

## Differential-Hall-Effect based Sensors Series A5S...

### Outstanding Characteristics

- Speed range covering most demands: from close to zero up to 25,000 pulses/second (response time < 20 microseconds),
- Accepting fine and coarse profiles, as gear wheels, slots, cams, holes in any ferrous material,
- Clearance to the rotating part up to 4 mm (depending on the profile size),
- Temperature range – 40 °C ...+ 125 °C (- 40 ...+255 °F),
- Differential principle hinders the influence of external magnetic fields and of machine vibration,
- Sealed stainless steel enclosure (1.4305) with protection grade IP67 and allowing > 200 bar pressure to sensor tip. Available for connection via tight plug, or with firmly attached cable (standard or Teflon insulated),
- Powerful square wave output signal equally high over the entire speed range. Level approximately that of the supply voltage. Adequate for signal transmission over more than 500 meters.

### Installation, profile size, and clearance to target

Flush placement into any material, close to an other sensor. The allowed clearance (gap) 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 gap of nearly 4 mm.

Note: An ambient temperature of > 90 °C or < 0° C, and a signal frequency < 10 Hz or > 10 kHz reduces the maximum gap by approx. 20 %.

The advantageous differential principle requires adjustment of the sensor to as position approximately parallel ( $\pm 20^\circ$ ) to the target profile edges, as indicated by its wrench planes. See Operating Instructions for details.

**Please pay special attention to the application notes at the end of this section.**

### The Various Series and their Range of Application

#### Series A5S05... A5S09...

Appropriate for any speed detection, unless the application has a special requirement as listed below.

#### Series A5S10... A5S13...

Speed Detection within Explosion Hazardous areas. These sensors are intrinsically safe when connected to our barrier units D461. No further precautions required in the Ex-area, with installation and cabling.

#### Series A5S30... A5S33...

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

#### Series A5S14... A5S17...

For speed and direction sensing as A5S30... A5S33..., but under intrinsically safety requirements for Ex-hazardous areas.

#### Series A5S40... A5S43...

Providing 2 phase-shifted speed pulse trains, for a separate direction detection with failure detection.

Each series includes several differing dimensions and connection modes, but all with the same functional characteristics. For details and ordering Nos. see the following pages.

### Connection Modes

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 standard (up to 85 °C) or high temp (up to 125 °C) Teflon quality. With a straight or angular plug, in metallic or plastic 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.

### Function Principle

The Hall effect (named for its discoverer) utilizes the fact, that a magnetic field may generate a voltage within a semi-conductor. And does this 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.

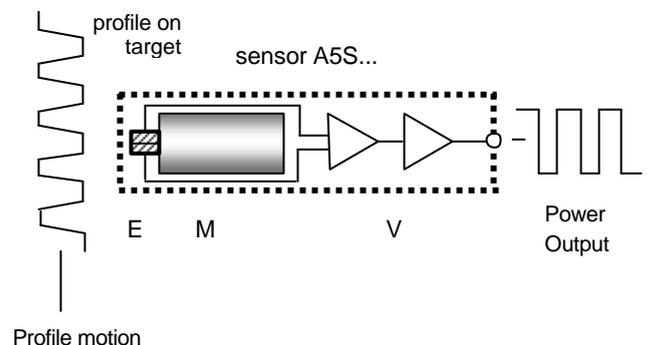
The sensors A5S... include the necessary magnet (M) and the hall element chip (E). With the profile passing by, the magnetic field varies, thereby creating the signal voltage within the chip. Here it is important to keep in mind, that the signal does not fade at low speed.

### The Differential Hall Effect Principle

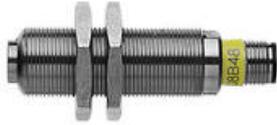
It engages a twin chip hall element, and the signal amplifier (V) uses only the difference between both. It is then amplified to provide the power square wave output.

### Its Advantages:

By its nature, this differential principle compensates target vibrations. And it balances an external magnetic field. Both important aspects for a reliable signal.



Design Versions



sensor without connector



sensor with straight plug-in connector and cable



sensor with angled plug-in connector and cable



Sensor with hardwire cable attached

**Sensor Series A5S... A5S09..**
**Application**

Standard for speed detection with a single trace output.

**Output signal**

Square wave pulses with sequence according to the target profile (1:1 with a standard gear). Amplitude (without load) close to supply voltage. Its power output pulls or sinks a load as heavy as 25 ma. This allows a transmission distance of more than 500 meters (= 1500 ft), allowing a high frequency = 15 kHz. The output level then drops by approximately 2 volts only. Output protected against short circuit.

**Power Supply**

Supply voltage + 5 volts ...+ 30 volts DC. Current approx. 15 ma + load current (may increase with large distance transmission and high signal frequency up to 60 ma). Safe against polarity error.

**Dimensions**

A number of different metric and UNF mounting threads (D) are available, with varied length (L). The opposite table lists the preference dimensions.

Customized dimensions have a longer lead time, and a higher price.

In addition, we offer a version with smooth shaft (16 mm Ø), mounting by means of a seal packing.

**Preference Dimensions**

Dimensional drawings on last page.

Mounting thread D	Thread length L (mm)	Series No.
M12x1	50,80,120	A5S07
M14x1,5	50,90,154,204	A5S05
M18x1	48,94	A5S08
M22x1	48,94	A5S09
5/8-18UNF2A	48	A5S08...A
5/8-18UNF2A	38	A5S08...B *
5/8-18UNF2A	38,48,100,165	A5S08...C **

\*) with hexagonal rear flange end and firmly attached PTFE (Teflon) cable.

\*\*) with hexagonal rear flange, 1/2 NPT inside thread, and firmly attached PTFE (Teflon) cable.

Specific sheets are available for these versions.

**Sensor Series A5S10... A5S13...**
**Application**

Speed detection within a hazardous area.

**Protection Class**

Approved for Intrinsic Safety according to ATEX as II 1 G EEx ia IIC T4 / T6 with correct supply provided.

**Dimensions**

A number of different metric and UNF mounting threads (D) are available, with varied length (L). The opposite table lists the preference dimensions.

Customized dimensions have a longer lead time, and a higher price.

In addition, we offer a version with smooth shaft (16 mm Ø), mounting by means of a seal packing.

**Output signal**

Square wave pulses with sequence according to the target profile (1:1 with a standard gear). Amplitude (without load) close to supply voltage. Its power stage pulls up or sinks a load as heavy as 25 ma. This allows a transmission distance of more than 500 meters (= 1500 ft), allowing a high frequency= 15 kHz. The output level then drops by approximately 2 volts, only. Output protected against short circuit.

Our recommended Isolating Barrier D461 provides a square wave output of 24 v level and an additional path allowing sensor supply monitoring.

**Power Supply**

By an approved source ensuring max +9.9 v and 64 ma. We recommend our Isolating Barrier D461, which additionally ensures the Intrinsically safe signal path. See section under "Units for permanent installation".

**Preference Dimensions**

Dimensional drawings on last page.

Mounting thread D	Thread length L (mm)	Series No.
M12x1	50,80,120	A5S12
M14x1,5	50,90,154,204	A5S13
M18x1	48,94	A5S10
M22x1	48,94	A5S11
5/8-18UNF2A	48	A5S10...A
5/8-18UNF2A	38,48,100,165	A5S10...C *

\*) with hexagonal rear flange, 1/2 NPT inside thread, and firmly attached PTFE (Teflon) cable.

Specific sheets are available for these versions.

**Sensor Series A5S30... A5S33..**
**Application**

Detection of speed and sense of rotation by a single sensor. Immediate response to motion reverse. Fitting our evaluating units D124.1S2 and systems E16. For use on pumps, turn gears, machine tools, test installations.

**Signal outputs**

Speed signal as square wave pulses with sequence according to the target profile (1:1 with a standard gear wheel). Sense of rotation as a DC-binary signal (high = forward, low = reverse).

Amplitude (without load) close to supply voltage. Its power stage pulls up or sinks a load as heavy as 25 ma. The output level then drops by approximately 2 volts only. Outputs protected against short circuit.

**Principle of direction detecting**

The sensor includes two Differential- Hall-Effect elements. They sequentially detect the profile edges passing. From the time sequence, the logic calculates the actual sense of their motion, converting it into a high/low state of the output. Thereby, it immediately detects a reversal after any edge, independent of the shape of the profile. Minimum division size 6 mm.

A delay or hysteresis in response, if required, may be introduced by the evaluating unit.

**Power Supply**

Supply voltage + 5 volts ...+ 30 volts 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.

**Dimensions**

A number of different metric and UNF mounting threads (D) are available, with varied length (L). The table lists the preference dimensions.

Customized dimensions have a longer lead time, and a higher price.

In addition, we offer a version with smooth shaft (16 mm Ø), mounting by means of a seal packing.

**Preference Dimensions**

Dimensional drawings on last page.

Mounting thread D	Thread length L (mm)	Series No.
M12x1	80,120	A5S33
M14x1,5	90,154,204	A5S31
M18x1	94	A5S30
M22x1	94	A5S32
5/8-18UNF2A	100	A5S30...A

**Sensor Series A5S14...A5S17..**

**Application**

Detection of speed and sense of rotation by a single sensor, within a hazardous area, at a feeding pump, for instance. Response to a reverse of motion is immediate. Characteristics similar to series A5S30...A5S33.., but as an intrinsically safe device.

**Protection Class**

Approved for Intrinsic Safety according to ATEX as II 1 G EEx ia IIC T4 / T6 with correct supply provided.

**Power Supply**

By an approved source ensuring max +9.9 v and 64 ma. We recommend our Isolating Barrier D461.21, which additionally ensures Intrinsically safe signal paths. See section under "Units for permanent installation".

**Signal outputs**

Speed signal as square wave pulses with sequence according to the target profile (1:1 with a standard gear wheel). Sense of rotation as a DC-binary signal (high = forward, low = reverse).  
Amplitude (without load) close to supply voltage. Its power stage pulls up or sinks a load as heavy as 25 ma. The output level then drops by approximately 2 volts only. Outputs protected against short circuit.

Our recommended Isolating Barrier D461.21 provides outputs of 24 v level and an additional path allowing sensor supply monitoring.

**Dimensions**

A number of different metric and UNF mounting threads (D) are available, with varied length (L). The table lists the preference dimensions.

Customized dimensions have a longer lead time, and a higher price.

In addition, we offer a version with smooth shaft (16 mm Ø), mounting by means of a sealing packing.

**Preference Dimensions**

Dimensional drawings on last page.

Mounting thread D	Thread length L (mm)	Series No.
M12x1	80, 120	A5S14
M14x1,5	90,154,204	A5S16
M18x1	94	A5S15
M22x1	94	A5S17
5/8-18UNF2A	100	A5S15...A

**Sensor Series A5S40... A5S43...**

**Application**

Speed detection providing two phase shifted pulse series. For speed and sense of rotation monitoring, at pumps or other installations, requiring double trace pulses for a direction signal with failure detection. Evaluation by series 224.1S2, for instance.

**Output signals**

2 phase shifted square wave pulse series with sequence determined by the target profile (1:1 with a standard gear wheel). Amplitude (without load) close to supply voltage. Their power pulls up or sinks a load as heavy as 25 ma. This allows a transmission distance over more than 500 meters( = 1500 ft), allowing a high frequency = 15 kHz. The output level then drops by approximately 2 volts only. Output protected against short circuit.

The phase shift between both pulse series depends on the target profile. With a gear wheel of module 2 it is approximately 90 degrees, at any speed.

**Power Supply**

Supply voltage + 5 volts ...+ 30 volts 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.

**Dimensions**

A number of different metric and UNF mounting threads (D) are available, with varied length (L). The table lists the preference dimensions.

Customized dimensions have a longer lead time, and a higher price.

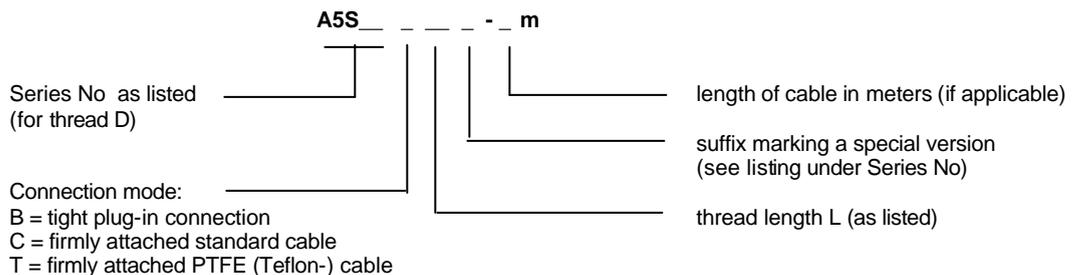
In addition, we offer a version with smooth shaft (16 mm Ø), mounting by means of a sealing packing.

**Preference Dimensions**

Dimensional drawings on last page.

Mounting thread D	Thread length L (mm)	Series No.
M12x1	80, 120	A5S43
M14x1,5	90,154,204	A5S41
M18x1	94	A5S42
M22x1	94	A5S43
5/8-18UNF2A	100	A5S42...A

**Key to Ordering Nos.**



**Application Notes to series A5S..**

**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.

This rule does not apply, if the target as wheel or shaft is divided into slots or cams with unequal length. Instead, the response time of the sensor should be compared to the period of time by which the slot or cam (whatever is the shorter) passes in front of the sensor element, at maximum speed.

Whatever the case, with a maximum frequency of 25000 Hz and a response time of <20 microseconds, any sensor of the A5S.. series will serve every application. Its low end of 0.05 Hz allows the operation close to machine stop.

**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 of more than 500 meters (1500 ft), up to its high frequency end. For details see Signal Transmission.

If more is required, a unit D461.11 may be installed after 500 meters transmission, or in front of an even heavier load, to feed it adequately.

**Shielding and grounding**

Always use an uninterrupted shield against interferences between sensor and signal evaluation. Connect the shield to ground (PE) at the receiving end. With a transmission distance exceeding 5 m a grounding at both ends may be helpful.

Note: The sensor body and the sensor zero are isolated from each other.

**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 mm<sup>2</sup> with R < 36 O/km and C < 150 pF/m. The transmission cables we supply are in conformity with this.

Connect these sensors A5S.. to the high level input of our units (response level of >7/<4volts).

To terminate a long transmission line, a load resistor of 10 kO each is recommended between the signal lead and both + supply and zero.

Important: Never transmit several different signals under one common screen.

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

**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 helps to hinder the influence of other magnetic 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 ±20 degrees will be tolerated.

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

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

**Requirements to the target**

**Target material**

Any standard steel will be accepted, but not stainless steel (as non-magnetic), and not a non-ferrous material. Slots in a steel profile may be filled with such material, however, or a steel bolt inserted in a non-magnetic part.

Single permanent magnets inserted into a non-magnetic rotor will also trigger the sensor, and may even allow for a somewhat larger gap.

**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 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 should also be given to a regular position of slots, holes, or bolts at the rotor. 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. And the pulse divider, compensating any irregularity, will affect the fast response of the unit.

The same accuracy, as requested for the measurement, should apply to the profile division.

**Profile size**

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

(all dimensions by mm)

Width of slot or cam	Profile height	Allowable max. gap
> 1.3	> 2	0.8
> 3	> 4	2
> 5	> 5	3
> 8	> 6	4

A larger profile is accepted, but does not increase the allowable gap any further. Minimum thickness of target = 5 mm (plus a possible lateral shift). Direction detection requires a minimum size slot/cam of 3 mm. Speed does not limit the size values.

**Number of poles**

This is of importance mainly when measuring a low speed. By nature, the measurement cannot react to a variation before the next pole is detected.

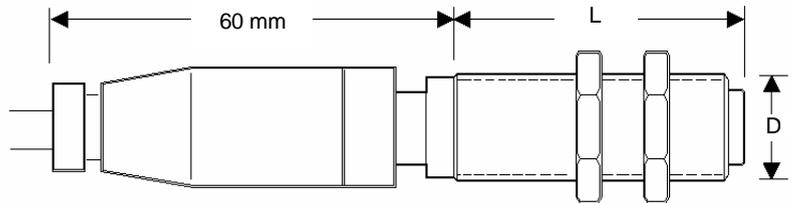
At higher speed the period automatics maintains a programmed response time. See our literature about measurement for further details.

An increase in the number of poles does not contribute to higher measuring accuracy with our units, but it might help in their fast reaction.

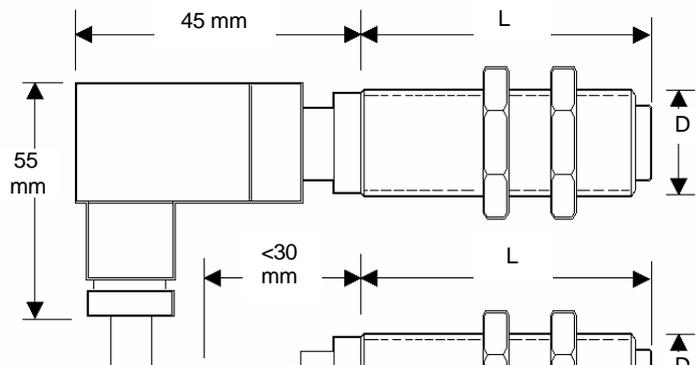
**Dimensions of different versions A5S...**

See tables in the series No. sections for available thread diameters D and length L

**Plug-in version shown with straight connector**



**Plug-in version shown with angled connector**



**Version with firmly attached cable**

