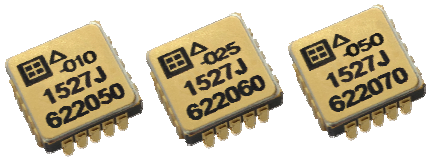
MODEL 1527 ANALOG INERTIAL MEMS SURFACE MOUNT ACCELEROMETER

- Excellent In-Run Bias Stability
- Small Bias and SF Temperature Coefficients
- Low Power +5 VDC, 6.5 mA
- -55 to +125°C Operation
- Internal Temperature Sensor
- ±4.0V Differential Analog Output
- Low Mass, 0.7 grams
- Small, J-Lead LCC-20, Hermetic, Ceramic Package



STANDARD G-RANGES

FULL SCALE ACCELERATION	20 PIN JLCC
± 10 g	1527J-010
± 25 g	1527J-025
± 50 g	1527J-050

DESCRIPTION

The Model 1527 is the best in class, low-cost, integrated accelerometer for use in inertial and zero to medium frequency instrumentation applications requiring high repeatability and low noise. The 1527 was designed for maximum stability required by inertial applications. Each miniature, hermetically sealed package combines two MEMS capacitive sense elements and a custom integrated circuit that includes a sense amplifier and differential output stage. It is relatively insensitive to wide temperature changes and gradients. Each device is marked with a serial number on its top and bottom surfaces for traceability. A calibration test sheet is supplied with each unit.

ZERO (DC) TO MEDIUM FREQUENCY APPLICATIONS

INERTIAL NAVIGATION INSTRUMENTATION OEM ROBOTICS

SPECIFICATIONS*

DESIGN PARAMETERS (NOT TESTED DURING MANUFACTURING)

PARAMETER	TYPICAL VALUE/RANGE +/-10G	TYPICAL VALUE/RANGE +/-25G	TYPICAL VALUE/RANGE +/-50G	UNITS
Temperature Sensor Sensitivity (IT Pin 7)	1.2 to 1.8	1.2 to 1.8	1.2 to 1.8	uA/C
Temperature Sensor Noise	0.33 RMS typ	0.33 RMS typ	0.33 RMS typ	C
Bias, Long Term Repeatability (1σ)	1.25	1.50	3.0	mg
Turn-On Time < 150 ppm of FS	0.5	0.5	0.5	msec
In Run Bias Stability at +1g, 2-40,000 sec. (AV Min)	12	30	60	µg
Operating Voltage	4.75 to 5.25	4.75 to 5.25	4.75 to 5.25	Volts
Scale Factor Long Term Repeatability (1σ)	300	300	300	PPM
Input Axis Misalignment	4	4	4	mrad
Peak Vibration (Operating and Non-operating	200%	200%	200%	FS
Output White Noise	18	25	50	µg/√Hz½ rms
Mass	0.68	0.68	0.68	grams
Vibration Rectification, typical Random, 10-50 Hz Random, 50-200 Hz	TBA	30 100	TBA	µg/g² rms
Velocity Random Walk	0.007	0.012	0.025	m/sv√Hr½

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

MAX OPERATING LIMITS

PARAMETER	MINIMUM	MINIMUM	UNITS
Differential Output	-4.0	+4.0	Volts
Operating Voltage	4.75	5.25	Volts
Quiescent Operating Current at +5V	----	6.5	mA
Operating / Storage Temperature	-55	+125	°C
Applied Voltage on Digital Pins	-0.5	5.5	Volts
Mechanical Shock (0.1 ms)	----	5,000	g-peak
Peak Vibration (Operating and Non-operating)	----	200	% of FS

TESTED PERFORMANCE REQUIREMENTS

PARAMETER	LIMIT +/-10G	LIMIT +/-25G	LIMIT +/-50G	UNITS
Bias	+/- 0.5	+/- 0.5	+/- 0.5	% of FS
Bias Temperature Coefficient	±25	±15	±15	PPM of FS/°C
Scale Factor Sensitivity, +/-0.5%	400	160	80	mV/g
Scale Factor Temperature Coefficient	±25	±25	±25	PPM/ °C
Frequency Response, DC to -3 dB, Minimum	600	900	1200	Hz
RMS Model Residual (+/- 1g, -40, +25,+85°C)	30	25	25	PPM of FS

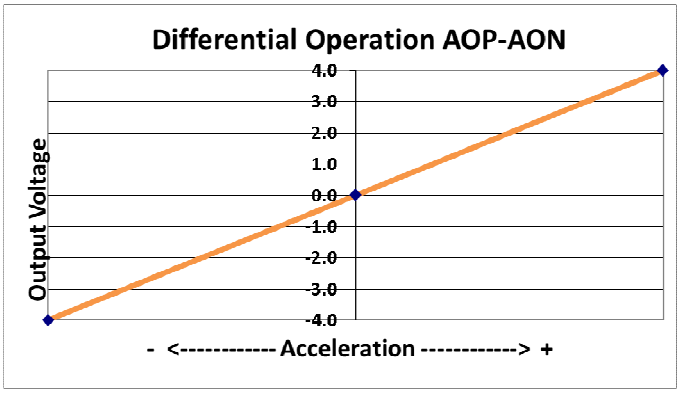
All Specifications are subject to change without notice.

**** NOTICE:*** *Stresses greater than those listed above may cause permanent damage to the device. These are maximum 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 and lifespan.*

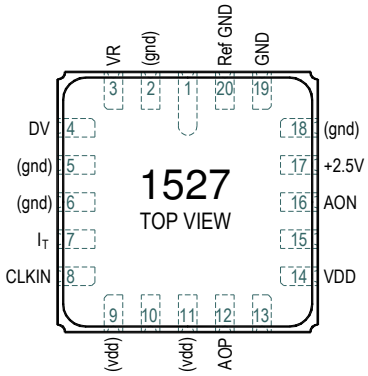
OPERATION

The model 1527 sensitive axis is perpendicular to the bottom of the package, with positive acceleration resulting from a positive force pushing on the bottom of the package. The 1527 produces a differential +/-4 volts output voltage, the value of which varies with acceleration as shown in figure 1. The seismic center is located on a centerline through the dual sense elements halfway between them. Any errors due to rotation about this point are effectively cancelled by the internal electronics

Two reference voltages, +5.0 and +2.5 volts (nominal), are required; the scale factor is ratiometric to the +5.0 volt reference voltage relative to GND.



SIGNAL DESCRIPTIONS



V_{DD} and GND (power): Pins (14) and (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 (AON 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. Use of differential mode is required for both low noise and high accuracy operation. Voltages can be measured ratio-metrically to VR for good repeatability without requiring a separate precision reference voltage for an A/D.

DV (input): Pin 4. Deflection Voltage. Connect to the 2.5 Volt pin for best repeatability. A test input that applies an electrostatic force to the sense element, simulating a positive acceleration. The nominal voltage at this pin is ½ V_{DD}. DV voltages higher than required to bring the output to positive full scale may cause device damage. See app note.

VR (input and Ref GND): Pin 3. Voltage Reference. Tie VR to a good reference (not directly to VDD) for best scale factor repeatability. A 0.1µF bypass capacitor is recommended at this pin. VR current is less than 100 uA. Ref GND can be connected to pin 19. However, to minimize 1/f noise, connect pin 20 separately to the ground of the voltage reference ground pin.

2.5 Volt (input): Pin 17. Sets output common-mode value. Tie to a resistive voltage divider from +5 volts. A 0.1µF bypass capacitor is recommended at this pin.

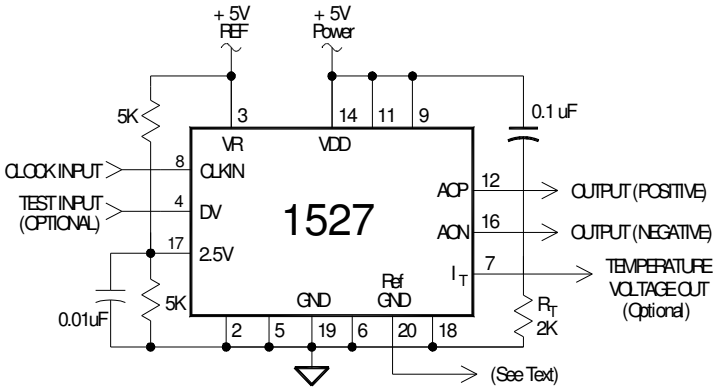
I_T (output): Pin 7. Uncalibrated temperature dependent current source. Tie to V_{DD} if not used.

CLKIN : Pin 8. Optional external clock input, leave unconnected or contact SDI for details on this feature.

Special Use Pins: Pins 9 and 11 should be tied to VDD; Pins 2,5,6 and 18 to GND; Pins 1,7,10,13, and 15 are reserved and should remain unused. Contact SDI for possible special use of these pins.

RECOMMENDED CONNECTIONS

DEFLECTION VOLTAGE (DV) TEST INPUT: This test input applies an electrostatic force to the sense element, simulating a positive acceleration. It has a nominal input impedance of 32 kΩ and a nominal open circuit voltage of **½ V_{DD}**. For best accuracy during normal operation, this input should be left unconnected or connected to a voltage source equal to ½ of the **V_{DD}** 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 (V_{DV}) and **½ V_{DD}**. Only positive shifts in the output voltage may be generated by applying voltage to the **DV** input. When voltage is applied to the **DV** input, it should be applied gradually. The application of **DV** voltages greater than required to bring the output to positive full scale may cause device damage. The proportionality constant (***k***) varies for each device and is not trimmed to a value.

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

ESD and LATCH-UP CONSIDERATIONS: The model 1527 accelerometer is a CMOS device subject to damage from large electrostatic discharges. Diode protection is provided on the inputs and outputs, and it is not easily damaged, but care should be exercised during handling. However, individuals and tools should be grounded before coming in contact with the device. Although the 1527 is resistant to latch-up, inserting a 1527 into or removing it from a powered socket may cause damage.

INTERNAL TEMPERATURE SENSING

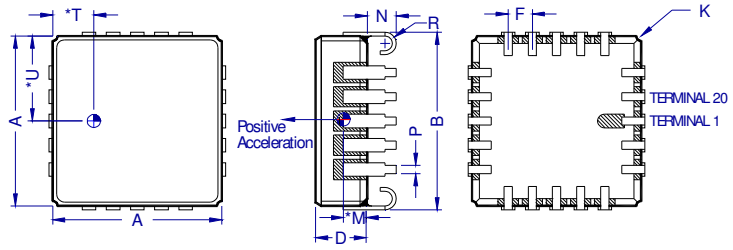
The model 1527 accelerometer outputs a temperature dependent current source on pin 8. This signal is useful for measuring the internal temperature of the accelerometer so that any previously characterized bias and scale factor temperature dependence, for a particular accelerometer, can be corrected. The nominal output current at 25°C is ≈500 (±200) µA and the nominal sensitivity is 1.5µA/°C. With a single resistor R_T = 2K between I_T (pin 8) and GND the output voltage V_T will vary between about +0.76 and +1.3 volts from -55°C to +125°C, giving a sensitivity of approximately +3 mV/°C.

INTERNAL CLOCK

The model 1527 contains an internal clock than runs at approximately 800 KHz. The internal clock is powered by Vdd. Like other synchronous sensors, it is subject to clock "lock-in" with other nearby accelerometers driven by the same Vdd. To avoid possible lock-in and small bias jumps, it is recommended that the Vdd power to each accelerometer be supplied by separately buffered sources or filtered from a common, well-bypassed source by a LC filter with a minimum of 20 db loss at 800 KHz. Alternatively, multiple accelerometers can be driven synchronously by the same external clock with a frequency in the range of 0.5 to 1 MHz. Contact SDI for more information on using an external clock.

PACKAGE DIMENSIONS

1. *Dimensions "M," "T," and "U" locate sensing element's center of mass.
2. Lid is electrically tied to terminal 19 (GND).
3. Controlling dimension: Inch.
4. Terminals are plated with 60 micro-inches min gold over 80 micro-inches min nickel. This plating specification does not apply to the Pin-1 identifier mark on the bottom of the J-lead package.



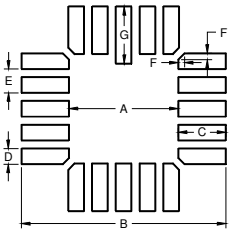
Dim	Inches		Millimeters	
	Min	Max	Min	Max
A	0.342	0.358	8.69	9.09
B	0.346	0.378	8.79	9.60
D	0.095	0.115	2.41	2.92
F	0.050 BSC		1.27 BSC	
K	0.010 R TYP		0.25 R TYP	
* M	0.066 TYP		1.68 TYP	
N	0.050	0.070	1.27	1.78
P	0.017 TYP		0.43 TYP	
R	0.023 R TYP		0.58 R TYP	
* T	0.085 TYP		2.16 TYP	
* U	0.175 TYP		4.45 TYP	

SOLDERING RECOMMENDATIONS

RoHS Compliance: The model 1527 does not contain elemental lead and is RoHS compliant.

Pre-Tinning of Accelerometer Leads is Recommended: To prevent gold migration embrittlement of the solder joints, it is best to pre-tin the accelerometer leads before soldering.

Do not use ultrasonic cleaners. Ultrasonic cleaning may break internal wire bonds and will void the warranty.



DIM	Inch	mm
A	.230	5.84
B	.430	10.92
C	.100	2.54
D	.033	0.84
E	.050	1.27
F	.013	0.33
G	.120	3.05

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