DESIGNED FOR ACCURACY, BUILT FOR TRUST
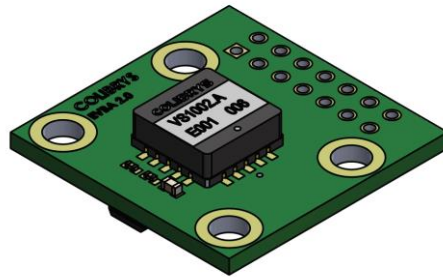
VS1000: Evaluation Kit EVBA_2.0

EVBA_2.0 – is a "plug and play" Evaluation Kit for Colibrys VS1000 accelerometers line.

To facilitate the integration in user environment and easily verify the excellent performances of VS1000 sensors, EVBA_2.0 integrates a VS1000 sensor with the user specified range, an ultra-low-noise, high-accuracy 3.3V voltage reference, the decoupling capacitors and output buffers.

Features:
- Low noise power supply management converting +5V to 3.3V
- Output signal conditioning:
  - ✓ buffers to enable the use of long lines between the sensor and the user electronic
  - ✓ low-pass filters with a cutting frequency
- Easy integration into system: 4 fixing holes
- Industrial interface

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Note	Colibrys reserves the right to change these data without notice

1   EVBA_2.0 description:

1.1   General overview

The EVBA_2.0 is a Kit containing 3 components:
- 1 analog evaluation board with soldered VS1000 of corresponding G range. Evaluation board contains electronic circuits to achieve a preliminary signal conditioning
- 1 * header connector "J1" with 14 pins (to be soldered onto the EVBA dedicated pads)
- 1 * mating connector (14 pins) including 13 cm length signal cable ribbon

The EVBA_2.0 is protected from outside atmospheric condition effects (temperature, humidity) by a vacuum sealed electrostatic conductive plastic bag
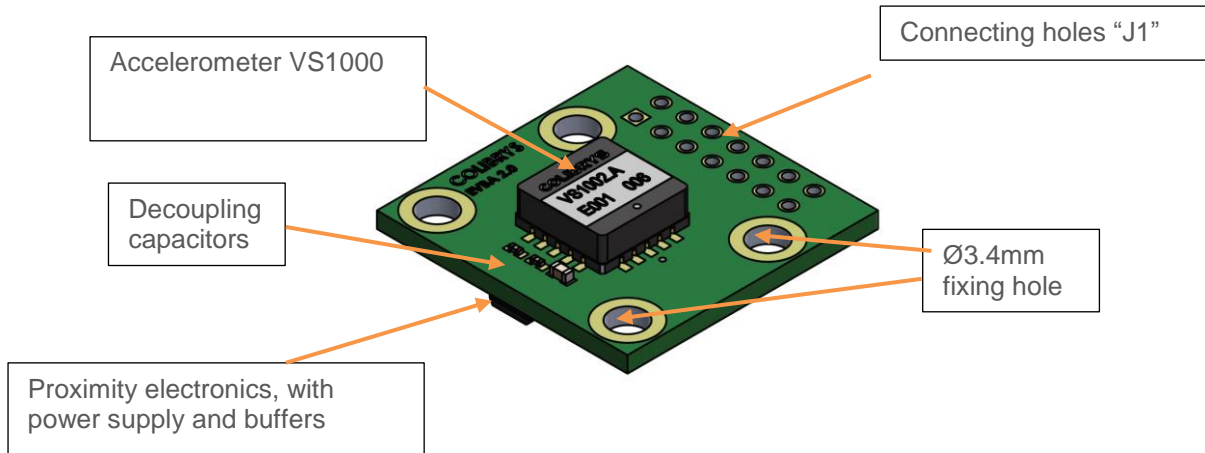
Note: MEMS accelerometer and electronic circuits on the EVBA can be damaged by electrostatic discharge (ESD). Handle with appropriate precautions and placement should be done in accordance with strict ESD control

Please check the integrity of the plastic bag and report if any damage or if the bag is open on arrival.

1.2   Interface Pinout

The Table 1 below describes the pin name and interface for the connecting pads J1:

Pin Nr	Pin name	Connector	Description
1	VTemp_f	J1	Temperature sensor analog output (buffered)
2	V_{DD}_s	J1	+3.3 V_{DC} reference voltage sense output (not buffered)
3	OUTN_f	J1	Negative differential output (buffered)
4	V_{MID}[1]	J1	Internal ASIC reference voltage. For decoupling capacitors only
5	OUTP_f	J1	Positive differential output (buffered)
6	V_{SS} (0 V)	J1	Must be connected to ground plane (GND)
7	Vout_SE	J1	Single output acceleration (Vout_SE = OUTP - OUTN) (buffered)
8	Vp (+5V)	J1	Power supply 5.0VDC – 5.5V_{DC}
9	V_{SS} (0 V)	J1	Must be connected to ground plane (GND)
10	V_{SS} (0 V)	J1	Must be connected to ground plane (GND)
11	ERR	J1	Error signal (output, active high)
12	ST	J1	Self-test activation (input, active high)
13	POR	J1	Power-on Reset signal (output, active high)
14	RESET	J1	System reset signal (input, active low)

Table 1: Interface Pinout

Note 1: this pin should be left unconnected.

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1.3   Electrical connections

It is the user choice to mount Header connector on J1 connecting pads or to solder the signal wires directly on the EVBA board. The size of the soldering hole are of 0.8mm, so wires up to a conductor area of 0.5mm2 or AWG21 are suitable. The wires or the Mating connector will ideally be hand soldered using a PB free solder with the appropriate flux.
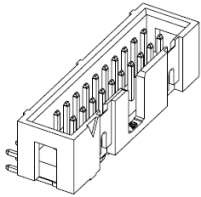

Note: Connector J1 is a 14 Positions Header, Shrouded Connector 0.100" (2.54mm) Through Hole, Right Angle

This connector is delivered unsoldered to the evaluation board. The user is free to use it or to solder any connection directly on the board.

Connector J1

1.4   Mechanical dimensions

The mechanical layout of the evaluation board is shown in Figure 1. All components are soldered on the top and bottom surface and the board can be mounted using the 4 x Ø3.40 mm through holes:
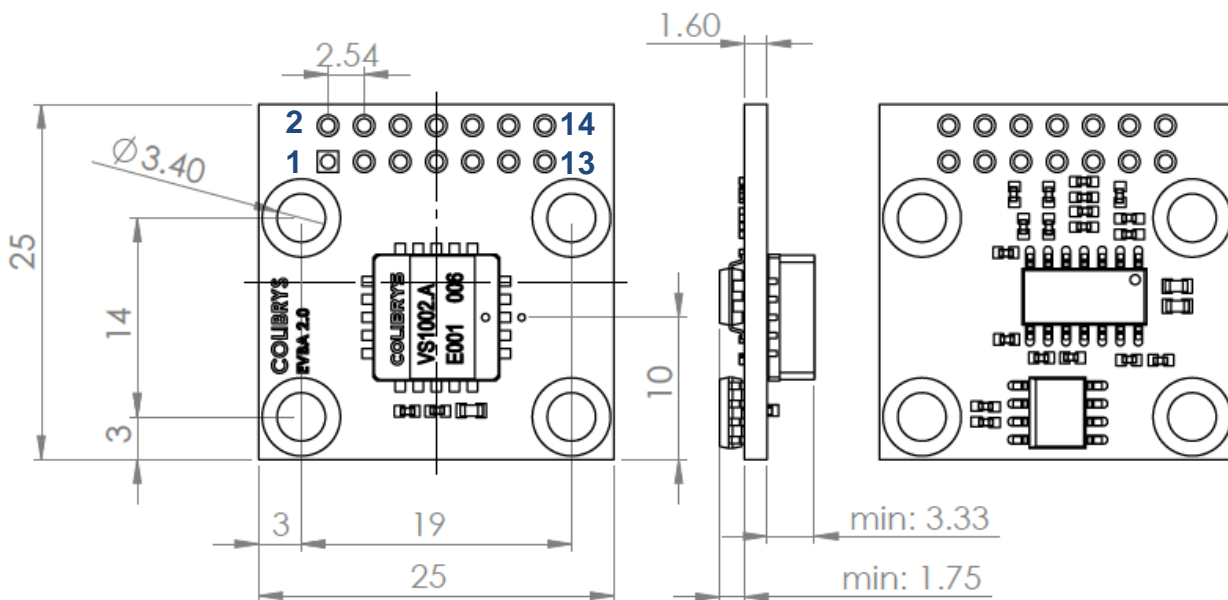
Note: This is for the VS1002, other range looks like same

Figure 1: Mechanical Dimensions [mm] showing a VS1002

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2 Evaluation board function

To facilitate the integration in an user environment and easily verify the excellent performances of the Colibrys VS1000 serie sensors, the plug and play board EVBA_2.0 integrates one VS1000 sensor with the user specified range, an ultra-low-noise, high-accuracy 3.3V voltage reference, the decoupling capacitors and output buffers as shown in Figure 3. The board will powered by a single +5V$_{DC}$ power supply.

2.1 Normal operation (recommended)
Optimal acceleration measurements are achieved by using the differential buffered signal outputs OUTP_f and OUTN_f.

2.2 Optional operation
If user application requires a unipolar signal, a single-ended buffered output Vout_SE is provided as well.

2.3 Block Diagram
The Block diagram of the EVBA2.0 is given below. The sensor implemented is represented by the green marked zone. The VS1000 sensor signal outputs are linked to a unity gain buffer via a 1st order low pass filter (fc=16kHz). The Output of the unity gain buffer is then connected to the dedicated pins of J1. The board +5.0V power supply is connected to VP and an Ultra-Low-Noise, High-Accuracy 3.3V Voltage Reference generates the necessary +3.30 VDD voltage. The capacitors C1, C2 and C3 forms the decoupling elements for the ASIC reference voltage Vmid. Note that this voltage level is also linked to J1. That pin must be left open for normal operation.

The single ended output signal Vout_SE expresses the relation described at §2.8
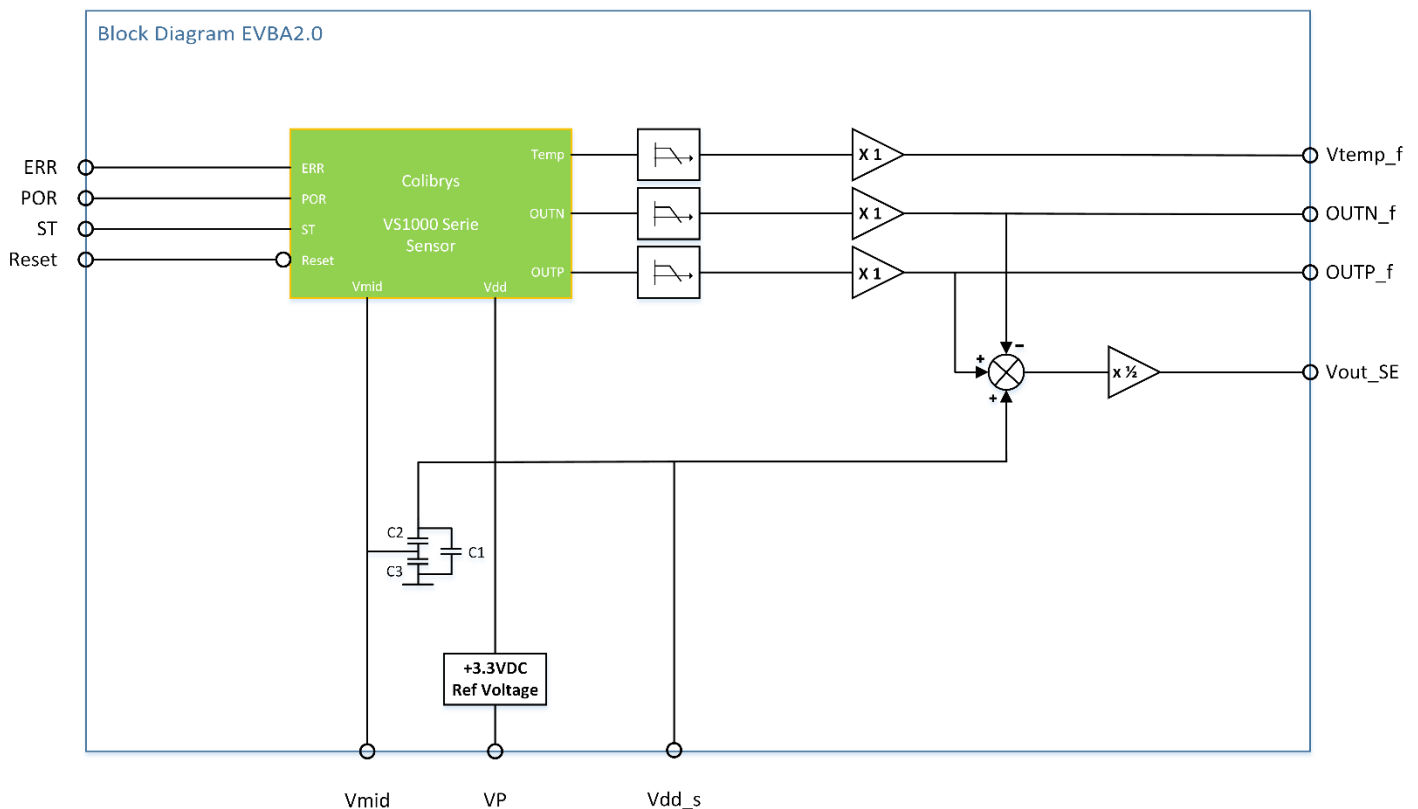

Figure 2: Functional Diagram EVBA2.0

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2.4   Electrical Schema
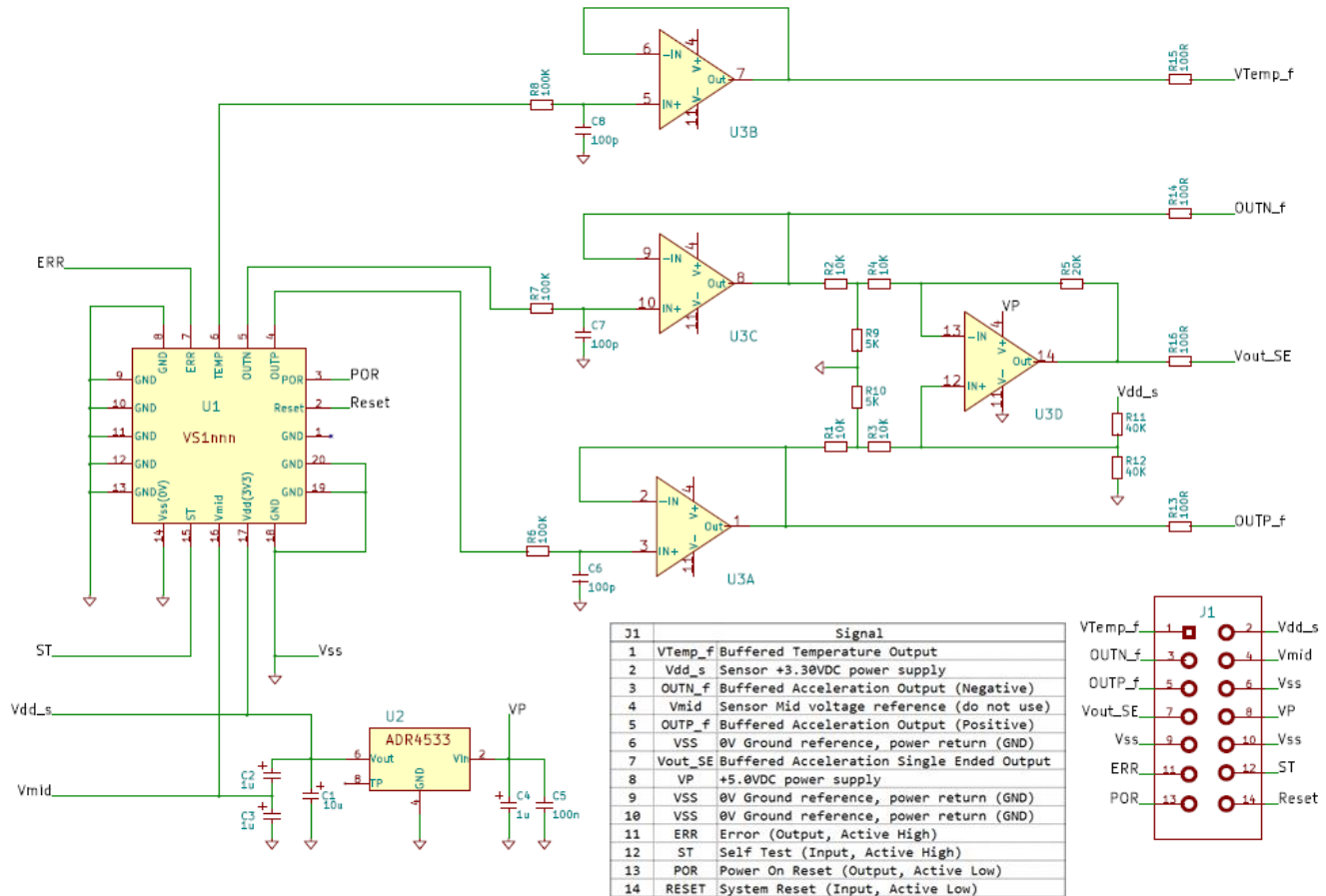The corresponding detailed electrical schema is given below.

Figure 3: EVBA Electronic circuit

2.5   Power Supply
The EVBA power supply is set for +5.0V_{DC} (pin8 of J1) and the 0V_{DC} must be connected to all VSS pins of J1 (pin 6, pin 9, pin10).

The VS1000 series accelerometers require a +3.30VDC power supply named Vdd. The sensor outputs are ratiometric to that Vdd voltage level. This could directly impact the accelerometer bias, scale factor, noise or thermal performance. Therefore, a low-noise, high-stability and low-thermal drift Vdd power supply has been implemented on the board using an Ultra-Low-Noise, High-Accuracy 3.3V Voltage Reference type ADR4533.

The Sensor Vdd line (+3.30V_{DC}) is also connected to PIN 2 of the J1 and can be then used as an output signal (VDD_S) in order to compensate any variation on the power supply voltage that may impact the accelerometer signal (ratiometric output).

The voltage Vmid sets to a level of 0.5 x Vdd and is a voltage required by the ASIC of the sensor. For a normal operation of the sensor this line should be left open. Checking the level shall be only reserved and limited for debug purposes. Any impedance connected to that line could directly impact the stability, bias, scale factor and noise figure of the VS1000 series sensors.

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2.6 Accelerometer sensor

The sensor block is composed of the VS1000 accelerometer and three capacitors C1 (10 µF), C2 (1 µF) and C3 (1 µF). These capacitors are required as decoupling capacitors and for a proper sensor startup. They are mandatory for the proper operation and full performance of the accelerometer. They are located as close as possible to the VS1000 package on the printed circuit board.

2.7 Output signal conditioning

The analog acceleration signal output lines (OutN, OutP) require a high impedance load in order not to degrade the signal characteristic. To drive long signal lines between the EVBA and the user electronic, buffers have been implemented on the EVBA. Additionally the Temperature analog output signal is also buffered.
The buffers are implemented using a Zero-Drift, Single-Supply, Rail-to-Rail Input/Output Operational Amplifiers type AD8574.

The operational amplifiers U3A, U3B and U3C are configured as voltage follower (gain=1) and are preceded by low-pass filters R8/C8, R7/C7 and R6/C6 respectively introducing a cutting frequency of 16 kHz. The attenuation at 1500Hz is less than 0.5%, allowing the use of the full bandwidth of the sensor.

The resistors R15, R14 and R13 (all of 100 Ω) are connected to the buffer output reduce the loop phase shift at high frequency when driving a capacitive load (ie the cable link between the EVBA and the Electronic system).

2.8 Differential to Single Output

Colibrys's VS1000 series provide a differential output for the sensed acceleration. The EVBA implements a differential to single ended mode converter built around the fourth OP amplifier of the AD8574 (U3D). A set of matched resistances is used to divide the voltages and add an offset to avoid saturation of the amplifier:

$$V_{Out\_SE} = \frac{V_{Out\_P} - V_{Out\_N}}{2} + \frac{V_{DD}}{2}$$

Note:
- The scale factor of the single ended output is only half that of the differential output.
- The common mode noise is not canceled when using a single ended output.

2.9 Temperature sensing

Each Colibrys VS1000 accelerometer integrate an internal temperature sensor. The output voltage Vtemp_f buffered by OPAMP U3B (unity gain) to PIN1 of J1 gives a voltage proportional to the internal sensor temperature and can be used to achieve additional compensation of the measured acceleration to obtain the optimum readouts.
The temperature is then given by the function

$$Vtemp = 1.23 - 0.004\,(Temp - Temp_{ref})$$

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2.10 Bill of material (BOM)

The following table lists all components used for the presented design:

Component	Value	Function
U1	VS1000	Colibrys Accelerometer
U2	ADR4533	3V3 Voltage Reference – Analog Devices ADR4533BRZ
U3	AD8574	Quad Operational Amplifier – Analog Devices AD8574ARZ
R1, R2, R3, R4	10 kΩ	Voltage divider – 0402 resistor
R5	20 kΩ	Voltage divider – 0402 resistor
R6, R7, R8	100 kΩ	Low pass filter – 0402 resistor
R9, R10	5 kΩ	Voltage divider – 0402 resistor
R11, R12	40 kΩ	Voltage divider – 0603 resistor
R13, R14, R15, R16	100 Ω	Output load – 0402 resistor
C1	10 µF	Decoupling – 0603 capacitor
C2, C3, C4	1 µF	Decoupling – 0402 capacitor
C5	100 nF	Decoupling – 0402 capacitor
C6, C7, C8	100 pF	Low pass filter – 0402 capacitor
J1	HEADER 7X2	Connector (if required*)

*The wires may also be soldered directly on the board.

Table 2: Bill of material

3 Operation

Handle with appropriate precautions and be done in accordance with strict ESD control.

It is the user choice to use the connector provided or to solder the signal wire lines directly on the board. In both situation please follow the proper soldering process. Hand soldering is recommended.

3.1 Power Up

Once the cabling done the EVBA can be powered up by applying the VP voltage level. The current consumption and the reference voltage V_{DD} shall be:

Parameter	Designation [unit]	Typical
Sensor +3.30V power supply	V_{DD} [V_{DC}]	3.30
Board current consumption	IP [mA_{DC}]	7.14

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3.2 Outputs

With the EVBA board placed horizontal in a quite environment will expose the sensor to an acceleration of 1g. The corresponding level of the signals OUTP_f, OUTN_f and Vout_SE settles proportional to the range and scale factor of the VS1000 mounted. The available ranges are ± 2g, 5g, 10g, 30g, 100g and 200g.

The typical readouts are at 1g acceleration:

Parameter	Designation [unit]	Typical						
		2g	5g	10g	30g	50g	100g	200g
OUTP	OUTP [V_{DC}]	2.325	1.920	1.785	1.695	1.677	1.663	1.657
OUTN	OUTN [V_{DC}]	0.975	1.380	1.515	1.605	1.623	1.636	1.643
Single-ended output	VOUT_SE [V_{DC}]	2.325	1.920	1.785	1.695	1.677	1.663	1.657

With the EVBA operated in an ambient temperature of +25°C ± 3°C the Vtemp-f signal on J1/1 shall read:

Parameter	Designation [unit]	Typical
Vtemp buffered	Vtemp_f [V_{DC}]	1.210

The VS1000 accelerometer provides logic output signals:

Parameter	Designation [unit]	Typical
Error signal (flag)	ERR [V_{DC}]	Vss
Power-on Reset signal (flag)	POR [V_{DC}]	Vdd

3.3 Logic signals
Some functionalities can be controlled by applied logical signals according to the Table 3.

They all are referenced to the VS1000 Vdd (+3.3V$_{DC}$) voltage level and proper interfacing is required. A Logic HIGH level corresponds to the Vdd voltage level and a logic LOW level to the Vss voltage level.

J1 / Pin#	Signal	Designation
12	ST	Self-test activation, active high
14	RESET	System reset signal, active low

Table 3

For the detailed function and effects of these signals please refer to the Datasheet of the VS1000 sensor.

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4 Ordering Information

The user will have to select the appropriate sensor range for his application (see VS1000 family data sheet) and then order the corresponding EVBA version. Table 4 shows the range, Designation and Part number for each available EVBAs.:

Range [g]	Designation	Part Number
±2	EVBA_2.0_VS1002.A	37628071
±5	EVBA_2.0_VS1005.A	37623081
±10	EVBA_2.0_VS1010.A	37625033
±30	EVBA_2.0_VS1030.A	37628084
±50	EVBA_2.0_VS1050.A	37629043
±100	EVBA_2.0_VS1100.A	37629061
±200	EVBA_2.0_VS1200.A	37629081

Table 4: EVBA ordering number

5 Disclaimer

EVBA_2.0_VS1000 evaluation kit is only intended for device evaluation, not for production purposes.