

Common Features of Electromechanical Switches

Switching systems

Switching elements lie at the heart of all electromechanical switching devices and must correspond to the respective application. Essentially there are two basic types of switching system that differ in terms of their mechanical design and consequently their scope of application:

- Slow-action contacts
- Snap-action contacts

Slow-action contacts

- On actuation, the normally-closed and normally-open contact functions correspond to the movement of the impact pin
- The approach speed controls the contact opening (closing) time
- Large distance/actuating travel between normally-closed and normally-open contact function
- The switching points are identical in forward and reverse travel

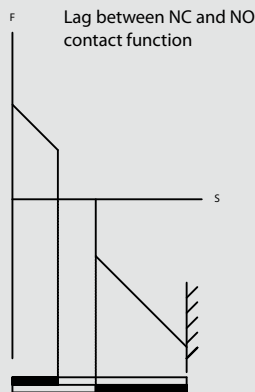


Fig. 1 shows the contact force during the switching cycle of a slow-action contact.

Overlap

- The switching principle of snap-action contacts makes overlapping of the NC/NO contact function possible. The term overlap refers to the area, in which both the normally-closed contact as well as the normally-open contact are closed in connection with a changeover switch with delay.

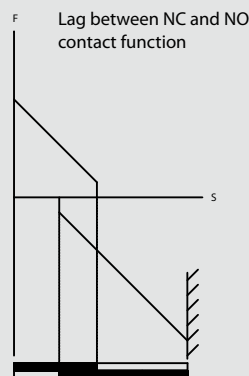


Fig. 2 shows the contact force during the switching cycle of a slow-action contact with overlap.

Snap-action contact

- On actuation, the normally-closed contact function is immediately followed by the normally-open contact function
- In this configuration there is no overlap of the NC/NO contacts. The switch provides a distinct OR-function.
- The changeover accuracy is not dependent on the approach speed
- Consistently effective suppression of DC arc
- Reliable contact-making also for extremely slow approach speeds
- The snap mechanism triggers the full opening width of the contact on reaching the changeover point
- Due to the force reversal in the mechanical system, a different switching point occurs in forward and reverse travel. The lag is referred to as hysteresis.

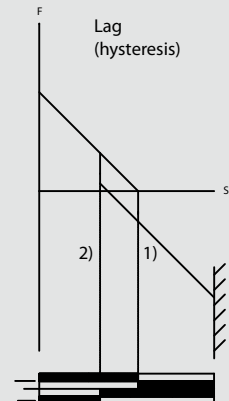


Fig. 3 shows the contact force during the switching cycle of a snap-action contact.

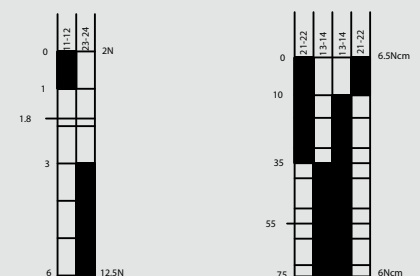
- 1) Changeover point in forward travel
- 2) Changeover point in reverse travel

Switching diagram

The switching diagram describes the function of the switching device in detail.

It combines the mechanical input variables that act on the contact system via the actuator with the electrical output variables. The user can deduce the following information from the switching diagram:

- Mechanical input variables (force, travel, torque, angle)
- Electrical contact-making in forward and reverse travel
- Terminal designation
- Point at which positive opening is achieved
- Type of contact system



Slow-action contact

Snap-action contact

- Contact closed
- Contact open

Contact designation

In accordance with DIN 50013 and DIN 50005 the terminal designations of the contact elements are always made up of two digits.

The contact rows are numbered consecutively with the allocating digit (1st digit) in actuation direction. Contacts of a switching element that belong together have the same allocating digit.

The second digit is the function digit that denotes the type of contact element.

- 1–2 Normally-closed contact
- 3–4 Normally-open contact
- 5–6 Normally-closed contact with delayed opening
- 7–8 Normally-open contact with delayed closing

Protection class

The protection class of an enclosed device denotes the degree of protection. The degree of protection includes the protection of persons against contact with parts under voltage and the protection of equipment against the infiltration of foreign bodies and water. BERNSTEIN standard enclosures mainly correspond to protection classes IP65 and IP67. Higher protection ratings are also available for individual customer solutions. In accordance with DIN EN 60521 (IEC 529), the numerals used in the protection rating denote the following:

1st digit Degree of protection against contact and infiltration of foreign bodies

2nd digit Degree of protection against infiltration of water

Example IP65:

- 6 =**
 - Complete protection against contact with components under voltage or with internal moving parts
 - Protection against dust infiltration
- 5 =**
 - A water jet directed from all directions at the device must not have damaging effects
 - Protection against hose water

Enclosures

Limit switches are supplied either in a moulded enclosure or a metal enclosure. Which material is to be selected for a specific application depends on the ambient conditions, the location as well as several other factors.

Moulded limit switches provide protective insulation and are resistant to many aggressive chemicals and liquids. The formation of condensation water in moist environments with extreme temperature fluctuations is significantly reduced on moulded enclosures.

In insulation-enclosed switches the switching elements are integrated directly in the moulded enclosure and are therefore not replaceable (complete switching devices).

Metal-enclosed limit switches are able to withstand high mechanical loads, they can also be used wherever hot metal chips and sparks occur and are resistant to many solvents and detergents. The switching elements in metal-enclosed switches are often integrated in the metal enclosure as modular built-in switches. The enclosure has a VDE-compliant connection for the PE conductor.

Safety switches

The scope of application for limit switches has changed over time. Whereas limit switches were previously used for the purpose of detecting end positions, today they are increasingly assuming functions designed to protect persons and products in machine, equipment and plant construction.

The BERNSTEIN range of safety switches offers the right solution for the most diverse applications in many branches of industry. Particularly when it comes to safety, users appreciate the fact that they are able to procure all required safety switches and receive professional advice from one source.

The decisive factors governing the selection of safety equipment include the ambient conditions, installation situation and risk analysis.

A switching device that can be used for safety functions is identified by the standardised symbol conforming to EN 65000-41 and EN 65000-42. The switches can, of course, also be used for pure position monitoring purposes.

Safety switches are divided into two categories, Type 1 and Type 2. The difference is in the actuating elements which are completely integrated in the enclosure in Type 1 and separated from the switching element in Type 2.



Type 1



Type 2

Common Features of Electromechanical Switches

Designation

The designation of BERNSTEIN switching devices comprises:

- The enclosure designation of the switching device
- The switching function
- The type of actuator

Type code of position and safety switches

I88	A2Z ¹⁾	AH	M12
Switch group	Switching system ²⁾	Actuator	Special features
● C2 ● Ti2 ● IF ● I88 ● Bi2 ● ENK ● GC ● SN2 ● ENM2 ● D	● U1 ● SU1 ● A2 ● SA2 ● E2 ● SE2	See Pages 72-73	● M12 connection ● Actuator turned 90°, 180°, 270° ● Special switching forces ● Special temperature ranges ● Other special features on request

¹⁾ The letter Z suffix to the designation of the switching function denotes the mechanical positive opening action of the normally-closed contacts. In technical data sheets, the positive opening point is identified by the international symbol .

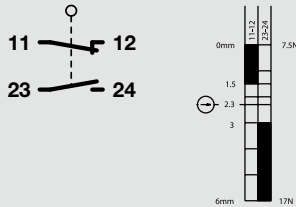
²⁾ Please refer to the following pages in the catalogue to establish which switching system can be used in the switch groups.

Switching function example

NC = Normally-closed contact
NO = Normally-open contact

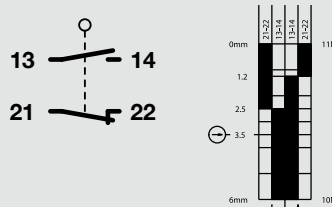
U1Z

Slow-action contact, 1 NC, 1 NO



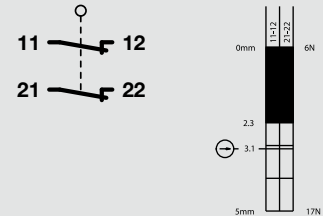
SU1Z

Snap-action contact, 1 NC, 1 NO



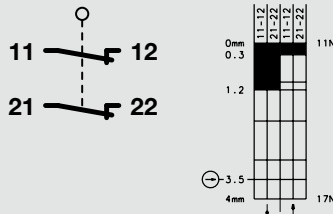
A2Z

Slow-action contact, 2 NC



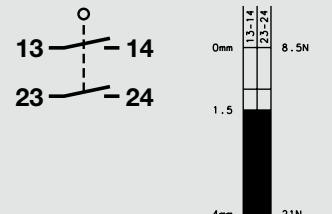
SA2Z

Snap-action contact, 2 NC



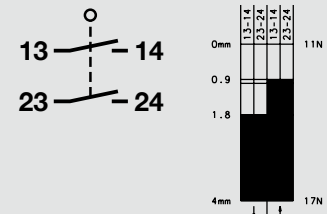
E2

Slow-action contact, 2 NO



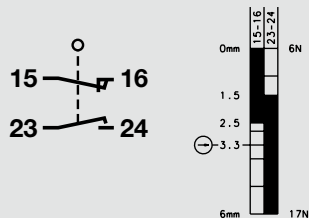
SE2

Slow-action contact, 2 NO



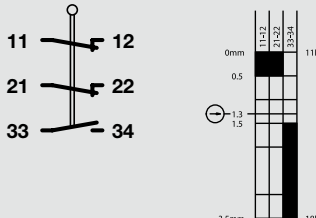
UV1Z

Slow-action contact,
with overlapping contacts,
1 NC, 1 NO



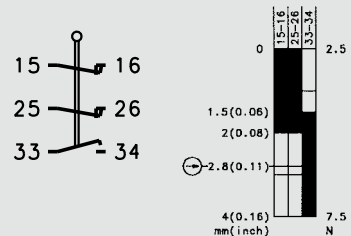
U15Z

Slow-action contact, 2 NC, 1 NO



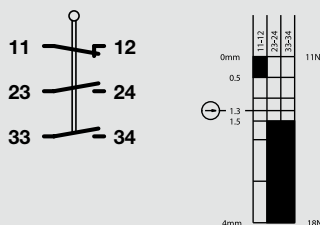
UV15Z

Slow-action contact,
with overlapping contacts,
2 NC, 1 NO



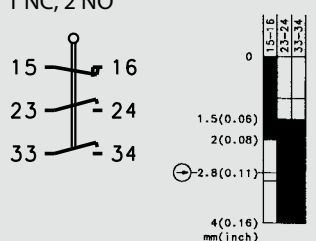
U16Z

Slow-action contact, 1 NC, 2 NO



UV16Z

Slow-action contact,
with overlapping contacts,
1 NC, 2 NO



The actuating forces and travel distances are subject to tolerances. These tolerances are listed in Table 1.
In Type 1 and Type 2 position switches, the tolerances are independent of the switching system and switching function.

Function	Tolerance
Switching travel	± 0.25 mm
Switching angle	± 3.5°
Switching force in N	± 10%
Actuating torque in	± 10%

Table 1

Common Features of Electromechanical Switches

⊕ = Mechanical positive opening action

The term positive opening action refers to contact separation as the direct result of defined movement of the switch actuator by means of non-sprung parts. All parts involved in contact separation must be form-fit connected. The positive opening distance describes the minimum travel distance from the start of actuation of the operating element up to the point where positive opening action of the opening contacts is completed.

DIN EN 60947-5-1 defines two types of positive opening action contacts with 4 connections and double break.

Type Za

- Positively opening contacts not galvanically isolated

Type Zb

- Positively opening contacts galvanically isolated

Galvanic isolation describes the isolation of electrically conducted parts by insulating material or by air gaps.

In switching devices with several contact elements, galvanically isolated contact elements make it possible to switch voltages with different potential (e.g. normally-closed contact in safety circuit, normally-open contact for indicator).

In accordance with applicable health and safety requirements, protective devices (guards) must be mounted on machines, devices and systems that perform hazardous movements. Safety switches in the form of electromechanical switching devices are predominantly used for this purpose as they offer the following advantages:

- High degree of safety
- Non-susceptibility to interference
- Safety status easily checked on site
- Rational solutions

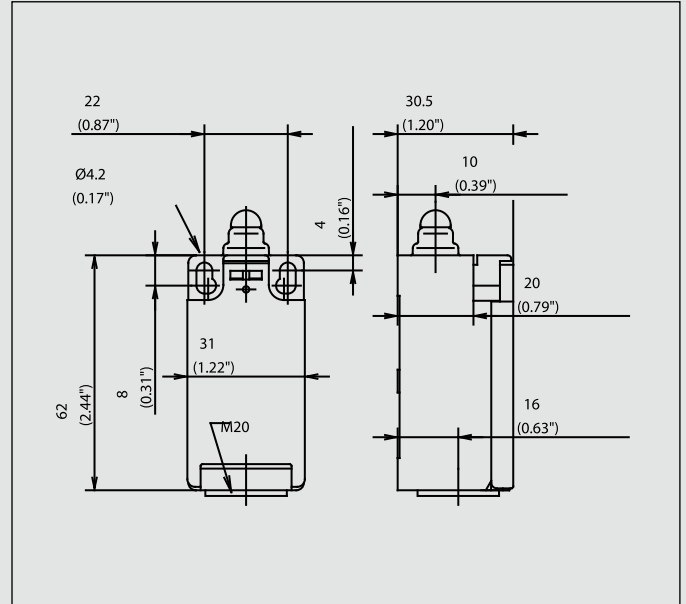
Form-fit, mechanical drives or coupling elements in the form of levers, rods, gearwheels etc. are necessary to ensure optimum operation of these safety components.

Switching devices that are used for safety functions must be identified with the symbol ⊕ internationally standardised in accordance with DIN EN 60947-5-1. In defining the class of switching devices, this symbol denotes two important properties that must be met for personal protection applications:

- Mechanical positive opening action
- Disruptive breakdown voltage > 2.5 kV

Disruptive breakdown voltage

In accordance with DIN EN 60947-5-1, the open contacts must be able to maintain a minimum surge voltage of 2.5 kV without disruptive breakdown.



Recommended use

Thanks to its standard dimensions as well as its wide range of contacts and actuators, this switch can be used on safety facilities and for position monitoring in virtually any industrial application.

Product advantages

- Standard switch conforming to DIN EN 50047
- Standard actuator conforming to DIN EN 50047, Type A, B, C, E
- Protection class IP65 to VDE 0470 T1
- Enclosure and cover PA 6, self-extinguishing (UL-94-V0)
- Actuator can be repositioned by 4 x 90°
- Cable entry M20 x 1.5
- Connection designation conforming to DIN EN 50013

Options

- Available with M12 connector
- AS interface variants available
- Cable entry M16 x 1.5

Design layout

- Slow-action and snap-action contacts
- Versions: 1 NC/1NO, 2 NC, 2 NO, overlapping contacts
- All NC contacts with $\ominus$ in the circuit diagram are positively opening contacts
- Type: Zb (galvanically isolated changeover contact)
- Latching function on request

Mounting

- Two M4 screws (distance between centres 22 mm), adjustment with slots
- Two M5 screws for safety applications without additional fixing element (Fig. 1)
- Additionally secured by guide plate for lateral approach forces (Fig. 2)
- Front mounting (depending on type, Fig. 3)

Installation advantages

- Snap-on cover can be released with screwdriver
- Cover opening range 135° (cover can also be detached from hinge)
- Cover protects switching element during installation
- Screw connections with self-lifting clamping plates
- Easy-action cover lock (close and press)
- Cover additionally secured with screw

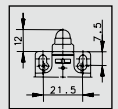


Fig. 1

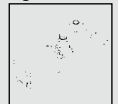


Fig. 2



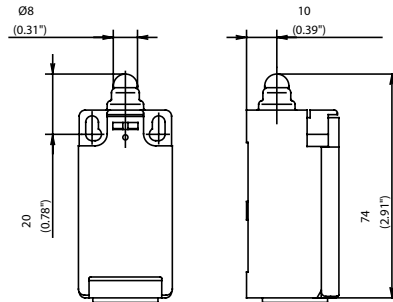
Fig. 3

Technical data

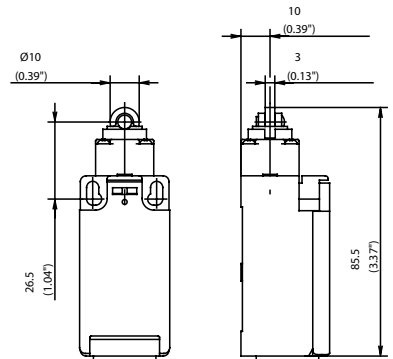
Electrical data	
Rated insulation voltage	U _i max. 250 V AC
Conventional thermal current (up to) ^①	I _{the} 10 A
Rated operating voltage	U _e max. 240 V
Utilization category (up to) ^①	AC-15, U _e /I _e 240 V/3 A
Short-circuit protection (up to) ^①	Fuse 10 A gL/gG
Protection class	II, Insulated
Mechanical data	
Enclosure material	Thermoplastic, glass fibre-reinforced (UL 94-V0)
Ambient temperature	-30 °C to +80 °C
Mechanical service life (up to) ^①	10 x 10 ⁶ switching cycles
B10d (up to) ^①	20 Mio.
Switching frequency	≤ 100/min.
Type of connection	Screw connections
Conductor cross sections	Single-wire 0.5 - 1.5 mm ² or Stranded wire with ferrule 0.5 – 1.5 mm ²
Cable entry	1 x M20 x 1,5
Standards	
VDE 0660 T100, DIN EN 60947-1, IEC 60947-1 VDE 0660 T200, DIN EN 60947-5-1, IEC 60947-5-1	

^① Depending on switching system. See Table on Pages 76-79.

W (Form B)



RIWK (Form C)



Switching operation

Slow-action

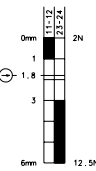
Snap-action

Slow-action

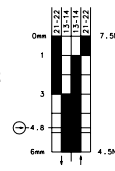
Snap-action

1 NC / 1 NO contact

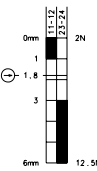
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I88-U1Z W



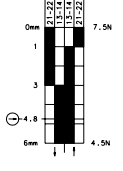
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6086117017
I88-U1Z RIWK

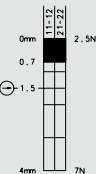


6086167018
I88-SU1Z
RIWK

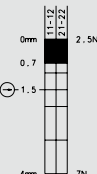


2 NC contacts

6086803013
I88-A2Z W

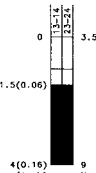


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I88-A2Z RIWK

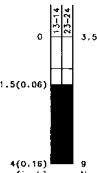


2 NO contacts

6086803014
I88-E2 W

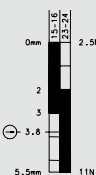


6086817071
I88-E2 RIWK



1 NC / 1 NO contact Overlapping

6086303011
I88-UV1Z W



Approvals



Replacement actuator: -

Replacement actuator: 3918161672

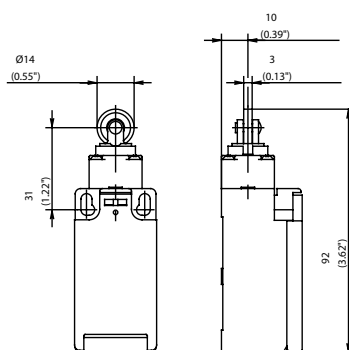
Special features/variants (on request)

- Available with black enclosure
- With latching function and following contacts:
2 NC / 1 NO contact
1 NC / 2 NO contact
- Both with and without overlap

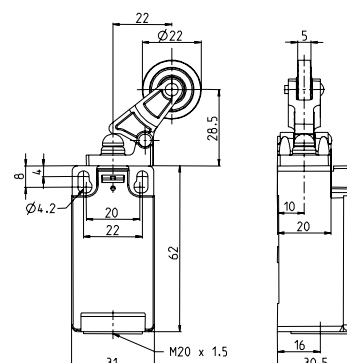
Special features/variants (on request)

- Available with black enclosure
- With latching function
- With steel roller and following contacts:
2 NC / 1 NO contact
1 NC / 2 NO contact
- Both with overlap

RIWL



KNW RO22



Switching operation

Slow-action

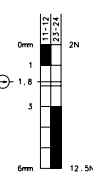
Snap-action

Slow-action

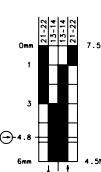
Snap-action

1 NC / 1 NO contact

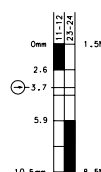
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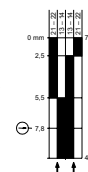
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I88-SU1Z RIWL



6186127112
I88-U1Z KNW
RO22

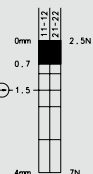


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I88-SU1Z KNW
RO22

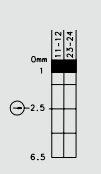


2 NC contacts

6086817072
I88-A2Z RIWL

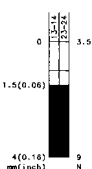


6186827246
I88-A2Z KNW
RO22



2 NO contacts

6086817069
I88-E2 RIWL

1 NC / 1 NO contact
Overlapping

Approvals



Replacement actuator: 3918161673

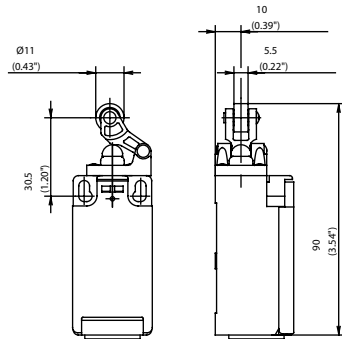
Replacement actuator: -

Special features/variants
(on request)

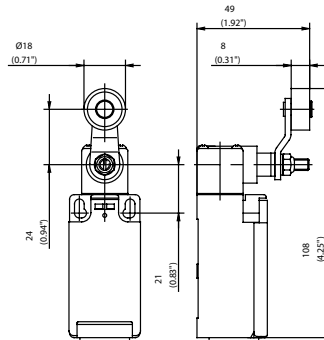
- Available with black enclosure
- With latching function
- Available with different actuating directions
- With steel roller

Special features/variants
(on request)

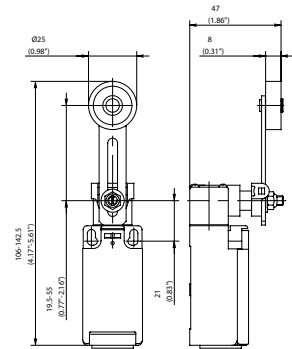
HW RO11 (Form E)



AH (Form A)



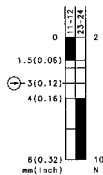
AV



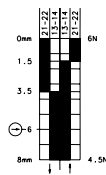
Slow-action

Snap-action

6086121021
I88-U1Z HW
RO11



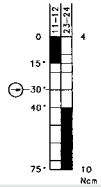
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I88-SU1Z HW
RO11



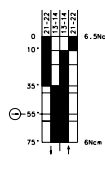
Slow-action

Snap-action

6086135033
I88-U1Z AH



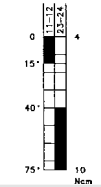
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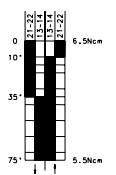
Slow-action

Snap-action

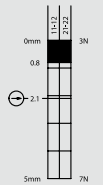
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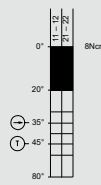
6086186038
I88-SU1 AV



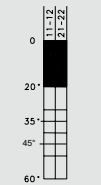
6086821099
I88-A2Z HW
RO11



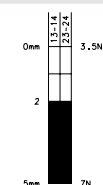
6086835059
I88-A2Z AH



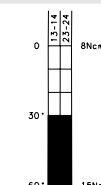
6086836131
I88-A2 AV



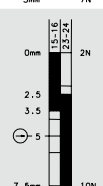
6086821068
I88-E2 HW
RO11



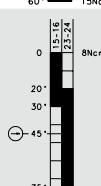
6086835116
I88-E2 AH



6086321100
I88-UV1Z HW
RO11



6186335628
I88-UV1Z AH



Replacement actuator: 3918191547

Replacement actuator: 3918351166

Replacement actuator: 3918360984

Special features/variants (on request)

- Available with black enclosure
- With steel roller
- Various roller diameters

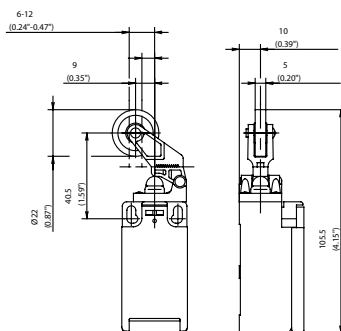
Special features/variants (on request)

- Available with black enclosure
- Available with different actuating directions
- With steel roller
- Various roller diameters
- Cranked or straight lever
- Various lever lengths

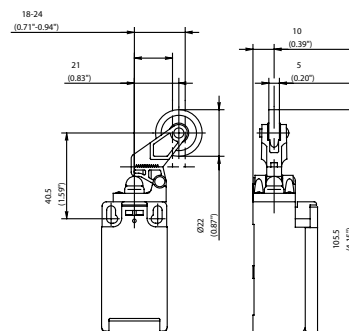
Special features/variants (on request)

- Available with black enclosure
- Various actuating directions
- Various roller diameters
- Cranked or straight lever
- Various lever lengths
- With roller over switch

DGHW RO22



DGKW RO22



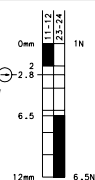
Switching operation

1 NC / 1 NO contact

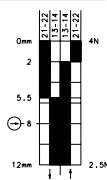
Slow-action

Snap-action

6086121029
I88-U1Z DGHW
RO22



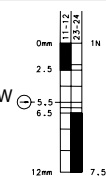
6086171030
I88-SU1Z
DGHW RO22



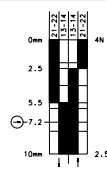
Slow-action

Snap-action

6086127025
I88-U1Z DGKW
RO22

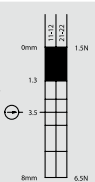


6086177026
I88-SU1Z
DGKW RO22



2 NC contacts

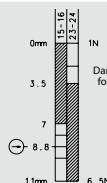
6086821120
I88-A2Z DGHW
RO22



2 NO contacts

1 NC / 1 NO contact
Overlapping

6186321244
I88-UV1Z
DGHW RO22



Approvals



Replacement actuator: 3918211529

Replacement actuator: 3918271528

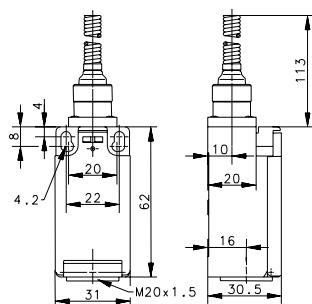
Special features/variants
(on request)

- Available with black enclosure
- Available with different actuating directions
- Various roller diameters

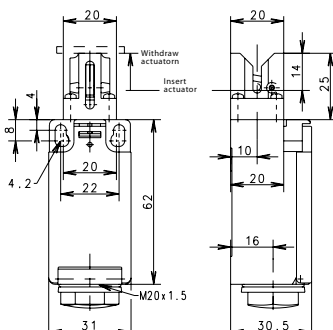
Special features/variants
(on request)

- With latching function
- Various roller diameters and with following contacts:
2 NC / 1 NO contact
1 NC / 2 NO contact
Both with overlap

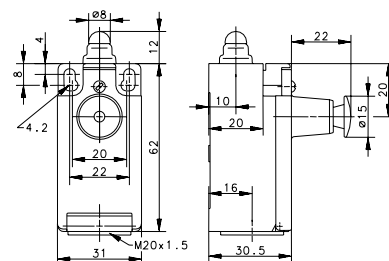
FF



KS

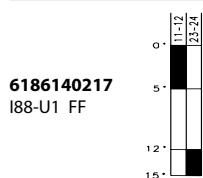


W RAST

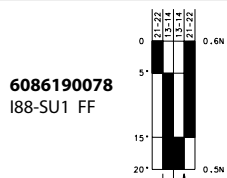


Slow-action

Snap-action



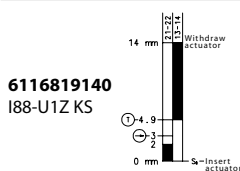
6186140217
I88-U1 FF



6086190078
I88-SU1 FF

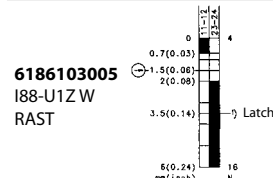
Slow-action

Snap-action

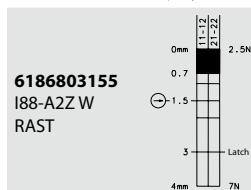


6116819140
I88-U1Z KS

Slow-action



6186103005
I88-U1Z W
RAST



6186803155
I88-A2Z W
RAST



Replacement actuator: 3918401031



Replacement actuator: -



Replacement actuator: -

Special features/variants
(on request)

- Available with black enclosure
- Various spring lengths
- Different spring versions or spring rod

Special features/variants
(on request)

Special features/variants
(on request)