A5S sensors – the best choice for demanding applications

The BRAUN Speed Sensors Series A5S are TÜV certified for SIL3 acc. IEC 61508:2010 and therefore meet the high SIL3 standards. The correct choice of sensor is always a prerequisite to achieving a successful solution. Therefore BRAUN A5S sensors base on the proven Differential-Hall-Effect principle. Their low end of 0 Hz allows monitoring 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 (> 200 bars). 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 (the Eurasian Customs Union with Russia, Kazakhstan, and Belarus). 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.
## The various Series and their Range of Application

### 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 is 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®)

### 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 is 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®)

### 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®)
**The Differential-Hall-Effect Principle**

The Hall effect (named after 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. the speed of motion) – unlike the induction effect of magnetic pick-up sensors, which rely on the rate and therefore are weak at low speed. The A5S... sensors 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 dual 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 are important aspects for a reliable signal. And it operates down to zero speed.

---

<table>
<thead>
<tr>
<th>Hazardous Area (Ex)</th>
<th>Signal Frequency</th>
<th>Signal Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = No</td>
<td>DD = 0 Hz...25 kHz</td>
<td>A5S0DD 0...</td>
</tr>
<tr>
<td>1 = Yes</td>
<td>DS = 0 Hz...12 kHz</td>
<td>A5S0DD 3...</td>
</tr>
<tr>
<td>A5S 0...</td>
<td>A5S0 DD...</td>
<td>A5S0DD 4...</td>
</tr>
<tr>
<td></td>
<td>A5S0 DS...</td>
<td>A5S0DS 0...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S0DS 3...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S0DS 4...</td>
</tr>
<tr>
<td>Ex ia (intrinsically safe)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>requires Isolating Barrier D461</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5S 1...</td>
<td>A5S1 DD...</td>
<td>A5S1DD 0...</td>
</tr>
<tr>
<td></td>
<td>A5S1 DS...</td>
<td>A5S1DD 3...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DD 4...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 0...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 3...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 4...</td>
</tr>
<tr>
<td>Ex nA (non-incendive)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5S 1...-n</td>
<td>A5S1 DD...-n</td>
<td>A5S1DD 0...-n</td>
</tr>
<tr>
<td></td>
<td>A5S1 DS...-n</td>
<td>A5S1DD 3...-n</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DD 4...-n</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 0...-n</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 3...-n</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S1DS 4...-n</td>
</tr>
</tbody>
</table>
Application Notes

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

Installation, profile size, and air gap to target
Flush mounting in any material possible. The allowed air gap (clearance) to the target depends on its size: see tables on the right and below. 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. A plug-in connector is the easier way to handle a long cable. Such can be provided in PVC (up to 85 ºC) with plastic connectors or high temperature (up to 125 ºC) Teflon® quality with metal connectors. With a straight or angular plug, in a metallic enclosure, all tight to IP 67. Alternatively, the connectors only.

Profile Size of a Pole Wheel
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:

<table>
<thead>
<tr>
<th>Gear Wheel* Module</th>
<th>Diametral Pitch approx.</th>
<th>Pole Wheel* Width</th>
<th>Allowable air gap</th>
<th>A5S0DS0</th>
<th>A5S0DD0</th>
<th>A5S0DS3 / DS4</th>
<th>A5S0DD3 / DD4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1</td>
<td>25.4 inch</td>
<td>--</td>
<td>0.5 - 0.8 mm</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Module 1.5</td>
<td>16.9 inch</td>
<td>--</td>
<td>0.5 - 1.0 mm</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Module 2</td>
<td>12.7 inch</td>
<td>--</td>
<td>0.8 - 1.5 mm</td>
<td>0.3 - 0.8 mm</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Module 3</td>
<td>8.5 inch</td>
<td>3 mm</td>
<td>0.8 - 2.0 mm</td>
<td>0.3 - 1.2 mm</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Module 4</td>
<td>6.4 inch</td>
<td>4 mm</td>
<td>1.0 - 2.5 mm</td>
<td>0.5 - 1.5 mm</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

* minimum thickness (T) of target = 6 mm

Target Requirements

Target Material
Any standard steel will be accepted, excluding stainless steel or any other non-magnetic material.

Target Profile
Frequently a standard gear wheel is 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. However, care should be taken to have smooth surface and edges. Edges may be sharp but must be deburred. 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 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.

For duty under liquids, however, or for narrow space applications, the firm cable is the better choice. Available with both insulation qualities and any required length.
Sensor Positioning
We recommend a radial orientation of the sensor to the target circumference. 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 of the target. Marking planes at the sensor rear end assist with this, as explained in its manual. A deviation of up to ±20 degrees will be tolerated.

Sensors, detecting the sense of rotation reverse their forward/reverse signal by an 180° 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
A5S... sensors 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 can transmit over a distance up to 500 m (1500 ft), up to its high-frequency end. For details see Signal Transmission.

If more is required, a unit D461 may be installed after 500 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 regarding Hz equals the target speed (regarding RPM) multiplied by the number of poles or teeth and divided by 60.

Signal Transmission
The characteristic of the transmission line is a major factor. The data given previously refer to a 3 lead screened cable with a lead cross section of 0.5 mm² with R < 36 Ω/km and C < 150 pF/m. The transmission cables supplied by BRAUN 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. Do not connect the screen to the connector housing.
Standard Design Versions

Plug-in version shown with straight connector

Plug-in version shown with angled connector

Version with firmly attached cable

NPT-version with fixed Teflon® cable, only for 5/8"-18 (inch) thread

See Ordering Key for available thread diameters D and length L
### Specifications of A5S

#### Conformity to Standards

<table>
<thead>
<tr>
<th>Directives</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014/30/EU (EMC Directive)</td>
<td>EN 61000-6-2, EN 61000-6-4</td>
</tr>
<tr>
<td>2014/35/EU (Low Voltage Directive)</td>
<td>EN 61010-1</td>
</tr>
<tr>
<td>2011/65/EU (RoHS Directive)</td>
<td>EN 50581</td>
</tr>
<tr>
<td>2014/34/EU (ATEX Product Directive)</td>
<td>EN 60079-0, EN 60079-11, EN 60079-15, EN 60079-26</td>
</tr>
</tbody>
</table>

#### Power Supply

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)

#### Signal Output

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 polarity error.

#### Signal Frequency

0 Hz…12 kHz, resp.  
0 Hz…25 kHz  
Its low end of 0 Hz allows to monitor the machine down to zero speed.

#### Signal Transmission

Screened cable with a lead cross section of 0.5 mm² 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).

#### Protection Class for Hazardous Area

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

#### Protection Grade

IP 67, sealed stainless steel enclosure (1.4305)

#### Connection Type

Plug-in connection (straight or angular), fixed PVC or Teflon® cable

#### Ambient Temperature

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® cable: -40...+125 °C

For A5S1 Sensors (Ex ia and Ex nA) see specific brochure and manual for details

#### Dimensions

Depends on length and shaft diameter of the sensor

#### Weight

Depends on length and shaft diameter of the sensor (plus fixed cable)

#### Optional Accessories

**L3A22BO-**x**m:** PVC sensor connecting cable (3 leads) with straight plastic connector  
**L3A23BO-**x**m:** PVC sensor connecting cable (3 leads) with angular plastic connector  
**L3T24MO-**x**m:** Teflon® sensor connecting cable (3 leads) with straight metal connector  
**L3T25MO-**x**m:** Teflon® sensor connecting cable (3 leads) with angular metal connector  
**L4A08BO-**x**m:** PVC sensor connecting cable (4 leads) with straight plastic connector  
**L4A06BO-**x**m:** PVC sensor connecting cable (4 leads) with angular plastic connector  
**L4T09MO-**x**m:** Teflon® sensor connecting cable (4 leads) with straight metal connector  
**L4T10MO-**x**m:** Teflon® sensor connecting cable (4 leads) with angular metal connector

x = cable length in m

**Optional Accessories (connector only)**

- **Bi4F/01:** Straight connector (plastic housing)  
- **Bi4F/02:** Angular connector (plastic housing)  
- **Bi4F/05:** Straight connector (metal housing)  
- **Bi4F/04:** Angular connector (metal housing)
BRAUN – Speed Monitoring and Protection Systems for Rotating Equipment

BRAUN Industrial Electronics develops, produces and sells an array of "Rotating Equipment" protection systems for use in industrial applications worldwide with the focus on overspeed protection. These systems comply with the highest standards of safety and availability.

As a globally leading technology provider with over 50 years of experience, BRAUN has been continually meeting and mastering the challenges associated with protecting the facilities of companies within the power generation, oil, gas, and chemical industries. Our protection systems are installed in more than 100 countries around the world and are mainly used in safety-critical applications with rotating parts.

For our OEM customers, BRAUN is both a solution oriented systems provider and a reliable partner. Our solutions comprise a variety of products for the detection 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