Differential-Hall-Effect based Sensors Ex ia for Detection of Speed and Direction of Rotation in Hazardous Areas Zone 0 or 1
Series A5S1DD3 / A5S1DS3

KEY FEATURES
- SIL3/IEC 61508:2010 certified by TÜV
- Detection of rotational speed and direction of rotation in Hazardous Areas Zone 0 or 1
- Speed range from 0 Hz to 25 kHz
- 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 the 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 polarity error
- Accepting fine and coarse profiles, as gear wheels, slots, cams, holes in any ferrous material

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
- A5S1 Sensors do not influence each other, no mounting distance in between is required

A5S1 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 A5S1 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 A5S1 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 (Ex Zone 0 or 1) 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). A5S1 sensors in conjunction with our Isolating Barrier D461 provide an intrinsically safe implementation to meet these specialized requirements.
Series A5S1DD3 / A5S1DS3 – the various Types and their Characteristics

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

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.

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 A5S1... 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.

### Principle of Operation

- Moving profile
- DH: Magnetic field
- M: Magnet
- A: Amplifier
- Signal output

<table>
<thead>
<tr>
<th>Hazardous Area (Ex)</th>
<th>Signal Frequency</th>
<th>Signal Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = No 1 = Yes</td>
<td>DD = 0 Hz...25 kHz DS = 0 Hz...12 kHz</td>
<td>0 = 1x Frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 = 1x Frequency / 1x Direction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 = 2x Frequency, phase shifted</td>
</tr>
<tr>
<td>A5S 0...</td>
<td></td>
<td>A5S0DD 0...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S0DD 3...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S0DD 4...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A5S0DS 0...</td>
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<tr>
<td></td>
<td></td>
<td>A5S0DS 3...</td>
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<tr>
<td></td>
<td></td>
<td>A5S0DS 4...</td>
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<tr>
<td>A5S 1...</td>
<td></td>
<td>A5S1DD 0...</td>
</tr>
<tr>
<td></td>
<td></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>
</tbody>
</table>

Ex ia (intrinsically safe)
requires Isolating Barrier D461

<table>
<thead>
<tr>
<th>Signal Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5S1DD 0...</td>
</tr>
<tr>
<td>A5S1DD 3...</td>
</tr>
<tr>
<td>A5S1DD 4...</td>
</tr>
<tr>
<td>A5S1DS 0...</td>
</tr>
<tr>
<td>A5S1DS 3...</td>
</tr>
<tr>
<td>A5S1DS 4...</td>
</tr>
</tbody>
</table>

Ex nA (non-incendive)

<table>
<thead>
<tr>
<th>Signal Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>A5S1DD 0...-n</td>
</tr>
<tr>
<td>A5S1DD 3...-n</td>
</tr>
<tr>
<td>A5S1DD 4...-n</td>
</tr>
<tr>
<td>A5S1DS 0...-n</td>
</tr>
<tr>
<td>A5S1DS 3...-n</td>
</tr>
<tr>
<td>A5S1DS 4...-n</td>
</tr>
</tbody>
</table>
Sensor Series A5S1

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 A5S1 sensors is required.

Connection Types
All A5S1... 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 °C) with plastic connectors or high temperature (up to 125 °C) 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>Allowable air gap</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>
</tr>
<tr>
<td>Module 1.5</td>
<td>16.9 inch</td>
<td>--</td>
<td>0.5 - 1.0 mm</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>
</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>
</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>
</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.

Profile Size of a Pole Wheel

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.

Number of poles or teeth
Any number of poles is possible. More than 60 poles do not improve the response time to a speed variation.
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 A5S1... 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
A5S1... 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 A5S1... 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 < 360Ω/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 A5S1DD3 / A5S1DS3

**Power Supply**
For Zone 0 or 1 supply voltage by Isolating Barrier D461. Sensor is protected versus polarity error.

**Signal Output**
Speed signalized as a square wave with constant high and low level over the entire speed range. Direction of rotation signalized as the high or low state of a binary DC voltage. Push-pull amplifier output. Max. load 20 mA. Output is short circuit proof and protected versus polarity error.

**Signal Frequency**
0 Hz…12 kHz (A5S1DS3), resp. 0 Hz…25 kHz (A5S1DD3)
Its low end of 0 Hz allows to monitor the machine down to zero speed.

**Response Time**
< 20 microseconds

**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**
ATEX / IECEx certified for Ex ia IIC T4/6 Ga (intrinsically safe)
UL / CSA certified for Class I, Div 1, groups A, B, C, D, temperature code T4/T6 (intrinsically safe) with supply voltage provided by D461

**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 Temperature Class T4 resp. T6**

<table>
<thead>
<tr>
<th>Class</th>
<th>Connection Type</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4</td>
<td>with plug-in socket</td>
<td>-40...+85 °C (-40...+185 °F), 125 °C at the sensor tip</td>
</tr>
<tr>
<td>T4</td>
<td>with fixed PVC cable</td>
<td>-5...+70 °C (23...+158 °F), 125 °C at the sensor tip</td>
</tr>
<tr>
<td>T4</td>
<td>with fixed Teflon® cable</td>
<td>-40...+125 °C (-40...+255 °F), 125 °C at the sensor tip</td>
</tr>
<tr>
<td>T6</td>
<td>for all types</td>
<td>-5...+60 °C (23...+140 °F), 80 °C at the sensor tip</td>
</tr>
</tbody>
</table>

**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**
(cable with connector)

- L4A08BO-<x>: PVC sensor connecting cable (4 leads) with straight plastic connector
- L4A08BD-<x>: PVC sensor connecting cable (4 leads) with angular plastic connector
- L4T05MO-<x>: Teflon® sensor connecting cable (4 leads) with straight metal connector
- L4T10MO-<x>: 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.