**SIL 3 / PL e**

# SIL VR SENSORS

## for Overspeed Protection

## Important Information for this Document

**DANGER:**

This datasheet is only for product information. It don't replaces the safety manual with all safety instructions and precautions of the plant which must be followed.

Failure to observe these instructions may cause damage to the product, personal injury and/or property damage, and voiding the factory warranty.

Installation, operation and work on or with this product must be performed by qualified personnel only. Unqualified personnel working on or with this product can cause hazardous situations.

JAQUET Technology Group Ltd. does not assume liability for loss or damage resulting from improper handling, installation or misuse of products.

## Product ID

| Type # | Product # | Drawing # |
|---|---|---|
| DSE 1010.07 SHZ SIL | 3042611632 | 124551 |
| DSE 1210.35 SHZ SIL | 3042611633 | 124555 |
| DSE 1620.01 AHZ SIL | 3042611338 | 124088 |
| DSE EH20.06 AHZ SIL | 3042610990 | 124088 |
| DSE EH20.07 AHZ SIL | 3042611336 | 124088 |
| DSE EH20.08 AHZ SIL | 3042611337 | 124088 |

## General

**Function**

The DSE xx20.xx AHZ SIL and DSE xx10.xx SHZ SIL series single channel variable reluctance (VR) speed sensors consist of an iron core, an inductive coil and a permanent magnet. A ferrous pole wheel passing the sensor face changes the magnetic field strength, resulting in an AC voltage being induced in the coil, which is directly available at the sensor output. The time delay of the sensor is negligible. The frequency of the output signal is proportional to the speed of the moving target. The amplitude of the signal depends on angular speed, air gap, target geometry, magnetic properties of target material and the electrical load. VR sensors, also known as passive or electromagnetic sensors, do not require an external supply.

**Directives**

The sensors are compliant with the directives 2004/108/EC and 2011/65/EC

**Certification**

The sensors from the following table are compliant with the standards API612:2005 sixth edition and API670:2000 fourth edition.

| Type # |
|---|
| DSE 1620.01 AHZ SIL |
| DSE EH20.06 AHZ SIL |
| DSE EH20.07 AHZ SIL |
| DSE EH20.08 AHZ SIL |

## Technical data

**Coil Properties**

There are three different coil systems available to provide the optimal sensor for each individual application

| Coil system type | Pole piece diameter | Inductance @ 1 kHz | Resistance @ 25°C | Magnet polarity |
|---|---|---|---|---|
| A | 4.8mm | 70mH ± 15% | 205Ω ± 15% | north pole towards front face |
| B | 3.0mm | 50mH ± 15% | 230Ω ± 15% | north pole towards front face |
| C | 2.7mm | 140mH ± 15% | 850Ω ± 15% | north pole towards front face |

The following table assigns the coil system to the sensor type:

| Sensor type | Coil system type |
|---|---|
| DSE 1010.07 SHZ SIL | C |
| DSE 1210.35 SHZ SIL | B |
| DSE 1620.01 AHZ SIL | A |
| DSE EH20.06 AHZ SIL | A |
| DSE EH20.07 AHZ SIL | A |
| DSE EH20.08 AHZ SIL | A |

**Signal Polarity**

According to drawing.

Signal output

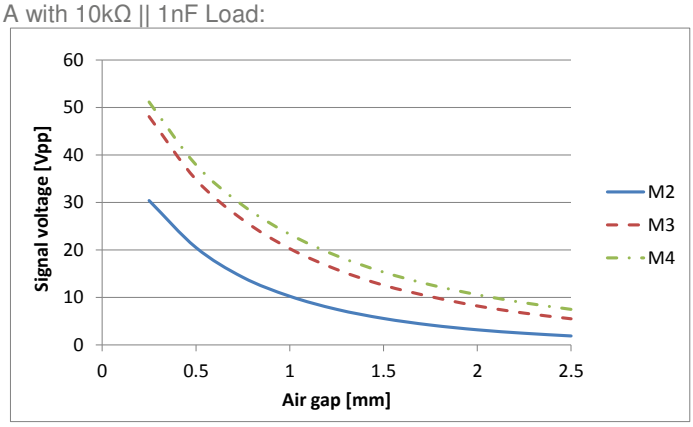
Using a sensor together with a toothed wheel having an involute gear form will generate a sinusoidal signal. Analyzing the frequency will determine the rotational speed. The signal amplitude is proportional to the rate of change of magnetic flux generated by the pole wheel. In principle, it depends on the following parameters:

- Circumferential velocity of the toothed wheel
- Module of the toothed wheel
- Air gap between toothed wheel and sensor's front surface
- Load impedance applied to the sensor The recommended minimum load resistance is given in the following table:

| Coil system type | Load resistance |
|---|---|
| A | 2.6kΩ |
| B | 2.8kΩ |
| C | 10kΩ |

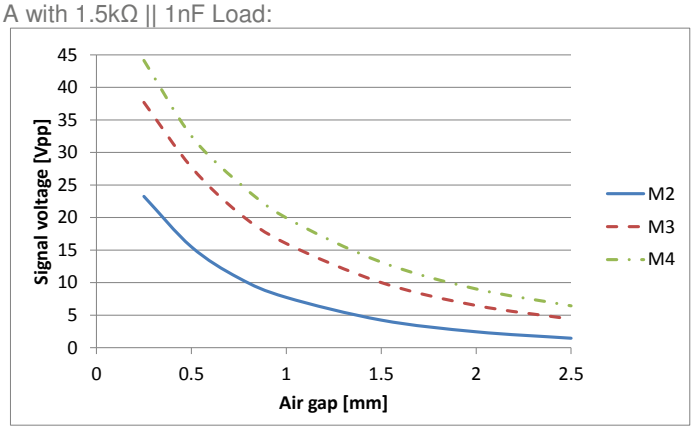
Signal graphs

Coil System A with 10kΩ || 1nF Load:

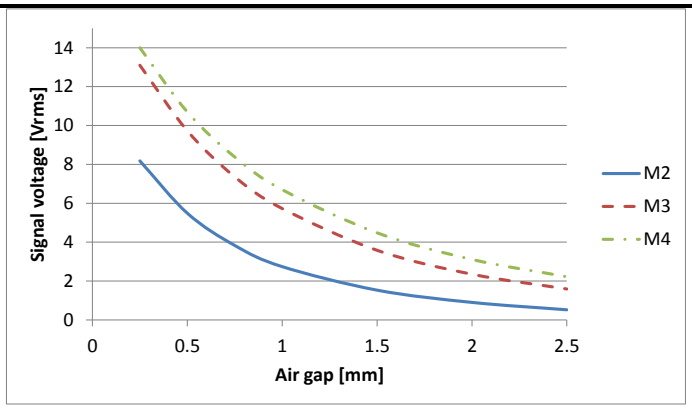



Typical sensor output voltage (peak-to-peak) for 15m/s

Coil System A with 1.5kΩ || 1nF Load:

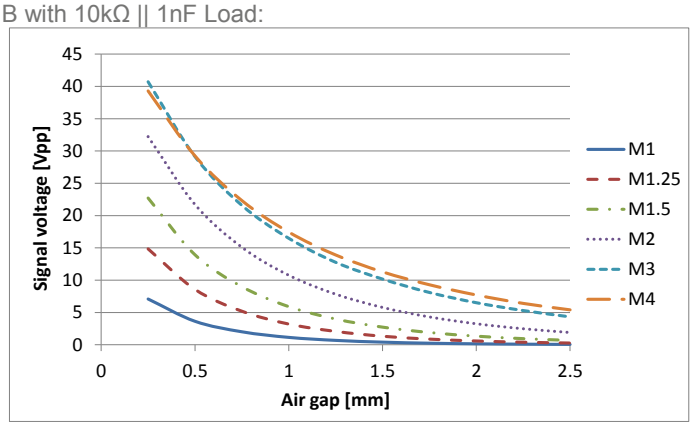



Typical sensor output voltage (peak-to-peak) for 15m/s



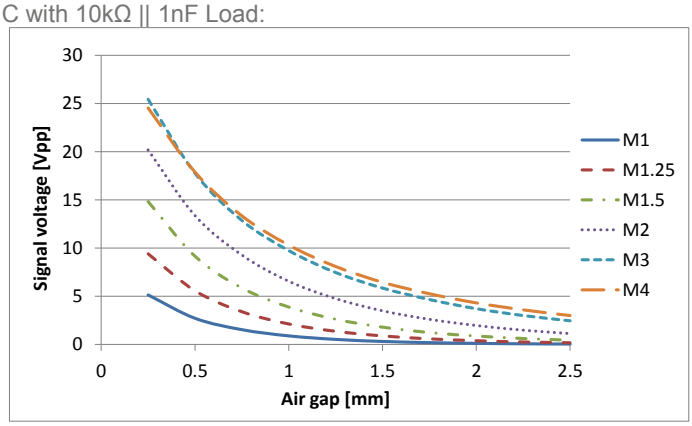

Typical sensor output voltage (rms) for 15m/s

Coil System B with 10kΩ || 1nF Load:



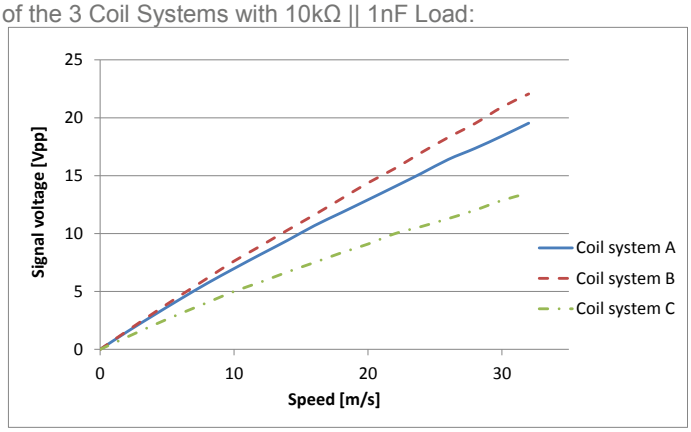

Typical sensor output voltage (peak-to-peak) for 15m/s

Coil System C with 10kΩ || 1nF Load:




Typical sensor output voltage (peak-to-peak) for 15m/s

Comparison of the 3 Coil Systems with 10kΩ || 1nF Load:




| | |
|---|---|
| Frequency range | The minimum and maximum frequency is dependent on the application (pole wheel, air gap, OSPS trigger level, etc.). |
| EMC | These sensors have been validated for the following EMC conditions. Tests have been performed with increased requirements for safety products with either a longer test time or a greater number of test impulses (acc. to IEC 61326-3-1).<br><br>Electrostatic discharge according to IEC 61000-4-2 and IEC 61326-3-1:<br>• Up to ± 8 kV air discharge<br>• Up to ± 6 kV contact discharge<br>Electrical fast transients/bursts according to IEC 61000-4-4 and IEC 61326-3-1 direct coupling:<br>• Toothed Up to ± 2 kV peak, 5/50 ns, 5 kHz, 75ms<br>Surges according to IEC 61000-4-5 and IEC 61326-3-1:<br>• ± 2 kV 1.2/50 µs (line to ground)<br>• ± 1 kV 1.2/50 µs (line to line)<br><br>EMC conformity of the sensor in combination with the OSPS is the responsibility of the end user. This is dependent upon more than the sensor alone (e.g. cables, input circuit, overall design of the overspeed protection circuit, etc.). |
| Housing | The housing is composed of 1.4301 or 1.4305 stainless steel and the front side is hermetically sealed and resistant to splashing water, oil, conducting carbon or ferrous dust and salt mist. Electronic components are potted in chemical and aging resistant synthetic resin.<br><br>Dimensions are according to sensor dimensional drawing.<br><br>Max. tightening torque:<br>2 Nm for M10x1.25<br>8 Nm for M16x1.5<br>8 Nm for 5/8”-18 UNF-2A |
| Pole wheel | Speed measurements are possible under the following target conditions:<br>• Toothed wheel of a magnetically permeable material (e.g. Steel 1.0036).<br>• Wheel with involute gear<br>Minimum module dimensions are as follows: |

| Coil system type | Pole wheel dimension |
|---|---|
| A | Module 2 and bigger |
| B | Module 1.25 and bigger |
| C | Module 1 and bigger |

**Air gap**

The air gap between the sensor and the pole wheel depends on the lowest circumferential speed which must be detected and the OSPS trigger level. The air gap needs to be adjusted to ensure that the signal amplitude is matched to the allowable minimum and maximum voltage limits of the OSPS.

The smallest possible pole wheel to sensor air gap should be implemented. However, the air gap should be set to prevent the face of the sensor from touching the pole wheel. Therefore the recommended minimum air gap is 0.2mm, but it can be higher if eccentricity or vibration of the target occurs.

**Operation Altitude**

Sensors have been validated for the following environmental conditions
0 to 4850m above sea level acc. to IEC 60068-2-13

**Insulation**

Housing and electronics are electrically isolated (500V/50Hz/1min).

**Protection class**

| Sensor type | Sensor head | Connector / cable output |
|---|---|---|
| DSE 1010.07 SHZ SIL | IP68 | IP68 |
| DSE 1210.35 SHZ SIL | IP68 | IP67 |
| DSE xx20.xx AHZ SIL | IP68 | IP54 (with mating connector MS3106F-10SL-4S) |

**Vibration & shock immunity**

Sine sweep: ± 0.35mm in the range 5 to 57Hz,
5g in the range of 57 to 2000Hz, 1 oct/min, 10 cycles acc. to IEC 60068-2-6
Noise: 0.0125g2/Hz in the range of 5 to 2000Hz, 30 min/axis acc. to IEC 60068-2-64
50g for 11ms, half sine wave, 3 shocks + and - for 3 axes,
shocks total acc. to IEC 60068-2-27

**Temperature**

Operating temperature of the sensor: -40° ... +150°C
Relative humidity in ambient atmosphere: 95% maximum

**Connection type**

| Sensor type | Connector type |
|---|---|
| DSE 1010.07 SHZ SIL | - |
| DSE 1210.35 SHZ SIL | - |
| DSE xx20.xx AHZ SIL | Integrated 2-pin-connector mates with MS3106A-10SL-4S or MS3106F-10SL-4S |

**Cable**

| Sensor type | Cable type |
|---|---|
| DSE 1010.07 SHZ SIL | PTFE cable, 3-wire, 0.21 mm² (AWG 24), outer-Ø max. 3.85 mm, bending radius min. 60 mm, shielded (metal braid), green |
| DSE 1210.35 SHZ SIL | PTFE cable, 3-wire, 0.21 mm² (AWG 24), outer-Ø max. 3.85 mm, bending radius min. 60 mm, shielded (metal braid), green |
| DSE xx20.xx AHZ SIL | - |

## Further Information

| | |
|---|---|
| Safety | All mechanical installations must be carried out by an expert. General safety requirements have to be met. |
| Connection | The sensors must be connected according to sensor drawing.<br><br>The Sensor wires are susceptible to radiated noise. Therefore the following points must be considered when connecting a sensor:<br>• The sensor cables must have an integrated shield with at least 80% mesh density connected to the OSPS.<br>• The sensor cables must be positioned as far as possible from large electrical machines.<br>• The sensor cables must not run in the vicinity of power cables.<br>• All signal cables need to be installed separately, not in a single bundle.<br><br>The following table defines the maximum total cable length allowed for each sensor type: |

| Sensor type | Maximum cable length |
|---|---|
| DSE 1010.07 SHZ SIL | 20m |
| DSE 1210.35 SHZ SIL | 50m |
| DSE 1620.01 AHZ SIL | 300m |
| DSE EH20.06 AHZ SIL | 300m |
| DSE EH20.07 AHZ SIL | 300m |
| DSE EH20.08 AHZ SIL | 300m |

| | |
|---|---|
| Installation | All mechanical installations must be carried out by an expert. General safety requirements must be met.<br><br>It is forbidden to install damaged sensors. The sensor must be aligned to the pole wheel according to the sensor drawing. Any deviation in positioning may affect the performance and decrease the noise immunity of the sensor. The signal amplitude of a VR sensor decreases with increasing air gap.<br><br>The sensor shall be positioned such that the center of the sensor face corresponds to the middle of a pole wheel tooth.<br><br>A solid and vibration free mounting of the sensor is important. Sensor vibration relative to the pole wheel may add extraneous and/or spurious noise to the signal.<br><br>The end user must guarantee that the sensors are installed correctly and according to the regulations of the corresponding application. Under no circumstances shall the sensors become disengaged from their mountings. |
| Maintenance | Product cannot be repaired. |
| Transport | These sensors must be handled with care to prevent damage of the front face. It is prohibited to use the sensor if it is dropped from a height of more than 1 m. If the sensor ha to be transported, the original single sensor packaging has to be used. |
| Storage | Product must be stored in dry conditions. The storage temperature corresponds to the operation temperature. |
| Disposal | In case of a failure or unusual behavior of a sensor in the field, the operator is obliged to replace the damaged product, report the failure to JAQUET Technology Group Ltd. and return the broken or failed sensor back to JAQUET Technology Group Ltd.<br><br>After the lifetime of the sensor has been reached, the product must not be used anymore and must be replaced. |

## Functional safety

### Introduction

The sensors, which are listed on page 1 of this document, have been developed according to the safety standards IEC 61508, IEC 61511, ANSI/ISA 84.00.01 and ISO 13849-1. The sensors are certified by TÜV SÜD Rail GmbH Munich to be used in SIL2 and SIL3 applications, according to IEC 61508, IEC 61511 and ANSI/ISA 84.00.01. Additionally, the sensors are certified by TÜV SÜD to be used up to PLe applications, according to ISO 13849-1.

The SIL certificate and the corresponding report on the certificate can be viewed and downloaded on the internet: www.jaquet.com

The sensors are designed to be integrated into a safety-related system or subsystem. Voting between individual sensors is required in accordance to IEC 61508 SIL2/SIL3 and ISO 13849-1 CAT 3 PLe. Impedance measurement to detect open circuit and channel trips shall be realized in accordance to IEC 61508 SIL2/SIL3 and ISO 13849-1 CAT 3 PLe.

### Configuration

To guarantee conformity to functional safety, the sensors must be used in a redundant structure of at least 2 sensors. Depending on the overall safety requirements, several configurations are possible (1oo2, 2oo3, 2oo4, etc.).

The sensors themselves do not have any integrated diagnostics. They safely deliver the tooth frequency to the over speed protection system.

The sensors can be used in either “low demand mode” or “high demand / continuous mode”.

The requirements to the Over Speed Protection System (OSPS) are listed in the safety manual

### Generic Safety Parameters

The following generic safety parameters are valid:

| | |
|---|---|
| DC | 94.0 % |
| SFF | 94.0 % |
| Element type | Type A |
| MTTR | 72h |
| Lifetime | 10 years |
| Systematic capability | SIL3 |

The following chapters show various configuration possibilities and their configuration dependent safety parameters. The list below is not exhaustive. Safety parameters for other configurations can be calculated from the failure rate data of a single sensor.

### Parameters according to IEC 61508

The sensors are compliant with SIL3 with the following values:

| **Configuration** | | **1oo2** | **2oo3** | **1oo3** | **2oo4** |
|---|---|---|---|---|---|
| HFT | | 1 | 1 | 2 | 2 |
| PFH > … · E-09 h-1 | | 0.8 | 1.2 | 0.4 | 0.5 |
| PFDavg > … · E-06 | @ T1 = 0.5 years | 3.3 | 5.0 | 1.7 | 1.7 |
| PFDavg > … · E-06 | @ T1 = 0.75 years | 5.0 | 7.5 | 2.5 | 3.0 |
| PFDavg > … · E-06 | @ T1 = 1 year | 6.6 | 10 | 3.3 | 4.0 |
| PFDavg > … · E-06 | @ T1 = 2 years | 13 | 20 | 6.6 | 7.9 |
| PFDavg > … · E-06 | @ T1 = 10 years | 66 | 100 | 33 | 40 |
| β | | 2.0 % | 3.0% | 1.0% | 1.2 % |
| βD | | 2.0 % | 3.0% | 1.0% | 1.2 % |
| SIL | | SIL3 | SIL3 | SIL3 | SIL3 |

Parameters according to ISO 13849

| | |
|---|---|
| $MTTF_d$ | > 100 years (high), (calculated 4309 years) |
| DC | 94 % (medium) |
| Category | Cat. 3 |
| Performance Level | PL e |

MTTFd is valid for one channel with a 1oo2 configuration according to ISO 13849.

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