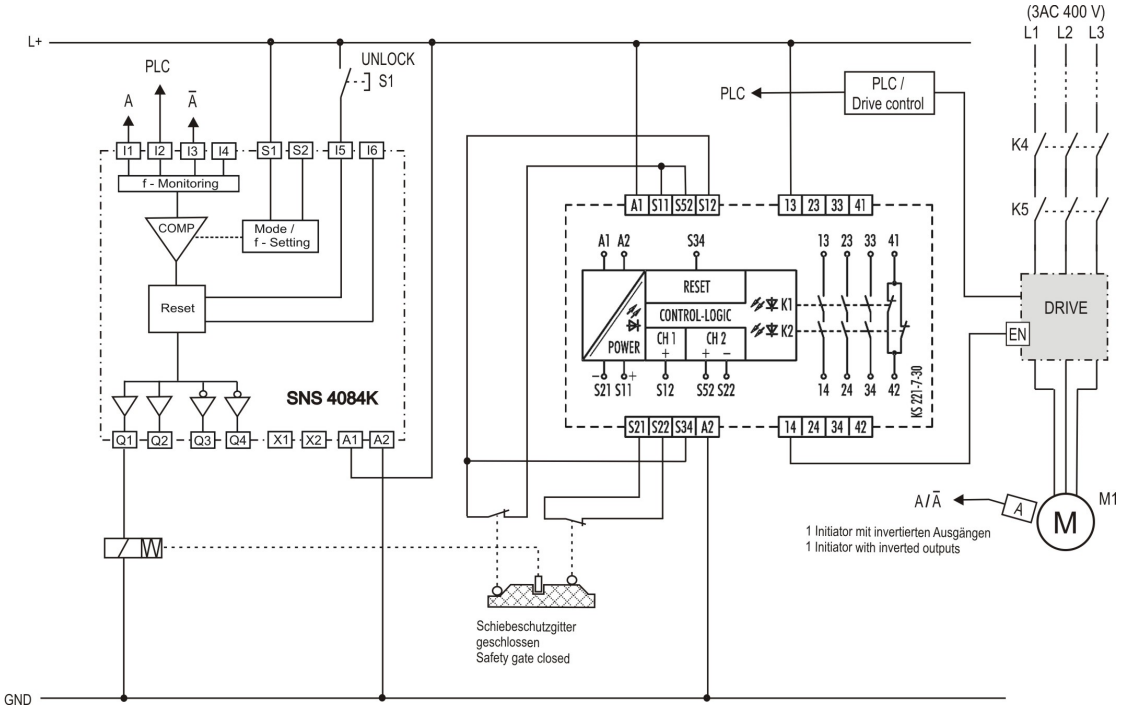
When the actual speed is less than the standstill speed, the lock maintained by spring force can be opened by pressing the button S1 and the safety door is automatically released during standstill. When the safety door is open, starting the machine is prevented by removing the enable for the drive controller.
The machine does not start until pressing the button S2 when the safety door is closed and locked again.

4.3 Zero speed monitor with initiators (operating mode B-1)



When the actual speed is less than the standstill speed, the magnetic lock is released automatically and the safety door is automatically opened during standstill.
When the safety door is open, starting the machine is prevented by removing the enable for the drive controller.
The machine cannot be restarted until the safety door is closed and locked again.

4.4 Zero speed monitor with initiators (operating mode C-1)



When the actual speed is less than the standstill speed, pressing the S1 button releases the spring force lock and opens the safety door during standstill, provided that the monitored frequency at inputs I1 and I3 are below the monitoring frequency, and a respective signal from the drive control is present at I2, indicating a standstill of the monitored drive. When the safety door is open, starting the machine is prevented by removing the enable for the drive controller.
The machine cannot be restarted until the safety door is closed and locked again.

5 Calculation Example

The following calculation example should provide assistance for the selection and adjustment of the sensors.

5.1 Determination of the number of pulses

The number of pulses Z of the sensor must be selected so that the sensor during operation of the machine at maximum speed *ng* never exceed the maximum cutoff frequency of the device. In the equation, the maximum values for *fg* (2000 Hz) and *ng* are used:

Z: Number of pulses per revolution
ng: Maximum speed of the drive (rpm)
fg: Pulse frequency (1/sec)

$$Z = fg * 60 / ng$$

Example for a machine with a maximum speed of 1000 rpm:

$$Z = 2000\ \text{Hz} * 60 / 1000\ \text{rpm} = 120$$

The maximum number of pulses of the sensor must not exceed 120 pulses per revolution.

5.2 Determination of the cutoff frequency to be set

The speed limit f_{ST} to be set for the monitoring of the standstill is then determined as follows using the previously calculated number of pulses Z and the standstill speed n_{ST} to be monitored of the drive:

Z: Number of pulses per revolution
n_{ST}: Standstill speed of the drive (rpm)
f_{ST}: Frequency to be set (1/sec)

$$f_{ST} = Z * n_{ST} / 60$$

Example for monitoring a speed of 3 rpm and a number of pulses of 120 per revolution:

$$f_{ST} = 6\ \text{Hz}$$

The frequency to be set on the device for monitoring the standstill of the drive is 6 Hz.

6 Sensors

6.1 Incremental Encoders

Incremental sensors (IGR) are sensors for the measurement of position changes (linear) or angle changes (rotating) which can measure displacement and displacement direction or angle change and rotation direction. Incremental encoders are also called rotary encoders, incremental rotary encoders or rotary pulse generators.
The displacement or rotation to be measured for the incremental measurement is divided into equally sized elements (increments). These increments are then counted and the displacement or number of revolutions is produced from the sum of the increments.

6.1.1 Example for suitable incremental encoder (rotating)

- Type DKS 40 (SICK)

6.1.2 Example for suitable incremental encoder (linear)

- Type LMIX 22 - 028 - 03.0 - 0625 - 00 (Elgo)

6.2 Proximity Switches

Proximity switches, also called proximity initiators or proximity sensors, use sensors which react to proximity, i.e. without direct contact or non-contacting. Proximity switches are used during technical processes for the position detection of workpieces and tools and as initiators of safety measures. The sensors and switches for some proximity switches are combined in one component.

- Inductive Proximity Switches: These react to the occurrence of an eddy current both for ferromagnetic as well as non-magnetic but metallic objects.
- Capacitive Proximity Switches: These react to non-conductive materials.
- Magnetic Proximity Switches (e.g. reed switches or also Hall sensors): These react to a magnetic field.
- Optical Proximity Switches: These react to light reflection.
- Light Barrier: Light barriers evaluate the interruption of a light beam.
- Ultrasound: These proximity switches evaluate the reflection of an ultrasound signal from an obstacle.
- Electromagnetic proximity switches where proximity changes the oscillation frequency of oscillating circuits. They react to both conductive as well as non-conductive materials.

6.2.1 Example for suitable inductive proximity switches with inverted outputs

- Type IG5792 (IFM)

7 Technical Data

Climatic conditions	Unit	
Ambient operating temperature T_B	°C	-25 to +55
Storage temperature	°C	-25 to +70
Relative humidity	%	10 to 95, no moisture condensation
Climatic Conditions (EN 61131-2) – Air pressure in operation	hPa	860 to 1060
Mechanical strength		
Vibration, sine (EN 60068-2-6) – Frequency range – Amplitude – Acceleration – Number of cycles	 Hz mm g	 5 to 150 3.5 (5 to < 9 Hz) 1 (9 to 150 Hz) 10 per axis (on 3 axes)
Vibration, broadband noise (EN 60068-2-64) – Frequency range – Acceleration	 Hz g	 5 to 500 4,9
Shocks, half sine (EN 60068-2-27) – Acceleration – Duration	 g ms	 15 11
Electrical safety		
Protection class (EN 60529)		IP 20
Finger-proof according to DIN EN 50274		
Air gap/creepage paths (EN 60664-1) – Surge voltage category – Degree of soiling		 III 2 inside, 3 outside
Test voltage alternating current Operating voltage	kV V AC	see EN 60664-1 300

Electromagnetic Compatibility	Unit		
Fast Transients (Burst) according to EN 61000-4-4 – Power Supply – I/O – Functional Earth (Shield)	 kV kV kV	 2 1 1	
High energy surge voltages (Surge) according to EN 61000-4-5 – Power Supply – I/O – Functional Earth (Shield) – Communication (field bus)	 kV / kV kV / kV kV kV / kV	Diff.-Mode 1,0 1,0 - -	Com.-Mode 2,0 2,0 1,0 1,0
High-frequency electromagnetic fields according to EN 61000-4-3	V/m	10	
Induced conducted interference according to EN 61000-4-6	V	10	
Electrostatic discharge according to EN 61000-4-2	kV	± 4 (contact discharge) ± 8 (air discharge)	
Interference emission according to DIN EN 55011:2003 Class A	db (V/m)	40 (20 - 230 MHz) 47 (230 - 1000 MHz)	
Short power failures according to EN 61000-4-29 – Duration – U / U_{Nenn} – Cycles – Test frequency	 ms % Hz	 10 85 20 1	 10 85 3 0,1

Voltage variation, shutdown/start-up according to EN 61000-4-29 – Switch-on time – Dwell time – Switch-off time – Interval – Cycles	 s s s Hz	24 V 60 10 60 0,1 3	19.2 V 10 10 10 0,1 3	30 V 5 0 5 0,1 3
Voltage variation – Start value (U / U_{Nenn}) – End value (U / U_{Nenn}) – Time1, (Start-End) – Dwell time – Time2, (End-Start) – Cycles	 % % s s s	 100 0 5 0 5 3	 80 100 60 0 60 3	
Mechanical elements and assembly				
Case material		Polycarbonate		
Case type Dimensions drawing		NGS device for switch cabinet installation K 4-4-1 (SNS 40x4K-A) K 4-5-1 (SNS 40x4K-C)		
Case width	mm	22,5		
Protection class – Case – Terminals		 IP 40 IP 20		
Colour		yellow / light grey		
Terminals		Pluggable screw terminals Pluggable spring-loaded terminals		
Mounting rail		DIN rail according to EN 50022-35		

General Data	**Unit**			
Function indicator		11 1	LED LED	green red
Controls		2	Switch	10-stage
adjustable frequency ranges 0.1...9.9 Hz	Hz	0,1 - 9,9 (00=0,1)		
 0.5…99Hz	Hz	01 - 99 (00=0,5)		
Wieght	kg		0,16	
Duty cycle ENTER button t_{ER}	s	3		
Electrical isolation – Power circuit - input circuit – Power circuit - output circuit – Input circuit - output circuit			 no no no	
Power circuit (A1, A2)		**Min.**	**Type**	**Max.**
Operating voltage U_B, DC	V	19,2	24	30,0
Residual ripple	V_{ss}			3,0
Rated power, DC	W		2,5	3,0
Peak current I_P	A			25
Ready time (after applying U_B) 5s + t_{ON}	s		$1/f_{ST}$	$1,8/f_{ST}$
Device fuse	A		4 (gG)	
Power supply requirements		Class II, UL 60950-1		
Input circuit (I5, I6, S1, S2)		**Min.**	**Type**	**Max.**
Input voltage, U_e (HIGH)	V	13,0		30
U_e (LOW)	V	- 5,0		5,0
Input current, I_e (HIGH)	mA	2,4		3,8
I_e (LOW)	mA	- 2,5		2,1
Input capacitance, C_{IN}	nF	8	10	12

Input resistance, R_{IN}	Ω		7.200	
Duty cycle, t_E	ms	52		70
Break time, t_A	ms	52		70
Actuating time at I5 and I6 for manual Reset	s	0,1		5
Interruption time of U_E (test pulses)	ms			4
Period duration of the interruption time	ms	192		
Safety related characteristics				
SIL (IEC 61508)		3		
SILCL (EN 62061)		3		
PL (EN ISO 13849-1)		e		
PFDd		2.2×10^{-5}		
PFHd	h^{-1}	5×10^{-9}		
SFF	%	98		
DC	%	96		
Average ambient temperature	°C	40		
Service life	years	20		

Input circuit (I1, I2, I3, I4)		**Min.**	**Type**	**Max.**
Input voltage, U_e (HIGH)	V	13,0		30
U_e (LOW)	V	- 5,0		5,0
Input current, I_e (HIGH)	mA	2,4		3,8
I_e (LOW)	mA	- 2,5		2,1
Input capacitance, C_{IN}	nF	8	10	12
Input resistance, R_{IN}	Ω		7.200	
Cutoff frequency fg (duty cycle 3:2)	kHz			2,0
Frequency change	kHz/s			21
Measurement accuracy of the frequency measurement	%	1% (<1Hz)	6% (<50Hz)	12% (≤99Hz)
LOW level (for f < 100 Hz)	µs	600		
HIGH level (for f < 100 Hz)	µs	600		
LOW level (for 100 Hz < f < 2 kHz)	µs	200		
HIGH level (for 100 Hz < f < 2 kHz)	µs	200		

Output circuit (X1, X2)		**Min.**	**Type**	**Max.**
Output voltage	V	18,0		30
Output current	mA			150
Ready time (after applying U_B)	s			4
Load capacitance, C_L	nF			1000
Load resistance R_L	Ω			100
Line length (single, ∅ 1.5 mm^2)	m			100
Short-circuit behaviour		strictly short-circuit protected		
Output circuit (Q1, Q2, Q3, Q4)		**Min.**	**Type**	**Max.**
Output voltage	V	18,4		30,0
Output current I_{Qn}, $T_U \leq 45$ °C Output current I_{Qn}, $T_U \leq 55$ °C	A		1,6	2,0 1,6
Total current I_{Qn}, $T_U \leq 45$ °C Total current I_{Qn}, $T_U \leq 55$ °C	A			4,0 3,2
Test pulse width, $t_{TI,HL}$	µs		400	650
Test pulse period duration Q1, $t_{PI,HL}$	ms	44		80
Test pulse period duration Q2, $t_{PI,HL}$	ms	40		80
Test pulse period duration Q3, $t_{PI,HL}$	ms	36		80

Test pulse period duration Q4, $t_{PI,HL}$	ms	32		80
Load capacitance, C_L	nF			500
Inductive cutoff energy, E=0.5*L*I	mJ			370
Line length (single, ∅ 1.5 mm²)	m			100
Short-circuit behaviour		strictly short-circuit protected		
Input test (internal)		**Min.**	**Type**	**Max.**
Test pulse width[1] (t_{TI})	µs		200	
Test duration (t_{TD})	µs		200	
Test pulse period duration (t_{TP})	ms		192	
Response time ($t_{AN} = t_{AN1} + t_{AN2}$) for overspeed		**Min.**	**Type**	**Max.**
t_{AN1}	ms	8		12
t_{AN2} for standstill frequency (f_{st}) 0.1 Hz - 99 Hz for duty cycle (3:2) for duty cycle (1:1)	 s s	 1 / f_{st} 1 / f_{st}		 1.6 / f_{st} 1.8 / f_{st}
Error detection time		**Min.**	**Type**	**Max.**
Short circuit to U_B , GND (I1,I2,I3,I4)				
- sensors with inverted outputs	ms	52		116
- sensors with duty cycle 3:2 (operating mode B-2)		52 ms		3/f
Short circuit to U_B (internal input)	ms			576
Short circuit to U_B (output)	ms			576
Error in the power supply	ms			576

[1] Signal changes are not detected for the duration of the test pulse.

wieland

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