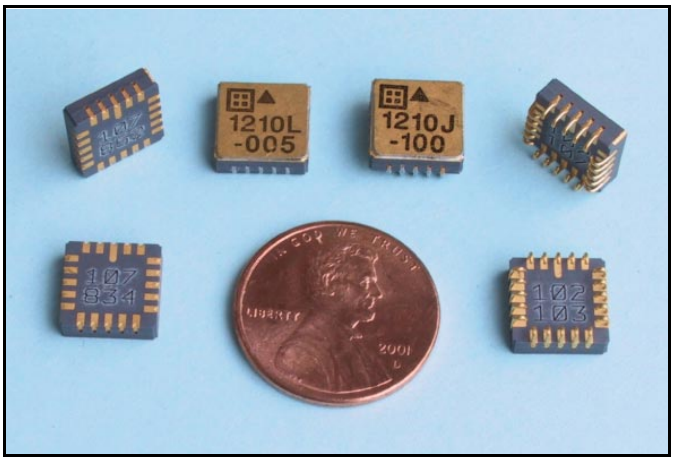
SILICON DESIGNS, INC

Model 1210
ANALOG ACCELEROMETER

CAPACITIVE SENSOR
ANALOG OUTPUT
WIDE TEMPERATURE RANGE
SURFACE MOUNT PACKAGE



FEATURES

- **±4V Differential Output or 0.5V to 4.5V Single Ended Output**
- **Low Power Consumption**
- **-55 to +125 °C Operation**
- **Built-in Nitrogen Damping**
- **Calibrated to 1% Bias and Scale Factor (typical)**
- **+5 V DC Power**
- **Responds to DC & AC Acceleration**
- **Non Standard G Ranges Available**
- **Hermetic LCC or J-Lead Surface Mount Package**
- **Serial Number for Traceability**

ORDERING INFORMATION

Full Scale Acceleration	Hermetic Packages	
	20 pin LCC	20 pin JLCC
±5 g	1210L-005	1210J-005
±10 g	1210L-010	1210J-010
±25 g	1210L-025	1210J-025
±50 g	1210L-050	1210J-050
±100 g	1210L-100	1210J-100
±200 g	1210L-200	1210J-200

DESCRIPTION

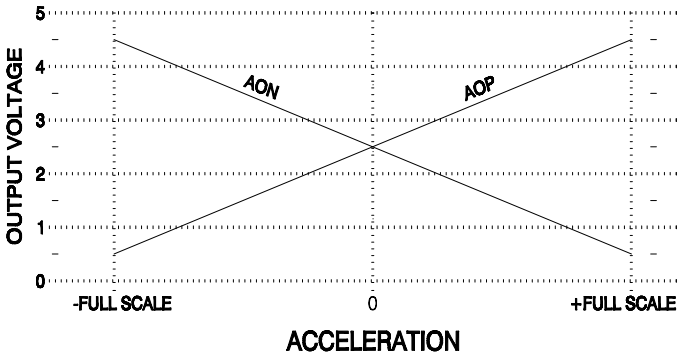
The Model 1210 accelerometer is a low-cost, integrated accelerometer for use in zero to medium frequency instrumentation applications. It combines in a single, miniature, hermetically sealed package, a micromachined capacitive sense element and a custom integrated circuit that includes a sense amplifier and differential output stages. It is relatively insensitive to temperature changes and gradients and each device is marked with a serial number on its bottom surface for traceability.

OPERATION

The Model 1210 accelerometer produces two analog voltage outputs which vary with acceleration as shown in the figure below. The outputs can be used either in differential or single ended modes referenced to +2.5 volts. Two reference voltages -- +5.0 and +2.5 volts (nominal) -- are required; the output scale factor is ratiometric to the +5 volt reference voltage, and both outputs at zero acceleration are equal to the +2.5 volt reference. The sensitive axis is perpendicular to the bottom of the package, with positive acceleration defined as a force pushing on the bottom of the package.

APPLICATIONS

COMMERCIAL	INDUSTRIAL
● Automotive	● Vibration Monitoring
Air Bags	● Vibration Analysis
Active Suspension	● Machine Control
Adaptive Brakes	● Modal Analysis
Alarm Systems	● Robotics
● Shipping Recorders	● Crash Testing
● Appliances	● Instrumentation



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SIGNAL DESCRIPTIONS

VDD and GND (Power): Pins (8,9,11,14) and (2,5,6,18,19) respectively. Power (+5 Volts DC) and ground.

AOP and AON (Output): Pins 12 and 16 respectively. Analog output voltages proportional to acceleration. The AOP voltage increases with positive acceleration, AON voltage decreases with positive acceleration; at zero acceleration both outputs are nominally equal to the 2.5 volt reference. The device experiences positive (+1g) acceleration with its lid facing up in the earth's gravitational field. Either output can be used individually or the two outputs can be used differentially. Voltages can be measured ratiometrically to VR for good accuracy without requiring a precision reference voltage. (See plot.)

DV (Input): Pin 4. Deflection Voltage. A test input that applies an electrostatic force to the sense element, simulating a positive acceleration. The nominal voltage at this pin is ½ VDD.

VR (Input): Pin 3. Voltage Reference. Tie directly to +5 volt power for ratiometric measurements or a +5 volt reference voltage for better absolute accuracy. A 0.1µF bypass capacitor is recommended at this pin.

2.5 Volt (Input): Pin 17. Voltage Reference. Tie to a voltage divider from +5 volts or to a 2.5 volt reference voltage.

PERFORMANCE by Model: V_{DD}=5.0VDC, T_C=25°C.

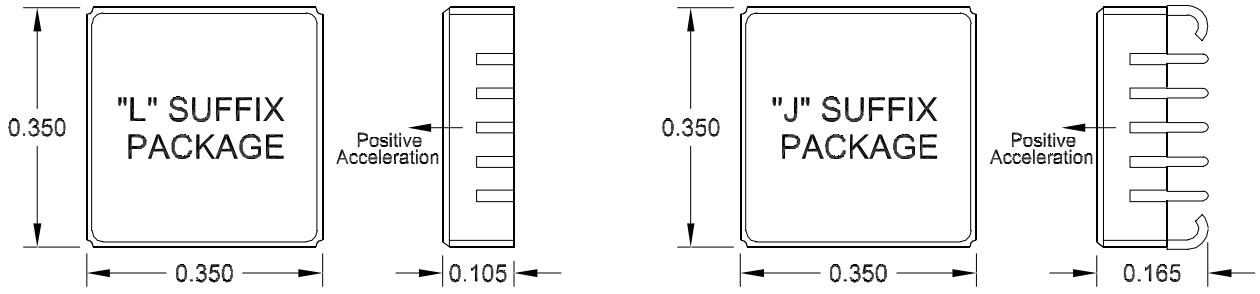
Model Number	1210x-005	1210x-010	1210x-025	1210x-050	1210x-100	1210x-200	Units
Input Range	±5	±10	±25	±50	±100	±200	g
Frequency Response (Nominal, 3 dB)	0 - 400	0 - 600	0 - 1000	0 - 1600	0 - 2000	0 - 2500	Hz
Sensitivity (Differential) [1]	800	400	160	80	40	20	mV/g
Max. Mechanical Shock (0.1 ms)	2000						g

Note 1: Single ended sensitivity is half of values shown.

PERFORMANCE - All Models: Unless otherwise specified V_{DD}=5.0VDC, T_C=25°C, Differential Mode.

Parameter	Min	Typ	Max	Units
Cross Axis Sensitivity		2	3	%
Bias Calibration Error [2]		1	2 [3]	% of span
Bias Temperature Shift (T_C=-55 to +125°C) [2]		50	200 [3]	(ppm of span)/°C
Scale Factor Calibration Error [2, 4]		1	2	%
Scale Factor Temperature Shift (T_C=-55 to +125°C) [2]		+300		ppm/°C
Output Noise (0 - 1.0 kHz)		800		µV (RMS)
Non-Linearity (-90 to +90% of Full Scale) [2, 4]		0.5	1.0 [3]	% of span
Power Supply Rejection Ratio		25		dB
Output Impedance		90		Ohms
Operating Voltage	4.75	5.0	5.25	V
Operating Current (I_{DD}+I_{VR}) [2]		6	8	mA
Mass: 'L' package (add 0.06 grams for 'J' package)		0.62		grams

Notes: 2. Tighter tolerances available on special order.
3. These maximums do not apply to 5g version; contact factory for current 5g specifications.
4. 100g versions and above are tested from -65 to +65g.



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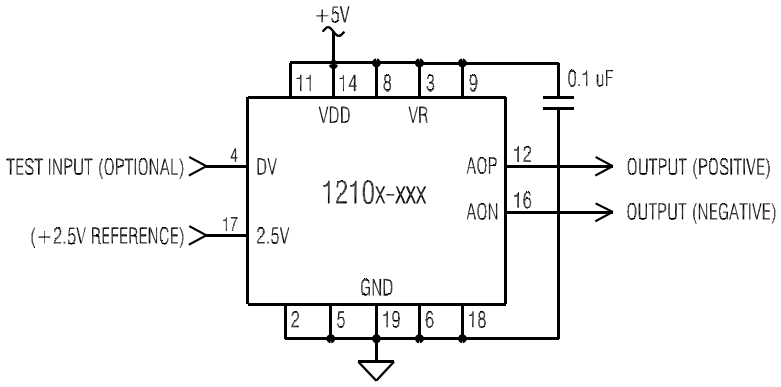
ABSOLUTE MAXIMUM RATINGS *

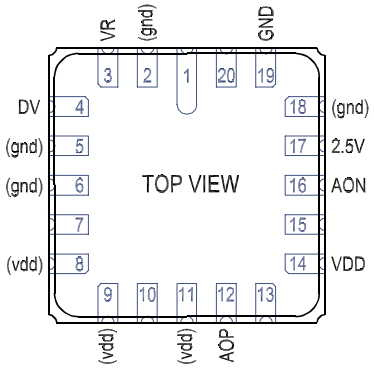
Case Operating Temperature	-55 to +125°C
Storage Temperature	-55 to +125°C
Acceleration Over-range	2000g for 0.1 ms
Voltage on V_{DD} to GND	-0.5V to 6.5V
Voltage on Any Pin (except DV) to GND [1]	-0.5V to V_{DD}+0.5V
Voltage on DV to GND	±15V
Power Dissipation	50 mW

NOTE 1: Voltages on pins other than DV, GND or V_{DD} may exceed 0.5 volt above or below the supply voltages provided the current into or out of the pin is limited to 1 mA.

** **NOTICE:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at or above these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*



RECOMMENDED CONNECTIONS



PINOUT

(LCC & JLCC PACKAGES)

The 2.5V reference input may be driven from either a precision voltage source or a 5kΩ/5kΩ resistive divider from a precision 5V supply. If a resistive divider is used, a 0.01µF bypass capacitor should be connected between the 2.5V input and GND.

USE of the (DV) test input: Left unconnected, the DV input has a nominal voltage of 1/2 VDD. For best accuracy during normal operation, this input should be left unconnected or connected to a voltage source equal to 1/2 of the VDD supply. The change in differential output voltage (AOP-AON) is proportional to the square of the difference between the voltage applied to the DV input (VDV) and 1/2 VDD. Note that only positive shifts in the output voltage may be generated by applying voltage to the DV input. The proportionality constant (*k*) varies for each device and is not characterized.

$$AOP - AON \approx k\left(V_{DV} - \tfrac{1}{2}V_{DD}\right)^2$$

ESD and LATCHUP CONSIDERATIONS: The model 1210 accelerometer is a CMOS device subject to damage by large electrostatic charges. Diode protection is provided on the inputs and outputs but care should be exercised during handling to assure that CMOS devices are placed on grounded conductive surfaces only. Individuals and tools should be grounded before coming in contact with CMOS devices. Do not insert or remove CMOS devices in sockets with power applied.

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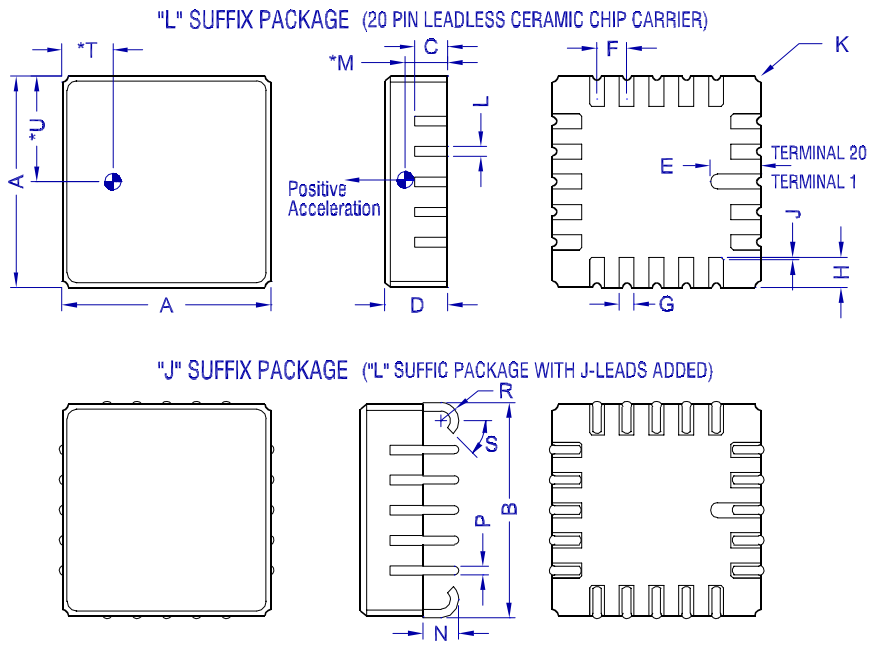
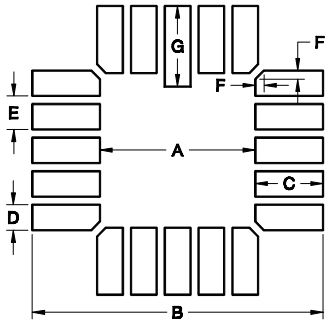
PACKAGE DIMENSIONS



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.342	0.358	8.69	9.09
B	0.354	0.370	8.99	9.40
C	0.050	0.060	1.27	1.52
D	0.095	0.115	2.41	2.92
E	0.075	0.095	1.91	2.41
F	0.050 BSC		1.27 BSC	
G	0.022	0.028	0.56	0.71
H	0.050 TYP		1.27 TYP	
J	0.004 x 45°		0.10 x 45°	
K	0.010 R TYP		0.25 R TYP	
L	0.016 TYP		0.41 TYP	
* M	0.048 TYP		1.23 TYP	
N	.055	.065	1.40	1.65
P	0.014 TYP		0.36 TYP	
R	0.03 R TYP		0.76 R TYP	
S	45° MINIMUM			
* T	0.085 TYP		2.16 TYP	
* U	0.175 TYP		4.45 TYP	

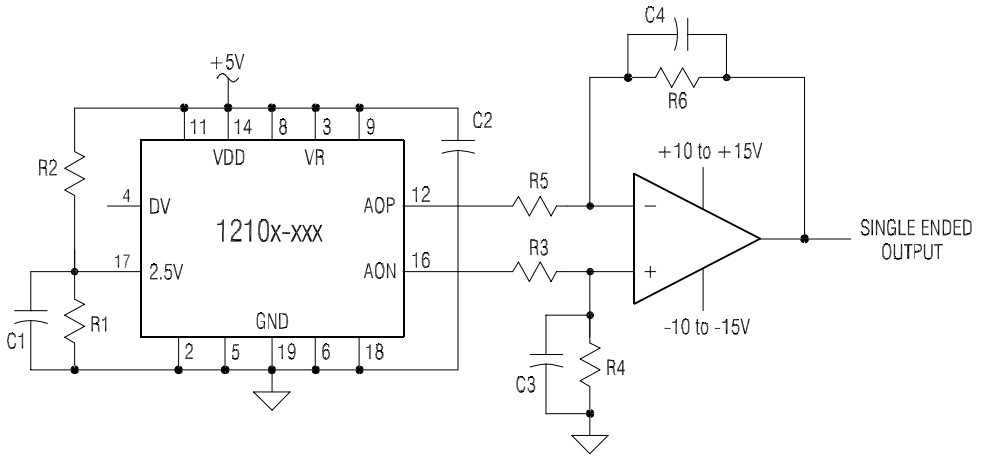
NOTES:
1. * DIM 'M', 'T' & 'U' LOCATE ACCELERATION SENSING ELEMENT'S CENTER OF MASS .
2. LID IS ELECTRICALLY TIED TO TERMINAL 19 (GND).
3. CONTROLLING DIMENSION: INCH.
4. TERMINALS PLATED 60 MICROINCHES MIN GOLD OVER 80 MICROINCHES MIN NICKEL.
5. PACKAGE: 90% MINIMUM ALUMINA (BLACK), LID: SOLDER SEALED KOVAR.

SOLDERING RECOMMENDATIONS: Manual soldering of the 1210 series accelerometers is recommended. Allow a brief cooling period between the soldering of each terminal so that the average case temperature remains at or below 150°C. Maximum allowed case temperature is 175°C for 60 seconds. The recommended solder pad size and shape for both the LCC and J-LCC packages is shown in the diagram and table below. These dimensions are recommendations only and may or may not be optimum for your particular soldering process.



DIM	inch	mm
A	.230	5.84
B	.430	10.92
C	.100	2.54
D	.038	0.97
E	.050	1.27
F	.013	0.33
G	.120	3.05

ADDING A SINGLE ENDED OUTPUT TO THE MODEL 1210 DIFFERENTIAL OUTPUT ACCELEROMETER



R1 = R2 = 5.00K ±0.5% for precision 2.50V ref.	R3, R4, R5 & R6 = 20kΩ to 50kΩ R3 = R5 to within 0.1% for common mode rejection R4 = R6 to within 0.1% for common mode rejection R4 / R3 ratio accurate to within 0.1% for gain control R6 / R5 ratio accurate to within 0.1% for gain control
C1 = C2 = 0.01 µF ceramic	

This circuit converts the ± 4 Volt differential output of the model 1210 accelerometer, centered at +2.5 Volts, to a single ended output centered about ground. It is useful when the user's voltage monitoring equipment lacks a true differential input and is only capable of ground referenced measurements. It provides the advantage of low common mode noise by preventing the ground current of the model 1210 from causing an error in the voltage reading.

The op-amp should be located as close as possible the user's voltage monitoring equipment. The majority of the length of the signal path can therefor be differential where any noise will affect the wire run as a common mode signal which will be rejected. The op-amp type is not critical; a µA741 or ¼ of a LM124 can be used. The power supplies need to be ±10V to ±15V to allow for both positive and negative output swing.

The gain of the op-amp is determined by the ratio R4/R3 (where R6/R5 must match R4/R3). If R3 through R6 are all the same value, the gain equals 1 and the output swing will be ± 4 Volts single ended with respect to ground. To obtain a ± 5 Volt single ended output, set R4/R3 = R6/R5 = 5/4 = 1.25. The single ended output of the op-amp will be centered at ground if R4 and C3 are tied to ground; using some other fixed voltage for this reference can shift the output. The value of the optional capacitors C3 and C4 can be selected to roll off the frequency response to the frequency range of interest.

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