Switch contacts in pressure and temperature devices

1 General information

Contact devices are auxiliary switches, which - depending on the direction of movement - open, close or change electrical circuits at the set limit values by means of a contact arm, which is moved by the actual value pointer.

2 Versions

A distinction is made between slow acting contacts, magnetic snap contacts and inductive contacts.

2.1 Slow acting contact

The slow acting contact is a mechanical touch contact for switching capacities up to 10 W 18 VA. As a result of the uniform switching operation carried out analogously with the measuring instrument, this construction is known as slow action. Switching takes place without delay when the red set pointer and the actual value pointer are congruent.

Slow acting contacts may be used in applications, which do not require high switching capacities or involve vibrations.

These switches are not recommended for use with high switching rates, in aggressive atmospheres where the contact would oxidize, in liquid filled measuring instruments or in areas, which are under a risk of explosion.

2.2 Magnetic snap contact

The magnetic snap contact is a mechanical touch contact for switching capacities up to 30 W 50 VA.

To close the circuit, the contact pin of the movable contact arm is attracted in a jump by the permanent magnet, fastened to the supporting arm, shortly before the set value has been reached. Due to the retention force of the magnet, magnetic snap contacts are more resistant against shock and vibration. The switching safety is increased by the reinforced contact pressure.

When the circuit is opened, the magnet keeps the contact arm in its place until the restoring force of the measuring element exceeds the magnetic force, and the contact opens in a jump. This sudden way of switching reduces the formation of a light arc between the contact pins and in this way allows for an increased switching capacity.

2.2.1 Connection characteristic data for magnetic snap contacts

Hysteresis:	2…5 % of measuring span according to DIN 16085 / DIN 16196
Switching accuracy:	1.5 of accuracy class (setting accuracy according to DIN 16085 / DIN 16196)
Contact setting range:	can be adjusted across the entire scale range (adjustment made with contact lock)
Contact material:	silver-nickel gold plating

Table 1: Connection characteristic data for magnetic snap contacts

2.3 Contact load of contacts

2.3.1 Recommended contact load under operation in air

Voltage per DIN IEC 60038		**Slow acting contact**			**Magnetic snap contact**		
		resistive load		inductive load	resistive load		inductive load
DC	AC	DC	AC	cos > 0,7	DC	AC	cos > 0,7
220 V	230 V	40 mA	45 mA	25 mA	100 mA	120 mA	65 mA
110 V	110 V	80 mA	90 mA	45 mA	200 mA	240 mA	130 mA
48 V	48 V	120 mA	170 mA	70 mA	300 mA	450 mA	200 mA
24 V	24 V	200 mA	350 mA	100 mA	400 mA	600 mA	250 mA

Table 2: Recommended contact load

At low switching voltages, the current to be switched may not be below 20 mA for reasons of switching reliability. The switching voltage should not be less than 24 V for the same reason.

2.3.2 Maximum values for resistive contact load and operation in air

		Slow acting contact	**Magnetic snap contact**
Rated insulation voltage U_I		60 < U_I ≤ 250V	60 < U_I ≤ 250V
Rated operation voltage U_{eff} max.		250 V	250 V
Nominal operating current	Inrush current	0.7 A	1.0 A
	Breaking current	0.7 A	1.0 A
	Continuous current	0.6 A	0.6 A
Switching capacity		10 W/18 VA	30 W/50 VA

Table 3: Maximum values for the contact load

2.3.3 Minimum values for resistive contact load and operation in air

	Slow acting contact	**Magnetic snap contact**
Rated operation voltage U_{eff} min.	24 V	24 V
Switching capacity (DC AC)	0.4 W/0.4 VA	0.4 W/0.4 VA

Table 4: Minimum values for the contact load

We recommend the use of our contact protection relay (product group M7), see Chapter 2.3.5, to guarantee the greatest possible switching reliability, to prevent switching interruptions and to improve the switching capacity.

2.3.4 Maximum values for operation in oil (Labofin)

	Slow acting contact	Magnetic snap contact		
Rated operation voltage U_{eff} max.:	Slow acting contacts are generally unsuitable for devices with liquid filling	230 V AC	110 V AC	48 V AC
Nominal operating current:		90 mA	90 mA	90 mA
Switching capacity (AC)		20 VA	10 VA	4.3 VA

Table 5: Maximum values for the contact load for operation in oil

2.3.5 Design and operation of contact protection relays

Contact protection relays improve the switching reliability and switching capacity of electromechanical switching contacts and reduce the contact load. They also prolong the service life of the contacts significantly since 99% of the time they open and close in a de-energised state on account of a pulse-to-pause ratio during contact sensing of 1:100. Flutter is almost completely ruled out through a dropout delay of approx. 0.5 seconds. Contact protection relays are available for single- and double contacts as well as double contacts in interval switching. The relay output is a potential-free changeover switch.

2.4 Inductive contact devices

Inductive contact devices are equipped with electrical distance sensors (proximity sensors) per DIN EN 60947-5-6 (NAMUR). These proximity sensors are two-wire DC switches that contain the transistor oscillator. LABOM uses proximity sensors that are also called slotted initiators due to the slot design. The electromagnetic field is concentrated between two axially opposed coils. The switch operates when the aluminum control vane moved by the actual value pointer enters into the space or slot between the two coils. The signal is transmitted without delay, analogoue to the movement of the actual value pointer.

If no material is present in the slot, the oscillator will resonate. In this condition, the impedance of the whole system is relatively low (approx. 1 kOhm). The coil system is attenuated as soon as the control vane enters into the slot. The oscillator stops to resonate and the impedance of the whole system becomes relatively high (approx. 7 kOhm).

The difference in the current consumption of resonating and non-resonating oscillators is used to drive a switching amplifier, which turns the input signal into a binary output signal. This is why the switching operation of inductive contacts is not only governed by the slotted initiator, but also by the switching amplifier.

The inductive contact is deemed to be open for the description of the switching function (see 3.2) when the control vane enters the slotted initiator (high-impedance state).

2.4.1 Different designs of inductive contacts

Types N (standard) and SN (safety version)

Inductive contacts are available as standard (type N) and safety versions (type SN). The SN types behave like the N types, but with two differences: In the event of a malfunction in the sensor, the evaluation unit or the connecting line system, the output of the evaluation unit automatically switches to the safe “OFF” state.

The second difference of the safety version (type SN) is that it allows operation down to -40°C.

Control flag	Resonant circuit	Resistor	Current	Contact
entered	damped	high-impedance	low <1 mA	open
exited	undamped	low-impedance	high > 2.2 mA	closed

Table 6: States of type N and SN inductive contacts

Types S1N (safety version, inverse)

The safety version is also available with an inverse switching behaviour (type S1N). This means that a line break as well as a broken control vane lead to the same output signal (permanently high-impedance => contact open).

Control flag	Resonant circuit	Resistor	Current	Contact
entered	undamped	low-impedance	high > 2.2 mA	closed
exited	damped	high-impedance	low <1 mA	open

Table 7: States of type S1N inductive contacts

2.4.2 Connection characteristics for initiators (proximity sensors) per DIN EN 60947-5-6 (NAMUR)

Nominal voltage:	8 V = (R_i ≈ 1KΩ)
Operating voltage:	5 - 25 V
Current consumption:	≥ 3 mA (active face uncovered) respectively ≤ 1 mA (active face damped)
Switching accuracy:	approx. 0,5% of full scale value
Contact setting range:	can be adjusted across the entire scale range (adjustment made with contact lock)

Table 8: Connection characteristic data for initiators

2.4.3 Inductive contact with an integrated switching amplifier

Inductive contacts with an integrated switching amplifier can directly switch a relay or be used as input for a PLC (the previously additionally required switching amplifier is not required anymore).

Electrical data		**Accuracy**	
Operating voltage range	10-30 VDC	approx. 0.5 % of the full-scale value	
Residual ripple	≤ 10 % U_{ss}	**Output**	
No-load current	≤ 15 mA	Switching output	PNP transistor
Reverse polarity protection	yes / fully	**Ambient temperature**	
Switching current	≤ 100 mA	Standard -25…+70 °C	
Residual current	≤ 0.1 mA	**EMC**	
Voltage drop at	≤ 1.8 V	In accordance with EN 60947-5-2	
Short-circuit proof	yes / cyclical inspection		

The switched output (A) establishes a connection to plus (+). The load (resistance) between output (A) and ground (-) should be selected so that the maximum switching current of 100 mA is not exceeded.
Versions with a double contact have a common power supply.

3 Definition of switch function

The order code consists of the contact type and the desired switching function.

3.1 Types of contact

The following types of contact are available:

- L2 = slow acting contact
- M2 = slow acting contacts with separated circuits
- L4 = magnetic snap contact
- M4 = magnetic snap contacts with separated circuits
- N1 = inductive contact, safety initiator (type SN)
- N2 = inductive contact, safety initiator inverse (type S1N)
- N4 = inductive contact, safety initiator (type N or type Si2-K08-Y1)
- N6 = inductive contact with integrated switching amplifier

The following order codes apply to the type series BNxxxx and BPxxxx pressure switches:

- N4 = inductive contact, safety initiator (type SN)
- N5 = inductive contact, safety initiator inverse (type S1N)

3.2 Type of construction

The graphic representation on the device shows the basic switching function or type of construction.

It always shows the switch position at the start of the scale.

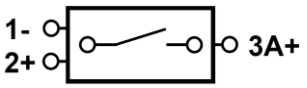
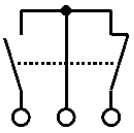
Type of construction	Representation	Representation with integrated switching amplifier
Switch is open at start of scale		
Switch is closed at start of scale		
One output of switch is open at start of scale, one is closed		-

Table 9: Graphic representation of the type of construction

3.3 Switch function, direction of action and their code number

Unlike in electrical engineering, the rest position of a switching contact is not obvious for pressure and temperature measuring devices. The start of the measuring range of a pressure gauge can be at vacuum level, that of a temperature gauge in the negative temperature range.

In addition to the switching function (normally open, normally closed, changeover switch), it is therefore necessary to specify the direction of action (on rising or falling measured value) for an optimum adjustment.

A code number is assigned to each combination of switching function and direction of action. For this, see DIN 16085 (for pressure gauges) or DIN 16196 (for temperature gauges):

Switch function	Slow acting contact/ magnetic snap contact	Inductive contact	direction of action	Code number
Normally open	Closes the switch	Control current on	on rising measured value	1
			on falling measured value	4
Normally closed	Opens the switch	Control current off	on rising measured value	2
			on falling measured value	5
Changeover switch	Closes one output and open the other	/	on rising measured value	3
			on falling measured value	6

Table 10: Switch functions, directions of action and their code numbers

Influence of the direction of action on the device adjustment

A contact that closes the switch on rising measured value and a contact that opens the switch on falling measured value is identical in construction. However, the switching contact is set and adjusted differently.

With the direction of action "rising measured value" (code numbers 1, 2, 3), the contact is set to 70% of the measuring range. With the direction of action "falling measured value" (code numbers 4, 5, 6), the contact is set to 30% of the measuring range.

For two switching contacts with the same operating direction, the contacts are set to 60 and 80 %, or 20 and 40 %.

The contacts are adjusted at these switching points and with the specified directions of action.

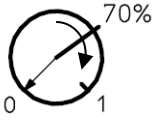
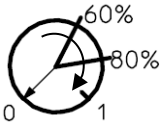
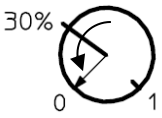
Switch function + direction of action	Type of Construction	Switch position and direction of action for factory adjustment	
		one switch	two switches
Closes for rising measured value (code number 1)			
Opens for falling measured value (code number 4)			

Table 11: Switch positions depending on the direction of action and number of switches

The same applies analogously to identical normally open contacts for falling measured values and normally closed contacts for rising measured values.

For an optimised contact adjustment, please specify the switching points of your application when ordering. The unit will then be optimally adjusted for these switching points.

3.4 Marking in the order code and on the type plate

The switching function is determined by a three-digit number code, whereby each digit stands for the code number of a switching contact per table 10. The contacts are counted in clockwise direction, starting with the contact closest to the beginning of the scale.

The unused contact spaces of single or double contacts are each identified by a zero, e.g. a single contact “closes on rising measured value“ (code 1) is identified with “100”.

3.5 Examples of order codes

Double inductive contact with safety initiator ➔ type of contact = N1

1. Inductive contact closes on rising measured value ➔ code number 1
2. Inductive contact opens on rising measured value ➔ code number 2
3. Inductive contact not be used ➔ code number 0

Order code - option:	N 1 1 2 0
type of contact	
switch function	

Table 13: Order code example

4 Pin connection

The assignment of terminal connections is realised according to DIN 16085 and DIN 16196.

4.1 Pin numbering for the cable connector

The cable connector has the following pin numbering (view of device respectively rear of cable connector):

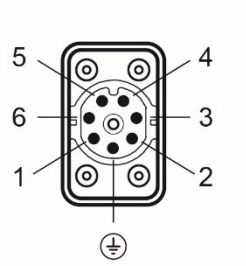


Figure 1: Cable connector

4.2 Pin assignment for switch contacts

See below the pin assignment of the respective switch functions:

4.2.1 Magnetic snap and slow acting contacts

contact function	switch function	Common circuit	separated circuits
single maker/breaker	maker or breaker	1 + 4	-
single change over element	maker breaker	1 + 4 2 + 4	-
double maker/breaker	1st contact 2nd contact	1 + 4 2 + 4	1 + 2 3 + 4
double change over element	1st change over element maker breaker 2nd change over element maker breaker	 1 + 4 2 + 4 5 + 4 6 + 4	 1 + 4 2 + 4 5 + 3 6 + 3
triple maker/breaker	1st contact 2nd contact 3rd contact	1 + 4 2 + 4 3 + 4	1 + 2 3 + 4 5 + 6

Table 14: Pin connection for magnetic snap and slow acting contacts

4.2.2 Inductive contacts

contact function	switch function	pins and polarity
single maker/breaker	maker or breaker	1 (-) / 2 (+)
double maker/breaker	1st contact 2nd contact	1 (-) / 2 (+) 3 (-) / 4 (+)
triple maker/breaker	1st contact 2nd contact 3rd contact	1 (-) / 2 (+) 3 (-) / 4 (+) 5 (-) / 6 (+)

Table 15: Pin connection for inductive contacts

4.2.3 Inductive contact with an integrated switching amplifier

contact function	switch function	pins and polarity
single maker/breaker	maker or breaker	1 (-) / 2 (+) 3 Output
double maker/breaker	1st contact 2nd contact	1 (-) / 2 (+) 3 Output 1 4 Output 2

Table 16: Pin connection for inductive contacts with an integrated switching amplifier

5 Setting the contacts

The contacts are set from outside through the adjusting lock in the window. To do so, press the key (Figure 2) down until the contact pointer driver makes contact with the contact's adjusting pin (Figure 3). The key is included in the supplied accessory kit and can be placed in the designated hole in the cable connector after use.

Figure 2: Key

Figure 3: Setting the contact

The set pointer can be adjusted over the entire scale range. Make sure that the contact is only adjusted in a clockwise direction. If the contact is accidentally set beyond the desired value, turn the contact pointer back at least 5% below the desired value and then set again in a clockwise direction.

The functionality and thus the switching reliability of the built-in switching contacts is guaranteed for the entire indication scale. However, the data sheet information on the accuracy is only ensured in accordance with the standard for switching points between 10 % and 90 % of the scale range.

Operating a switching point outside of the scale range is not permitted.