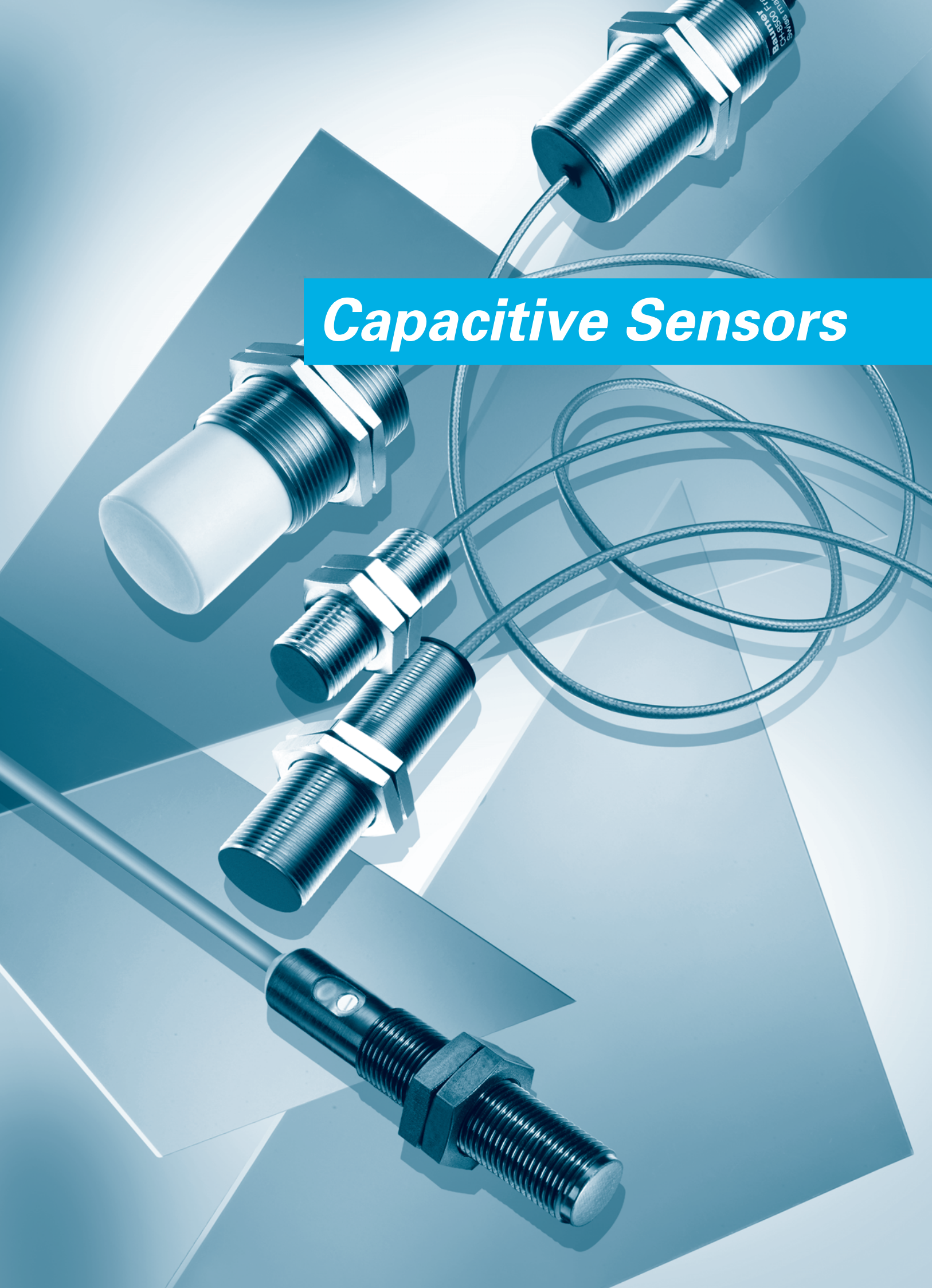


# Capacitive Sensors

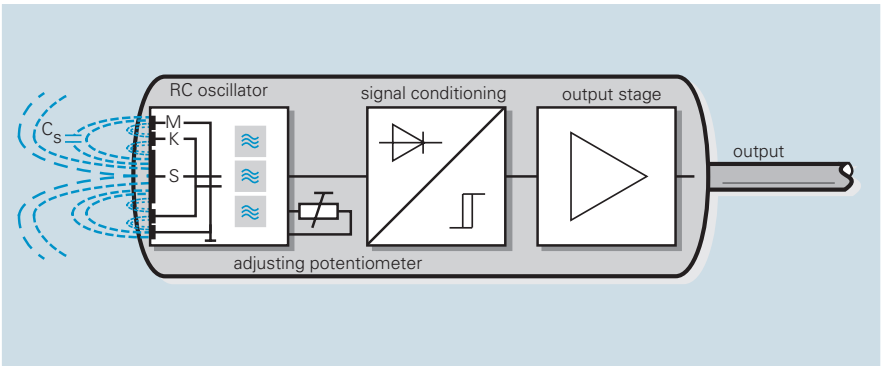
## cylindrical designs

| product family | CFAM 12 | CFAM 18 | CFBM 20 | CFAM 30 | CFAK 12 | CFAK 18 | CFAK 30 |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| shielded | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| nominal sensing distance Sn | 4 mm | 8 mm | 10 mm | 15 mm | 4 mm | 8 mm | 15 mm |
| housing length | 60 mm<br>76 mm | 64 mm<br>78,5 mm | 80 mm | 71 mm<br>82 mm | 60 mm | 64 mm | 71 mm |
| NPN | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PNP | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| cable | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| connector M12 | ■ | ■ | | ■ | | | |
| brass nickel plated | ■ | ■ | ■ | ■ | | | |
| PBT | | | | | ■ | ■ | ■ |
| Pot, 270° | ■ | | | | ■ | | |
| Pot, 10 turn | | ■ | | | | ■ | |
| Pot, 18 rev | | | ■ | ■ | | | ■ |
| protection class | IP 65 | IP 65 | IP 65 | IP 65 | IP 65 | IP 65 | IP 65 |
| **Page** | **151** | **152** | **153** | **154** | **155** | **156** | **157** |

## cylindrical / rectangular designs

| product family | CFAK 12P | CFDM 20 | CFDK 30 | CFAH 30 |
|---|---|---|---|---|
| |  |  |  |  |
| liquid level sensor | ■ | | | |
| sensor for high temperatures | | | | ■ |
| shielded | | ■ | ■ | |
| unshielded | ■ | | | ■ |
| nominal sensing distance Sn | 0,5 mm | 5 mm | 15 mm | 15 mm |
| housing length | 39,5 mm | 35 mm | 65 mm<br>75 mm | 65 mm |
| NPN | | ■ | ■ | |
| PNP | ■ | ■ | ■ | ■ |
| cable | ■ | | ■ | |
| connector M8 | | ■ | | |
| connector M12 | | | ■ | ■ |
| brass nickel plated | | ■ | | |
| PBT | ■ | | ■ | |
| V2A/PTFE | | | | ■ |
| Pot | | | | ■ |
| Pot, 18 rev | | | ■ | |
| protection class | IP 67 | IP 65 | IP 65 | IP 67 |
| **Page** | **159** | **160** | **161** | **163** |

## Theory of operation




The RC oscillator starts up when the sensitive capacitance Cs of the sensing element is affected by an external object. The internal change in current is detected by an adjustable trigger which controls the sensor output.

### Cause of change in capacitance Cs

• Proximity to **conductive objects**

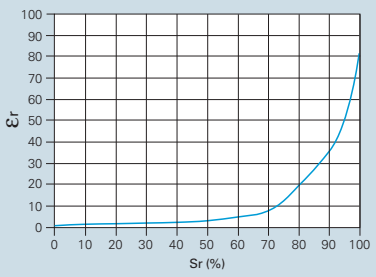
If an object of conductive material is located within the sensing distance of the sensor, it will form two series connected capacitances with sensor areas S and M. The series connected capacitances are much larger than the capacitance of the undamped oscillator. Maximum sensing distance can be achieved with conductive objects like metals, water etc..

| Material | Relative permittivity ($\varepsilon_r$) |
|---|---|
| Air, vacuum | 1 |
| Paper | 1,2 - 3 |
| Paraffin oil | 2,2 |
| PVC | 3 |
| Glass | 3 - 5 |
| Wood | 2 - 7 |
| Marble | 8,4 - 14 |
| Alcohol | 25 |
| Methanol | 33,5 |
| Water | 81 |

• of **non-conductive objects**

If a non-conductive object is moved into the sensor field, the field will be amplified in relation to the relative permittivity ($\varepsilon_r$) of the material to be detected and thus increase capacitance Cs. As from a relative permittivity of $\varepsilon_r$ = 81 (water), sensing distances can be achieved that are equivalent to those for conductive materials. The sensing distance is reduced for materials with a lower $\varepsilon_r$.

Sensing distance in relation to $\varepsilon_r$




### Close range shielding

The capacitive sensor responds to all materials whose relative permittivity $\varepsilon_r$ is greater than 1 (air, vacuum). This means that dirt deposits and moisture on the sensor surface are also detected. In order to avoid this unwanted effect, Baumer sensors have been equipped with an additional compensating electrode (K).

This electrode is used to generate an electric field close to the sensor surface which counteracts the main field. A field free area is produced in proximity to the electrode in which objects may be located without being detected by the sensor. Although this design is a very effective solution to the problem of unwanted switching it is not completely foolproof.

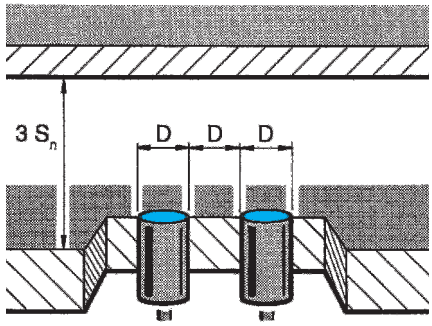
## Mounting instructions

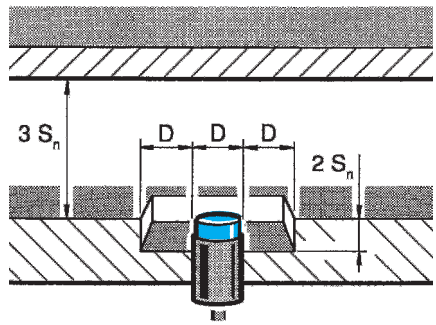
● shielded (flush) mounting

Shielded capacitive sensors may be flush-mounted in metal and other materials. They are especially suited for the detection of non-conductive target materials, such as plastics, wood, glass, etc. As compared to unshielded versions, shielded sensors have a slightly increased sensitivity to soiling and condensation on the sensor's face.

○ unshielded (non-flush) mounting

When installing unshielded capacitive sensors, they must be mounted such that there is no interfering material within a certain perimeter around the active face. This perimeter has a radius of 1,5 x the diameter of the sensing head. Unshielded capacitive sensors are insensitive to soiling as well as condensation on the sensing head. They are especially suited for the detection of conductive target materials like metals, water etc.



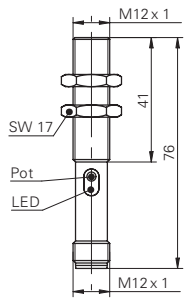
CAPACITIVE

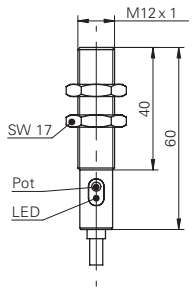
# Sn = 4 mm

- Sensitivity adjustment via pot

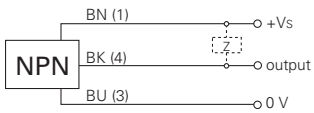
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 4 mm |
| nominal sensing distance Sn adjustable | 0,5 ... 4 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 270° |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | brass nickel plated |
| dimension | 12 mm |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |
| **accessories** | |
| connectors | ES 14, ES 18, ESW 33S, ESG 34S |

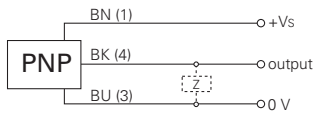
## dimension drawings




## connection diagrams




| order reference | housing length | output circuit | connection types |
|---|---|---|---|
| **CFAM 12N1600** | 60 mm | NPN make function (NO) | cable |
| **CFAM 12N1600/S14** | 76 mm | NPN make function (NO) | connector M12 |
| **CFAM 12N3600** | 60 mm | NPN break function (NC) | cable |
| **CFAM 12N3600/S14** | 76 mm | NPN break function (NC) | connector M12 |
| **CFAM 12P1600** | 60 mm | PNP make function (NO) | cable |
| **CFAM 12P1600/S14** | 76 mm | PNP make function (NO) | connector M12 |
| **CFAM 12P3600** | 60 mm | PNP break function (NC) | cable |
| **CFAM 12P3600/S14** | 76 mm | PNP break function (NC) | connector M12 |

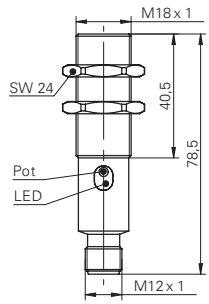
CAPACITIVE

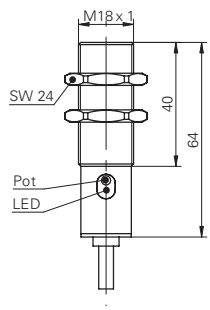
## Sn = 8 mm

- Sensitivity adjustment via pot

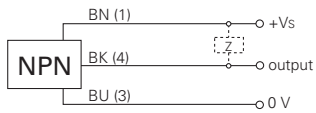
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 8 mm |
| nominal sensing distance Sn adjustable | 2 ... 8 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 10 turn |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | brass nickel plated |
| dimension | 18 mm |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |
| **accessories** | |
| connectors | ES 14, ES 18, ESW 33S, ESG 34S |

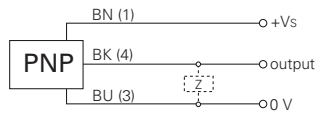
**dimension drawings**




**connection diagrams**




| order reference | housing length | output circuit | connection types |
|---|---|---|---|
| **CFAM 18N1600** | 64 mm | NPN make function (NO) | cable |
| **CFAM 18N1600/S14** | 78,5 mm | NPN make function (NO) | connector M12 |
| **CFAM 18N3600** | 64 mm | NPN break function (NC) | cable |
| **CFAM 18N3600/S14** | 78,5 mm | NPN break function (NC) | connector M12 |
| **CFAM 18P1600** | 64 mm | PNP make function (NO) | cable |
| **CFAM 18P1600/S14** | 78,5 mm | PNP make function (NO) | connector M12 |
| **CFAM 18P3600** | 64 mm | PNP break function (NC) | cable |
| **CFAM 18P3600/S14** | 78,5 mm | PNP break function (NC) | connector M12 |

CAPACITIVE

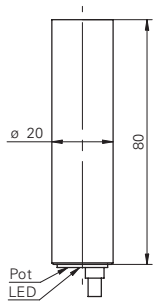
# Sn = 10 mm

- Sensitivity adjustment via pot

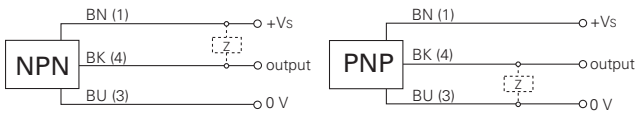
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 10 mm |
| nominal sensing distance Sn adjustable | 2 ... 10 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 18 rev |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | brass nickel plated |
| dimension | 20 mm |
| housing length | 80 mm |
| connection types | cable |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |

| order reference | output circuit |
|---|---|
| **CFBM 20N1600** | NPN make function (NO) |
| **CFBM 20N3600** | NPN break function (NC) |
| **CFBM 20P1600** | PNP make function (NO) |
| **CFBM 20P3600** | PNP break function (NC) |

## dimension drawing




## connection diagrams



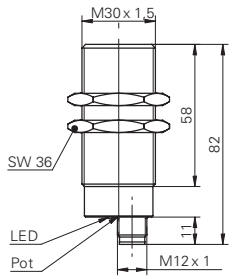
CAPACITIVE

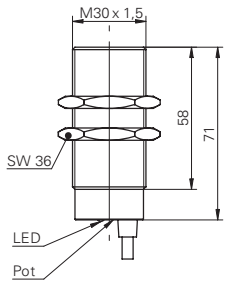
## Sn = 15 mm

- Sensitivity adjustment via pot

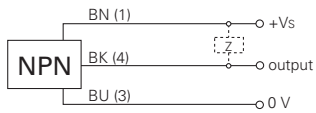
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 15 mm |
| nominal sensing distance Sn adjustable | 4 ... 15 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 18 rev |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | brass nickel plated |
| dimension | 30 mm |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |
| **accessories** | |
| connectors | ES 14, ES 18, ESW 33S, ESG 34S |

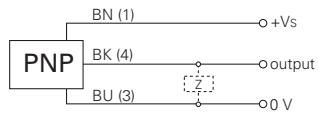
**dimension drawings**




**connection diagrams**




| order reference | housing length | output circuit | connection types |
|---|---|---|---|
| **CFAM 30N1600** | 71 mm | NPN make function (NO) | cable |
| **CFAM 30N1600/S14** | 82 mm | NPN make function (NO) | connector M12 |
| **CFAM 30N3600** | 71 mm | NPN break function (NC) | cable |
| **CFAM 30N3600/S14** | 82 mm | NPN break function (NC) | connector M12 |
| **CFAM 30P1600** | 71 mm | PNP make function (NO) | cable |
| **CFAM 30P1600/S14** | 82 mm | PNP make function (NO) | connector M12 |
| **CFAM 30P3600** | 71 mm | PNP break function (NC) | cable |
| **CFAM 30P3600/S14** | 82 mm | PNP break function (NC) | connector M12 |

CAPACITIVE

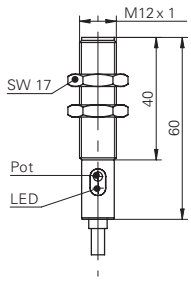
# Sn = 4 mm

- Sensitivity adjustment via pot
- Completely sealed housing

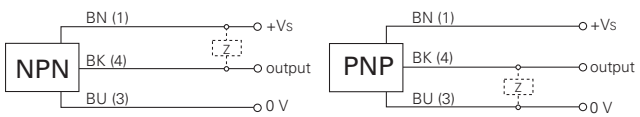
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 4 mm |
| nominal sensing distance Sn adjustable | 0,5 ... 4 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 270° |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | PBT |
| dimension | 12 mm |
| housing length | 60 mm |
| connection types | cable |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |

| order reference | output circuit |
|---|---|
| **CFAK 12N1600** | NPN make function (NO) |
| **CFAK 12N3600** | NPN break function (NC) |
| **CFAK 12P1600** | PNP make function (NO) |
| **CFAK 12P3600** | PNP break function (NC) |

## dimension drawing




## connection diagrams



CAPACITIVE

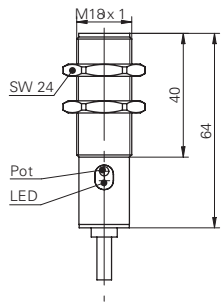
## Sn = 8 mm

- Sensitivity adjustment via pot
- Completely sealed housing

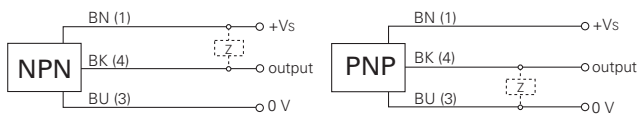
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 8 mm |
| nominal sensing distance Sn adjustable | 2 ... 8 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 10 turn |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | PBT |
| dimension | 18 mm |
| housing length | 64 mm |
| connection types | cable |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |

| order reference | output circuit |
|---|---|
| **CFAK 18N1600** | NPN make function (NO) |
| **CFAK 18N3600** | NPN break function (NC) |
| **CFAK 18P1600** | PNP make function (NO) |
| **CFAK 18P3600** | PNP break function (NC) |

### dimension drawing




### connection diagrams



CAPACITIVE

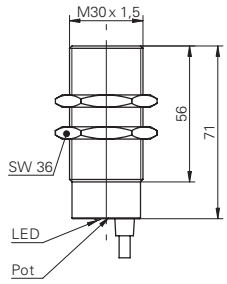
# Sn = 15 mm

- Sensitivity adjustment via pot
- Completely sealed housing

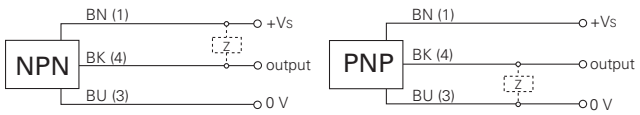
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 15 mm |
| nominal sensing distance Sn adjustable | 4 ... 15 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 18 rev |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | PBT |
| dimension | 30 mm |
| housing length | 71 mm |
| connection types | cable |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |

| order reference | output circuit |
|---|---|
| **CFAK 30N1600** | NPN make function (NO) |
| **CFAK 30N3600** | NPN break function (NC) |
| **CFAK 30P1600** | PNP make function (NO) |
| **CFAK 30P3600** | PNP break function (NC) |

## dimension drawing




## connection diagrams



## Reliable detection of liquid levels

The new capacitive fill level sensor for electrically conductive liquids and aqueous solutions reliably detects liquid fill levels even under the most difficult ambient conditions. The compact M12 x 40 mm device is IP 67 sealed and is available in PBT, PVDF, PA 12 and PP plastic enclosures. The availability of various housing materials covers a wide range of fill level monitoring applications ranging from the chemical industry to the food processing industry. The non-flush sensor has been specifically designed so that soiling and condensation on the sensor's face do not cause false triggers. The product, featuring an EMI immunity far exceeding the limits specified by the applicable CE sensor norm, offers an excellent price to performance ratio. Some of Baumer's photoelectric, pressure and ultrasonic products can also be used as fill level sensors. Please consult our application engineers or ask for our special literature.

CAPACITIVE

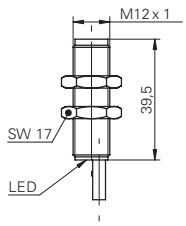
# Sn = 0,5 mm

- Completely sealed housing
- Compact design
- Fill level monitoring

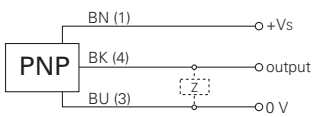
| general data | |
|---|---|
| special type | liquid level sensor |
| mounting type | unshielded |
| nominal sensing distance Sn | 0,5 mm |
| nominal sensing distance Sn adjustable | 0,25 ... 0,75 mm |
| temperature drift | ± 20% |
| sensitivity adjustment | no |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 10 mA |
| output circuit | PNP make function (NO) |
| output current | < 200 mA |
| voltage drop Vd | < 2,5 VDC |
| switching frequency | < 15 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | cylindrical |
| housing material | PBT |
| dimension | 12 mm |
| housing length | 39,5 mm |
| connection types | cable |
| **ambient conditions** | |
| operating temperature | 0 ... +70 °C |
| protection class | IP 67 |

| order reference |
|---|
| **CFAK 12P1103** |

**dimension drawing**




**connection diagram**



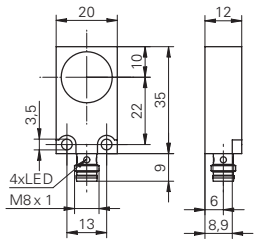
CAPACITIVE

# Sn = 5 mm

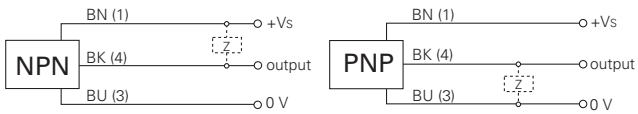
| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 5 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | no |
| output indicator | 4 port LED |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | rectangular |
| housing material | brass nickel plated |
| dimension | 20 mm |
| housing length | 35 mm |
| connection types | connector M8 |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |
| **accessories** | |
| connectors | ESW 31S, ESG 32S |

| order reference | output circuit |
|---|---|
| **CFDM 20N1500/S35L** | NPN make function (NO) |
| **CFDM 20N3500/S35L** | NPN break function (NC) |
| **CFDM 20P1500/S35L** | PNP make function (NO) |
| **CFDM 20P3500/S35L** | PNP break function (NC) |

## dimension drawing




## connection diagrams

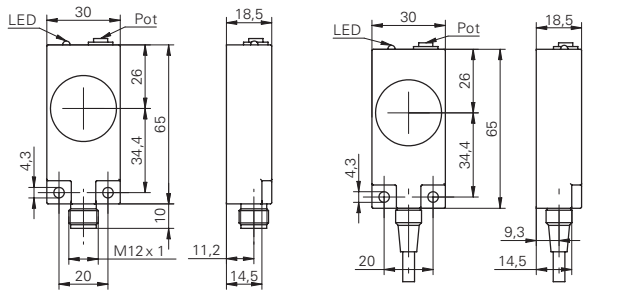


CAPACITIVE

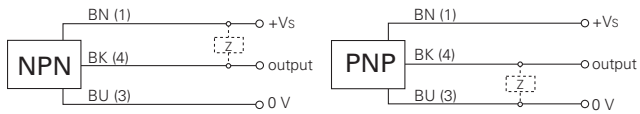
# Sn = 15 mm

| general data | |
|---|---|
| mounting type | shielded |
| nominal sensing distance Sn | 15 mm |
| nominal sensing distance Sn adjustable | 4 ... 15 mm |
| temperature drift | ± 15% (+10 ... +70 °C) |
| sensitivity adjustment | Pot, 18 rev |
| output indicator | LED yellow |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 30 VDC |
| current consumption max. | 20 mA |
| output current | < 200 mA |
| voltage drop Vd | < 1,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| type | rectangular |
| housing material | PBT |
| dimension | 30 mm |
| **ambient conditions** | |
| operating temperature | -25 ... +75 °C |
| protection class | IP 65 |
| **accessories** | |
| connectors | ES 14, ES 18, ESW 33S, ESG 34S |

## dimension drawings




## connection diagrams




| order reference | housing length | output circuit | connection types |
|---|---|---|---|
| **CFDK 30N1600** | 65 mm | NPN make function (NO) | cable |
| **CFDK 30N1600/S14** | 75 mm | NPN make function (NO) | connector M12 |
| **CFDK 30N3600** | 65 mm | NPN break function (NC) | cable |
| **CFDK 30N3600/S14** | 75 mm | NPN break function (NC) | connector M12 |
| **CFDK 30P1600** | 65 mm | PNP make function (NO) | cable |
| **CFDK 30P1600/S14** | 75 mm | PNP make function (NO) | connector M12 |
| **CFDK 30P3600** | 65 mm | PNP break function (NC) | cable |
| **CFDK 30P3600/S14** | 75 mm | PNP break function (NC) | connector M12 |

# Capacitive high temperature sensor -40...+250 °C


## Some like it hot - some do not!

Many applications demand process temperatures of up to +200 °C and more. These high temperatures spell disaster for most electronic devices. Not so for our high temperature capacitive sensors from the CFAH series! These sensors are right "at home" when things get hot. Target materials such as liquids, granulates, pastes and similar substances can be detected reliably even at very high ambient temperatures. Since conventional electronic components cannot stand temperatures of +100 °C or more over longer periods, this sensor has simply been "split" into hot and cold components. The actual "hot" sensor head, which can be used at an ambient temperature of -40 to +200 °C (optional up to +250 °C), is made of chemical-resistant Teflon and stainless steel. The high temperature sensor CFAH is the ideal substitute for mechanical sensors in a wide range of applications. Due to its high chemical resistance, it can also be used in chemically harsh environments. This sensor will operate in nearly any environment and not even break a sweat.

CAPACITIVE

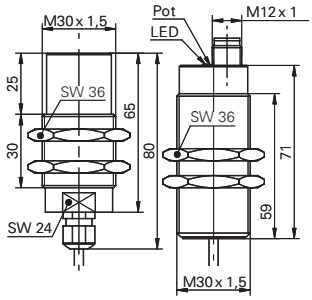
# Sn = 15 mm

- High temperature proof to +250 °C
- Resistant against a number of chemicals
- Probe made of stainless steel & teflon (anti-adherence)

| general data | |
|---|---|
| special type | sensor for high temperatures |
| mounting type | unshielded |
| nominal sensing distance Sn | 15 mm |
| nominal sensing distance Sn adjustable | 4 ... 15 mm |
| sensitivity adjustment | Pot |
| output indicator | LED |
| **electrical data** | |
| voltage supply range +Vs | 10 ... 35 VDC |
| current consumption max. | 20 mA |
| output circuit | PNP make function (NO) |
| output current | < 200 mA |
| voltage drop Vd | < 2,5 VDC |
| switching frequency | < 50 Hz |
| short circuit protection | yes |
| reverse polarity protection | yes |
| **mechanical data** | |
| **processing electronics** | |
| type | cylindrique |
| housing material | brass nickel plated |
| dimension | 30 mm |
| housing length | 71 mm |
| connection types | connector M12 |
| **sensing head** | |
| type | cylindrique |
| housing material | V2A/PTFE |
| dimension | 30 mm |
| housing length | 65 mm |
| **ambient conditions** | |
| **processing electronics** | |
| operating range | -25 ... +75 °C |
| temperature drift | ± 15% (+10 ... +70 °C) |
| protection class | IP 65 |
| **sensing head** | |
| operating range | -40 ... +200 °C<br>(+250 °C on request) |
| temperature drift | ± 0,02 mm/°C |
| protection class | IP 67 |
| **accessories** | |
| connectors | ES 14, ES 18, ESW 33A,<br>ESG 34A |

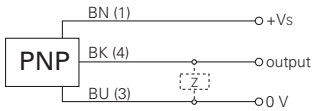
| order reference |
|---|
| **CFAH 30P1200/S14** |

## dimension drawing



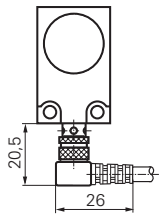

Teflon cable dia 3,7 mm L = 1 m

## connection diagram

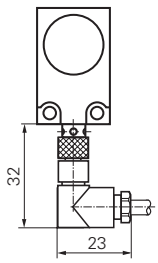


Series 20
rectangular

**ESW 31**

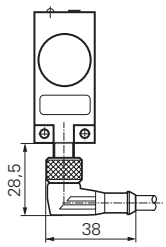



**ES 22**

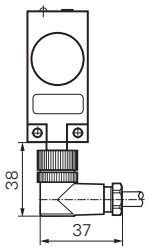



Series 30
rectangular

**ESW 33**




**ES 14**

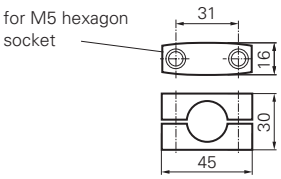



**Color code DC**

| wire color | short name | signal |
|---|---|---|
| blue | BU | 0 V |
| black | BK | output |
| brown | BN | +Vs |

**Support bracket (2x) 143377**

for 20 mm diameter proximity switches
material plastic (PA 6.6. black)




**Test set**

**Part No. 115437**