

MEMS Capacitive Accelerometers

# Data sheet

## VS9000.D

30S.VS9000.G.12.09

### Features

**Extra small LCC20 packaging (8.9mm x 8.9mm)**  
**±2g to ±200g Full Scale Range**  
**Large bandwidth (DC to > 1.0 kHz @ 5%)**  
**Excellent long term stability**  
**Harsh Environment (shock, vibration, temperature)**  
**Low power analog voltage output**  
**Brown out protected**  
**Integrated temperature sensor**

### Applications

**Vibration sensing**

- Helicopter & Aircraft testing
- Aerospace structural/modal analysis
- Aerospace flight & flutter testing
- HUMS
- Automotive testing & crash test
- Railway technology
- Bogies monitoring & diagnostics
- Industrial testing

### Description

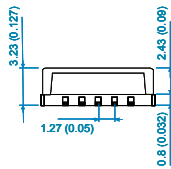
Colibrys VS9000 accelerometer is a new extra small high end product dedicated to applications in the domains of **vibration** sensing. The large bandwidth, combined with robust and low power design and excellent bias stability guarantee the superior reliability of the VS9000 MEMS accelerometer.

The Colibrys VS9000 accelerometer is a MEMS capacitive sensor, based upon a bulk micro-machined silicon element, a low power ASIC for signal conditioning, a micro-controller for storage

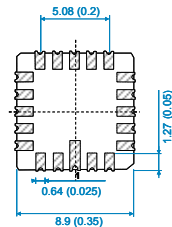
of compensation values and a temperature sensor. The product is low power, calibrated, robust and stable and the electronic configuration provides a solid power on reset and ensures a full protection against brown-out.

The variable capacitive sensor has been specifically designed to provide a wide bandwidth. For the ±100g version (VS9100.D), the bandwidth is DC to > 1.0 kHz @ 5%. This product still benefits from the high stability of the MS9000 series with a low noise level and a low bias and scale factor temperature coefficient

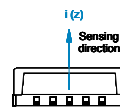
VS9000 side view



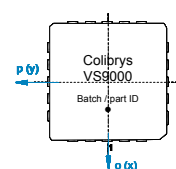
VS9000 bottom view



VS9000 side view



VS9000 top view



### Specifications

All values are specified at +20°C (+68°F) and 5.0 VDC supply voltage, unless otherwise stated

|   | Units           | VS9002.D  | VS9010.D     | VS9030.D     | VS9050.D     | VS9100.D     | VS9200.D     |
|---|-----------------|---|--------------|--------------|--------------|--------------|--------------|
| Full scale range                            | g               | ± 2g  | ± 10g        | ± 30g        | ± 50g        | ± 100g       | ± 200g       |
| Packaging                                   |                 | LCC20 (non magnetic, 8.9mm x 8.9mm / 0.35inch x 0.35inch) |              |              |              |              |              |
| Bandwidth, (± 5 %) [3]                      | Hz              | 0 to > 250  | 0 to > 1000  | 0 to > 1000  | 0 to > 1000  | 0 to > 1000  | 0 to > 1000  |
| Resonant frequency                          | kHz             | 1.3   | 2            | 4            | 5.1          | 7.2          | 11           |
| Noise spectral density in band [0 ; 400 Hz] | µV/√Hz typ.     | 25  | 25           | 25           | 25           | 25           | 25           |
|   | Max.            | 27  | 27           | 27           | 27           | 27           | 27           |
| Bias calibration                            | mg              | < 10  | < 50         | < 150        | < 250        | < 500        | < 1000       |
| One year bias stability [1]                 | mg typ. (max.)  | 1.5 (<5)  | 7.5 (<25)    | 22 (<75)     | 37.5 (<125)  | 75 (<250)    | 150 (<500)   |
| Switch on/off repeatability                 | mg max.         | < 0.15  | < 0.75       | < 1.5        | < 3.8        | < 7.5        | < 15.0       |
| Bias temp. coefficient [2]                  | mg/°C typ.      | <0.1  | <0.5         | <1.5         | <2.5         | < 5          | < 10.0       |
|   | mg/°C max.      | ± 0.4   | ± 2          | ± 6          | ± 10         | ± 20         | ± 40         |
| Scale factor sensitivity (K1)               | mV/g            | 1000 ± 8  | 200 ± 2      | 66.6 ± 1     | 40 ± 1       | 20 ± 1       | 10 ± 1       |
| One year scale factor stability [1]         | ppm typ. (max.) | 300 (< 1000)  | 300 (< 1000) | 300 (< 1000) | 300 (< 1000) | 300 (< 1000) | 300 (< 1000) |
| Scale factor temp. coefficient [2]          | ppm / °C typ.   | 100   | 100          | 100          | 100          | 100          | 100          |
|   | min. / max.     | -50 / 250   | -50 / 250    | -50 / 250    | -50 / 250    | -50 / 250    | -50 / 250    |
| Input axis misalignment (Kp, Ko)            | mrad max.       | < 10  | < 10         | < 10         | < 10         | < 10         | < 10         |
|   | % max           | 1   | 1            | 1            | 1            | 1            | 1            |
| Resolution / Threshold (@ 1Hz)              | mg max.         | < 0.1   | < 0.6        | < 1.7        | < 2.8        | < 5.5        | < 11.0       |
| Non linearity [4]                           | % of FS max.    | < 0.8   | < 0.9        | < 0.9        | < 0.9        | < 1          | < 1          |
|   | g max.          | < 0.02  | < 0.09       | < 0.27       | < 0.50       | < 1          | < 2          |

[1]: One year stability defined according to IEEE 528-2001: turn on / on, storage at -55°C and 85°C, -40°C to 125°C T cycling, -55°C to 85°C unpowered harass, vibration, shock (@ 6000g, single shock).

[2]: Temperature coefficients are specified for a range of -40°C to 20°C, where temperature behavior is typically linear.

[3]: The bandwidth is defined as the frequency band for which the sensitivity has decreased by less than 5%.

[4]: The non linearity specification for 200g version is validated to maximum ± 100g range.

| Environmental   | VS9002.D  | VS9010.D | VS9030.D | VS9050.D | VS9100.D | VS9200.D |
|---|---|----------|----------|----------|----------|----------|
| Operating temperature range   | -55°C to +125°C (-67°F to 255°F)  |          |          |          |          |          |
| Reliability   | Results based on MIL-HDBK-217, notice 2, are available on request.  |          |          |          |          |          |
| Shock resistance (product still within spec)  | Up to 6'000 g (0.15ms half-sine, single shock, not repetitive, in one direction o, p or l)  |          |          |          |          |          |
| Recovery time   | < 1ms (1000g, half-sine period 1ms, shocks in direction i)  |          |          |          |          |          |
| Vibration   | 20 g rms, 20-2000 Hz (random noise, 30 minutes in each direction o, p, i)   |          |          |          |          |          |
| LCC packaging   | The product has been qualified according to MIL-STD-883-G<br>Hermetic sealing is qualified at 5·10 <sup>-8</sup> atm·cm <sup>3</sup> /s |          |          |          |          |          |
| ESD sensitivity   | Class 2 (requirements MIL-STD-883-G, 1 Method 3015.7), HBM 2kV  |          |          |          |          |          |
| Note: - LCC must be tightly fixed to the PCB, using the bottom of the housing as reference plan for axis alignment. |   |          |          |          |          |          |

| Electrical                                 | VS9002.D  | VS9010.D | VS9030.D | VS9050.D | VS9100.D | VS9200.D |
|--|---|----------|----------|----------|----------|----------|
| Input voltage (VDD – VSS)                  | 2.5 to 5.5 VDC. The standard voltage for calibration is 5.0 VDC.  |          |          |          |          |          |
| Output voltage range                       | From 0.5 to 4.5 VDC @ 5.0 VDC input voltage (2.5 V ± 10mV at 0g)  |          |          |          |          |          |
| Operating current consumption              | < 400 µA @ 5.0 VDC  |          |          |          |          |          |
| Initialization & reset current consumption | Typ. 1500 µA @ 5.0 VDC during the initialization phase (less than 50 ms at room temperature)  |          |          |          |          |          |
| Reset                                      | The sensor is Brown out protected. A reset occurs when the power supply jumps more than +0.46 V with a slope >380V/s or if the power supply drops below 2.2V. The recovery time is typ. 45 ms (max 50 ms) |          |          |          |          |          |
| Output impedance / load                    | Min. 50 kΩ at Vout (pin 8) and VAGND (pin 5)<br>Max. 50 pF at Vout (pin 8) and Max. 100 µF at VAGND (pin 5)   |          |          |          |          |          |

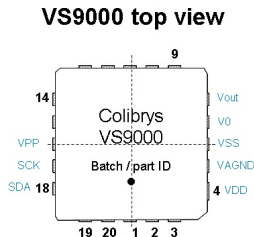
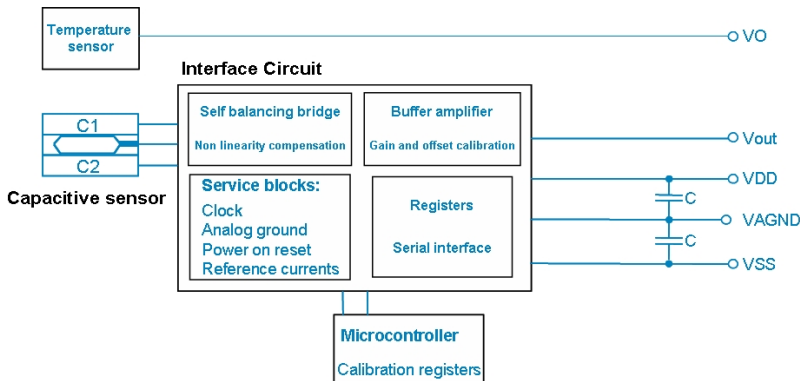
| Physical | Hermetically sealed LCC, 20 pins housing  |
|----------|---|
| Weight   | < 1.5 grams   |
| Size     | Typ. 8.9 x 8.9 x 3.23 mm (0.35 x 0.35 x 0.127 inch)<br>Max. 9.2 x 9.2 x 3.5 mm (0.354 x 0.354 x 0.138 inch) |

| Temperature sensor:    |  |
|------------------------|--|
| Output Voltage at 20°C | Typ: 1.632 V                           |
| Sensitivity            | Typ: -11.77 mV/°C                      |
| Long term stability    | Max -0.03°C to +0.09°C (1000h @ 150°C) |
| Accuracy               | ± 5°C (From -40°C to 125°C)            |

### Block diagram and electrical connections

It is necessary to use decoupling capacitors [C] of 1µF each between VDD and VAGND and between VAGND and VSS, placed as close as possible from the accelerometer.

COG or X7R @ 5% capacitor types are recommended. The VAGND track should be as short as possible



| Pin | Description                             | Remarks                                       |
|-----|---|---|
| 4   | VDD                                     | Power supply                                  |
| 5   | VAGND                                   | Accelerometer output reference voltage(VDD/2) |
| 6   | VSS                                     | Ground  |
| 7   | VO                                      | Temperature sensor output                     |
| 8   | Vout                                    | Accelerometer output signal                   |
| 16  | VPP (Colibrys internal calibration pin) | <b>Must</b> be connected to VSS               |
| 17  | SCK (Colibrys internal calibration pin) | <b>Must</b> be connected to VSS               |
| 18  | SDA (Colibrys internal calibration pin) | <b>Must</b> be connected to VSS               |

A detailed MS9000 / VS9000 Product Description (30D.MS9X.x.xx) and further Application Notes are available on demand or on our web site. In order to provide an ideal support to our customers, our

standard VS9000 products will be available worldwide through a wide network of distributors and agents or directly at Colibrys. Do not hesitate to access our web site for precise contacts or contact directly Colibrys in Europe or in US for more details.

