COLIBRYS
SMART SENSING SOLUTIONS

DATASHEET

HS8030.D / Full specification, single axis high shock accelerometer

30S.HS8030-Full.B.05.11

Energy
Mil/Aerospace
Industrial

Inertial
Tilt
Vibration
Seismic

Features

- ±30g
- Very high shock survivability
- Excellent bias stability including gun hard shock
- Single power supply (+4.4V, ratiometric voltage output)
- Small 48 pin LCC ceramic package with hermetic sealing (14.2mm x 14.2mm)
- Individually calibrated (bias, scale factor and non linearity)
- Demonstrated high reliability
- RoHS compliant suitable for lead free soldering process and SMD mounting
- Product submitted to Swiss export control

The HS8000 product is a gun hard single axis MEMS capacitive accelerometer based on a bulk micro-machined silicon element specifically designed for high stability, a low power ASIC for signal conditioning, a micro-controller for storage of compensation values and a temperature sensor. The product is low power, fully calibrated, robust and extremely stable and the electronic configuration provides a solid power on reset and ensures a full protection against brown-out.

The HS8000 products operate from a single power supply voltage (between +2.5V and +5.5V) with low current consumption (< 0.5mA at 5V). The HS8030.D is calibrated at 4.4V. The output is a ratiometric analog voltage that varies between +0.5V and +3.9V for the full-scale acceleration range at a voltage supply of +4.4V. The sensor is fully self-contained and packaged in a 48-pin LCC ceramic housing, thus insuring a full hermeticity.

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GLOSSARY

ASIC	Application specific integrated circuit
g	Gravity
HARASS	Highly Accelerated Rapid Airflow Stress Screening
IA	Input Axis
PA	Pendulous axis
OA	Output axis also named Pivot Axis
IEEE	Institute of Electrical and Electronics Engineers
N/A	Not applicable
ppm	Parts per million
VAGND	Accelerometer output reference
VDD	Accelerometer power supply voltage
VOUT	Accelerometer output voltage
VSS	Accelerometer ground voltage
VRE	Vibration rectification error
LCC	Ceramic Leadless Chip Carrier
DR4	Colibrys design review 4
COC	Certificate Of Conformance

1. Introduction

This documents is a complete version of the data sheet 30S.HS8x.x.xx.xx with extended specification of the product HS8030.D (±30g gun hard accelerometer)

2. General Description

The Colibrys MEMS accelerometer HS8030.D is an advanced product providing an analogue output voltage directly proportional to the applied acceleration along its sensitive axis (IA: input axis – z axis) perpendicular to the surface of the LCC package. The two other axes of the accelerometer are the pendulous axis (PA – y axis) and the output axis (OA – x axis) also named pivot axis.

Note: Preferential axes for gun hard accelerations are "+ IA" (z) and "– PA" (y) (90° of the sense axis as presented in Figure 1).

The HS8030.D is provided in a hermetically sealed LCC 48 housing (48 pins). The hermetic sealing is qualified according to MIL-STD-833 method 1014 at 5.10^{-8} $atm.cm^3/s$.

The bias and scale factor are ratiometric by design to the power supply voltage and therefore these performances will vary with varying power conditions.

The HS8030.D is calibrated at (VDD-VSS) = 4.4V, therefore, all specifications are valid for this power supply, unless otherwise stated. A reference voltage VAGND is also provided at half of the power voltage supply and corresponds to the output voltage at zero g.

With impacts on the parameters and specifications, the product could be used between 2.5V and 5.5V.

To get a clean signal out of the accelerometer, it is necessary to use decoupling capacitors [C] of 1µF each between VDD and VAGND and between VAGND and VSS, located as close as possible from the accelerometer. *COG* or *X7R* @ 5% capacitor types are recommended. The VAGND track should also be as short as possible. Any other setup will directly affect the bias calibration.

At every power-up, the microcontroller transfers the calibration parameters (bias calibration, scale factor calibration and non linearity) to the ASIC and then goes in a watch mode. During this initialization phase, which takes less than 50ms, the current consumption goes up to max. 1.5mA @ 4.4V and room temperature. Then, the normal operating current consumption remains less than 400µA under similar conditions.

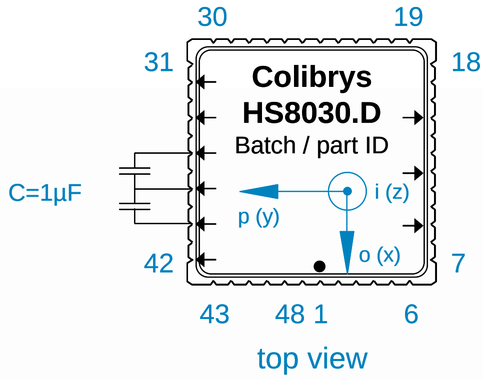
A temperature sensor is also integrated in the LCC packaging and is providing an analogue voltage output directly proportional to the internal temperature.

3. HS8030.D Specifications

The HS8030.D has been fully qualified following the standard qualification process of Colibrys. The product has demonstrated the full conformity to the current specifications and successfully passed the Design Review 4 (DR4) and is therefore delivered with a standard Colibrys "Certificate Of Conformance" (COC).

3.1. Mechanical Outline

The mechanical outline of the accelerometer is in accordance with the following drawings (Figure 1). This picture is a top view which shows the pin orientation, the labeling, the location of the inertial reference point of the seismic mass and the three different axes (o, p, i).



Each accelerometer is clearly marked with the manufacturers part number (i.e. HS8030.D), the batch number or lot number and the part ID number.

A unique serial number is allocated to each individual accelerometer

A reference point printed on the lid indicates the approximate location of the pin number 1 to insure a correct orientation of the product during assembly. From the bottom, the pin number one is also clearly differentiated.
Note: As already mentioned, +i(z) and –p(y) and the preferential axis for gun hard shocks.

3.1.1. Pin Allocation

Pin	Description	Remarks
9	VPP (Colibrys internal calibration pin)	**Must** be connected to VSS
12	SCK (Colibrys internal calibration pin)	**Must** be connected to VSS
15	SDA (Colibrys internal calibration pin)	**Must** be connected to VSS
32	VOUT	Accelerometer output signal
34	CG	Bandwidth control (Disables) NC
36	VSS	Ground
38	VAGND	Accelerometer output reference voltage(VDD/2)
40	VDD	Power supply
42	V0	Temperature sensor output

Table 1: HS8030.D Pin Allocation

3.1.2. Packaging Size

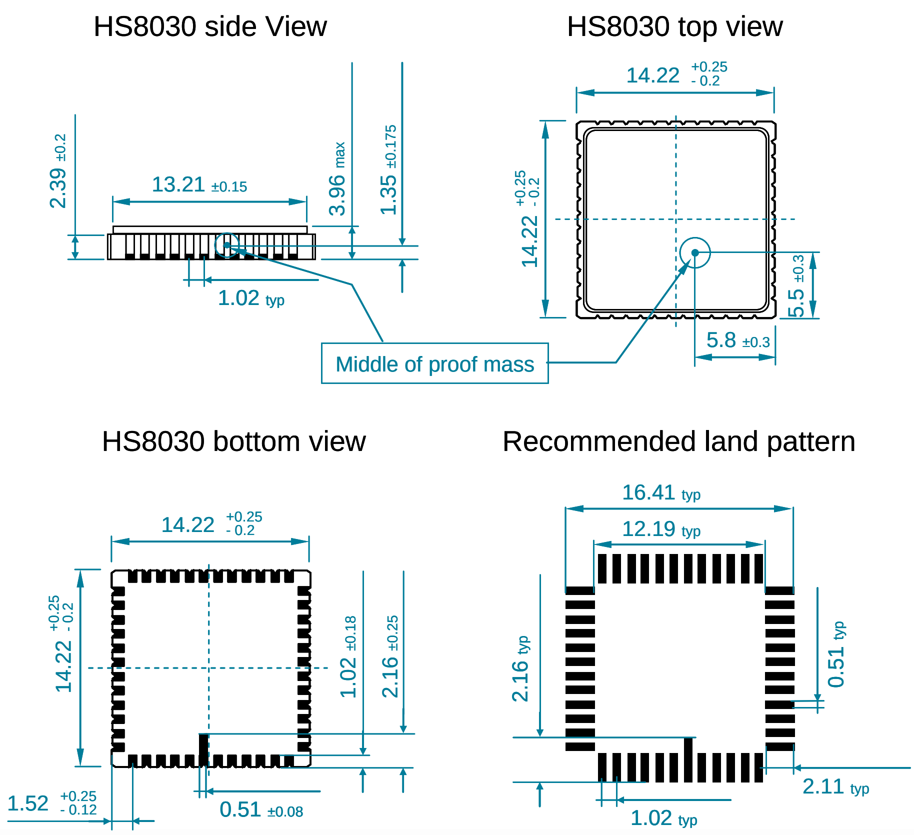


Figure 2: HS8030.D Packaging Size (all dimensions in mm)

Note that the total thickness of the LCC package (3.96mm max) includes an allowance for an optional bar code labeling sticker. Without sticker, the thickness is 3.87mm max.

Physical			
3.1.2.1	Weight	Typ 1.64	grams
3.1.2.2	Material	LCC48 ceramic packaging with Gold leads finishing	

Table 2: Packaging Physical

3.2. Electrical Interface

The electrical interface is defined by VDD, VSS, VAGND and VOUT

VDD: is the power supply voltage

VSS is the ground voltage = 0V

VAGND is the acceleration output reference (half of the power voltage supply and corresponds to output voltage at zero g) VAGND = VSS + [(VDD-VSS)/2]

VOUT is the acceleration output voltage

The acceleration in g is generally calculated as follows, especially if voltage input is not stable:

- $$\text{Acceleration (g)} = \frac{\text{VOUT} - \text{VAGND}}{\text{Scale factor}} \times 1000 \qquad \text{where scale factor units are } \frac{\text{mV}}{\text{g}}$$

In case of availability of a high precision and high stability voltage supply powering the accelerometer, the acceleration in g can also be calculated as follow:

- $$\text{Acceleration (g)} = \frac{\text{VOUT} - (\text{VDD}/2)}{\text{Scale factor}} \times 1000$$

3.2.1. Electrical Specification

The accelerometer operates from a stabilized power source with the following steady state characteristics

Electrical			Comments
3.2.1.1	Calibration Voltage	+ 4.40 Vdc	± 1 mVdc
3.2.1.2	Nominal Input Voltage	+ 4.40 Vdc	
3.2.1.3	Minimum Input Voltage	+ 2.50 Vdc	Specifications are only valid at + 4.4Vdc
3.2.1.4	Maximum Input Voltage	+ 5.50 Vdc	
3.2.1.5	Operating current	< 0.4 mA	@ -40°C to 85°C
3.2.1.6	Peak Current During Initialization	< 2 mA	@ -40°C to 85°C
3.2.1.7	Output load	Min. 50 kÙ at VOUT and VAGND	
		Max 50pF at VOUT Max 100µF at VAGND	
3.2.1.8	Reset time	Max 35 ms	@ 20°C
		Max 50 ms	@ -40°C to 85°C
3.2.1.9	Reset	A reset occurs when the power supply varies by more than 0.46 V with a slope >380 V/s or if the voltage supply drops below 2.2V.	
3.2.1.10	Brown out protection	The sensor is brown-out protected. In the event of a power supply disruption either during the start up phase or steady state operation, the accelerometer is capable of restoring itself to the correct operational configuration within the reset time specification	

Table 3: General Electrical Specifications

Note: decoupling capacitors [C] of 1µF each between VDD and VAGND and between VAGND and VSS, located as close as possible from the accelerometer. *COG* or *X7R* @ 5% capacitor types are recommended. The VAGND track should also be as short as possible. Any other setup will directly affect the bias calibration and noise.

3.2.2. Acceleration Signal Characteristics (VOUT)

The accelerometer HS8030.D provides full performance up to ± 30g.

The nominal signal (VOUT) characteristics are presented in the next table.

VOUT Characteristics		Minimum	Typical	Maximum	Units	Comment
3.2.2.1	Full scale range	-30		+30	g	
3.2.2.2	Bias calibration	-10		+10	mV	@ 20°C
3.2.2.3	Bias T. coeff	-2		+2	mV/°C	@ -40°C to 85°C
		-0.5		+0.5	mV/°C	@ -40°C to 20°C
3.2.2.4	Scale Factor calibration	55.6	58.6	61.6	mV/g	@ 20°C
3.2.2.5	Scale Factor T. coeff	-750	+150	750	ppm/°C	@ -40°C to 85°C
		-250	+150	250	ppm/°C	@ -40°C to 20°C
3.2.2.6	Bandwidth	100		500	Hz	@ -3dB
3.2.2.7	Noise spectral density over 300Hz			36	µV/√Hz	@ 20°C
3.2.2.8	Vibration Rectification Error	- 0.6		+ 0.6	mg/g2	@ 20°C [20-2000Hz], 15g peak
3.2.2.9	Velocity random walk	- 0.5		+ 0.5	m/s/√hr	
3.2.2.10	Misalignment			10	mrad	@ 20°C

Table 4: VOUT Signal Characteristics

3.2.3. Temperature Sensor Characteristics

The temperature sensor mounted in the HS8030.D is the National Semiconductor LM20B. The sensor is mounted as close as possible from the MEMS element to ensure the most accurate temperature measurement for further potential compensations.

Some typical values are:

T sensor LM20B		Typical	Units	Comment
3.2.3.1	Output voltage @ 20°C	1.632	V	@ 20°C
3.2.3.2	Sensitivity	-11.77	mV/°C	
3.2.3.3	Accuracy	± 5	°C	-40°C to 125°C
3.2.3.4	Long term stability	-0.03 to +0.09	°C	1000h @ 150°C

Table 5: T Sensor Characteristics

3.3. HS8030.D Performances

Some parameters are affected by the environmental and lifing conditions of the product. Out of many parameters, the major external factors that can impact the specifications of the products are generally the temperature, the shocks, the vibrations and the time.

To assess the sensitivity of the HS8030.D to these external conditions, qualifications have been performed based on standard succession of events representing typically one year composite repeatability (including 11 days @ 85°C to represent ageing over 1 year service life).

Measurements of repeatability have been performed at 20°C before and after successive events to finally determine resulting stability.

3.3.1. Environmental Parameters

The limits of the various environmental parameters are described hereafter

Temperature				
3.3.1.1	Operating temperature range	-40 to 85	°C	
3.3.1.2	Hot temperature storage	+85	°C	Survivability
3.3.1.3	Cold temperature	-55	°C	Survivability
3.3.1.4	Temperature shocks in service	-40 to 85	°C	@ max 5°C/min
3.3.1.5	Temperature shocks HARASS	-40 to 85	°C	@ 70°C/min survivability

Mechanical				
3.3.1.6	Vibration	15	g rms	20 – 2000Hz 240 s each axis
3.3.1.7	Shock resistance single shock, not repetitive, in one direction o(x), p(y) or i(z)	6000	g	> 5ms half-sine
3.3.1.8	Gun hard shock resistance* single shock, not repetitive, in one direction o(x), p(y) or i(z)	Up to 20'000	g	> 6ms, half-sine
3.3.1.9	Recovery time after shock	1.6	ms	Qualified after 1000g, 1ms, half sine

Note: For reliability issues, every single accelerometer is submitted to an acceleration test on a centrifuge prior final calibration. The acceleration conditions are 20'000g during 60 seconds.

Table 6: Environmental parameters

*) The typical acceptable gun hard profile is presented in the next table. Note that high frequency shocks generally associated to a gun hard shock must be attenuated at the final assembly level to ensure full performances of the HS8030.D accelerometer

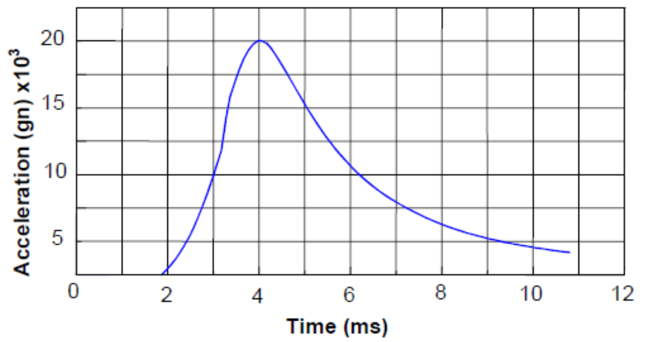


Figure 3: Typical gun hard shock profile

3.3.2. HS8030.D Stability

The short term and one year composite stability of various parameters are specified hereafter:

HS8030.D Stability

3.3.2.1	Short term stability	1ó	± 1.5	mg	During 30 minutes after power up
3.3.2.2	One year bias composite repeatability without gun hard shock	1ó	± 15	mg	→ 72h @ -55°C unpowered → 11 days @ 85°C unpowered → 10 cycles -40°C to 85°C @ max 5°C/min → 10 cycles harass -40°C to 85°C @ 70°C/min unpowered → Vibration 14g rms, 240s each axis
3.3.2.3	Impact of gun hard shock on bias stability	1ó	± 12.5	mg	→ Gun hard shock, up to 20’000g, >6ms, half sine
3.3.2.4	One year scale factor composite repeatability without gun hard shock	1ó	± 650	ppm	Measured @ ± 1g → 72h @ -55°C unpowered → 11 days @ 85°C unpowered → 10 cycles -40°C to 85°C @ max 5°C/min powered → 10 cycles harass -40°C to 85°C @ 70°C/min unpowered → Vibration 14g rms, 240s each axis
3.3.2.5	Impact of gun hard shock on scale factor stability	1ó	± 300	ppm	Measured @ ± 1g → Gun hard shock, up to 20’000g, >6ms, half sine
3.3.2.6	One year misalignment stability without gun hard	Max	± 1	mrad	

Note: Impact of gun hard shock on bias and scale factor is based on Aerobut testing with firing level between 11’000g and 22’000g. Accelerometers have been potted in a 3 axis configuration respecting preferential orientations mentioned in chapter 2 and 3.1.

Table 7: Stability table

3.3.3. Reliability

The operational reliability has been calculated using MIL-HDBK-217F, notice 2.

The HS8030.D reliability values are presented in the following table

Reliability

3.3.3.1	Ground fixed at 30°C, operating	609’307 hours or 1.64 failures / 106 hrs
3.3.3.2	Ground fixed at 30°C, non operating	620’374 hours or 1.61 failures / 106 hrs