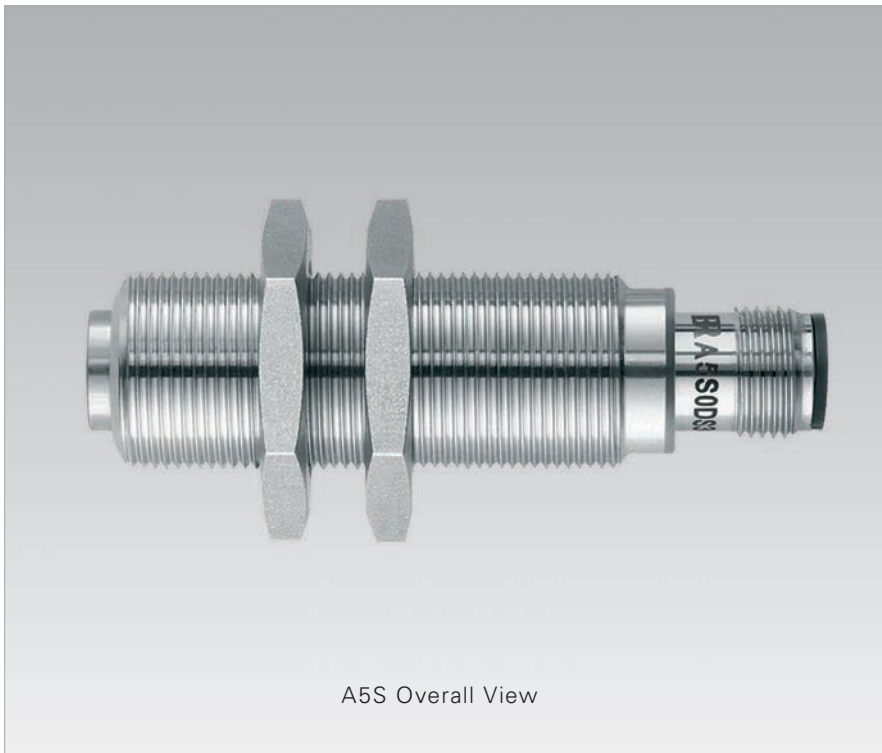


# Differential-Hall-Effect based Sensors

## Series A5S Overview



A5S Overall View

### KEY FEATURES

- Speed range from 0 Hz up to 25 kHz (response time < 20 microseconds)
- Air gap to the target / pole wheel up to 2.5 mm (depending on the profile size)
- Temperature range -40...+125 °C (-40...+255 °F)
- Differential principle diminishes the influence of external magnetic stray fields and of machine vibration
- Sealed stainless steel enclosure > 200 bar pressure to sensor tip
- Available for connection via tight plug, or with firmly attached cable (PVC or Teflon® insulated)
- Powerful square wave output signal equally high over the entire speed range
- Sensor short circuit proof and protected versus reverse polarity error
- Accepting fine and coarse profiles, as gear wheels, slots, cams, holes in any ferrous material

### A5S sensors – the best choice for demanding applications

The correct choice of sensor is always a prerequisite to attaining a successful solution. Our A5S sensors are based on the proven Differential-Hall-Effect principle. Their low end of 0 Hz allows to monitor the machine down to zero speed. They are contact-free, wear-free, maintenance-free and unsusceptible versus external magnetic stray fields and machine vibration. These characteristics make the series of A5S sensors especially suited for all applications where high levels of accuracy and reliability are at a premium. In contrast, other sensors like magnet inductive or static Hall-sensors do not meet these demands.

Each sensor in the series is available in various lengths and diameters and comes with a choice of connections. However, functionally all sensors have the same characteristics. The stainless steel sensor housing is sealed at the front and is pressure resistant (>200bar). A flat shaft is available or with a screw-in thread M12x1, M14x1, M14x1,5, M16x1, M16x1,5, M18x1, M18x1,5, M22x1, 5/8-18UNF-2A. Customized dimensions and thread specifications are possible.

To meet the specific requirements of hazardous areas we provide specialized types which are certified for ATEX / IECEx, as well as for other international standards such as UL / CSA and EAC (Russia, Kazakhstan and Belarus Customs Union).

For Ex Zone 0 or 1 we provide an intrinsically safe implementation in conjunction with our Barrier D461, for Ex Zone 2 a non-sparking (non-incendive) variation is available.

### BENEFITS

- Contact-free with a large air gap, so the potential for damage is eliminated
- Wear-free due to its unique design principle
- Maintenance-free during Lifetime, therefore minimized TCO
- Unsusceptible versus external magnetic stray fields and machine vibration
- Operates down to zero speed
- Can not be damaged by faulty wiring
- Almost every target profile can be used
- A5S Sensors do not influence each other, no mounting distance in between is required

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## The various Series and their Range of Application

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### Sensors for Detection of Speed (one speed signal output)

#### Non Hazardous Areas (safe areas)

Appropriate for any speed detection of rotating steel profile, unless the application has a special requirement as listed below. Speed signalized as the frequency of a pulse train.

**Series A5S0DD0**  
**Series A5S0DS0**

#### Ex ia for Hazardous Areas (Zone 0 or 1 locations)

Detection of Speed within hazardous areas Zone 0 or 1. These sensors are intrinsically safe (Ex ia) when connected to our Isolating Barrier units D461. No further precautions required in the hazardous area regarding installation and cabling.

**Series A5S1DD0**  
**Series A5S1DS0**

#### Ex nA for Hazardous Areas (Zone 2 locations)

Detection of Speed within hazardous areas Zone 2. These sensors are non-incendive (non-sparking).

**Series A5S1DD0...-n**  
**Series A5S1DS0...-n**

**Corresponding cables** L3A... (PVC)  
L3T... (Teflon®)

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### Sensors for Detection of Speed and Direction (one speed, one direction signal output)

#### Non Hazardous Areas (safe areas)

Detection of Speed and Direction of Rotation by only one sensor. Speed signalized as the frequency of a pulse train, Direction of Rotation as the high or low state of a binary DC voltage.

**Series A5S0DD3**  
**Series A5S0DS3**

#### Ex ia for Hazardous Areas (Zone 0 or 1 locations)

Detection of Speed and Direction of Rotation within hazardous areas Zone 0 or 1. These sensors are intrinsically safe (Ex ia) when connected to our Isolating Barrier units D461. No further precautions required in the hazardous area regarding installation and cabling.

**Series A5S1DD3**  
**Series A5S1DS3**

#### Ex nA for Hazardous Areas (Zone 2 locations)

Detection of Speed and Direction of Rotation within hazardous areas Zone 2. These sensors are non-incendive (non-sparking).

**Series A5S1DD3...-n**  
**Series A5S1DS3...-n**

**Corresponding cables** L4A... (PVC)  
L4T... (Teflon®)

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### Sensors for Detection of Speed and Direction (two phase-shifted speed signals)

#### Non Hazardous Areas (safe areas)

Detection of Speed and Direction of Rotation providing two phase-shifted speed signals, direction detection in subsequent monitor (with failure detection possible).

**Series A5S0DD4**  
**Series A5S0DS4**

#### Ex ia for Hazardous Areas (Zone 0 or 1 locations)

Detection of Speed and Direction of Rotation (two phase-shifted signals) within hazardous areas Zone 0 or 1. These sensors are intrinsically safe (Ex ia) when connected to our Isolating Barrier units D461. No further precautions required in the hazardous area regarding installation and cabling.

**Series A5S1DD4**  
**Series A5S1DS4**

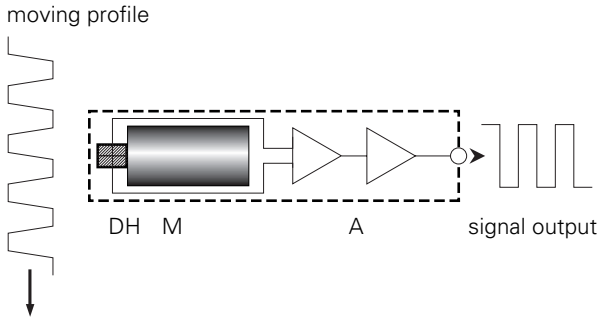
#### Ex nA for Hazardous Areas (Zone 2 locations)

Detection of Speed and Direction of Rotation (two phase-shifted signals) within hazardous areas Zone 2. These sensors are non-incendive (non-sparking).

**Series A5S1DD4...-n**  
**Series A5S1DS4...-n**

**Corresponding cables** L4A... (PVC)  
L4T... (Teflon®)

## Principle of Operation



## The Differential-Hall-Effect Principle

The Hall effect (named for its discoverer) utilizes the fact that a magnetic field generates a voltage within a hall element. Its level is independent of its rate of change (i.e. speed of motion) – unlike the induction effect of magnetic pick-ups, which rely on the rate and therefore are weak at low speed. The sensors A5S... include the necessary magnet (M) and the dual hall element (DH). With the profile passing by, the magnetic field varies, thereby creating the signal voltage within the hall element. Here it is important to keep in mind, that the signal does not fade at low speed.

The principle engages a twin chip hall element and the signal amplifier (A) uses only the difference between both. It is then amplified to provide the power square wave output.

## Its Advantages

By its nature, this differential principle compensates target vibrations. And it diminishes the influence of external magnetic stray field. Both important aspects for a reliable signal. And it operates down to zero speed.

Hazardous Area (Ex)	Signal Frequency	Signal Output
<p>0 = No 1 = Yes</p> <p><b>A5S 0...</b></p>	<p>DD = 0 Hz...25 kHz DS = 0 Hz...12 kHz</p> <p><b>A5S0 DD...</b></p> <p><b>A5S0 DS...</b></p>	<p>0 = 1x Frequency 3 = 1x Frequency / 1x Direction 4 = 2x Frequency, phase shifted</p> <p><b>A5S0DD 0...</b></p> <p><b>A5S0DD 3...</b></p> <p><b>A5S0DD 4...</b></p> <p><b>A5S0DS 0...</b></p> <p><b>A5S0DS 3...</b></p> <p><b>A5S0DS 4...</b></p>
<p><b>Ex ia (intrinsically safe)</b></p> <p>requires Isolating Barrier D461</p> <p><b>A5S 1...</b></p>	<p><b>A5S1 DD...</b></p> <p><b>A5S1 DS...</b></p>	<p><b>A5S1DD 0...</b></p> <p><b>A5S1DD 3...</b></p> <p><b>A5S1DD 4...</b></p> <p><b>A5S1DS 0...</b></p> <p><b>A5S1DS 3...</b></p> <p><b>A5S1DS 4...</b></p>
<p><b>Ex nA (non-incendive)</b></p> <p><b>A5S 1...-n</b></p>	<p><b>A5S1 DD...-n</b></p> <p><b>A5S1 DS...-n</b></p>	<p><b>A5S1DD 0...-n</b></p> <p><b>A5S1DD 3...-n</b></p> <p><b>A5S1DD 4...-n</b></p> <p><b>A5S1DS 0...-n</b></p> <p><b>A5S1DS 3...-n</b></p> <p><b>A5S1DS 4...-n</b></p>

## Application Notes

Each series includes various dimensions and connection types, but all with the same functional characteristics. For details and ordering codes see last page.

### Installation, profile size, and air gap to target

Flush placement into any material possible. The allowed air gap (clearance) to the target depends on its size: with the smallest detectable profile size of module 0.8 (pitch 30) it is <1 mm, a profile size of module 4 (pitch 6) or more allows a maximum air gap of up to 2.5 mm. No mounting distance in between A5S sensors is required.

### Connection Types

All A5S... sensors are available with a hardwired cable attached or with a socket accepting plug-in connectors. This is the easier way to handle a long cable. Such can be provided in PVC (up to 85 °C) or high temperature (up to 125 °C) Teflon® quality. With a straight or angular plug, in metallic enclosure, all tight to IP 67. Or, the connectors only.

For duty under liquids however, or with narrow space applications, the firm cable is the better choice. Available with both insulation qualities and any requested length.

### Target Requirements

#### Target Material

Any standard steel will be accepted, excluding stainless steel or any other non-magnetic material. Slots in a steel profile may be filled with such material, however, or a steel bolt inserted in a non-magnetic part.

#### Target Profile

A standard gear wheel is frequently used, as it is easy to get and to place on the shaft. A split gear wheel must have its division at the bottom between the teeth.

Slots milled into a steel shaft or other rotor also result in a sharp and well defined signal. But care should be taken to have smooth surface and edges. The sensor with its sharp resolution might otherwise respond to scratches or other irregularities.

Care however must be given to a regular position of slots, holes or bolts at the rotor. Irregular distances will result in fluctuating speed measurements. Hexagonal screw heads may result in an irregular pulse division. A slot or such like in the screw head may cause multiple pulses.

### Repeatability of the profile marks

An important factor, specifically with high accuracy and high reliability applications. An irregularity, though covered up by the averaging automatics in our evaluating units may cause a fluctuation in the measurement.

### Profile Size

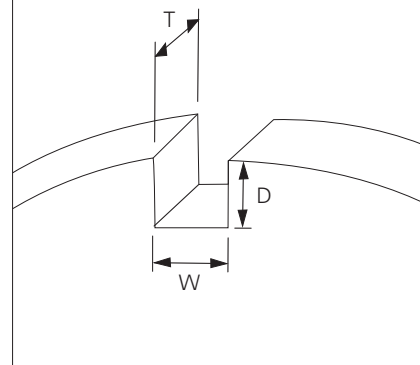
It determines the allowable air gap (clearance) between sensor tip and target. Defined by the slot or cam width (whichever is the shorter), this table gives thumb rules:

Width of slot or cam	Profile height	Allowable max. air gap
> 3 mm	> 4 mm	2 mm
> 5 mm	> 5 mm	2.5 mm

A larger profile is accepted, but does not increase the allowable gap any further. Minimum thickness (T) of target = 10 mm (plus a possible lateral shift). Direction detection requires a minimum width size (W) slot / cam of 3 mm. Speed does not limit the size values.

### Details of Profil Size

D = minimum 3 mm  
T = minimum 10 mm  
W = minimum 3 mm



### Number of poles

Any number of poles is possible. More than 60 poles do not improve the response time to a speed variation.



Figure includes special versions

### Sensor Positioning

A radial orientation of the sensor to the target circumference is recommended. Its position in parallel to the rotational axis, though possible, may involve problems caused by a lateral shift of the target. All specifications refer to the recommended radial position. The differential principle of the A5S... sensors, which diminishes the influence of other magnetic stray fields and machine vibrations, necessitates a correct positioning in reference to the profile on the target. Marking planes at the sensor rear end assist with this, as explained in its instructions. A deviation of up to  $\pm 20$  degrees will be tolerated.

Sensors detecting the sense of rotation reverse their forward / reverse signal by a  $180^\circ$  turn of the sensor. A marking at the sensor end indicates the required position for a given sense of the direction signal.

The allowable air gap (clearance) between sensor tip and profile depends on the profile size (see table).

### Signal Output

Sensors of series A5S... provide a square wave pulse train as their speed signal. The incorporated output amplifier is strong enough to pull up or to sink a load as heavy as 25 mA (push-pull characteristics). With any higher load, specifically if short circuited (to zero or to supply lead), the incorporated limiter responds and cuts off before the sensor can sustain damage. Thus, every A5S... sensor has the ability to transmit over a distance up to 1000 m (3000 ft), up to its high frequency end. For details see Signal Transmission.

If more is required, a unit D461 may be installed after 1000 m transmission or in front of an even heavier load to feed it adequately.

### Signal Frequency

With a regularly divided target profile (and a correspondingly regular output pulse train) the signal frequency in terms of Hz equals the target speed (in terms of RPM) multiplied by the number of poles or teeth and divided by 60.

### Signal Transmission

The characteristics of the transmission line is an important factor. The data given previously refer to a 3 leads screened cable with a lead cross section of  $0.5 \text{ mm}^2$  with  $R < 36 \Omega / \text{km}$  and  $C < 150 \text{ pF/m}$ . The transmission cables we supply are in conformity with this.

Important: Each sensor connection must be individually screened.

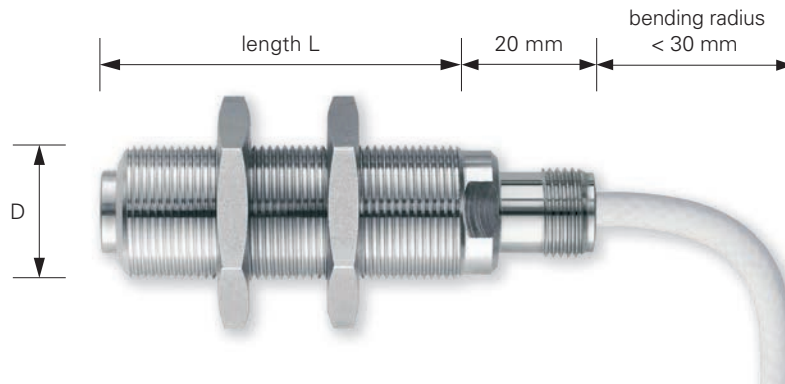
Keep the signal cable clear of interfering sources and do not run it in parallel to power supply cables.

### Shielding and grounding

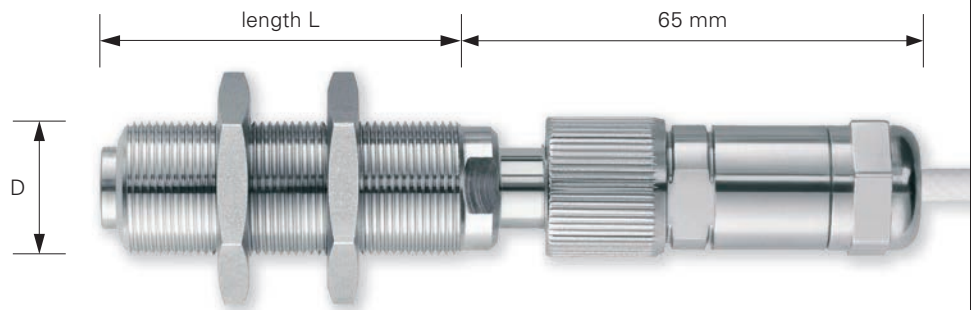
Always use an uninterrupted shield against interferences between sensor and signal evaluation. Connect the shield to a screen bar at the receiving end. With a transmission distance exceeding 5 m a grounding at both ends may be helpful, but may lead to equalizing current due to different ground potentials. Note: The sensor body and the sensor screen are isolated from each other.

# Design Versions

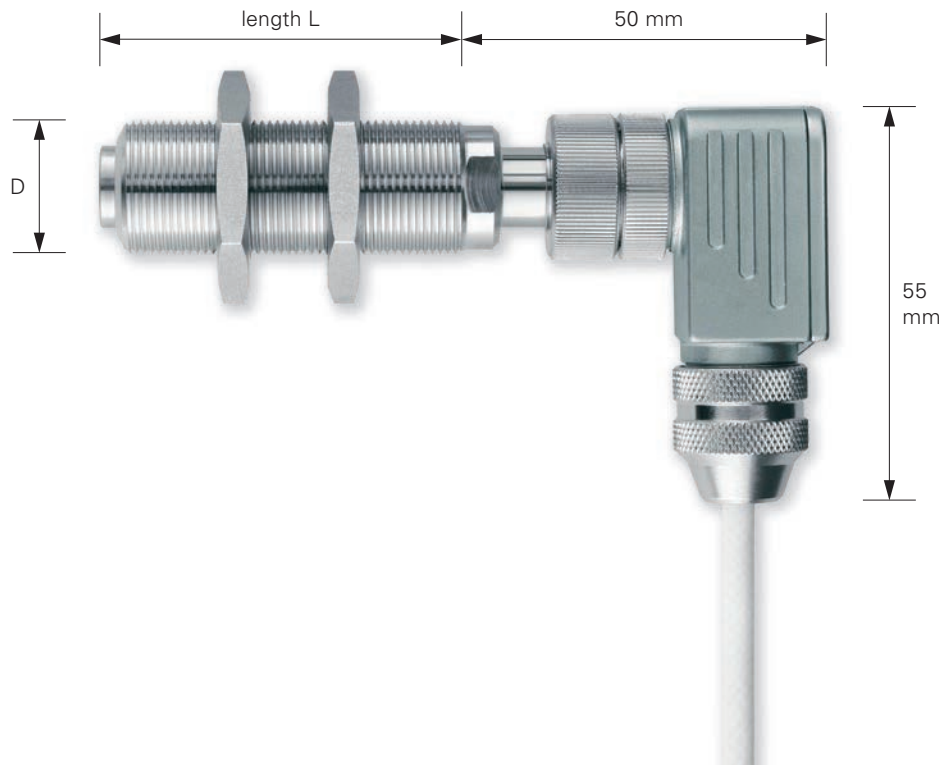
Version with firmly attached cable



Plug-in version shown with straight connector



Plug-in version shown with angled connector



See Ordering Key for available thread diameters D and length L



## Specifications of A5S

<b>Compatibility to Standards</b>	2014/30/EU (EC Electromagnetic Compatibility Directive) 2014/35/EU (EC Low Voltage Directive) 94/9/EC (ATEX Product Directive) EN IEC 61000-6-2, EN IEC 61000-6-4, EN IEC 61010-1 EN IEC 60079-0, EN IEC 60079-11, EN IEC 60079-15 US Standards: National Electrical Code (NEC) dated 2014 UL 60079-0, UL 60079-11, UL 60079-15, UL 913 - 8 <sup>th</sup> edition, UL 61010-1, edition 3 Canadian Standards: Canadian Electrical Code (CEC) dated 2012 CSA C22.2 Nos. 60079-0, 60079-11, 60079-15, 157-92, 213-1987, 61010-1-12, edition 3
<b>Power Supply</b>	For A5S0 Sensors: Supply voltage +5 V...+30 V DC Current approx. 20 mA + load current (may increase with longer distance transmission and high signal frequency up to > 60 mA), Sensor safe against polarity error. For A5S1 Sensors: For Zone 0 or 1 supply voltage by Isolating Barrier D461. For Zone 2 supply voltage +6 V...+30 V DC / min. 40 mA*, max. 120 mA*, *depending on temperature class and connection type (see manual for details)
<b>Signal Output</b>	Square wave with constant high and low level over the entire speed range. Push-pull amplifier output. Max. load 20 mA. Output is short circuit proof and protected versus reverse polarity error.
<b>Signal Frequency</b>	0 Hz...12 kHz, resp. 0 Hz...25 kHz Its low end of 0 Hz allows to monitor the machine down to zero speed.
<b>Response Time</b>	< 20 microseconds
<b>Signal Transmission</b>	Screened cable with a lead cross section of 0.5 mm <sup>2</sup> with R < 36Ω / km and C < 150 pF/m. Connect sensors A5S1... to the high level input of BRAUN units (response level of >7 / <4 V).
<b>Protection Class for Hazardous Area</b>	For A5S0 Sensors: No protection required For A5S1 Sensors: ATEX / IECEx certified for Ex ia IIC T4/T6 Ga (intrinsically safe) UL / CSA certified for Class I, Div 1, groups A, B, C, D (intrinsically safe) with supply voltage provided by BRAUN Isolating Barrier D461 For A5S1...-n Sensors: ATEX / IECEx certified for Ex nA IIC T4/T6 Gc (non-incendive) UL / CSA certified for Class I, Div 2, groups A, B, C, D (non-incendive) with correct supply provided
<b>Protection Grade</b>	IP 67, sealed stainless steel enclosure (1.4305)
<b>Connection Type</b>	Plug-in connection (straight or angular), fixed PVC or Teflon <sup>®</sup> cable
<b>Ambient Temperature</b>	For A5S0 Sensors: -40...+125 °C (-40...+255 °F) With plug-in socket: -40...+85 °C (125 °C at the sensor tip) With fixed PVC cable: -5...+70 °C (125 °C at the sensor tip) With fixed Teflon <sup>®</sup> cable: -40...+125 °C For A5S1 Sensors (Ex ia and Ex nA) see specific brochure and manual for details
<b>Dimensions</b>	Depends on length and shaft diameter of the sensor
<b>Weight</b>	Depends on length and shaft diameter of the sensor (plus fixed cable)
<b>Optional Accessories (cable with connector)</b>	<b>L3A22BO-xm:</b> PVC sensor connecting cable (3 leads) with straight plastic connector <b>L3A23BO-xm:</b> PVC sensor connecting cable (3 leads) with angular plastic connector <b>L3T24MO-xm:</b> Teflon <sup>®</sup> sensor connecting cable (3 leads) with straight metal connector <b>L3T25MO-xm:</b> Teflon <sup>®</sup> sensor connecting cable (3 leads) with angular metal connector <b>L4A08BO-xm:</b> PVC sensor connecting cable (4 leads) with straight plastic connector <b>L4A06BO-xm:</b> PVC sensor connecting cable (4 leads) with angular plastic connector <b>L4T09MO-xm:</b> Teflon <sup>®</sup> sensor connecting cable (4 leads) with straight metal connector <b>L4T10MO-xm:</b> Teflon <sup>®</sup> sensor connecting cable (4 leads) with angular metal connector x = cable length in m
<b>Optional Accessories (connector only)</b>	<b>Bi4F/01:</b> Straight connector (plastic housing) <b>Bi4F/02:</b> Angular connector (plastic housing) <b>Bi4F/05:</b> Straight connector (metal housing) <b>Bi4F/04:</b> Angular connector (metal housing)

## Ordering Key A5S

A5S a b c d e f g i j

### Hazardous Area (Ex)

a = 0 : No (A5S0)  
a = 1 : Yes (A5S1)

### Signal Frequency

b = DD : 0 Hz...25 kHz  
b = DS : 0 Hz...12 kHz

### Signal Output

c = 0 : 1x Frequency  
c = 3 : 1x Frequency / 1x Direction\*  
c = 4 : 2x Frequency, phase shifted\*  
\*minimum nominal thread length 80 mm

### Unit of Shaft Diameter

d = M : Metric  
d = N : Inch and 1/2-NPT at rear end of sensor  
(only in conjunction with Teflon® cable)  
d = U : Inch

### Thread of Shaft Diameter

Standard thread:

e = 1210 : M12x1 (metric)  
e = 1410 : M14x1 (metric)  
e = 1415 : M14x1,5 (metric)  
e = 1610 : M16x1 (metric)  
e = 1615 : M16x1,5 (metric)  
e = 1810 : M18x1 (metric)  
e = 1815 : M18x1,5 (metric)  
e = 2210 : M22x1 (metric)  
e = 5818 : 5/8"-18 (inch)  
other thread or flat shaft on request

### Protection Type

j = -n : A5S1 Ex nA  
(omit for all others)

### Cable Length in -m

i = -1m to -99m\*  
\*obsolete for connection type B  
(plug-in connection)

### Nominal Thread Length in mm

Standard lengths for thread:  
g = 50, 80, 120 : M12x1 (1210)  
g = 50, 154 : M14x1 (1410)  
g = 50, 90, 154 : M14x1,5 (1415)  
g = 48 : M16x1 (1610)  
g = 80, 154 : M16x1,5 (1615)  
g = 48, 94 : M18x1 (1810)  
g = 50, 94 : M18x1,5 (1815)  
g = 48, 94 : M22x1 (2210)  
g = 48, 100, 165 : 5/8"-18 (5818)  
other length on request

### Connection Type

f = B : plug-in connection  
f = C : fixed PVC cable  
f = T : fixed Teflon® cable

## BRAUN – Speed Monitoring and Protection Systems for Rotating Equipment

BRAUN is a worldwide leading supplier of protection systems for rotating equipment in industrial applications that require the highest standards of safety and availability.

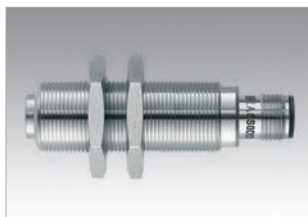
For more than 50 years BRAUN systems have been protecting the facilities of the world's leading companies within the power generation, oil, gas and chemical industries. BRAUN Protection Systems have been installed in over 100 countries worldwide, especially in those areas where rotational equipment safety is of the highest priority.

Our solutions comprise a variety of products for the detection, reporting and monitoring of speed and related parameters.

Always matching the requirement. Always the perfect solution for safety and availability.



PROTECTION SYSTEMS



SPEED SENSORS



TACHOMETERS



PORTABLE TACHOMETERS

**BR** BRAUN  
Speed and Frequency

### BRAUN GMBH

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