

Pilot devices

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Pilot devices

RMQ – System

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Commands and signals are the fundamental functions for controlling machines and processes. The required control signals are produced either manually by pilot devices or mechanically by position switches. The respective application governs the protection type, the shape and color.

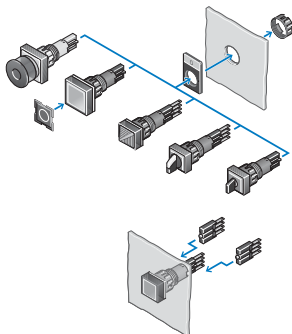
Advanced technology has been used consistently in control circuit devices „RMQ-Titan®“. The use of LED elements and laser inscription throughout offer maximum reliability, efficiency and flexibility. In detail, this means:

- High-quality optics for a uniform appearance,
- Highest degree of protection up to IP67 and IP69K (suitable for steam-jet cleaning),
- Clear contrast using LED element lighting, even in daylight,
- Up to 100,000 h, i.e. machine lifespan,
- Impact and vibration resistant,
- LED operating voltage from 12 to 500 V,
- Low power consumption – only 1/6 of filament lamps,
- Expanded operating temperature range -25 to +70 °C,
- Light testing circuit,
- Built-in safety circuits for highest operational reliability and accessibility,
- wear-resistant and clearly contrasting laser inscription,
- Customer-specific symbols and inscriptions from 1 off,
- Text and symbols can be freely combined,
- Terminal type using screws and Cage Clamp¹⁾ throughout,

- Spring-loaded Cage Clamp connections for reliable and maintenance free contact,
- Switching contacts suitable for use with electronic devices to EN 61131-2: 5 V/1 mA,
- user-programmable switching performance on all selector switch actuators: momentary/maintained
- All actuators in illuminated and non-illuminated version,
- Emergency switching off pushbuttons with pull and turn-to-release function,
- Emergency switching off pushbuttons with lighting option for active safety,
- Contacts switch differing potentials,
- For use also in safety-related circuits using positive operation and positive opening contacts,
- Complying with industry Standard IEC/EN60947.

¹⁾ Cage Clamp is a registered trade mark of Messrs. WAGO Kontakttechnik GmbH, Minden

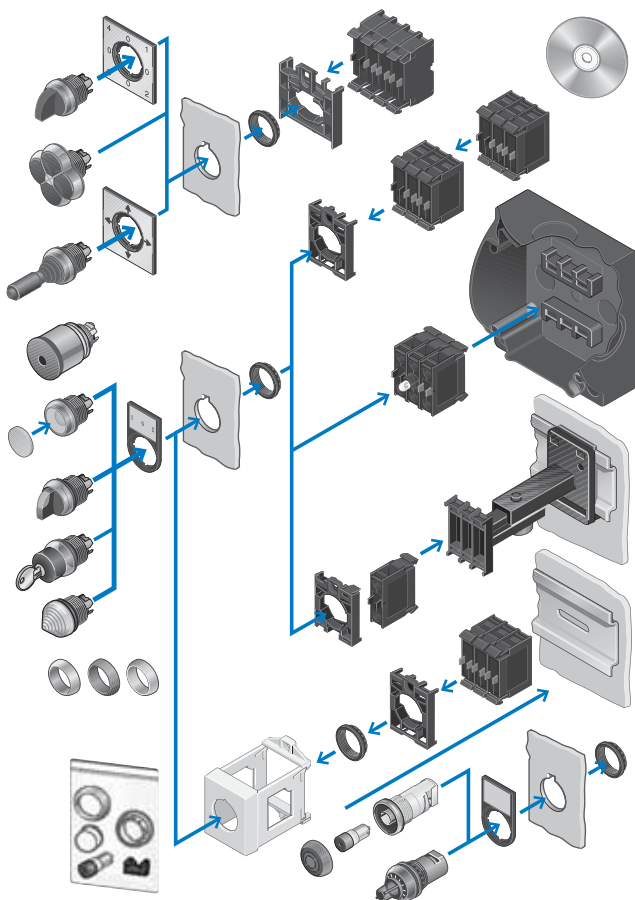
RMQ16 system overview



Pilot devices

RMQ – System

RMQ-Titan® system overview



Pilot devices

RMQ – System

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Four-way pushbutton

Eaton has added more operator elements to its highly successful range of pilot devices RMQ-Titan. It has a modular surface mounting. Contact elements from the RMQ-Titan range are used. The bezels and front frames are of the familiar RMQ-Titan format and color.

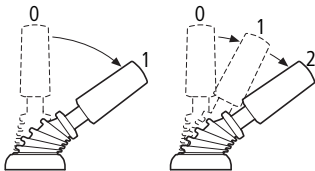
Four-way pushbutton

The four-way pushbuttons enable users to control machines and systems in four directions of movement. Each direction of movement is being assigned one contact element. The pushbutton has four individual button plates. They can be specifically selected for various applications and can be laser-inscribed to suit the customer's requirements.



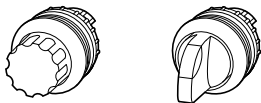
Joystick with double contact

The joystick allows the control of up to four directions of movement on machines. Different variants of the joystick have 2/4 positions and other variants have 2 settings for each position. This allows for example two speed settings for each direction. For this a standard NO and an NO early-make are fitted in series. Momentary contact and latching contact versions are possible.



Selector switch actuators

The selector switch actuators have four positions. The actuator is available either as a rotary head or as a thumb-grip. One contact element is assigned to each On and each Off position.



Pilot devices

RMQ – System

Labels

Eaton offers various types of labels for all operating elements. Versions available are:

- Blank,
- With direction arrows,
- With inscription 0–1–0–2–0–3–0–4.

Customised inscriptions are also possible. The software Labeleditor enables

customized inscriptions to be designed and these can be subsequently applied to the labels by laser, permanently and proof against wiping off. → Section "Labeleditor", page 3-13



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Contact versions

Screw terminals	Spring-loaded terminals	Front fixing	Base fixing	Contact	Contact travel diagram ¹⁾
Contact elements					
x	x	x	x		 0 2.8 5.5 M22-(C)K(C)10
x	x	x	—		 0 1.2 5.5 M22-(C)K(C)01
x	x	x	x		 0 3.5 5.5 M22-(C)K01D ²⁾
x	—	x	—		 0 1.8 5.5 M22-K10P

1) Stroke in connection with front element.

2) N/C: Positive opening safety function according to IEC/EN 60947-5-1.

Pilot devices

RMQ – System

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Screw terminals	Spring-loaded terminals	Front fixing	Base fixing	Contact	Contact travel diagram ¹⁾
Double contact elements					
—	x	x	—		 0 3.6 5.5 M22-CK20
—	x	x	—		 0 1.2 5.5 M22-CK02
—	x	x	—		 0 1.2 3.6 5.5 M22-CK11 ²⁾
Self-monitoring contact elements					
x	—	x	x		 0 1.2 2.8 5.5 M22-K(C)01SMC10
x	—	x	x		 0 1.2 2.8 5.5 M22-K(C)02SMC10

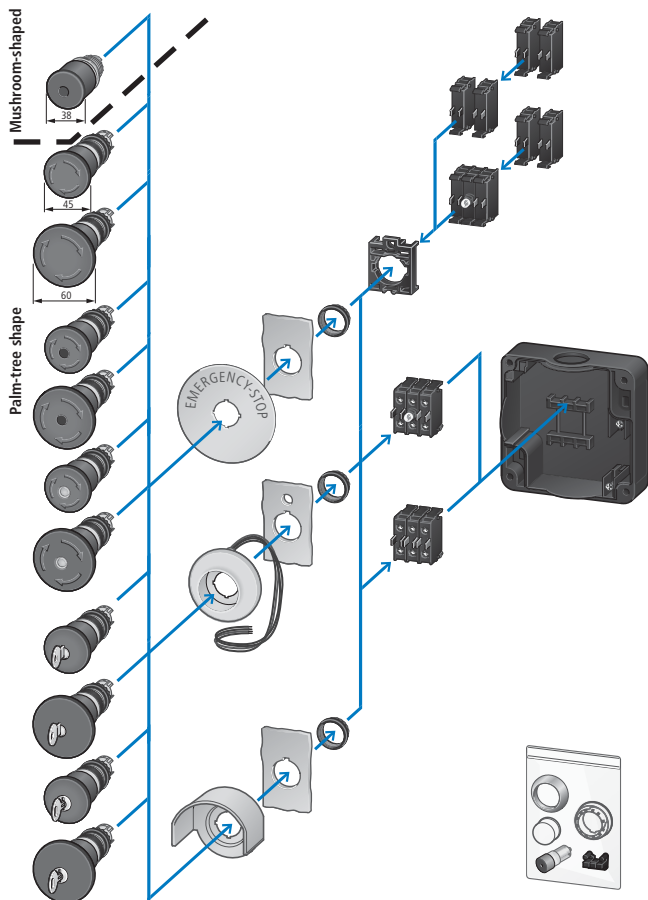
1) Stroke in connection with front element.

2) N/C: Positive opening safety function according to IEC/EN 60947-5-1.

Pilot devices

RMQ – System

Emergency-stop/off pushbuttons, system overview



Pilot devices

RMQ – System

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The new emergency stop or emergency-off pushbutton actuators for the RMQ-Titan range of pilot devices for global use have a palm shaped design with a 45 or 60 mm diameter. They are available with or without keys, turn-releasable, non-illuminated, illuminated with standard LEDs or with mechanical switch position indication (green/red) in the center of the actuator element. The self-monitoring contact elements ensure extensive operational safety; even with a faulty installation or after excessive force is used for actuation. As well as the emergency-off NC contact, the modular contact elements feature an integrated second contact for querying the mechanical connection to the emergency stop actuator element. The contact elements are available for front or bottom fixing, for single or dual-channel safety circuits up to SIL 3 in accordance with IEC 62061 or Performance Level PL e to EN ISO 13849-1.

An optional illuminated ring enables emergency-stop/off pushbutton actuators on a machine or a plant to be made more conspicuous. Even in darkened environments, the position of these pushbutton actuators is clearly indicated. The illuminated ring also clearly indicates the operating state from a considerable distance. When tripped, for example, it is possible to activate three separately controllable LED rows as a running light.

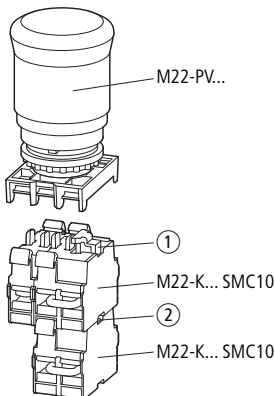
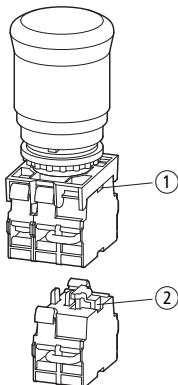
Pilot devices

RMQ – Engineering

Assembly and function

M22...SMC10

3



- ① The self-monitoring contact mechanically monitors the connection on the M22-PV...
- ② The self-monitoring contact mechanically monitors the interface on the M22-K...SMC10 safety contact above it; but NOT the connection on the M22-PV...

M22-K01SMC10 M22-KC01SMC10



M22-K02SMC10 M22-KC02SMC10



When the self-monitoring contact is mounted correctly, the N/O contact is closed.

The emergency switching off/Stop circuit is activated via series connection of N/C and N/Os if

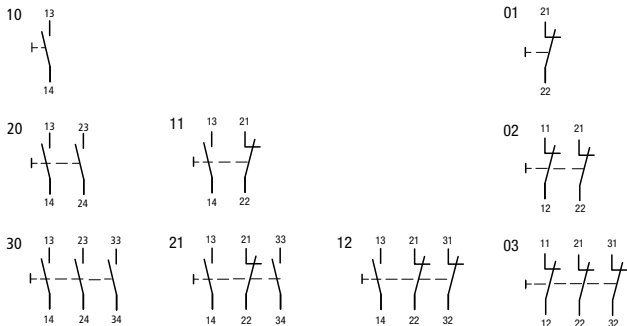
- the emergency switching off/stop pushbutton is actuated or
- the self-monitoring contact is isolated mechanically from the pushbutton

Pilot devices

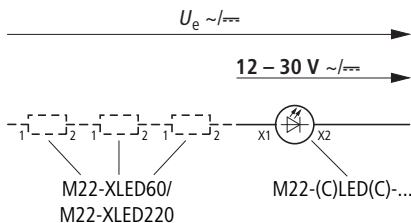
RMQ – Engineering

Terminal markings and function numbers (distinctive number/contact sequence), EN 50013

3

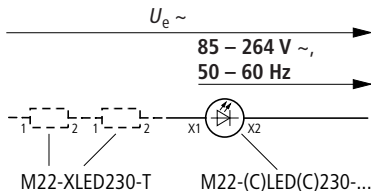


Voltage variants with series elements



M22-XLED60 ¹⁾	$U_e \leq \text{AC/DC}$
1x	60 V
2x	90 V
3x	120 V
...	...
7x	240 V
M22-XLED220	$U_e \leq$
1 x	220 V DC

1) For increasing the voltage AC/DC.



M22-XLED230-T ¹⁾	$U_e \leq$
1x	400 V~
2x	500 V~

1) AC- for increasing the voltage 50/60 Hz.

Pilot devices

RMQ – Engineering

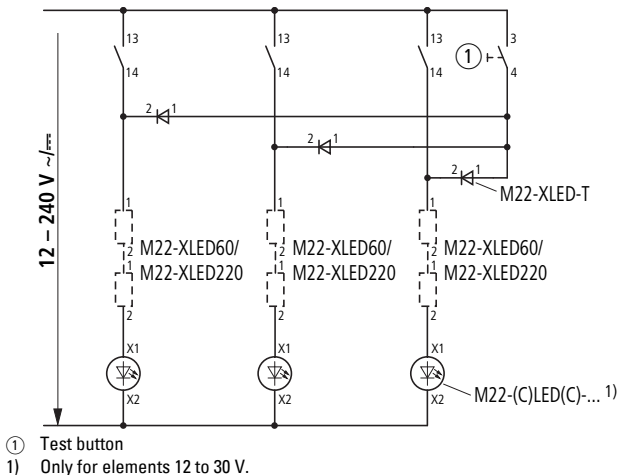
Connection for light test

The test button is used to check operation of the indicator lights independently of the respective control state. Decoupling elements prevent voltage feedback.

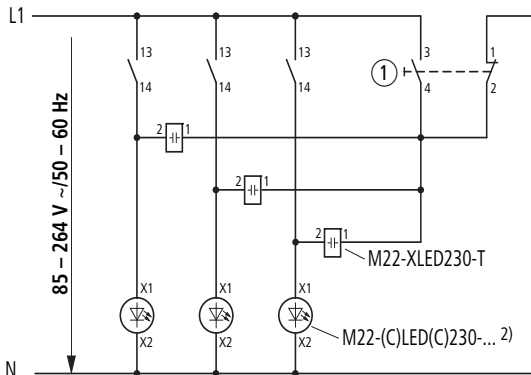
M22-XLED-T

for $U_n = 12$ to 240 V AC/DC (also for light test with signal towers SL)

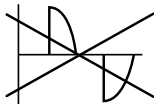
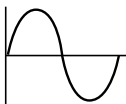
3



for $U_n = 85$ to 264 V AC/50 – 60 Hz



- ① Test button
- 2) For elements 85 to 264 V.



Pilot devices

RMQ – Inscription

Labeleditor



Customized inscription of devices using the Labeleditor software

You can label your device to your individual requirements in four simple steps:

- Download the inscription software:
www.eaton.com/moeller/support
keyword: "Labeleditor"
- Creation of label template (menu-guided in the software)
- Send the label template to the factory by email. The email address is automatically set for the selected product by the program. When your template is sent, the Labeleditor issues a file name such as "RMQ_Silver_12345.zip". This file name is part of the article to be ordered (see Ordering examples).
- Send order to the Eaton sales office or the electrical engineering wholesaling.

Ordering examples

- M22-XST insert label for M22S-ST-X legend label mount with special inscription

Basic type: M22-XST-*

* = File name generated by Labeleditor

Please order:

1 x M22-XST-RMQ_Titan_xxxxxx.zip

- Button plate in green with special inscription

Basic type: M22-XDH-*

1. * = Colour (here „G“ for green),

2. * = File name generated by Labeleditor

Please order:

1 x M22-XDH-G-RMQ_Titan_xxxxx.zip

- Double actuator pushbutton with white pushbutton plates and special symbols

Basic type: M22-DDL-*-**

1. * = Colour (here „W“ for white),

2. and 3. * = File name assigned by Labeleditor; must be stated here 2 x

Please order:

1 x M22-DDL-W-RMQ_Titan_xx
xxx.zip-RMQ_Titan_xxxxx.zip

- Key-operated button, 2 positions, individual lock mechanism no. MS1, individual symbol

Basic type: M22-WRS*-MS*-*

WRS*: * = Number of positions,

MS*: * = Number of individual lock mechanism,

-*: * = File name assigned in Labeleditor

Please order:

1 x

M22-WRS2-MS1-RMQ_Titan_xxxxxx.zip

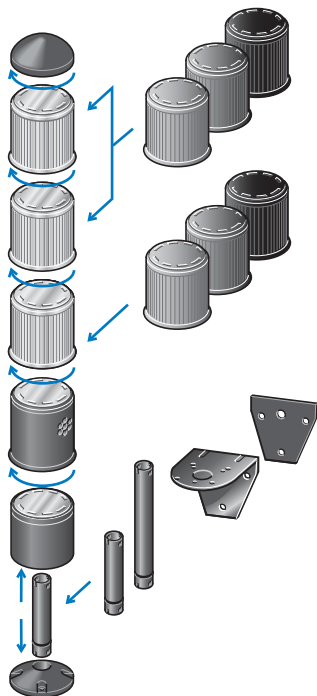
Pilot devices

Signal Towers SL

Signal Towers SL – everything under visual control at all times

Signal towers SL (IP65) indicate machine states using visible and acoustic signals. Mounted on control panels or on machines, they can be reliably recognized as continuous light, flashing light, strobe light or acoustic device even from a distance, and dealt with as necessary.

3



Product features

- Continuous light, flashing light, strobe light and acoustic device can be combined as required.
- Free programmability permits the actuation of five addresses.
- Simple assembly without tools by bayonet fitting.
- Automatic contacting by built-in contact pins.
- Excellent illumination by specially shaped lenses with Fresnel effect.
- Use of filament lamps or LEDs as required.
- A large number of complete devices simplifies selection, ordering and stockkeeping for standard applications.

The various colors of the light elements indicate the operating state in each case to IEC/EN 60204-1 an:

RED:

Dangerous state – Immediate action necessary

YELLOW:

Abnormal status – monitor or -action

GREEN:

Normal status – no action necessary

BLUE:

Discontinuity – action mandatory

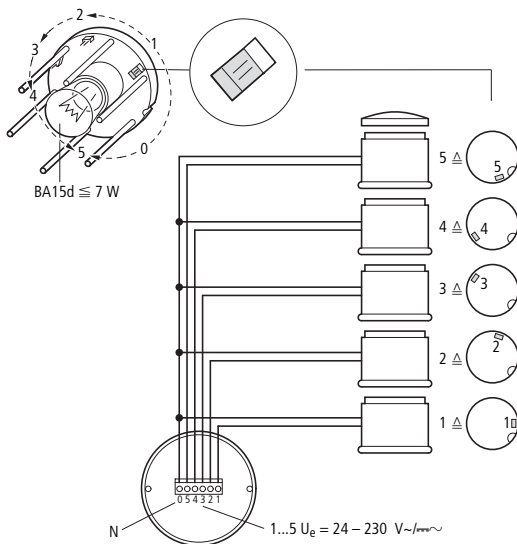
WHITE:

Other status – can be used as required.

Pilot devices

Signal Towers SL

Programmability



Five signal lines from a terminal strip in the base module run through each module. The module is addressed via a wire link (jumper) on each card. Five different addresses can also be allocated several times.

Thus, for example, a red strobe light and in parallel with it an acoustic device can indicate and announce the dangerous status of a machine. Plug both jumpers into the same position on the pcb – and it's done!

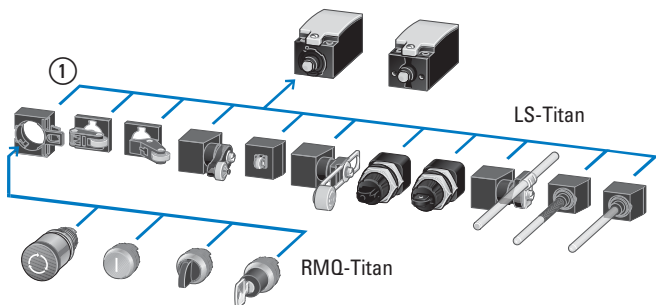
(→ Section "Connection for light test", page 3-11.)

Pilot devices

LS-Titan® position switches

New combinations for your solutions with LS-Titan®

3



- ① Operating heads in four positions, each turned by 90°, can be fitted subsequently.

Actuating devices RMQ-Titan® simply snap fitting

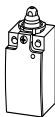
Another unique feature is the possibility to combine actuators from the RMQ-Titan range with the position switches LS-Titan. Pushbuttons, selector switches or emergency switching off pushbuttons can all be directly snapped on to any position switch as operating head. The complete unit then has at least the high protection type IP66 at front and rear.

In addition, all the operating heads and the adapter for accepting the RMQ-Titan pushbuttons have a bayonet fitting that enables quick and secure fitting. Using the bayonet fitting, the heads can be attached in any of the four directions (4 x 90°).

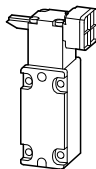
Pilot devices

LS-Titan® position switches

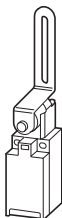
Overview



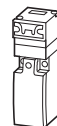
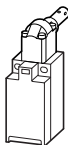
LS, LSM



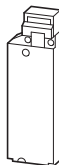
LS4...ZB



LSR...



LS...ZB



LS...ZBZ

Pilot devices

LS-Titan[®] position switches

3

Safety position switches LS4...ZB, LS...ZB

Eaton safety position switches have been specially designed for monitoring the position of protective guards such as doors, hinged flaps, shrouds and protective guards. They meet the requirements of the employers' liability insurance Association for the testing of positive opening position switches for safety functions (GS-ET-15). These requirements include:

"Position switches for safety functions must be designed so that the safety function cannot be bypassed manually or simple tools." Simple tools are: pliers, screwdrivers, pins, nails, wire, scissors, penknives etc.

In addition to these requirements, LS...ZB position switches offer additional manipulation safety by means of an operating head which can rotate but cannot be removed.

Positive opening

Mechanically operated position switches in safety circuits must have positive opening contacts (see EN 60947-5-1). Here, the term positive opening is defined as follows: "The execution of a contact separation as the direct result of a predetermined motion of the keypad of the switch via non-spring operated parts (e.g. not dependent on a spring)".

Positive opening is an opening movement by which it is ensured that the main contacts of a switch have attained the open position at the same time as the keypad assumes the Off position. Eaton position switches all meet these requirements.

Certification

All Eaton safety position switches are certified by the employers' liability insurance Association or by the Technical Monitoring Service (TÜV), Rheinland.



LS4...ZB



LS...ZBZ



LS...ZB



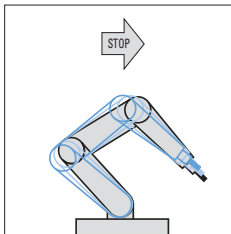
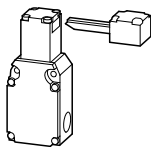
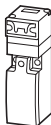
LSR-ZB...

Pilot devices

LS-Titan® position switches

"Personnel protection" by monitoring the protective device

LS...ZB LS4...ZB



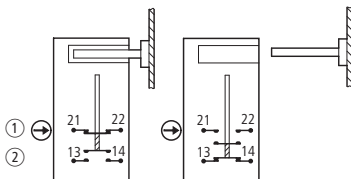
- Door open
- LS...ZB disconnects power
- No danger

3

LS...ZB

closed

Open



- ① Safety contact
- ② Signalling contact

Door closed

→ Safety contact (21 - 22) closed
Signalling contact (13 - 14) open

Door open

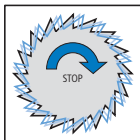
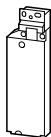
→ Safety contact (21 - 22) open
Signalling contact (13 - 14) closed

Pilot devices

LS-Titan® position switches

„Enhanced personnel protection“ with separate signal for door position

LS...ZBZ

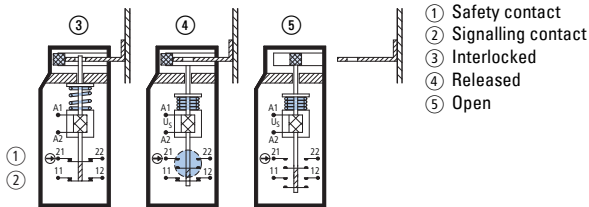


- Stop command
- Waiting time
- Machine is stopped
- Protective mechanism open
- No danger

3

LS...FT-ZBZ, spring-powered interlock (closed-circuit principle)

LS-S02...FT-ZBZ



Door closed and interlocked

→ Coil at (A1, A2) de-energized also with mains failure or wire breakage:
Door interlocked = safe state
Safety contact (21 - 22) closed
Signalling contact (11 - 12) closed

Releasing of door

→ Apply voltage to coil (A1, A2)
e.g. via zero-speed monitor
Safety contact (21 - 22) opens
Signalling contact (11-12) remains closed

Door open

→ Only possible once it is released
Signalling contact (11 - 12) opens.

Door open

→ Both contacts in the open position
tamperproof against simple tools

Close door

→ Signalling contact (11 - 12) closes

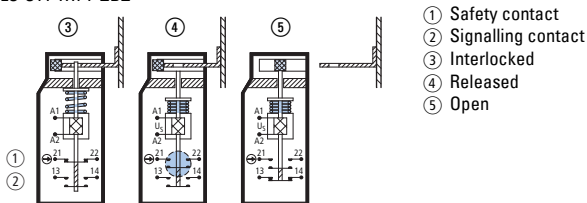
Lock door

→ Switch off the voltage from coil (A1, A2)
1st actuator interlocked
2nd safety contact (21 - 22) closes

Pilot devices

LS-Titan® position switches

LS-S11-...FT-ZBZ



Door closed and interlocked

→ Coil at (A1, A2) de-energized also with mains failure or wire breakage:
Door interlocked = safe state
Safety contact (21 - 22) closed
Signalling contact (13 - 14) open

Releasing of door

→ Apply voltage to coil (A1, A2)
e.g. via zero-speed monitor
Safety contact (21 - 22) opens
Signalling contact (13 - 14) remains open

Door open

→ Only possible once it is released
Signalling contact (13 - 14) closes.

Door open

→ Safety contact (21 - 22) open
Signalling contact (13 - 14) closed

Close door

→ Signalling contact (13 - 14) opens

Lock door

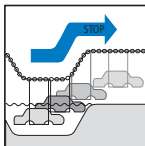
→ Switch off the voltage from coil (A1, A2)
1st actuator interlocked
2nd safety contact (21 - 22) closes

Pilot devices

LS-Titan® position switches

„Process protection and enhanced personnel protection“ with separate signal for door position

LS...ZBZ

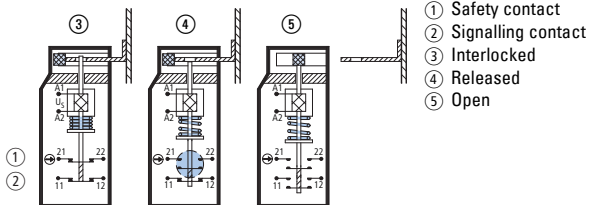


- Stop command
- Waiting time
- Process sequence halted
- Protective mechanism open
- Product OK

3

LS...MT-ZBZ, magnet-powered interlock (open-circuit principle)

LS-S02-...MT-ZBZ



Door closed and interlocked

→ Voltage on coil (A1, A2)
Safety contact (21 - 22) closed
Signalling contact (11 - 12) closed

Releasing of door

→ Coil de-energized (A1, A2)
e.g. via zero-speed monitor,
Safety contact (21 - 22) opens
Signalling contact (11 - 12) remains closed

Door open

→ Only possible once it is released
Signalling contact (11 - 12) opens.

Door open

→ both contacts in the open position, even with tampering with simple tools

Close door

→ Signalling contact (11 - 12) closes

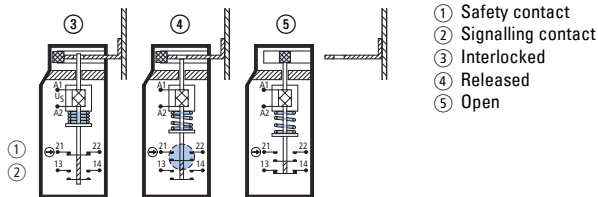
Lock door

→ Apply voltage to coil (A1, A2)
1st actuator interlocked
2nd safety contact (21 - 22) closes

Pilot devices

LS-Titan® position switches

LS-S11-...MT-ZBZ



Door closed and interlocked

→ Voltage on coil (A1, A2)
Safety contact (21 - 22) closed
Signalling contact (13 - 14) open

Releasing of door

→ Coil de-energized (A1, A2)
e.g. via zero-speed monitor,
Safety contact (21 - 22) opens

Door open

→ Only possible once it is released
Signalling contact (13 - 14) closes.

Door open

→ Safety contact (21 - 22) open
Signalling contact (13 - 14) closed

Close door

→ Signalling contact (13 - 14) opens

Lock door

→ Apply voltage to coil (A1, A2)
1st actuator interlocked
2nd safety contact (21 - 22) closes

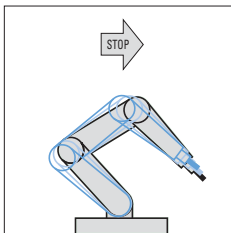
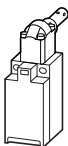
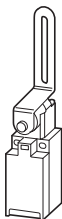
Pilot devices

LS-Titan® position switches

"Personnel protection" by monitoring of the protective mechanism

LSR...I(A)/TKG LSR...I(A)/TS

3

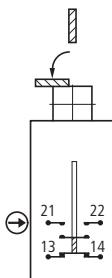
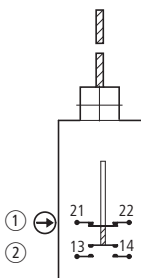


- Hinged protective cover open
- LSR... disconnects power
- No danger

LSR...TKG, LSR...TS

Closed

Open



- ① Safety contact
- ② Signalling contact

Hinged protective cover closed

Protective flap open

→ Safety contact (21 - 22) closed
Signalling contact (13 - 14) open

→ Safety contact (21 - 22) open
Signalling contact (13 - 14) closed

Pilot devices

LS-Titan® position switches

	LS, LSM	LS4...ZB	LS...ZB	LS...ZBZ
Standards	<ul style="list-style-type: none"> • IEC 60947-5-1 → EN 50047 • Dimensions • Fixing dimensions • Operating points • Minimum IP65 	<ul style="list-style-type: none"> • IEC 60947-5-1 → EN 50041 • Dimensions • Fixing dimensions • Operating points • IP65 	<ul style="list-style-type: none"> • IEC 60947-5-1 • IP65 	<ul style="list-style-type: none"> • IEC 60947-5-1 • IP65
Suitable applications	<ul style="list-style-type: none"> • Also for use in safety circuits, by positive operation and positive opening contacts 	<ul style="list-style-type: none"> • Safety position switches for protection of personnel • with separate operating element for protective covers • Positive operation and positive opening contacts • Approval of employers' liability insurance Association 	<ul style="list-style-type: none"> • Safety position switches for protection of personnel • with separate operating element for protective covers • Positive operation and positive opening contacts • Approval of employers' liability insurance Association 	<ul style="list-style-type: none"> • Safety position switches for protection of personnel • with separate operating element for protective covers • Positive operation and positive opening contacts • electromagnetic interlock • Approval of employers' liability insurance Association
Drive	<ul style="list-style-type: none"> • Rounded plunger (centre fixing) • Roller plunger (centre fixing) • Rotary lever • Angled roller lever • Adjustable roller lever • Actuating rod • Spring-rod actuator • Operating heads adjustable in 90° steps 	<ul style="list-style-type: none"> • Coded actuating element • Operating head: <ul style="list-style-type: none"> – Can be rotated by 90° – Can be actuated from both sides • Actuating element <ul style="list-style-type: none"> – Convertible for vertical and horizontal fixing • With triple coding 	<ul style="list-style-type: none"> • Coded actuating element • Operating head: <ul style="list-style-type: none"> – Can be rotated by 90° – Can be actuated from four sides and from above 	<ul style="list-style-type: none"> • Coded actuating element • Operating head: <ul style="list-style-type: none"> – Can be rotated by 90° – Can be actuated from four sides

Pilot devices

LSE-Titan® electronic position switches

Operating point variably adjustable

The operating point on electronic position switches LSE-Titan is adjustable and variable. Two high-speed and bounce-free PNP switching outputs enable high switching frequencies.

3

The position switch is overload as well as conditionally short-circuit proof and has snap-action switching performance. This ensures a defined and reproducible switching point. The operating point lies in the range from 0.5 to 5.5 mm (as supplied = 3 mm).

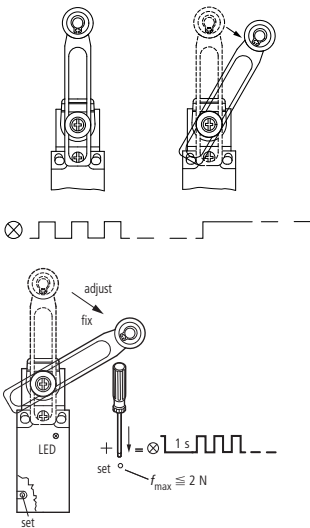
Adjustment to a new operating point is carried out as follows:

Move the plunger from the original to the new switch position. For this purpose, press the setting pushbutton for 1 s. The LED now flashes with a high pulse frequency and the new operating point is retentively set.

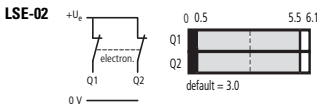
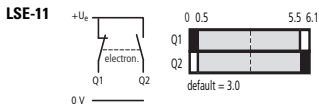
The LSE-11 and LSE-02 complete devices can be used in safety-oriented connections. They have the same function as electromechanical position switches.

Note

This means that all the devices are also suitable for safety applications designed for personnel or process protection.



Contact travel diagram



Pilot devices

Analog electronic position switches

Two part no. are available:

- LSE-AI with current output,
- LSE-AU with voltage output.

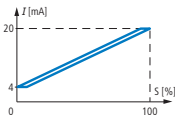
Analog, mechanically actuated position switches directly linked with the world of automation

Analog position switches LSE-AI (4 to 20 mA) and LSE-AU (0 to 10 V) represent another innovation in electronic position switches. Using them, it is now possible for the first time to monitor the actual position of a flue gas valve or an actuator continuously. The actual position is converted in analog fashion into voltage (0 to 10 V) or current (4 to 20 mA) and then continuously signalled to the electronics. Even objects of varying sizes or thicknesses, such as brake shoes, can be scanned and the results processed further.

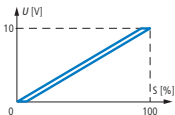
Simple rotational-speed dependent control systems of fan motors or smoke-venting blowers signal the opening angle of the air damper (e.g. 25, 50 or 75 %) and thus save power and material wear. The analog position switches also have a diagnosis output for further processing of data. This means that the safe status can be monitored and analyzed at all times. The position switch also has a self-test function. The outputs Q1 and Q2 are constantly scanned for overload, short-circuit against 0 V and short-circuit against +U_e.

Contact travel diagram

LSE-AI



LSE-AU

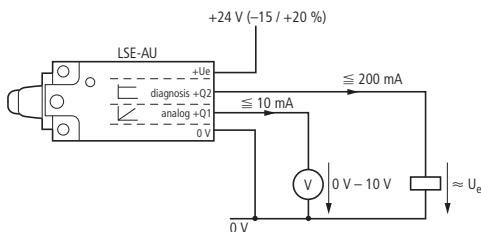
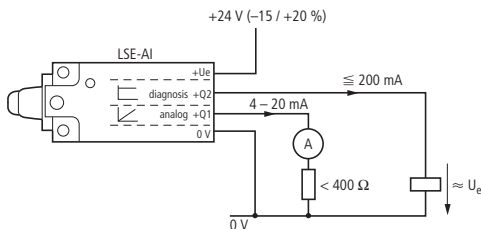


Pilot devices

Analog electronic position switches

Connection diagram

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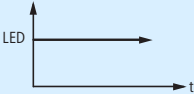
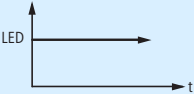


Pilot devices

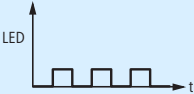
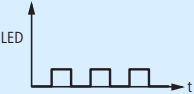
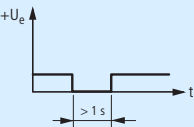
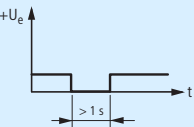
Analog electronic position switches

Circuit symbol

Normal scenario

	LSE-AI	LSE-AU
Q1	4 – 20 mA	0 – 10 V
Q2	$\approx U_e$	$\approx U_e$
LED		

Fault scenario

	LSE-AI	LSE-AU
Q1	0 mA	0 V
Q2	0 V	0 V
LED		
Reset		

Pilot devices

Sensors – Functionality

Inductive Sensors

Inductive sensors are used to detect metal objects. The objects are detected through an electromagnetic field.

With the ability to detect at close range, inductive proximity sensors are very useful for precision measurement and inspection applications.

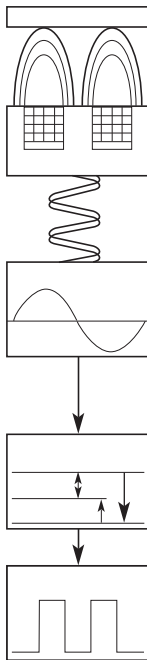
3

How an inductive sensor works

Inductive sensors create an invisible high frequency oscillation field. When metal objects are brought into this field, this oscillating field is affected. Each sensor has a specific sensing range switch point so that metal target detection is very accurate and repeatable.

If a metal object is brought into the field created by the sensor, this is interrupted and causes a reduction in the current flowing through the sensor coil (eddy current damping). The detector circuit senses this change and sends a signal via the sensor output.

Assembly parts



A metal object, or target, enters the sensing field.

The sensor coil is a coil of wire typically wound around a ferrite core. If you could see the electromagnetic field created by it, it would be cone shape. The target will pass through this field. The ferrite core

Pilot devices

Sensors – Functionality

shapes the field and the size of the coil determines the sensing range.

The resonance circuit creates a high frequency oscillation of the electromagnetic field (between 100 Hz and 1 MHz). If a metal object is located in the field, this causes a change in the magnetic field oscillation.

This change creates an eddy current which dampens the signal fed back to the sensor coil.

The detector circuit senses the change and switches ON at a particular set point (amplitude). This ON signal generates a signal to the solid-state output.

The output circuit remains active until the target leaves the sensing field. The oscillator responds with an increase in amplitude, and when it reaches the setpoint value, the detector circuit switches OFF. The output returns to its normal state.

Material wire of the target object

The sensing ranges stated by the sensor manufacturer are usually based upon ferrite targets made of carbon-rolled steel (IE FE 235) defined by ISO 630.

Sensing ranges to targets made of other materials have to have a correction factor applied as listed in the table below. To use this table, multiply the sensing distance of the device by the factor given below.

Correction factors

Multiply the sensing distance by the factor given below.

Target object	Sensor size			
	4–8 mm	12 mm	18 mm	30 mm
Stainless Steel 400 ¹⁾	0.90	0.90	1.0	1.0
Stainless Steel 300 ²⁾	0.65	0.70	0.70	0.75
Brass	0.35	0.45	0.45	0.45
Aluminium	0.35	0.40	0.45	0.40
Copper	0.30	0.25	0.35	0.30

¹⁾ Stainless steel 400 series to ASTM A240, martensitic or ferritic, magnetizable.

²⁾ Stainless steel 300 series to ASTM A240, austenitic, non-magnetizable.

The index of stainless steels is provided in EN 10088-1.

Pilot devices

Sensors – Functionality

Capacitive sensors

Capacitive sensors are designed to detect both metallic and nonmetallic targets. They are ideally suited for liquid level control and for sensing powdered or granulated material.

3

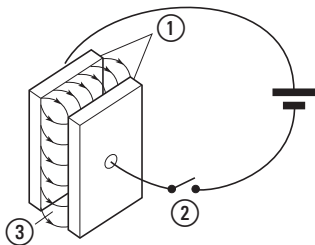
Operation of the capacitive sensors

Capacitive sensors operate using a capacitor. This consists of two metal plates that are separated by an insulating dielectric material. The function of this type of sensor is based on dielectric capacitance, which is the ability of a dielectric to store an electrical charge.

The distance between the plates determines the ability of the capacitor to store an electrical charge.

If an object is put into the electrical field, the capacitance of the capacitor changes. This change is used to implement the on/off switch function.

- Capacitor



- ① Plates
- ② Switch
- ③ Dielectric

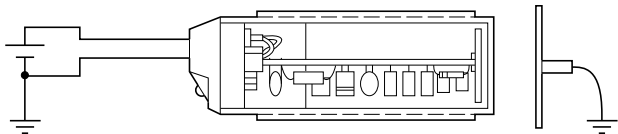
When this principle is applied to the capacitive sensor, one capacitive plate is part of the switch, the enclosure (the sensor face) is the insulator. The target is the other "plate". Ground is the common path.

Capacitive proximity sensors can detect any target that has a dielectric constant greater than air. Liquids have high dielectric constants. Metal also makes a good target.

Pilot devices

Sensors – Functionality

- Capacitive sensor



Capacitive sensors consist essentially of four basic elements:

- Sensor (Dielectric)
- Resonance circuit
- Detector circuit
- Output circuit.

As an object approaches the sensor, the dielectric constant of the capacitor changes. The oscillator circuit's vibration begins when feedback capacitance is detected. This is just the opposite in the inductive proximity sensor, where the vibration is damped when the target is present.

solid and liquid materials is greater than that for air.

Objects made of non-conductive materials affect the active surface of a capacitive proximity switch in the same way. The coupling capacitance is increased. Materials with a high dielectric constant achieve great switching distances.

Notes

When scanning organic materials (wood, grain, etc.) it must be noted that the attainable switching distance is greatly dependent on their moisture content. ($\epsilon_{\text{Water}} = 80!$)

3

Effects

Capacitive sensors are activated both by conductive as well as non-conductive objects.

Metals achieve the greatest switching distances due to their high conductivity. Derating factors for various metals, such as are necessary with inductive sensors, need not be taken into account.

Actuation by objects made of non-conductive materials (insulators):

When an insulator is brought between the electrodes of a capacitor, the capacitance rises relative to the dielectric constant ϵ of the insulator. The dielectric constant for all

Pilot devices

Sensors – Functionality

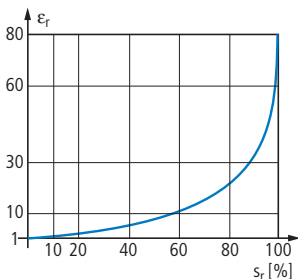
Influence of environmental conditions

As can be seen from the following diagram, the switching distance S_x is dependent on the dielectric constant ϵ_x of the object to be monitored.

Metal objects produce the maximum switching distance (100 %).

3

With other materials, it is reduced relative to the dielectric constant of the object to be monitored.



The following table lists the dielectric constants ϵ_x of some important materials. Due to the high dielectric value of water, the fluctuations with wood can be significant. Damp wood therefore is registered much more effectively by capacitive sensors than dry wood.

Material	ϵ_x
Air, vacuum	1
Teflon	2
Wood	2 - 7
Paraffin	2.2
Kerosene	2.2
Oil of terpentine	2.2
Transformer oil	2.2
Paper	2.3
Polyethylene	2.3
Polypropylene	2.3
Cable insulation	2.5
Soft rubber	2.5
Silicone rubber	2.8
Polyvinyl chloride	2.9
Polystyrene	3
Celluloid	3
Perspex	3.2
Araldite	3.6
Bakelite	3.6
Silica glass	3.7
Hard rubber	4
Oil-impregnated paper	4
Chipboard	4
Porcelain	4.4
Laminated paper	4.5
Quartz sand	4.5
Glass	5
Polyamide	5
Mica	6
Marble	8
Alcohol	25.8
water	80

Pilot devices

Sensors – Functionality

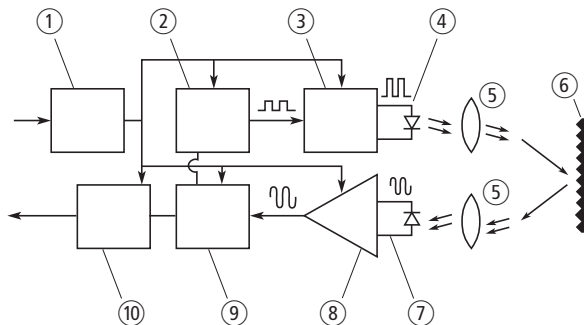
Optical sensors

Optical sensors use light to detect the presence or absence of an object. The main advantages of optical sensors are contactless sensing of objects and greatly extended sensing ranges.

Operating principle of the optical sensor

A LED sends a beam of light, which is picked up by a photodetector. An object is detected when it passes between the LED and photodetector, interrupting the light beam.

Let's look at how an optical sensor works.

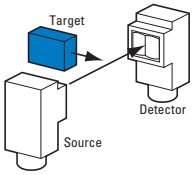
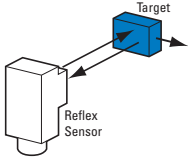
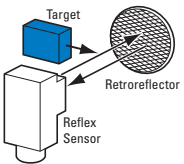
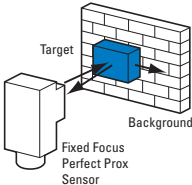


- ① **Power supply:**
Feeds the sensor circuit with a regulated DC voltage.
- ② **Modulator:**
generates pulses to cycle amplifier and LED at desired frequency.
- ③ **Source current amplifier**
- ④ **LED**
- ⑤ **Lens**
- ⑥ **Target object or reflector**
- ⑦ **Photodetector:**
Either a photodiode or a phototransistor device, selected for a maximum sensitivity at the source LED's emitted light wave-length. Both the source LED and the detector have protective lenses. When the sensor picks up the light, it sends a small amount of current to the detector amplifier.
- ⑧ **Detector Amplifier:**
Blocks current generated by the background light. It also provides amplification of the signal received to a usable level, and sends it through to the demodulator.
- ⑨ **Demodulator:**
Sorts out the light thrown out by the sensor from all other light in the area. If the demodulator decides the signals it receive are okay, it signals the output.
- ⑩ **Output:**
Performs switching routine when directed to do so by the demodulator.

Pilot devices

Sensors – Functionality

Detection methods

Operating Mode	Description	Operating Mode	Description
Light barriers 	<p>A source unit in one location sends a light beam to a detector unit in another location. An object is detected when it passes between the source unit and the detector unit, interrupting the light beam.</p>	Reflected-light beam 	<p>Light source and receiver are located in the same unit. If a target moves in front of the optical sensor, it reflects the light beam directly back to the receiver.</p>
Polarisation reflex sensor 	<p>Light source and receiver are located in the same unit. If a target moves in front of the optical sensor, a reflector reflects the light beam directly back to the receiver.</p>	Background rejection (Perfect Prox) 	<p>This is a special type of diffuse reflective sensor that includes two detectors. This sensor offers reliable detection of target objects in a defined sensing range and at the same time ignores objects outside of this range. Unlike a standard diffuse reflective optical sensor, color or reflectivity has minimal effect on the sensing range of this sensor.</p>

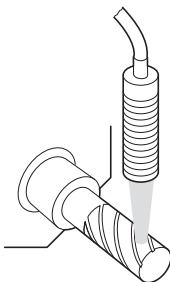
Pilot devices

Sensors – Applications

Broken Tool Detection

Description	Catalog Number
E58 Perfect Prox Sensor	E58-30DP or E58-18DP Sensor

This sensor is used to sense for the presence of the bit on a mill. The high sensing power and background suppression of the Perfect Prox allows reliable detection through high levels of cutting fluids, while ignoring objects just beyond the bit. The rugged harsh duty sensor survives constant exposure to lubricants, cutting fluids and flying metal chips.

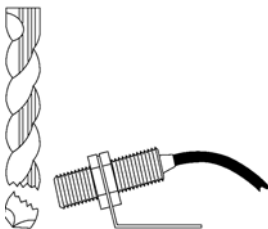


3

Broken Tool Detection

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

A tubular sensor is used to detect the presence of a drill bit – should the drill bit be broken the sensor would signal a controller.



Pilot devices

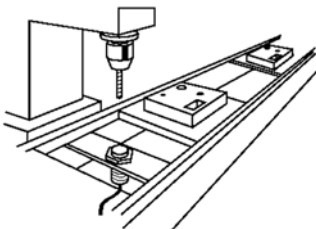
Sensors – Applications

Machining process

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

3

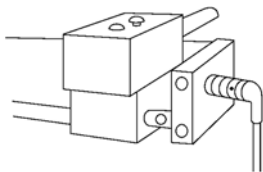
A ferrous only sensor is used in a process where aluminum is being machined. The ferrous only sensor ignores the aluminum (non-ferrous) chips from the machining process and only detects the ferrous target.



Tool Position

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

A tubular sensor is used to detect the position of a tool chuck.



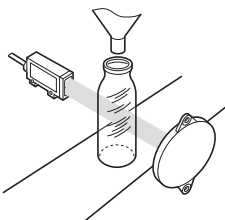
Pilot devices

Sensors – Applications

Bottle Filling Detection

Description	Catalog Number
E65 Clear Object Sensor	E71-CON or E71-COP

A clear object sensor is used to sense the presence of bottles at a filling operation. The sensor offers high reliability in sensing clear bottles of different colors and thicknesses.

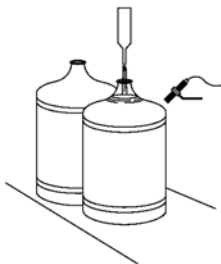


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Process control engineering

Description	Catalog Number
Tubular capacitive Sensor	E53 Product Family

A capacitive sensor used to verify fill level of bottled water on a filling process line.



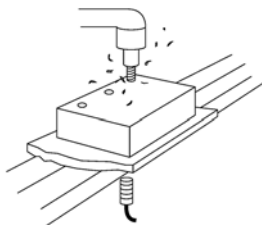
Pilot devices

Sensors – Applications

Conveyor System Control

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

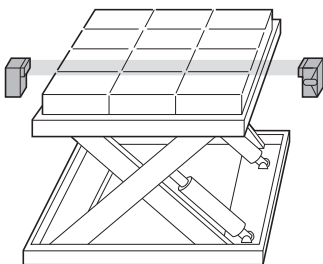
A tubular inductive sensor is used to detect the presence of metal carriers holding parts to be machined.



Stack Height Control

Description	Catalog Number
Comet Series Thru-Beam - source	11100A
Comet Series Thru-beam - detector	12100A

A set of thru-beam sensors determines the height of a scissor lift. For example, when the control is set for “dark-to-light” energize, the lift rises after a layer has been removed and stops when the next layer breaks the beam again.



Pilot devices

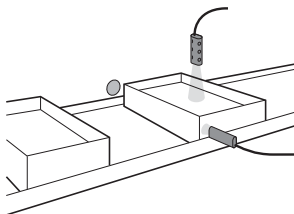
Sensors – Applications

Carton Fill-Level Detection

Description	Catalog Number
Comet visible reflex photoelectric sensor	14102A
Comet reflected-light beam with background suppression (Perfect Prox)	13103A
Retro-reflector	6200A-6501

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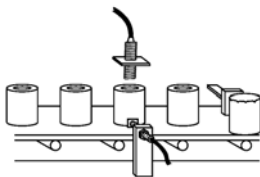
Two sensors work together to inspect the fill level in cartons on a conveyor. A reflex sensor senses the position of the carton and energizes the sensors located over the contents. If the sensor does not “see” the fill level, the carton does not pass inspection.



Lid Detection

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

Two sensors are used to detect a can on a conveyor belt and to check whether it has a cover.



Pilot devices

Sensors – Applications

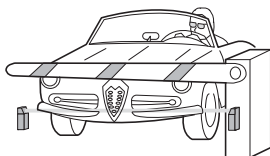
Tollbooth Control

Description	Catalog Number
E67 Perfect Prox long range sensor	E67-LRDP

3

The long range polarized reflex controls are used for the time control of a toll barrier. As soon as the car that has paid passes, the barrier closes in order to ensure that the next car stops. With the initiator E67 Long Range Perfect Prox you can mount the sensor on just one side instead of both. It detects cars with different colors and finishes whilst reliably ignoring all other background objects.

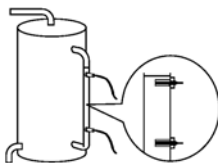
The rugged design makes it also suitable for continuous operation in extreme weather conditions.



Liquid Level Detection

Description	Catalog Number
Tubular capacitive Sensor	E53 Product Family

A pair of capacitive sensors are used to sense high and low liquid levels in a tank through a sight glass. This arrangement starts a pump to fill the tank when the lower sensor is energized and shuts the pump off when the top sensor is energized.



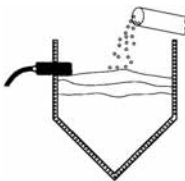
Pilot devices

Sensors – Applications

Bulk Material Detection

Description	Catalog Number
Tubular capacitive Sensor	E53 Product Family

A capacitive sensor is used to control fill level of solids such as plastic pellets in a hopper or bin.

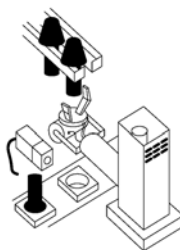


3

Parts Presence

Description	Catalog Number
Limit switch, inductive sensor	E57 Product Family
Comet Perfect Prox	1310
Inductive sensor iProx	E59-M

A sensor configured as a limit switch can be used to detect whether a component is present in an automatic assembly machine. The Comet detects all materials, colors and services and masks out the background. The iProx can be programmed to detect a particular material and thus to ignore all other materials.



Pilot devices

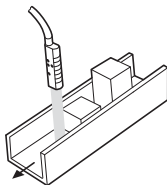
Sensors – Applications

Parts Presence

Description	Catalog Number
Comet reflected-light beam (Perfect Prox), 100 mm	13101A

3

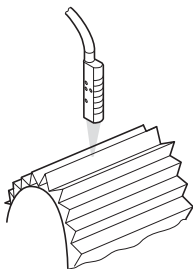
The sensor detects components with different heights from approx. 13 to 76 mm in a channel and can mask out the channel. Installation is simple and does not require any drilling or cutting of the channel.



Filter Paper Length Control

Description	Catalog Number
A focused diffuse Comet reflective sensor	13102A

A focused diffuse reflective sensor interfaces with a programmable controller to measure a specific length of corrugated automotive filter paper. The controller detects the presence or absence of a corrugation. When a predetermined number of corrugations has been detected, the programmable controller directs a shear to cut the paper.



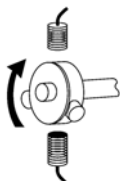
Pilot devices

Sensors – Applications

Speed monitoring

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

A tubular sensor is used to detect the presence of set screws on a shaft hub providing a control device with signals for speed regulation or detection of rotation.

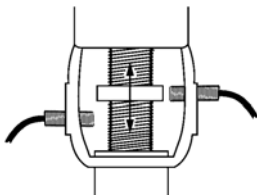


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Motion Control

Description	Catalog Number
Tubular inductive sensor	E57 Product Family or iProx

A pair of tubular sensors is used to determine full open and fully closed valve position.



Pilot devices

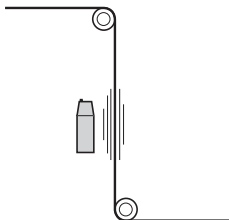
Sensors – Applications

Clear Plastic Web Break Detection

Description	Catalog Number
Comet series 150 mm diffuse focus reflective light sensor	13107A

3

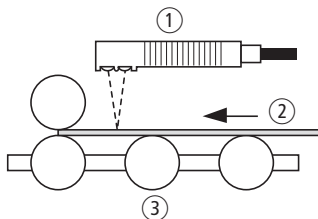
The clear web is detected by an extremely sensitive diffuse reflective sensor. Its short detection range makes it immune to reflective objects in the background. The extremely high excess gain helps it ignore reflection caused by fluttering of the web.



Paper detection

Description	Catalog Number
Comet Perfect Prox, 50 mm series, right angled	13104R

Right angle viewing and compact size allow the sensor to be mounted in the tight confines of paper handling systems. High resolution and sharp optical cut-off ensure that background machinery will be ignored while paper will be detected regardless of color and texture.



- ① Comet sensors
- ② Paper
- ③ Roller

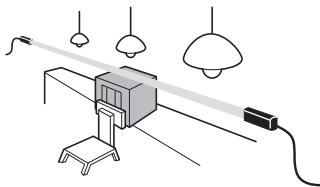
Pilot devices

Sensors – Applications

Damage Warning

Description	Catalog Number
Comet E58 series Thru-Beam, Source	E58-30TS
Thru-beam sensor E58 series, detector	E58-30TD

Source and detector are mounted at opposite ends of a long warehouse storage shelf with the beam situated a safe distance below overhead obstacles (lighting, cable ducts, gas lines, etc.). If a forklift operator interrupts the beam while moving a load, a siren or flashing light will warn him to stop before any damage occurs.



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Notes

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