MSA-H3-2 Series Data Sheet

Accelerometers and Inclinometers Multiplexed Analog Output

MSA-H3-2 **— Tri-Axis XYZ, 2.8V**

APPLICATIONS

Drop Detection

Gesture Recognition

Inclination and Tilt Sensing

Image Stabilization

Sports Diagnostics

Vibration Analysis

Static or Dynamic Acceleration

Inertial Navigation and Ded(uctive) Reckoning

Cell Phones and Handheld PDAs

Gaming and Game Controllers

Universal Remote Controls

Theft and Accident Alarms

GPS Recognition Assist

Hard-drive Protection

Pedometers

Computer Peripherals

Cameras and Video Equipment

FEATURES

Ultra-Small Package — 5x5x1.2mm DFN

Precision Tri-axis Orthogonal Alignment

Multiplexed Analog Output

High Shock Survivability

Excellent Temperature Performance

Low Noise Density

Very Low Power Consumption

Selectable Power Reduction Modes

User Definable Bandwidth

Factory Programmable Offset and Sensitivity

Self-test Function

PROPRIETARY TECHNOLOGY

These high-performance silicon micromachined linear accelerometers and inclinometers consists of a sensor element and an ASIC packaged in a 5x5x1.2mm Dual Flat No-lead (DFN). The sensor element is fabricated from single-crystal silicon with proprietary Deep Reactive Ion Etching (DRIE) processes, and is protected from the environment by a hermetically-sealed silicon cap wafer at the wafer level.

The AH-3-2 series is designed to provide a high signal-to-noise ratio with excellent performance over temperature. These sensors can accept supply voltages between 2.7V and 5.25V. Sensitivity is factory programmable allowing customization for applications requiring ±1.0g to ±6.0g ranges. Sensor bandwidth is user-definable.

The sensor element functions on the principle of differential capacitance. Acceleration causes displacement of a silicon structure resulting in a change in capacitance. An ASIC, using a standard CMOS manufacturing process, detects and transforms changes in capacitance into an analog output voltage, which is proportional to acceleration. The analog output is also accessed through an on-board 3 channel multiplexor. The sense element design utilizes common mode cancellation to decrease errors from process variation and environmental stress.

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PRODUCT SPECIFICATIONS

PERFORMANCE SPECIFICATIONS [1]			
PARAMETERS	**UNITS**	MSA-H3-2	**CONDITION**
Range [2]	g	±2.0	Factory programmable
Sensitivity	mV/g	560	@2.8V
0g Offset vs. Temp.	mg	±150 (x and y) ±300 (z)	Over temp range
	°C	-40 to 85 [3]	
Sensitivity vs. Temp	%	±2.0 max	Over temp range
Span	mV	±1120	@ 2.8 V
Noise	$\mu g / \sqrt{Hz}$	175 typical	
Bandwidth [4]	Hz	0 to 3300 max (x and y)	-3dB
		0 to 1700 max (z)	
Output Resistance [5]	Ω	32K typical	
Non-Linearity	% of FS	0.1 typical (0.5 max)	
Ratiometric Error	%	±0.4 typical (±1.5 max)	
Cross-axis Sensitivity	%	±2.0 typical (±3.0 max)	
Power Supply	V	2.7 to 5.25	
	V	-0.3 (min) 7.0 (max)	Absolute min/max
	mA	1.1 typical	Current draw @ 2.8V
	μA	<10	Shutdown pin connected to GND
	ms	1.6	Power-up time @ 500 Hz [6]
ENVIRONMENTAL SPECIFICATIONS			
PARAMETERS	**UNITS**	MSA-H3-2	**CONDITION**
Operating Temperature	°C	-40 to 125 [7]	Powered
Storage Temperature	°C	-55 to 150	Unpowered
Mechanical Shock	g	4600	Powered or unpowered, 0.5 msec halversine
ESD	V	3000	Human body model

Notes

[1] The performance parameters are programmed and tested at 2.8 volts. However, the device can be powered from 2.7 V to 5.25 V. Performance parameters will change with supply voltage variations.

[2] Custom ranges from 1g to 6g available.

[3] Temperature range for specified offset.

[4] Lower bandwidth can be achieved by using the external C_2 , C_3 , and C_4 (see application note on page 3).

[5] 32K Ω resistor connects the output amplifier to the output pin. Resistive loading may reduce sensitivity or cause a shift in offset. Maintaining a load resistance at 3.2M Ω will prevent appreciable changes.

[6] The power-up time will increase or decrease according to bandwidth (5RC).

[7] 0g offset and sensitivity change linearly with temperature.

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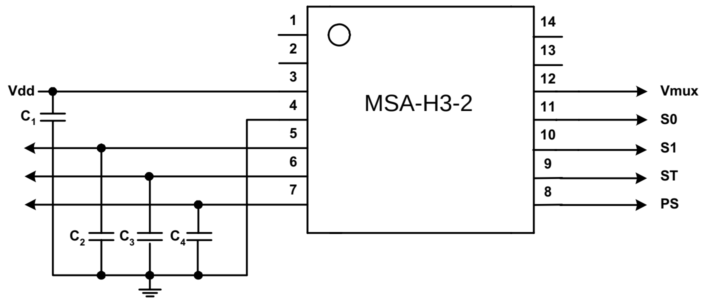
APPLICATION SCHEMATIC & PIN FUNCTION TABLES

Pin	Tri-Axis Function
1	DNC
2	DNC
3	Vdd
4	GND
5	X Output
6	Z Output
7	Y Output
8	PS
9	Self Test
10	S1
11	S0
12	Vmux
13	DNC
14	DNC



MSA-H3-2 Pin Descriptions

GND – Ground

PS — Power shutdown pin. When the PS pin is connected to GND or left floating, the KXPA4 is shutdown and drawing very little power. When the PS pin is tied to Vdd, the unit is fully functional.

Self Test — The output of a properly functioning part will increase when Vdd is applied to the self-test pin.

SO — MUX select

S1 — MUX select

Vdd – Power supply

Vmux — Multiplexed analog output

X Output – Analog X output

Y Output – Analog Y output

Z Output – Analog Z output

Application Design Equations

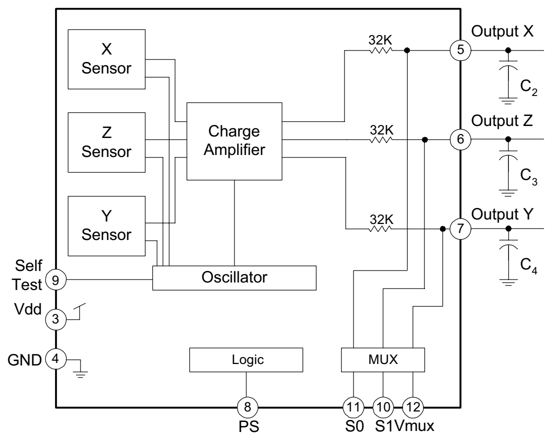
The bandwidth is determined by the filter capacitors connected from pins 3, 4 and 5 to ground. The response is single pole. Given a desired bandwidth, f_{BW}, the filter capacitors are determined by:

$$C_2 = C_3 = C_4 = \frac{4.97\ x10^{-6}}{f_{BW}}$$

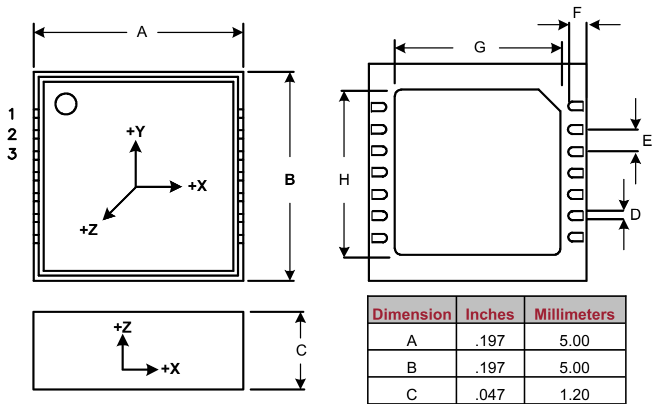
Notes

1. Recommend using 0.1 μF for decoupling capacitor C_1.

FUNCTIONAL DIAGRAM



5x5x1.2mm DFN PACKAGE



Note

1. When device is accelerated in +X, +Y or +Z direction, the corresponding output will increase.

Dimension	Inches	Millimeters
A	.197	5.00
B	.197	5.00
C	.047	1.20
D	.009	0.23
E	.020	0.50
F	.016	0.40
G	.142	3.60
H	.142	3.60

ORDERING GUIDE

Product	Axis(es) of Sensitivity	Range	Sensitivity (mV/g)	Offset (V)	Operating Voltage (V)	Temperature	Package
MSA-H3-2	XYZ	2g	560	1.40	2.8	-40 to +85 °C	5x5x1.2mm DFN

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Multiplexor Data Select

The AH3-2 features an integrated 3-channel multiplexor. This feature reduces system MCU requirements to only 1 ADC and 2 digital I/O's. The AH3-2 uses two select (S0, S1) inputs to control the data flow from Vmux. When a microprocessor toggles the select inputs, the desired output is attained based on the select table in Figure 1. Note that logic 0 is GND and logic 1 is Vdd.

S1	S0	Vmux
0	0	X Output
0	1	Z Output
1	0	Y Output
1	1	Y Output

Figure 1 Output Select Table

Data Sampling Rate

When operating in its multiplexed mode, the AH3-2 has the ability to achieve very high data sampling rates. Internally, the sensor elements (X, Y, and Z) are sequentially sampled in a "round robin" fashion at a rate of 32KHz per axis. Note that this is a differential capacitance sampling of each sensor element, which stores an analog voltage on the filter cap for each axis. Combine this high sensor element sampling rate with the short 5μS settling time of the integrated multiplexor, and the user can achieve a performance very close to that of the 3 separate analog outputs. This is more than sufficient to eliminate any aliasing in the final application since the AH3-2 will be operating with a typical bandwidth of ~50Hz and a maximum of 2500Hz.

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