

An Atlas rocket is shown launching from a launch pad, ascending into a blue sky with scattered white clouds. The rocket is white with orange and black accents. The launch pad structure is visible on the left, with the word "ATLAS" written vertically on it. The rocket has a "CO" logo on its nose cone. The background is a dark gradient with a pattern of white hexagons of varying sizes and opacities, some containing images of inertial sensors.

 **Columbia** *Research Laboratories, Inc.*

**INERTIAL PRODUCTS**

[www.crlsensors.com](http://www.crlsensors.com)

## HISTORY OF COLUMBIA RESEARCH LABORATORIES, INC. WOOLDYN, PA



For over fifty years, Columbia Research Laboratories, Inc. has been committed to designing and manufacturing advanced technology, cost-effective products. Each product is designed to withstand hard use over long periods of time. Precision manufactured and tested to the most exacting quality standards, Columbia's products frequently exceed customer specifications.



Columbia offers a diversified product line with a wide selection of instruments. Columbia's continually growing product line includes, but is not limited to, Piezoelectric Accelerometers, Pressure Transducers, Force Balance Inertial Grade Accelerometers and Inclinometers, Standard Linear Variable Differential Transducers, Flight Qualified Fatigue Load monitoring Foil Strain Sensors, Charge Amplifiers for signal conditioning of Piezoelectric Accelerometers and Pressure Transducers, Force Balance Technology Inclinometer Systems, Hand Held Vibration Meters and Solid State Sensors. Columbia specializes in manufacturing to customers specifications.



Columbia's involvement in designing and manufacturing specialized products for the U.S. Government's Aerospace Programs and Commercial Aviation programs goes back many years as noted below:



Columbia provided the AS16-321 Vibration Measurement System for the LEM Spacecraft launched in 1974 and the Vibration Measurement Set model 123101 designed for the 1<sup>st</sup> M1T500 Flight Vehicle launched March 6, 1975. In more recent years, Columbia has designed and provided instrumentation for the Mark-12, GBU-15, AGM-130, AMRAM, HELLFIRE, ALCM, SLCM, Trident I & II, ASROC, Atlas II, Pershing II, MX, SICBM, P-3, DC-10, T-45 Trainer, Atlas-Titan, Atlas-Centaur, Shuttle Columbia, Cruise Missile, Lance Missile, ASAT Program, Killer Satellite, Captor Program, F-18 Fighter Aircraft, A-10 Fighter Aircraft, mark 21 HIT, AV-8, B-52, F-16 and JPATS.



Columbia was also involved in the recently retired venerable F117 Stealth Fighter Plane that served the U.S. so well for many years. However currently Columbia has participated in the Space X, F-22(test units), 787 Dream Liner (test units), C130 Hercules and MH-60 Black Hawk Helicopter.



This program history is typical of Columbia's performance. Columbia delivers quality products at competitive costs.



Visit our web-site [www.crlsensors.com](http://www.crlsensors.com)  
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## FOREWORD

COLUMBIA offers a wide selection of Force Balance Servo Accelerometers and Inclinometers, specifically designed to give the user a diversified choice of sizes, configurations and performance levels for industrial, O.E.M. and military requirements.

Many COLUMBIA Force Balance Transducers have been in-flight missile qualified in accordance with all applicable MIL-Standards / Commercial standards and are currently being used on a variety of our government's most technically demanding military in-flight weapons systems. COLUMBIA also offers servo accelerometers that have been TSO-Approved by the Federal Aviation Agency (FAA) for flight avionics, commercial and general aircraft flight control systems. For over thirty-five years, high reliability product performance for such critical applications have been a significant feature of COLUMBIA Force Balance Servo Accelerometers and Inclinometers.

## THE COLUMBIA FACILITY

Self-sufficiency has been a COLUMBIA key-note over the fifty years of the company's existence. Dependency on outside sources for critical components, materials and services is discouraged.

All the torque mechanisms used in the miniature and high performance inertial products are totally manufactured at COLUMBIA. This is done to insure consistent availability and precision of critical components.

Torque parts, housing and hardware for COLUMBIA Force Balance Accelerometers are manufactured in COLUMBIA's on-site shop facilities using efficient, high-speed, numerically-controlled machines.

No cast parts are used in the COLUMBIA torquers. All parts are precision machined and checked to exacting standards. Critical assembly operations are performed in a "Limited Access White Room".

COLUMBIA also has extensive "in-house" environmental testing capabilities in sine and random vibration, shock, angular and linear acceleration, and temperature. The COLUMBIA facility and all COLUMBIA procedures and processes have been quality surveyed and are certified to be in full compliance with Federal Government Quality Assurance Documents MIL-Q-9858 / MIL-I-45208.

Fine details such as identification engraving, label and data sheet printing are also included in COLUMBIA's repertoire of "in-house" capabilities.

COLUMBIA will continue to expand their facilities and capabilities in order to guarantee the ability to respond rapidly and economically to customers' needs for specialized packaging or performance in the field of force balance accelerometers and to insure the highest level of product accuracy and performance available from any source.

## TECHNICAL INFORMATION

The servo force balance accelerometer offers significant performance and accuracy advantages. This fact is evident by their extensive use in application requiring 0.1% or better overall accuracy. Unlike conventional accelerometers, the servo type contains a freely suspended mass constrained by an electrical equivalent mechanical spring.

There are two classes of servo force balance accelerometers: the pendulous type, having an unbalanced pivoting mass with angular displacement, and the non-pendulous type, having a mass which is displaced linearly.

The behavior of all accelerometers is explained by Newton's second law of motion: Force equals mass times acceleration.

$$F = ma$$

This equation tells us, for one thing, that if a mass is to be accelerated, a force proportional to the amount of acceleration must exist. If the force can be measured, the amount of acceleration can be determined.

For pendulous type accelerometers, the polar form of the equation applies: Torque equals pendulous mass times acceleration.

$$T = (ml) a$$

where (l) is the distance from axes of rotation to center of mass, and (m) is the pendulous mass.

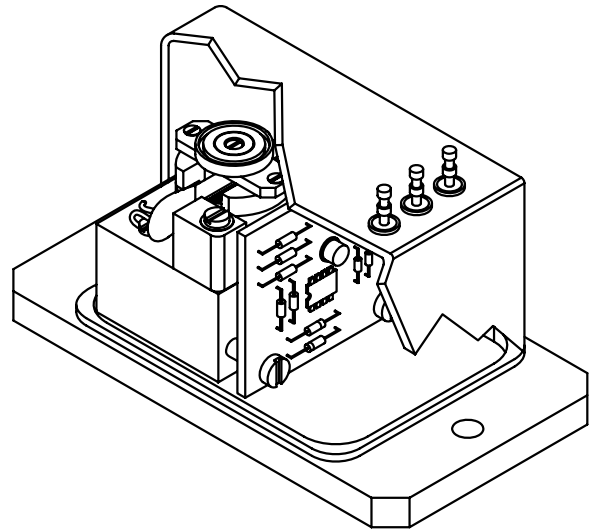


Fig. 1 - Force Balance Sensor

## WHY CHOOSE A FORCE BALANCE SENSOR?

The force balance sensor is intended for DC and low frequency acceleration measurements, such as those encountered in the motion of vehicles, aircraft and ships. These sensors are capable of measuring levels from as low as 0.0001g up to 200g's over a frequency range from DC to 1000Hz. In addition, due to their inherent sensitivity to gravity, the force balance accelerometers with certain modifications or special features become excellent instruments for measuring angles of inclination. This type of sensor often referred to as an inclinometer is useful in applications such as platform leveling, pipeline leveling, gunsight control, borehole mapping or other low level seismic measurement applications.

## ADVANTAGES

The force balance sensor has several advantages which result in exceptional performance in the type of applications mentioned above.

Internal displacements within any accelerometer lead to inaccuracies an errors usually in the form of excessive hysteresis, stickiness, non-linearity and non-repeatability. LVDT, potentiometric, variable reluctance and similar type sensors all produce these errors due to the fact that the sensing element must move over some distance in order to produce a measurable change in output.

In contrast, the output signal from a force balance accelerometer does not depend on the displacement of some internal element being a linear function of acceleration. Internal displacements are kept relatively small, typically less than one ten thousandth of an inch. In addition to minimizing static error the minute displacements associated with the force balance sensor contribute to this type of sensor having a relatively high natural frequency. A strain gage sensor does not require excessive internal displacements but does suffer from instability due to effects of temperature, creep and aging. Unlike other low frequency accelerometers which require a viscous media, dash pot or similar mechanical damping technique, the dynamic response of the force balance sensor is easily damped and adjusted to a precise value by means of electronics networks.

The damping ratio may be set to near critical for a maximum usable response or to a higher degree or limited response and sensitivity to high frequencies. Normally in open loop types of transducers the damping ratio is either uncontrolled as in the case of piezoelectric devices or controlled by means of viscous media. In the latter case, the damping ratio cannot be controlled by any tight tolerance, due to viscosity changes vs. temperature. Many strain gage, potentiometric or LVDT type accelerometers include thermostatically controlled heaters in an attempt to stabilize damping characteristics. Furthermore, the force balance accelerometer in most cases is entirely self-controlled, requiring no additional signal conditioning, and capable of interfacing directly with spectrum analyzers, oscilloscopes, data acquisition systems, digital volt meters and displays. The full scale output is normally in the order of several volts and requires no further amplification.

### HOW THE FORCE BALANCE SENSOR WORKS

The force balance sensor consists of a position detector, not necessarily one that is linear, an amplifier, and an electromechanical system. This combination performs the function of converting a mechanical force into a proportional current which is in turn converted back into an equal opposing mechanical force. The position of a mass coupled to the force generator is monitored by the position detector. An externally induced change in mass position results in a combination position detector, amplifier output such as that the force generator drives the mass back to its original position. The output of the sensor is a measure of the current through the force generator, this current being proportional to the restoring force which is equal and opposite to the input force. The input acceleration is equaled to the input force through the calibrated mass. Refer to Fig. 2. With no acceleration present the current through the force generator is zero. The force generator current is monitored by means of a resistor in series with it thereby providing a voltage output exactly proportional to the original mechanical input. The electronic damping is supplied by a capacitor and placed across the sampling resistor. The capacitor and sampling resistor comprise a lead network which results in a reduction at high frequencies of the amplifier voltage necessary to drive the restoring current

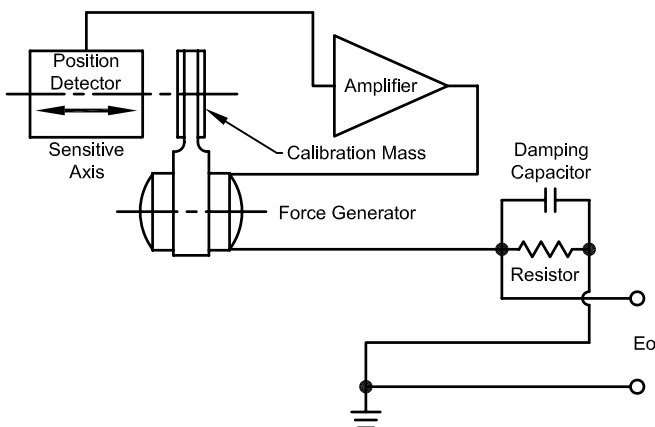


Fig. 2 - Block Diagram of Force Balance Sensor

Fig. 3 illustrates the relationship between frequency response and damping ratio as applied to a typical force balance accelerometer.

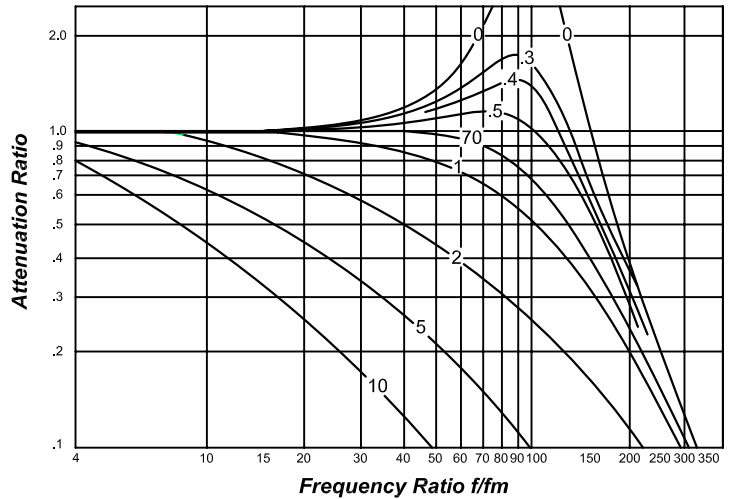


Fig. 3 - Frequency Response

### THE COLUMBIA "HP" (HIGH PERFORMANCE TORQUER)

A force balance accelerometer requires a suspended mass in order to translate acceleration into a measurable force, also a means must be present to apply a current through a coil in a magnetic circuit in order to balance out the force caused by the applied acceleration. This assembly is referred to in force balance circles as a forcer or torquer. One of the most critical aspects of a torquer is the method employed to support the mass, ideally, the means of support should allow the mass to move in only a single, well defined direction and at the same time eliminate motion in remaining across axis directions. Also the support should not add forces of its own, such as friction or spring effects. The mass support must also be rugged enough to survive the required physical environments without degrading.

Three methods are commonly used by accelerometer manufacturers. They include: flexures, taut bands and bearings. The flexure and taut band systems both have similar advantages and draw-back. They are essentially frictionless and thus yield excellent repeatability. The flexure has good sensitive axis definition while the taut band sags under cross axis loading and thus must be supported in fluid in order to reduce its sensitivity to cross loads and vibration. Both are susceptible to damage from shock. Metal flexures can suffer permanent deformation, resulting in zero bias errors, while brittle non-metallic flexures fracture and fail catastrophically under the same conditions. Stiff flexures also produce non-linear output characteristics, due to their self-restoring tendency. This non-linearity is not evident in bearing type accelerometer. COLUMBIA accelerometers make use of bearings to support a pendulous mass. The least expensive COLUMBIA accelerometers employ a pivot and jewel bearing. This system is more than adequate for applications where cost is major concern and accuracy and environmental requirements are not severe.

The more sophisticated COLUMBIA accelerometers use high performance ball bearings suspension in place of the pivot and jewel. The physical tolerances of these bearings are some twenty times tighter than those of a typical pivot and jewel bearing. Their performance rivals the best flexures while at the same time they will survive severe shock and vibration environments. Other benefits of the COLUMBIA "HP" TORQUER include: low rectification, no pivot-flop, no progressive deterioration and excellent static performance under vibration. All standard and "HP" torquers are completely manufactured at COLUMBIA to guarantee consistent "unit to unit" performance and reliability.

## EXPLANATION OF CHARACTERISTICS

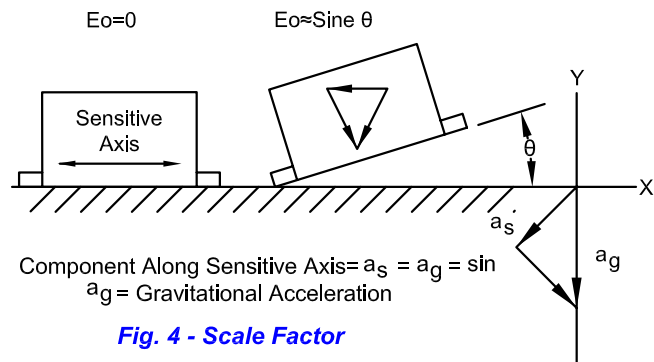
The following section defines a number of specifications which should assist in evaluating and selecting force balance sensors for specific application.

### SCALE FACTOR

Scale Factor is the ratio of a change in output to a change in the input intended to be measured or applied. The scale factor calibration supplied with COLUMBIA accelerometers is expressed volts/g or volts/radian/sec<sup>2</sup>. The scale factor of the inclinometer is also expressed in volts/g. However, it must be used in conjunction with equation,

$$\theta = \text{Sin}^{-1} \frac{E_o}{K}$$

to establish the measured angle  $E_o$  being the measured output and  $K$  being the output at 90° or one g. See Fig. 4. No conversion is necessary when the inclinometer is used with a COLUMBIA DVM calibrated to read directly in degrees.



## NON-LINEARITY

Non-Linearity describes the deviation of the output data from the straight line defined by the zero input bias and scale factor coefficient. Refer to Fig. 5, Non-linearity.

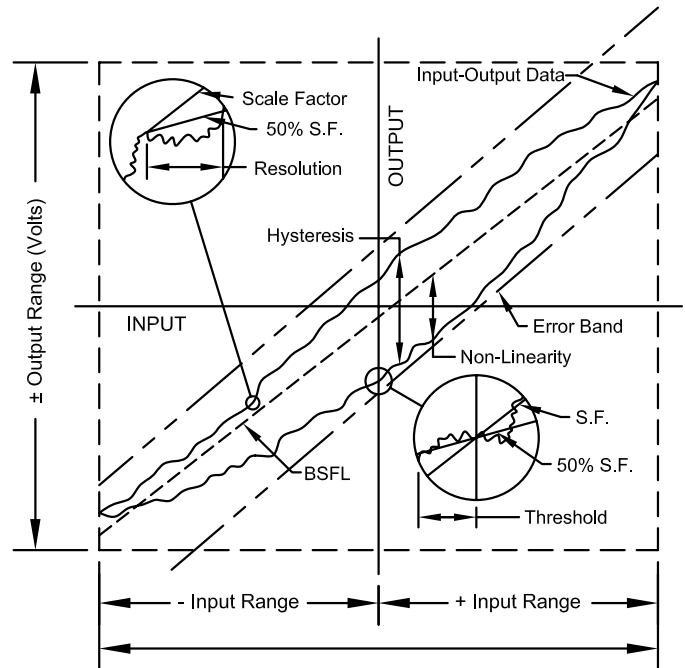


Fig. 5 - Input-Output Characteristics of a typical Force-Balance Accelerometer

### BIAS

Bias is the measured sensor output when no mechanical input is applied.

### INPUT AXIS

An input axis is an axis along which an acceleration or inclination of the case causes a maximum output.

### CROSS AXIS SENSITIVITY

Cross axis sensitivity is the proportionally constant that relates a variation of accelerometer or inclinometer output to cross acceleration or inclination.

### COMPOSITE ERROR

Composite error is the maximum deviation of the output data from the specified output function. Composite error may include the effects of hysteresis, resolution, non-linearity, non-repeatability, and other uncertainties in the output data. It is generally expressed as a percentage of the output range

### REPEATABILITY

Repeatability is the property of a sensor to reproduce a given output of performance characteristic under identical input and environmental conditions. Repeatability contains the effects of threshold, resolution, and uncertainties in other performance characteristics.

### HYSTERESIS ERROR

Hysteresis error is the difference between output signals for increasing and decreasing inputs at that input for which the difference is maximum measured after cycling through the input scan. Refer to Fig. 5, Hysteresis.

### RESOLUTION

Resolution is the largest value of the minimum change in input for inputs greater than the threshold, which produces a change in output equal to some specific percentage (at least fifty percent) of the change in output expected using the nominal scale factor. Refer to Fig. 5, Resolution.

### THRESHOLD

Threshold is the largest absolute value of the minimum input that produces an output equal to some specified percentage (at least fifty percent) of the output expected using the nominal scale factor. Refer to Fig. 5, threshold.

### RECTIFICATION ERROR

Rectification error is a steady state error in the output induced by vibratory disturbances acting on an accelerometer or inclinometer.

# Linear Accelerometer

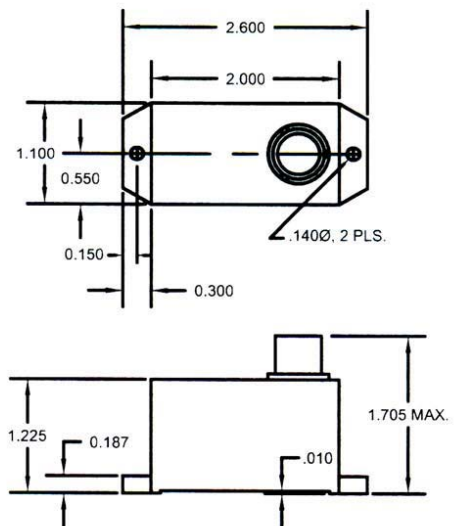
## SA-101HP

The Columbia Model SA-101HP is an extremely rugged, compact premium-performance accelerometer. The SA-101HP accelerometer design has exceptional versatility allowing for performance and packaging adaptations to optimize the cost vs. performance ratio.

This device incorporates Columbia's patented HP torquer system, which provides exceptional performance and reliability in severe vibration and shock environments. The accuracy of Model SA-101HP is the best obtainable with the pendulous force balance design. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* High Performance
- \* +/-15 VDC Operation
- \* Compact & Rugged



### Specifications

	SA-101HP
<b>Operational</b>	
Ranges Available	$\pm 0.5$ G To $\pm 100$ G
Output Voltage	$\pm 7.5$ Volts into 100K Load
Excitation	$\pm 15$ VDC <15 mA
Output Impedance	5000 Ohms Max.
Sensitive Axis Alignment	Better Than 0.25 Deg
Scale Factor Tolerance	$\pm 1\%$
Scale Factor Temp Coefficient	0.02% / Deg C Max.
Zero Bias	$\pm 0.05\%$ F.R.
Null Temp Sensitivity	0.0006% F.R./ Deg C
Natural Frequency	50 To 300 Hz Dependent Upon Range
Damping	0.8 $\pm$ 0.2
Cross Axis Sensitivity	0.002 G/G Exclusive of Sensitive Axis Alignment
Output Noise	<5 mV RMS
Non-Linearity	$\pm 0.1\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.02\%$ F.R.
Threshold & Resolution	0.0005% F.R.

### Environmental

Temperature, Operating	-50 To +90 Deg C
Temperature, Storage	-60 To +100 Deg C
Vibration Survival (2 To 2,000 Hz)	20 G RMS, 1.0" Disp D.A.
Shock Survival	250 G, 5 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	4 Oz (114 Gms)
Size	2.6 In L x 1.1 In W x 1.2 In H (6.6 cm L x 2.8 cm W x 3.1 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Environmental
Connector	PT1H-10-6P or Equiv.
Mating Connector	PT06A-10-6S(SR) or Equiv.

### Output Connector Pin Functions:

Pin	Function	Pin	Function
A	+15 VDC	D	Eo (Voltage Out)
B	Ground	E	Io (Current Out) *
C	-15 VDC	F	Self Test

\* Pin E Shorted to Pin B for Normal Operation

### Ordering Information:

**SA-101HP (+/- X G)**

Std Accelerometer w/Connector  
Range +/- X G (Required)

Mating Connector Supplied (Optional)

1G Counterbias Option (Ranges  $\pm 1$ G & higher)

M Y



Columbia Research Laboratories, Inc. 1925 Mac Dade Blvd. Woodlyn, PA 19094 USA

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# Linear Accelerometers

## SA-102BHC, SA-302BHC

The Columbia Models SA-102BHC and SA-302BHC are compact, premium-performance force balance accelerometers, extremely rugged and well suited for demanding missile and airborne applications. Both the single-axis SA-102BHC and triaxial version SA-302BHC are designed to operate from +24 to +32 volt aircraft supply and deliver a bi-polar +/-5 volt output isolated from power ground.

The basic systems have been qualified and supplied in substantial volume on many small missile programs. These designs have also been selected by a number of aircraft instrument manufacturers as key components of their strap-down systems. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Premium Performance
- \* +28 VDC Operation
- \* Rugged Construction
- \* 1 & 3 Axis Configurations



### Specifications

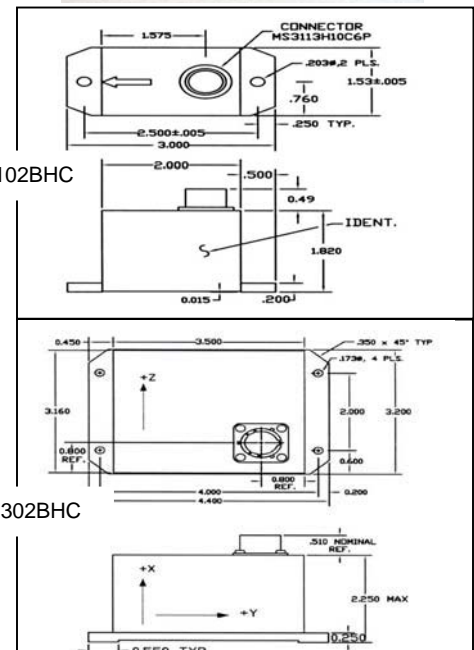
Operational	SA-102BHC	SA-302BHC
Ranges Available	$\pm 0.5$ G To $\pm 50$ G	$\pm 1$ G To $\pm 35$ G
Output Voltage	$\pm 5$ VDC into 100K Load	
Excitation	+24 To +32 VDC 50 mA Max.	
Output Impedance	<5000 Ohms	
Sensitive Axis Alignment	Better Than 0.25 Deg	Better Than 0.5 Deg
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	0 $\pm 0.01$ VDC	
Null Temp Sensitivity	0.0006% F.R. / Deg C	
Natural Frequency	150 Hz Min.	100 Hz Min.
Damping	0.7 $\pm 0.1$ @ 25 Deg C 0.5 To 1.0 Over Temperature	
Cross Axis Sensitivity	0.002 G/G Exclusive of Case Alignment	
Output Noise	15 mV P/P, DC To 10 KHz	
Non-Linearity	$\pm 0.05\%$ F.R.	
Hysteresis & Non-Repeatability	$\pm 0.05\%$ F.R.	
Threshold & Resolution	$\pm 0.001\%$ F.R.	

### Environmental

Temperature, Operating	-55 To +85 Deg C
Temperature, Storage	-60 To +100 Deg C
Vibration Survival (2 To 2,000 Hz)	15 G RMS
Shock Survival	100 G, 11 mSec
Ambient Pressure	0 To 5 Atmospheres
Altitude	-1,000 To +88,000 Ft.
Humidity	95% R.H.

### Physical

Weight	6 Oz (170 Gm)	22 Oz (624 Gm)
Size	3.00 In L x 1.53 In W x 1.82 In H (7.1 cm L x 3.9 cm W x 4.6 cm H)	4.40 In L x 3.16 W x 2.25 In H (11.3 cm L x 8.0 cm W x 5.7 cm H)
Case Material	Aluminum	
Finish	Corrosion Resistant Per MIL-C-5541E, Class 1A	Black Anodized Per MIL-A-8625, Type II, Class 2
Identification Label	Metal Photo Label Compatible with MIL-STD-130K	
Sealing	Environmental	
Electrical Connector	MS3113H-10C-6P	MS3112E12-10P or Equiv.
Optional Mating Connector	PT06A-10-6S(SR)	PT06A-12-10S(SR)



### I/O Connector Pin Functions:

SA-102BHC		SA-302BHC	
Pin	Function	Pin	Function
A	Signal Output	A	+28 VDC
B	Signal Ground	B	Power Ground
C	Power Ground	C	Case Ground
D	+28 VDC	D	Signal Ground
E	Self Test (+)	E	Signal Output X
F	Self Test (-)	F	Test X
		G	Signal Output Y
		H	Test Y
		J	Signal Output Z
		K	Test Z

### Ordering Information:

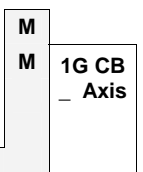
SA-102BHC (+/- X G)

SA-302BHC (+/- X G)

Standard Accelerometer  
Range +/- X G (Required)

Optional Mating Connector

1G Counterbias Option (Specify Axis)



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# Linear Accelerometers

## SA-102MFTB, SA-302MFTA

The Columbia Models SA-102MFTB and SA-302MFTA are precision miniature force balance accelerometers designed to operate from +24 to +32 VDC aircraft power. The high level output signal and inherent self-regulation qualities of the servo loop design make these accelerometers excellent candidates for airborne telemetry applications. The output signal format is compatible with most airborne VCO's and signal processing systems.

Both configurations incorporate the Columbia HP torquer system, which provides exceptional performance and reliability in the severe vibration and shock environments associated with aircraft and missile flights. The Model SA-302MFTA is a compact triaxial version of the single axis Model SA-102MFTB. **Consult the factory for customized versions of these sensors.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- Miniature Airborne Sensors
- +28 VDC Operation
- High Reliability
- 1 & 3 Axis Configurations



### SPECIFICATIONS

Operational	SA-102MFTB	SA-302MFTA
Ranges Available	±1G to ±50G	±1G to ±35G
Output Voltage	0.2 to 4.8VDC into 100K Load	
Excitation	+24 to +32VDC, <30mA	
Output Impedance	<5000Ω	
Sensitive Axis Alignment	>0.5°	
Scale Factor Tolerance	±1%	
Scale Factor Temp. Coefficient	0.02% / °C Max.	
Zero Bias	2.5±0.025VDC	
Null Temp Sensitivity	0.005% F.R. / °C	
Natural Frequency	50 to 350 Hz Dependent Upon Range	
Damping	0.7±0.2	
Cross Axis Sensitivity	0.002 G/G Exclusive of Case Alignment	
Output Noise	<0.02% F.R.	
Non-Linearity	±0.1% F.R.	
Hysteresis & Non-Repeatability	±0.1% F.R.	
Threshold & Resolution	±0.001% F.R.	

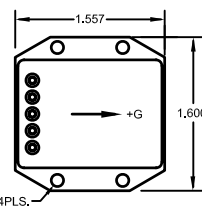
### Environmental

Temperature, Operating	-50 to +90°C	
Temperature, Storage	-50 to +90°C	
Vibration Survival (2 to 2000 Hz)	10 G RMS, 0.75" Disp. D.A	
Shock Survival	1000 G, 5mSec	1500 G, 0.5mSec
Ambient Pressure	0 to 5 Atmospheres	
Humidity	90% R.H.	

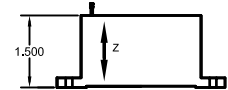
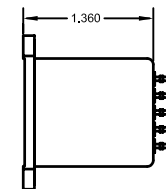
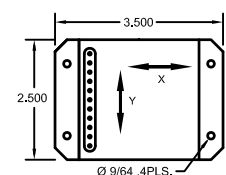
### Physical

Weight	2oz. (57gm) Max.	14oz. (397gm) Max.
Size	1.60" L x 1.56" W x 1.36" H (4.1cmL x 4.0cmW x 3.5cmH)	3.5"L x 2.5"W x 1.00" H (8.9cmL x 6.4cmW x 2.5cm H)
Case Material	Nickel-Plated Aluminum	
Sealing	Environmental	
Electrical Interface	5 Terminal Pins	11 Terminal Pins

SA-102MFTB



SA-302MFTA



### I / O Terminal Pin functions:

SA-102MFTB	
Pin	Function
1	+28VDC
2	Pwr / Sig Grd
3	Signal Out
4	Test (+)
5	Test (-)

SA-302MFTA	
Pin	Function
A	+28VDC
B	Ground
C	"X" Signal
D	"X" Ground
E	"Y" Signal
F	"Y" Ground
G	"Z" Signal
H	"Z" Ground
I	"X" Test
J	"Y" Test
K	"Z" Test

### Ordering Information:

SA-102MFTB (±XG)

SA-302MFTA (±XG)

**Standard Accelerometer**

Range ±XG Required



# Linear Accelerometers

## SA-107B, SA-107BC, SA-107BHP, SA-107BHPC

The Columbia Models SA-107B, SA-107BC, SA-107BHP and SA-107BHPC Servo Accelerometers offer the superior performance of force balance technology and are configured for general purpose and high performance applications respectively. These sensors are ideal for DC and low frequency measurements. The accelerometers are self-contained and provide high level, low impedance output. No signal conditioning is required in most applications.

The SA-107B Series is well suited for many OEM and industrial applications. These devices are available with either terminal pins or a 4-pin connector for convenient installation. **Consult the factory for customized versions of these sensors.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

### SPECIFICATIONS

Operational	SA-107B SA-107BC	SA-107BHP SA-107BHPC
Ranges Available	±0.25G to ±100G	0.1G to ±100G
Output Voltage	±7.5 Volts into 10K Load	
Excitation	+15±1VDC 10mA Max.	
Output Impedance	<100Ω	
Sensitive Axis Alignment	<0.5° Max.	<0.25° Max.
Scale Factor Tolerance	±1% of Nominal	
Scale Factor Temp. Coefficient	±0.02% / °C	
Zero Bias	±0.05% F.R. or $3 \times 10^{-4}$ (Larger Value Applies)	
Null Temp Sensitivity	±0.0005% / °C	
Natural Frequency	30 to 250Hz, Dependent Upon Range	
Damping	0.7±0.2	
Output Noise	<2mV RMS (2 to 10KHz)	
Cross Axis Sensitivity	0.002 G/G Exclusive of Case Alignment	
Non-Linearity	±0.1% F.R.	±0.05% F.R.
Hysteresis & Non-Repeatability	±0.05% F.R. or $3 \times 10^{-4}$ G	±0.03% F.R. or $1.5 \times 10^{-4}$ G
Threshold & Resolution	±0.001% F.R.	

### Environmental

Temperature, Operating	-50 to +85°C	
Temperature, Storage	-60 to +100°C	
Random Vibration (2 to 2000 Hz)	5 G RMS, 0.5" Disp. D.A	15 G RMS, 0.5" Disp. D.A
Shock Survival	125 G, 5mSec	1500 G, 1mSec
Ambient Pressure	0 to 5 Atmospheres	
Humidity	95% R.H.	

### Physical

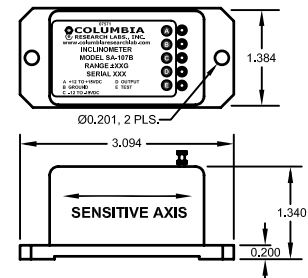
Weight	4oz. (113.4gm)	
Size	3.09" L x 1.38" W x 1.34" H (7.85cm L x 3.51cm W x 3.41cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	5 Terminal Pins (SA-107B / SA-107BHP) Connector # PT02A-8-4P or Equiv (SA-107BC / SA-107BHPC)	
Mating Connector (Optional)	PT06A-8-4S(SR) (SA-107BC & SA-107BHPC)	

**Cable Options for Models SA-107BC and SA-107BHPC: COL P/N AFB04439**

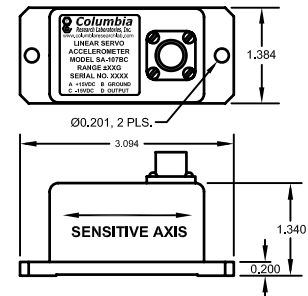
- Single Axis
- ±15VDC Operation
- Low Cost and High Performance



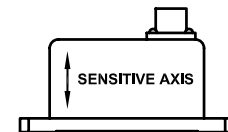
Models  
SA-107B &  
SA-107BHP



Models  
SA-107BC &  
SA-107BHPC



Z Option:  
Alternate  
Sensitive Axis



### I/O Terminal Pins:

SA-107B & SA-107BHP	
Pin	Function
A	+15VDC
B	Ground
C	-15VDC
D	Output
E	Test

### I/O Connector:

SA-107BC & SA-107BHPC	
Pin	Function
A	+15VDC
B	Ground
C	-15VDC
D	Output

### Ordering Information:

SA-107B (±XG)	Y	Z
SA-107BHP (±XG)	Y	Z
SA-107BC (±XG)	Y	Z
SA-107BHPC (±XG)	Y	Z
<b>Standard Accelerometer</b>		
Range ±XG Required		
Optional Side Connector	S	M
Optional Mating Connector Supplied	S	M
1G Counterbias Option ( Ranges±0.5G & Higher)		
Z Option (See Above)		

# Linear Accelerometers

## SA-107AI, SA-107AIHP, SA-107AIC, SA-107AIHPC

The Columbia Models SA-107AI, SA-107AIC, SA-107AIHP & SA-107AIHPC Force Balance Accelerometers are designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem. A single +15 volt supply powers both the sensor and 4-20 mA line driver.

The Model SA-107AI and SA-107AIC is a low cost device, while the SA-107AIHP and SA-107AIHPC incorporates Columbia's patented HP torquer design providing improved accuracy and repeatability in adverse shock environments. Models SA-107BI, SA-107BIC, SA-107BIHP and SA-107BIHPC are similar configurations that provide voltage output in addition to current output. **Consult the factory for customized versions of these sensors.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

### SPECIFICATIONS

Operational	SA-107AI SA-107AIC	SA-107AIHP SA-107AIHPC
Ranges Available	±1G to ±10G	±0.25G to ±10G
Output Current	4-20mA corresponding to F.S. Range into a Maximum load of 600Ω	
Excitation	+15±1VDC <50mA Max.	
Output Impedance	50 Megohm Typical	
Sensitive Axis Alignment	<0.5°	
Scale Factor Tolerance	±1%	
Scale Factor Temp. Coefficient	±0.02% / °C	
Zero Bias	12±0.05 mA	
Null Temp Sensitivity	±0.002% F.R. / °C	±0.001% F.R. / °C
Frequency Response	DC to 50Hz, ±5%	
Damping	0.7±0.2	
Cross Axis Sensitivity	0.002 G/G	
Non-Linearity	±0.1% F.R.	±0.05% F.R.
Hysteresis & Non-Repeatability	±0.1% F.R.	±0.05% F.R.
Threshold & Resolution	±0.01% F.R.	±0.001% F.R.

### Environmental

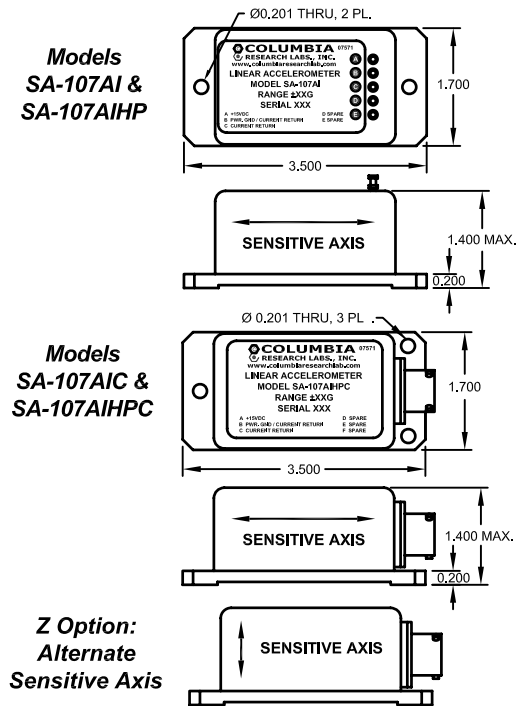
Temperature, Operating	-40 to +85°C	
Temperature, Storage	-40 to +85°C	
Random Vibration (2 to 2000 Hz)	5 G RMS, 0.5" Disp. D.A	15 G RMS, 0.5" Disp. D.A
Shock Survival	125 G, 5mSec	1500 G, 1mSec
Ambient Pressure	0 to 5 Atmospheres	
Humidity	95% R.H.	

### Physical

Weight	5oz. (141.8gm)
Size	3.50" L x 1.70" W x 1.40" H (8.89cm L x 4.32cm W x 3.56cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	5 Terminal Pins (SA-107AI / SA-107AIHP) Connector # PT02H-10-6P (SA-107AIC / SA-107AIHPC)
Mating Connector (Optional)	PT06A-10-6S(SR)

Cable Options for Models SA-107AIC and SA-107AIHPC: COL P/N AFB04437A01

- 4-20mA Output
- +18VDC Operation
- Low Cost and High Performance



### I/O Terminal Pins:

SA-107AI & SA-107AIHP	
Pin	Function
A	+15VDC Power
B	Pwr Gnd / Io Return
C	Current Output
D	Spare
E	Spare

### I/O Connector:

SA-107AIC & SA-107AIHPC	
Pin	Function
A	+15VDC Power
B	Pwr Gnd / Io Return
C	Current Return
D	Spare
E	Spare
F	Spare

### Ordering Information:

SA-107AI (±XG)  
SA-107AIHP (±XG)  
SA-107AIC (±XG)  
SA-107AIHPC (±XG)

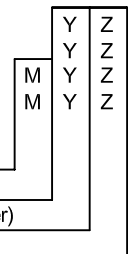
### Standard Accelerometer

Range ±XG Required

Optional Mating Connector Supplied

1G Counterbias Option ( Ranges±1G & Higher)

Z Option (See Above)



# Linear Accelerometers

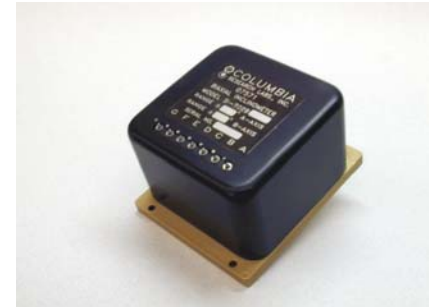
## SA-207B, SA-207BHP

The Columbia Models SA-207B and SA-207BHP are force balance accelerometers capable of measuring DC and low frequency acceleration simultaneously in two axes. These sensors are self-contained and provide a high level, low impedance output. No additional signal conditioning is required in most applications.

The Model SA-207B is a low cost design and is well suited for many OEM and general-purpose industrial applications. The Model SA-207BHP incorporates Columbia's patented "HP" torquer design providing improved accuracy and repeatability in adverse shock and vibration environments. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Biaxial Sensors
- \* +/-15 VDC Operation
- \* Low Cost and High Performance



### Specifications

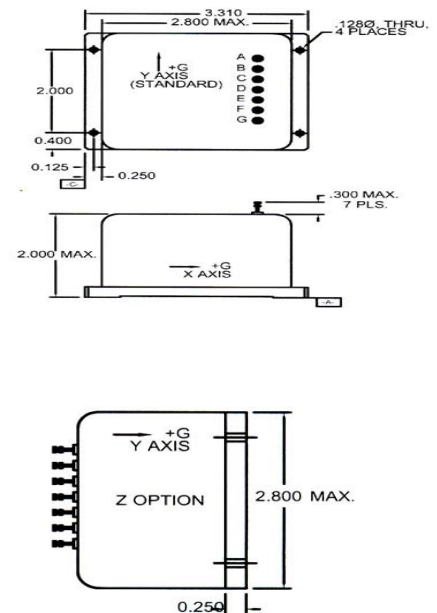
Operational	SA-207B	SA-207BHP
Ranges Available	$\pm 1$ G To $\pm 50$ G	$\pm 0.5$ G To $\pm 50$ G
Output Voltage	$\pm 7.5$ Volts into 100K Load	
Excitation	$\pm 15$ VDC <30 mA	
Output Impedance	<100 Ohms	
Sensitive Axis Alignment	Better Than 0.5 Deg	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	0.02% / Deg C Max.	
Zero Bias	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R. or $3 \times 10^{-4}$ G
Null Temp Sensitivity	0.0005% F.R./ Deg C	
Natural Frequency	75 To 300 Hz Dependent Upon Range	
Damping	$0.7 \pm 0.2$	
Cross Axis Sensitivity	0.002 G/G Exclusive of Sensitive Axis Alignment	
Output Noise	<5 mV RMS	
Non-Linearity	$\pm 0.05\%$ F.R.	$\pm 0.03\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.075\%$ F.R.	$\pm 0.05\%$ F.R.
Threshold & Resolution	0.001% F.R.	

### Environmental

Temperature, Operating	-50 To +85 Deg C	
Temperature, Storage	-60 To +100 Deg C	
Vibration Survival (2 To 2,000 Hz)	5 G RMS, 0.5" Disp D.A.	15 G RMS, 0.5" Disp D.A.
Shock Survival	125 G, 5 mSec	1000 G, 0.5 mSec
Ambient Pressure	0 To 5 Atmospheres	
Humidity	95% R.H.	

### Physical

Weight	7.7 Oz (219 Gms)	
Size	3.31 In L x 3.31 In W x 2.00 In H (8.4 cm L x 8.4 cm W x 5.1 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	7 Terminal Pins	



### Output Terminal Pin Functions:

Models SA-207B and SA-207BHP			
Pin	Function	Pin	Function
A	+15 VDC	E	Test X
B	Ground	F	E <sub>0</sub> Y
C	-15 VDC	G	Test Y
D	E <sub>0</sub> X		

### Ordering Information:

SA-207B (+/- X G )

SA-207BHP (+/- X G )

Standard Accelerometer  
Range +/- X G (Required)

1G Counterbias Option (Ranges  $\pm 1$ G & higher)

Z Option (See Above)

Y Z  
Y Z



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# Linear Accelerometers

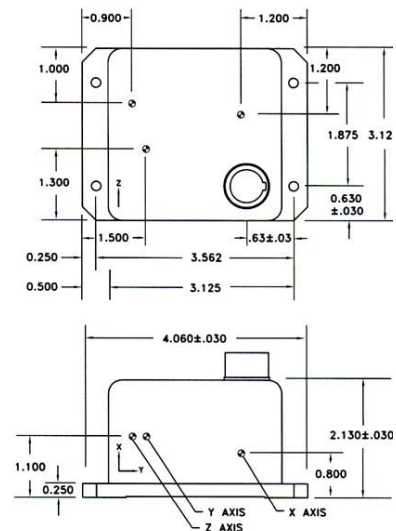
## SA-307TX, SA-307HPTX

The Columbia Models SA-307TX and SA-307HPTX are force balance accelerometers capable of measuring DC and low frequency acceleration simultaneously in three axes. These sensors are self-contained and provide a high level, low impedance output. No additional signal conditioning is required in most applications.

The Model SA-307TX is a low cost design and is well suited for many OEM and general-purpose industrial applications. The Model SA-307HPTX incorporates Columbia's patented "HP" torquer design providing improved accuracy and repeatability in adverse shock and vibration environments. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Triaxial Sensors
- \* +/-15 VDC Operation
- \* Low Cost and High Performance



### Specifications

	SA-307TX	SA-307HPTX
<b>Operational</b>		
Ranges Available	±1 G To ±50 G	±0.5 G To ±50 G
Output Voltage	±7.5 Volts into 100K Load	
Excitation	±15 VDC <30 mA	
Output Impedance	<5000 Ohms	
Sensitive Axis Alignment	Better Than 0.5 Deg	
Scale Factor Tolerance	±1%	
Scale Factor Temp Coefficient	0.02% / Deg C Max.	
Zero Bias	±0.1% F.R.	±0.05% F.R. or 3 x 10 <sup>-4</sup> G
Null Temp Sensitivity	0.0005% F.R./ Deg C	
Natural Frequency	75 To 300 Hz Dependent Upon Range	
Damping	0.7 ±0.2	
Cross Axis Sensitivity	0.002 G/G Exclusive of Sensitive Axis Alignment	
Output Noise	<0.02% F.R.	
Non-Linearity	±0.05% F.R.	±0.03% F.R.
Hysteresis & Non-Repeatability	±0.075% F.R.	±0.05% F.R.
Threshold & Resolution	0.001% F.R.	

### Environmental

Temperature, Operating	-50 To +85 Deg C	
Temperature, Storage	-60 To +100 Deg C	
Vibration Survival (2 To 2,000 Hz)	5 G RMS, 0.5" Disp D.A.	15 G RMS, 0.5" Disp D.A.
Shock Survival	125 G, 5 mSec	1000 G, 0.5 mSec
Ambient Pressure	0 To 5 Atmospheres	
Humidity	95% R.H.	

### Physical

Weight	12 Oz (340 Gms)	
Size	4.06 In L x 3.13 In W x 2.13 In H (10.3 cm L x 8.0 cm W x 5.4 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	Connector MS3443412-10P or Equiv.	
Mating Connector (Optional)	PT06A-12-10S(SR) or Equiv.	

### Output Connector Pin Functions:

SA-307TX and SA-307HPTX			
Pin	Function	Pin	Function
A	+15 VDC	F	E <sub>o</sub> Y
B	Ground	G	Test Y
C	-15 VDC	H	E <sub>o</sub> Z
D	E <sub>o</sub> X	J	Test Z
E	Test X		

### Ordering Information:

SA-307TX (+/- X G )	M	1G CB
SA-307HPTX (+/- X G )	M	1G CB
Standard Accelerometer Range +/- X G (Required)		— Axis
Optional Mating Connector		
1G Counterbias Option (Ranges ±1G & higher) Specify Axis (X, Y or Z)		



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# Linear Accelerometers

## SA-107LN, SA-107LNC

Columbia Models SA-107LN and SA-107LNC Servo Accelerometers are high-sensitivity, low noise sensors designed for use in seismic and low level, low frequency motion studies. The accelerometers are self-contained and provide a high level, low impedance output. No signal conditioning is required in most applications.

These sensors utilize low noise electronics in conjunction with the force balance principle to make possible measurements in the low frequency micro-G range. Aside from the traditional DC-coupled zero output, the SA-107LN(C) also provides AC-coupled zero output which eliminates tilt-induced or offset errors facilitating high amplification of the basic output. **Consult the factory for customized versions of this sensor.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- Seismic Event Sensor
- Ultra Low Noise
- High Level Output



### SPECIFICATIONS

Operational	SA-107LN	SA-107LNC
Ranges Available	$\pm 0.1G$ to $\pm 2G$	
Output Voltage	$\pm 7.5$ Volts into 100K Load	
Excitation	$\pm 12$ to $\pm 15VDC$ <10mA	
Output Impedance	<1000 $\Omega$	
Sensitive Axis Alignment	>0.25°	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp. Coefficient	$\pm 0.01\%$ / °C Max.	
Zero Output		
A.C. Coupled	<5mV	
D.C. Coupled	<1mG	
Null Temp Sensitivity	75 $\mu V$ / °C	
Natural Frequency	100 to 200Hz Dependent upon Range	
Damping	0.7 $\pm$ 0.1	
Cross Axis Sensitivity	0.002 G/G Exclusive of Sensitive Axis Alignment	
Output Noise	<2.5 $\mu V$ RMS From 0 to 50Hz	
Non-Linearity	< $\pm 0.1\%$ F.R.	
Hysteresis & Non-Repeatability	<0.5mG	
Threshold & Resolution	>1 $\mu G$	

### Environmental

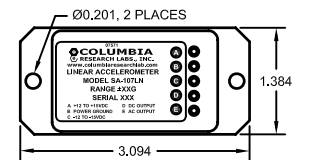
Temperature, Operating	-40 to +80°C
Temperature, Storage	-50 to +90°C
Random Vibration (2 to 2000 Hz)	5 G RMS, 0.5" Disp. D.A
Shock Survival	200G, 5mSec (1/2 sine)
Ambient Pressure	0 to 5 Atmospheres
Humidity	95% R.H.

### Physical

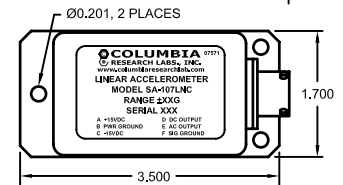
	4oz. (113.4gm)	5oz. (141.8gm)
Weight	4oz. (113.4gm)	5oz. (141.8gm)
Size	3.09"L x 1.38"W x 1.34" H (7.85cmL x 3.51cmW x 3.41cmH)	3.50"L x 1.70"W x 1.40" H (8.89cmL x 4.32cmW x 3.56cmH)
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	5 Terminal Pins	PT02H-10-6P or Equiv
Mating Connector (Optional)	N/A	PT06A-10-6S(SR)

Cable Options for Models SA-107LN: COL P/N AID04348 ; SA-107LNC: AFB04322

SA-107LN



SA-107LNC



Z Option:  
Alternate  
Sensitive Axis



### I/O Terminal Pins:

SA-107LN	
Pin	Function
A	+15VDC
B	Power Ground
C	-15VDC
D	DC Output
E	AC Output

### I/O Connector:

SA-107LNC	
Pin	Function
A	-15VDC
B	Power Ground
C	-15VDC
D	DC Output
E	AC Output
F	Signal Ground

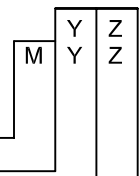
### Ordering Information:

SA-107LN ( $\pm XG$ )  
SA-107LNC ( $\pm XG$ )  
**Standard Accelerometer**  
Range  $\pm XG$  Required

Optional Mating Connector Supplied

1G Counterbias Option

Z Option (See Above)



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# Linear Accelerometers

## SA-207LN, SA-307LN

Columbia Models SA-207LN and SA-307LN Servo Accelerometers are high-sensitivity, low noise sensors designed for use in seismic and low level, low frequency motion studies. The accelerometers are self-contained and provide high level, low impedance output. No signal conditioning is required in most applications.

Like the single-axis SA-107LN, these multi-axis sensors allow measurements in the low frequency micro-G range. Aside from the traditional DC-coupled zero output, the SA-207LN and SA-307LN Accelerometers provide AC-coupled zero output which eliminates tilt-induced or offset errors facilitating high amplification of the basic output. **Consult the factory for customized versions of this sensor.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- Seismic Event Sensor
- Ultra Low Noise
- High Level Output
- 2 or 3 Axis



### SPECIFICATIONS

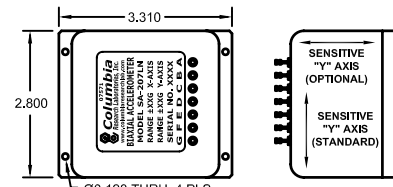
Operational	SA-207LN	SA-307LN
Ranges Available	±0.1G to ±2G	±0.5G to ±2G
Output Voltage	±7.5 Volts into 100K Load	
Excitation	±12 to ±15VDC <20mA	±12 to ±15VDC <30mA
Output Impedance	<1000Ω	
Sensitive Axis Alignment	>0.25°	
Scale Factor Tolerance	±1%	
Scale Factor Temp. Coefficient	±0.01% / °C Max.	
Zero Output		
A.C. Coupled	<5mV	
D.C. Coupled	<1mG	
Null Temp Sensitivity	75µV / °C	
Natural Frequency	100 to 200Hz Dependent upon Range	
Damping	0.7±0.1	
Cross Axis Sensitivity	0.002 G/G Exclusive of Sensitive Axis Alignment	
Output Noise	<2.5µV RMS From 0 to 50Hz	
Non-Linearity	<±0.1% F.R.	
Hysteresis & Non-Repeatability	<0.5mG	
Threshold & Resolution	>1µG	

### Environmental

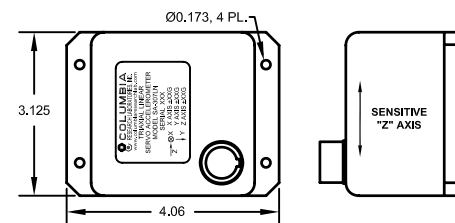
Temperature, Operating	-40 to +80°C
Temperature, Storage	-50 to +90°C
Random Vibration (2 to 2000 Hz)	5 G RMS, 0.5" Disp. D.A
Shock Survival	200G, 5mSec (1/2 sine)
Ambient Pressure	0 to 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	8oz. (227gm)	12oz. (340gm)
Size	3.31"L x 2.80"W x 2.00" H (8.4cmL x 7.1cmW x 5.1cmH)	4.06"L x 3.13"W x 2.13" H (10.3cmL x 7.9cmW x 5.4cmH)
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	7 Terminal Pins	MS3443412-10P or Equiv
Mating Connector (Optional)	N/A	PT06A-12-10S(SR)



SA-207LN



SA-307LN

### I/O Terminal Pins:

SA-207LN	
Pin	Function
A	+15VDC
B	Ground
C	-15VDC
D	DC Output X
E	AC Output X
F	DC Output Y
G	AC Output Y

### I/O Connector:

SA-307LN	
Pin	Function
A	+15VDC
B	Ground
C	-15VDC
D	DC Output X
E	AC Output X
F	DC Output Y
G	AC Output Y
H	DC Output Z
J	AC Output Z

### Ordering Information:

SA-207LN (±XG)  
SA-307LN (±XG)

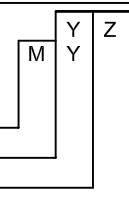
### Standard Accelerometer

Range ±XG Required

Optional Mating Connector Supplied

1G Counterbias Option

Z Option (See Above)



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# Linear Accelerometer

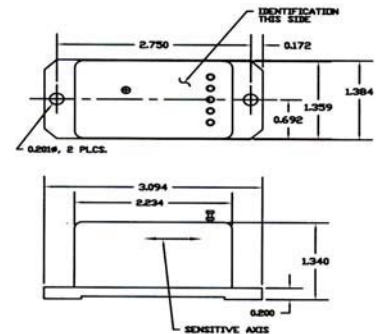
## SA-100MR

The Columbia Model SA-100MR offers the superior performance of force balance technology with the flexibility of multiple operating ranges for DC and low frequency measurements. The accelerometer is self-contained and provides a high level, low impedance output. No signal conditioning is required in most applications.

The full range for Model SA-100MR is specified when the accelerometer is ordered. The range may then be adjusted from 0.05 to 1 times the full range by means of an external resistor. The selected range always corresponds to an output of  $\pm 7.5$  volts. The noise floor remains constant and does not increase as the scale factor is increased, thereby achieving the optimum signal-to-noise ratio for any range selected.

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* **Selectable-Range Sensor**
- \* **+/-15 VDC Operation**
- \* **Low Cost / Flexibility**



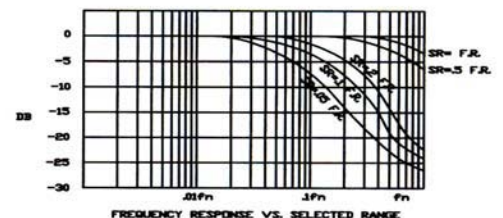
### Specifications

<b>SA-100MR</b>	
<b>Operational</b>	
Full Scale Ranges Available	$\pm 1G$ , $\pm 5G$ , $\pm 10G$ , $\pm 50G$
Output Voltage	$\pm 7.5$ Volts Adjustable from F.R. to 10% of F.R.
Excitation	$\pm 12$ VDC To $\pm 15$ VDC 8 mA Standby, 20 mA @ F.R.
Output Impedance	100 Ohms Typical
Sensitive Axis Alignment	Better Than 0.25 Deg.
Scale Factor Tolerance	$\pm 1\%$
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C
Zero Bias	$\pm 0.15\%$ F.R.
Null Temp Sensitivity	0.00015% F.R. / Deg C
Natural Frequency	50 To 500 Hz Min., Dependent upon Range
Damping	Refer to Figure 1
Output Noise	0.002 V RMS Independent of S.R.
Cross Axis Sensitivity	0.002 G/G Exclusive of Axis Alignment
Non-Linearity	$\pm 0.1\%$ F.R.
Hysteresis & Non-Repeatability	0.02% F.R.
Threshold & Resolution	0.0005% F.R.

### I/O Terminal Pin Functions:

Pin	Function	Pin	Function
A	+15 VDC	D	Output
B	Ground	E	Range Select
C	-15 VDC		

Figure 1



Full Range (F.R.) is defined as the maximum measuring range of the accelerometer obtained with the sensitivity adjusted to the minimum value. The full range is specified when the accelerometer is purchased. The user may then adjust the selected range (S.R.) from 0.05 to 1 times the full range. The selected range (S.R.) always has an output voltage equal to  $\pm 7.5$  for any SA-100MR.

The selected range (S.R.) is adjusted by means of a resistor placed between the output terminal and the range select terminal. The resistor should be limited to values between 1,000 ohms and 20,000 ohms corresponding to a selected range (S.R.) determined from the following relation:

$$R_{sel} = \frac{F.R. \times 1000}{S.R.}$$

$R_{sel}$  should have as stable a temperature coefficient as possible and a power rating of no less than 0.125 watt.

### Ordering Information:

**SA-100MR (+/- X G)**  
**Standard Accelerometer**  
 Full Range +/- X G (Required)

### Environmental

Temperature, Operating	-50 To +85 Deg C
Temperature, Storage	-50 To +85 Deg C
Vibration Survival (2 To 2,000 Hz)	
Range $\pm 1G$	5 G P/P
Ranges $\pm 5G$ , $\pm 10G$ , $\pm 50G$	10 G P/P
Shock Survival	
Range $\pm 1G$	50 G, 1 mSec Half Sine
Ranges $\pm 5G$ , $\pm 10G$ , $\pm 50G$	150 G, 1 mSec Half Sine
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	4 Oz (113.4 Gm)
Size	3.09 In L x 1.38 In W x 1.34 In H (79.5 cm L x 35.1 cm W x 34.1 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	5 Terminal Pins



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# Linear Accelerometer

## SA-120R & SA-120RNP

Columbia Models SA-120R and SA-120RNP Force Balance Accelerometer have been designed as Measurement While Drilling (MWD) sensors for use in downhole well service applications. These sensors are completely self-contained and require no additional signal conditioning.

The Model SA-120R and SA-120RNP Accelerometers are extremely rugged and will survive severe shock and vibration exposures. The Model SA-120RNP provides optimum accuracy and repeatability in high temperature environments up to +125°C. Refer to Columbia Model SA-120RHT for extreme high temperature applications up to 200°C. **Consult the factory for customized versions of this sensor.**

- Miniature MWD Sensors
- Operational to 125°C
- Low Cost and High Performance

### SPECIFICATIONS

Operational	SA-120R	SA-120RNP
Ranges Available	±1G to ±10G	
Output Voltage	±5 Volts into 100K Load	
Excitation	±15VDC <20mA	
Output Impedance	<5000Ω	
Sensitive Axis Alignment	>0.5°	>0.25°
Scale Factor Tolerance	±1%	
Scale Factor Temp. Coefficient	±0.025% / °C Max	
Zero Bias	±0.1% F.R.	±0.05% F.R.
Null Temp Sensitivity	0.001% F.R. / °C	
Natural Frequency	50Hz to 300Hz Dependent Upon Range	
Damping	0.7±0.2	
Cross Axis Sensitivity	0.005 G/G	
Output Noise	<0.02% F.R.	
Non-Linearity	±0.05% F.R.	±0.025% F.R.
Hysteresis & Non-Repeatability	±0.1% F.R.	±0.05% F.R.
Threshold & Resolution	±0.001% F.R.	

### Environmental

Temperature, Operating	-50 to +125°C	
Temperature, Storage	-60 to +150°C	
Random Vibration (2 to 2000 Hz)	25 G RMS, 0.5" Disp. D.A	
Shock Survival	1000 G, 0.5mSec	1500 G, 0.5mSec 12 Shocks per Axis
Ambient Pressure	0 to 5 Atmospheres	
Humidity	95% R.H.	

### Physical

Weight	1.5oz. (42.5gm)	
Size	<b>Standard:</b> 1.16"Sq. x 0.73"H (2.95cmSq x 1.86"H) <b>Round Flange:</b> Ø1.10" x 0.73"H (Ø2.79cm x 1.86"H)	
Case Material	Nickel Plated Aluminum	
Sealing	Environmental	
Electrical Interface (Standard)	4 Terminal Pins	

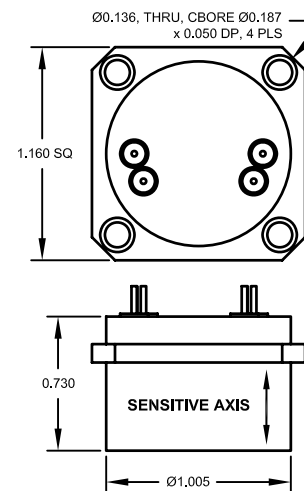
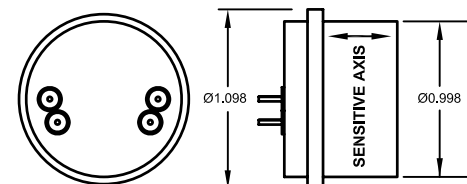


Figure 1 - Optional Round Flange



### Output Terminal Pin Function

Pin	Function
A	+15VDC
B	Ground
C	-15VDC
D	Output

### Ordering Information:

SA-120R (±XG)

SA-120RNP (±XG)

**Standard Accelerometer**

Range ±XG Required

Optional Round Flange (See Fig. 1)

F  
F



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# Linear Accelerometers

## SA-520RNP

Columbia Model SA-520RNP Force Balance Accelerometer is an extremely rugged, high performance accelerometer available with choice of operating ranges from +/-1G through +/-50G. It is completely self-contained and requires no additional signal conditioning.

The sensor incorporates Columbia's patented HP torquer system and provides exceptional performance and reliability in severe vibration and shock environments. Its small size and superior accuracy and repeatability make it the preferred sensor for applications where space is limited. Model SA-520RNP is designed to operate in temperatures up to +125 degrees C. Refer to Columbia Models SA-132RHT and SA-528RHT for extreme high temperature applications. *Consult the factory for customized versions of this sensor.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* High Performance
- \* +/-15 VDC Operation
- \* Small Size
- \* Environmentally Rugged



### Specifications

	SA-520RNP
<b>Operational</b>	
Ranges Available	$\pm 1$ G To $\pm 50$ G
Output Voltage	$\pm 5$ Volts into 100K Load
Excitation	$\pm 15$ VDC <20 mA
Output Impedance	<5000 Ohms
Sensitive Axis Alignment	Better Than 0.25 Deg
Scale Factor Tolerance	$\pm 1\%$
Scale Factor Temp Coefficient	0.025% / Deg C Max.
Zero Bias	$\pm 0.05\%$ F.R.
Null Temp Sensitivity	0.001% F.R./ Deg C
Natural Frequency	50 To 300 Hz Dependent Upon Range
Damping	0.7 $\pm 0.2$
Cross Axis Sensitivity	0.005 G/G
Output Noise	<0.02% F.R.
Non-Linearity	$\pm 0.025\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.05\%$ F.R.
Threshold & Resolution	$\pm 0.001\%$ F.R.

### Environmental

Temperature, Operating	-50 To +125 Deg C
Temperature, Storage	-60 To +150 Deg C
Vibration Survival (2 To 2,000 Hz)	25 G RMS, 0.5" Disp D.A.
Shock Survival	1,500 G, 0.5 mSec 12 Shocks per Axis
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	1.5 Oz (42.5 Gm)
Size	
Standard Square Flange	1.16 In Sq x 0.73 In H (2.95 cm Sq x 1.46 cm H)
Optional Triangular Flange	1.49 In Dia. x 0.73 In H (3.78 cm Dia. x 1.86 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Environmental
Electrical Interface	4 Terminal Pins

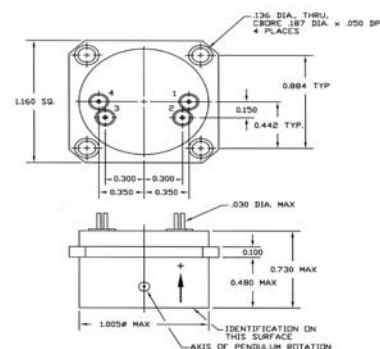
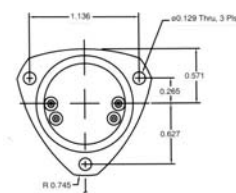


Figure 1 – Optional Triangular Flange



### Output Terminal Pin Functions:

Pin	Function
A	+15 VDC
B	Ground
C	-15 VDC
D	Output

### Ordering Information:

SA-520RNP (+/- X G)

Standard Accelerometer  
Range +/- X G (Required)

Optional Triangular Flange (See Fig. 1)

F



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# Linear Accelerometers

## SA-120RHT, SA-125RHT

Columbia Models SA-120RHT and SA-125RHT Force Balance Accelerometers have been designed as Measurement While Drilling (MWD) sensors for use in downhole well service applications. The Model SA-120RHT operates from +/-15 volts supply and is capable of operating at temperatures of up to 200 degrees Celsius. Model SA-125RHT requires +/-5VDC and operates to 190 degrees Celsius. Both sensors are completely self-contained and provide a high level, low impedance output eliminating the need for high temperature signal conditioning.

In addition to exceptional high temperature performance, the small size, rugged construction and low power consumption have made the SA-120RHT and SA-125RHT sensors the accepted standard for use in downhole high temperature mapping. *Consult the factory for customized versions of these sensors.*

- \* Miniature MWD Sensors
- \* 200°C & 190°C Operation
- \* Choice of Power Options
- \* Extreme Shock and Vibration Survival



### Specifications

	SA-120RHT	SA-125RHT
<b>Operational</b>		
Ranges Available	±1 G To ±10 G	±1 G To ±5 G
Output Voltage	±5 Volts ±2% into 100K Load	±3 Volts ±2% into 100K Load
Excitation	±15 VDC <20 mA	±5 VDC <10 mA
Output Impedance	<5000 Ohms	<2000 Ohms
Sensitive Axis Alignment	Better Than 0.5 Deg	
Scale Factor Tolerance	±1.5%	
Scale Factor Temp Coefficient	0.025% / Deg C Max.	
Zero Bias	±0.15% F.R.	±0.25% F.R.
Null Temp Sensitivity	0.002% F.R./ Deg C	0.003% F.R./ Deg C
Natural Frequency	50 To 300 Hz Dependent Upon Range	50 To 250 Hz Dependent Upon Range
Damping Ratio	0.6 To 1	0.7 ±0.2
Cross Axis Sensitivity	0.01 G/G	
Output Noise	<3 mV RMS (0 To 10KHz)	
Non-Linearity	±0.05% F.R.	±0.1% F.R.
Hysteresis & Non-Repeatability	±0.07% F.R.	±0.15% F.R.
Threshold & Resolution	0.001% F.R.	Better Than 0.002% F.R.

### Environmental

Temperature, Operating	-40 To +200 Deg C	-40 To +190 Deg C
Temperature, Storage	-50 To +200 Deg C	
Vibration Survival (2 To 2,000 Hz)	25 G RMS, 0.5" Disp D.A.	
Shock Survival	500 G, 0.5 mSec	
Ambient Pressure	0 To 5 Atmospheres	
Humidity	95% R.H.	

### Physical

Weight	1.5 Oz (42.5 Gm)	
Size		
Standard Square Flange	1.16 In Sq x 0.73 In H (2.95 cm Sq x 1.86 cm H)	
Optional Round Flange	1.10 In Dia. x 0.73 In H (2.79 cm Dia. x 1.86 cm H)	
Case Material	Nickel-Plated Aluminum	
Sealing	Environmental	
Electrical Interface	4 Terminal Pins	

Cable Options: AID04313

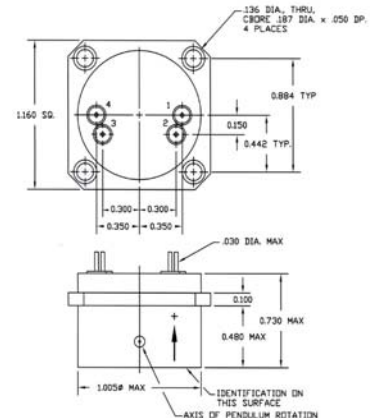
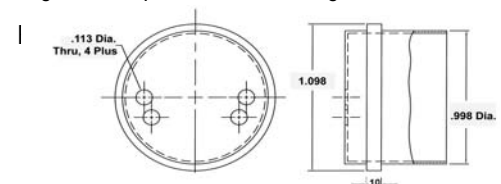


Figure 1 – Optional Round Flange



### Output Terminal Pin Functions:

SA-120RHT		SA-125RHT	
Pin	Function	Pin	Function
A	+15 VDC	A	+5 VDC
B	Ground	B	Ground
C	-15 VDC	C	-5 VDC
D	Output	D	Output

### Ordering Information:

SA-120RHT (+/- X G )

SA-125RHT (+/- X G )

Standard Accelerometer  
Range +/- X G (Required)

Optional Round Flange (See Fig. 1 Above)

F  
F

# Linear Accelerometer

## SA-132 RHT

Columbia Model SA-132RHT Force Balance Accelerometer has been designed for extreme high temperature environments including aircraft engines. The Model SA-132RHT is capable of operating at temperatures of up to 185° Celsius. This sensor is completely self-contained and provides a high level, low impedance output eliminating the need for high temperature signal conditioning.

This sensor is also available with optional pre-wired 5-conductor #22AWG high temperature cable installed for additional convenience. User-specified load resistor will be installed with cable by special request. **Consult the factory for customized versions of this sensor.**

- Miniature / High Temp.
- Operational to 185°C
- Extreme Shock and Vibration Survival

### SPECIFICATIONS

Operational	SA-132RHT
Ranges Available	±5G to ±15G
Output Voltage	±5 Volts ±2% into 100K Load
Excitation	±15VDC <20mA
Output Impedance	<5000Ω
Sensitive Axis Alignment	>0.5°
Scale Factor Tolerance	±1.5%
Scale Factor Temp. Coefficient	±0.025% / °C Max
Zero Bias	±0.15% F.R.
Null Temp Sensitivity	0.002% F.R. / °C
Natural Frequency	75Hz to 200Hz
Damping Ratio	0.6 to 1
Cross Axis Sensitivity	0.01 G/G
Output Noise	<3mV RMS (0 to 10KHz)
Non-Linearity	±0.15% F.R.
Hysteresis & Non-Repeatability	±0.15% F.R.
Threshold & Resolution	±0.001% F.R.

### Environmental

Temperature, Operating	-40 to +185°C
Temperature, Storage	-50 to +200°C
Random Vibration (2 to 2000 Hz)	25 G RMS, 0.5" Disp. D.A
Shock Survival	500 G, 0.5mSec
Ambient Pressure	0 to 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	1.5oz. (42.5gm)
Size	1.16" Sq. x 0.73"H (2.95cm Sq x 1.86"H) Ø1.10" x 0.73"H (Ø2.79cm x 1.86"H)
Case Material	Nickel Plated Aluminum
Sealing	Environmental
Electrical Interface (Standard)	4 Terminal Pins
Optional High Temp Cable	5 Leads

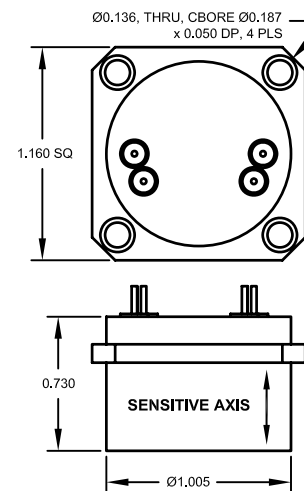
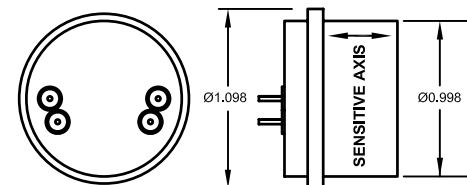


Figure 1 - Optional Round Flange



### Output Terminal Pin / Cable Lead Function

Pin	Function	Lead Color
A	+15VDC	Red
B	Power Ground Signal Ground	Black White
C	-15VDC	Yellow
D	Output	Green

### Ordering Information:

SA-132RHT (±XG)

Standard Accelerometer

Range ±XG Required

Optional Round Flange (See Fig. 1)

Optional High Temp Cable Installed

XX= Cable Length (Feet)

XXM= Cable Length (Meters)

F C X X



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# Linear Accelerometers

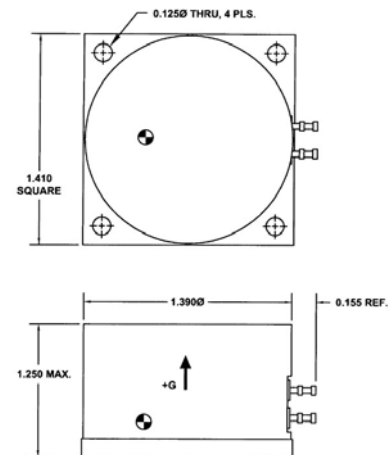
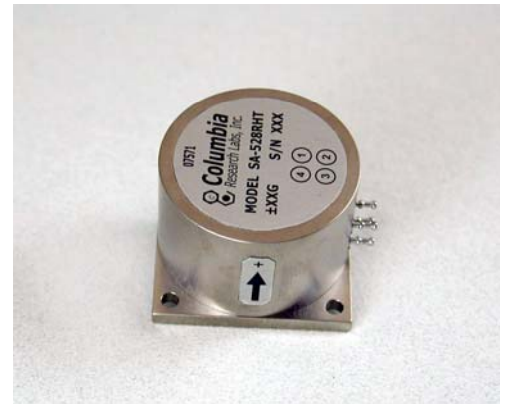
## SA-528RHT

The Columbia Model SA-528RHT Force Balance Accelerometer is designed for extreme high temperature environments including aircraft engines. The Model SA-528RHT is capable of operating at temperatures of up to 175 degrees Celsius. This sensor is completely self-contained and provides a high level, low impedance output eliminating the need for high temperature signal conditioning.

In addition to small size and exceptional high temperature performance, Model SA-528RHT incorporates our patented high performance torquer system, which provides exceptional performance and reliability in severe vibration and shock environments. An optional integrated high temperature cable is also available. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Miniature Aircraft Sensors
- \* High Temperature To 175 C
- \* Extreme Shock and Vibration Survival



### Specifications

	SA-528RHT
<b>Operational</b>	
Ranges Available	$\pm 1$ G To $\pm 50$ G
Output Voltage	0.2 To 4.8 $\pm 2\%$ VDC into 100K Load
Excitation	+28 $\pm 4$ VDC, +30mA Max.
Output Impedance	Less Than 1000 Ohms
Sensitive Axis Alignment	<1 Degree
Scale Factor Tolerance	$\pm 1.5\%$
Scale Factor Temp Coefficient	Less Than 0.03% / Deg C Max.
Zero Bias	2.500 $\pm 0.030$ VDC
Null Temp Sensitivity	Less Than 0.005% F.R. / Deg C
Natural Frequency	75 Hz To 250 Hz (Function of G Range)
Damping Ratio	0.7 $\pm 0.2$
Cross Axis Sensitivity	0.01 G/G
Output Noise	3 mV RMS Max.
Non-Linearity	$\pm 0.15\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.1\%$ F.R.
Threshold & Resolution	<0.001% F.R.

### Environmental

Temperature, Operating	-50 To +175 Deg C
Temperature, Storage	-60 To +200 Deg C
Vibration Survival (2 To 2,000 Hz)	18 G RMS, 0.5" Disp D.A.
Shock Survival	1500 G, 0.5 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	3 Oz (85 Gm)
Size	1.41 In Sq x 1.25 In H (3.58 cm Sq x 3.18 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Environmental
Electrical Interface Standard	4 Terminal Pins
Optional High Temp Cable	4 Cable Leads

### Output Terminal Pin / Cable Lead Functions:

Pin	Function	Optional Cable Lead Color
1	Signal Output	Green
2	+28 VDC	Red
3	Power Ground	Black
4	Signal Ground	White

### Ordering Information:

**SA-528RHT (+/- X G) Cxx**

Standard Accelerometer w/Pins  
Range +/- X G (Required)

Integrated High Temp Cable Option

xx = Cable Length (Feet)

xxM = Cable Length (Meters)



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# Linear Accelerometers

## SA-130

The Columbia Model SA-130 is a precision force balance accelerometer developed for the severe shock and vibration environments associated with aircraft and missile flights. This sensor incorporates hi-rel electronic components ensuring long-term stability and superior reliability over a wide temperature range.

The Model SA-130 is light weight and hermetically sealed. Additionally, this unit features a self-test capability requiring an input current range of 0.2 to 3.0 mA/G depending on selected operating range. *Consult the factory for customized versions of this sensor.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Premium Performance
- \* +/-15 VDC Operation
- \* Compact, Rugged Design
- \* Hermetically Sealed



### Specifications

	SA-130
<b>Operational</b>	
Ranges Available	$\pm 1$ G To $\pm 50$ G
Output Voltage	$\pm 5$ VDC into 100K Load
Excitation	$\pm 15$ VDC <20 mA
Output Impedance	<2000 Ohms
Sensitive Axis Alignment	Better Than 0.25 Deg
Scale Factor Tolerance	$\pm 0.5\%$
Scale Factor Temp Coefficient	0.018% / Deg C Max.
Zero Bias	$\pm 5$ mV or $\pm 6$ mG (Lower Value Applies)
Null Temp Sensitivity	0.00015% F.R./ Deg C
Natural Frequency	75 To 300 Hz Dependent Upon Range
Damping	0.7 $\pm$ 0.2
Cross Axis Sensitivity	<0.005 G/G
Output Noise	<2 mV RMS
Non-Linearity	$\pm 0.05\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.05\%$ F.R.
Threshold & Resolution	$\pm 0.001\%$ F.R.

### Environmental

Temperature, Operating	-50 To +125 Deg C
Temperature, Storage	-60 To +125 Deg C
Vibration Survival (2 To 2,000 Hz)	25 G RMS, 0.5" Disp D.A.
Shock Survival	1,500 G, 0.5 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	100% R.H.

### Physical

Weight	<1.5 Oz (42.5 Gm)
Size	
Standard Square Flange	1.15 In Sq x 1.17 In H (2.92 cm Sq x 2.97 cm H)
Optional Triangular Flange	1.43 In L x 1.34 In W x 1.17 In H (3.63 cm L x 3.40 cm W x 2.97 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Hermetic (Solder Sealed)
Electrical Interface	6 Terminal Pins

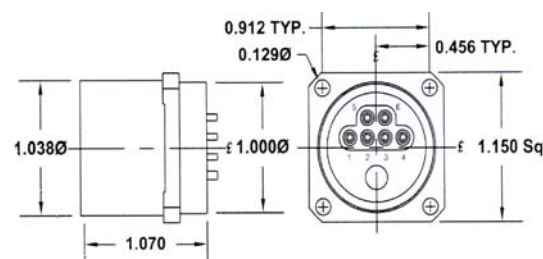
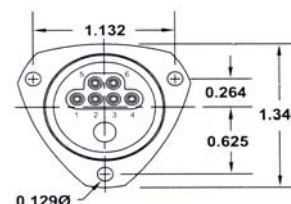


Figure 1 – Optional Triangular Flange



### Output Terminal Pin Functions:

SA-130			
Pin	Function	Pin	Function
A	+15 VDC	D	Output
B	Ground	E	Test
C	-15 VDC	F	Test

### Ordering Information:

SA-130 (+/- X G )

Standard Accelerometer  
Range +/- X G (Required)

Optional Triangular Flange  
(See Fig. 1 Above)

F



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# Linear Accelerometer

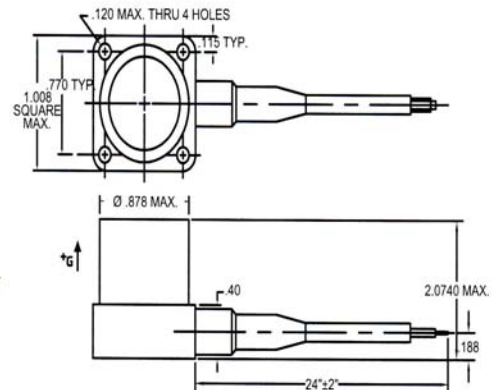
## SA-122R

The Columbia Model SA-122R miniature force balance accelerometer is a lightweight sensor designed to survive severe mechanical environments without degradation to unit performance. Originally conceived as a replacement for a popular strain gage design frequently used by major aircraft manufacturers, this device has found widespread acceptance by major airframe producers.

The SA-122R eliminates the need for supplementary signal conditioners by providing a standard 0 to 5 volt low impedance output while operating from +28VDC aircraft power. The force balance design delivers accuracy and stability far superior to that which can be expected from a comparably priced strain gage system. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Miniature Sensor
- \* +28 VDC Power
- \* High Shock and Vibration Survival



### Specifications

	SA-122R
<b>Operational</b>	
Ranges Available	$\pm 0.5$ G To $\pm 50$ G
Output Voltage	0.2 To 4.8 VDC into 100K Load
Excitation	+24 To +32 VDC 25 mA Nominal
Output Impedance	<1000 Ohms
Sensitive Axis Alignment	1 Deg Max.
Scale Factor Tolerance	$\pm 1\%$ for a given range
Scale Factor Temp Coefficient	0.02% / Deg C Max.
Zero Bias	2.5 $\pm 0.020$ VDC
Null Temp Sensitivity	$\pm 0.25$ mV / Deg C
Natural Frequency	100 To 400 Hz Dependent Upon Range
Damping	0.7 $\pm 0.2$
Cross Axis Sensitivity	0.002 G/G Exclusive of Case Alignment
Output Noise	0.02% F.R.
Non-Linearity	$\pm 0.1\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.1\%$ F.R.
Threshold & Resolution	0.001% F.R.

### Environmental

Temperature, Operating	-55 To +120 Deg C
Temperature, Storage	-60 To +125 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS
Shock Survival	100 G, 11 mSec 1,000 G, 1 mSec
Ambient Pressure	0 To 2 Atmospheres
Humidity	95% R.H.

### Physical

Weight	2 Oz (56.3 Gm)
Size (Exclusive of 24 In Cable)	1.00 In Sq x 2.074 In H (2.54 cm Sq x 5.27 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Environmental
Electrical Interface	(3) #28 AWG Leads

### I/O Wire Lead Functions:

Lead	Function
RED	+DC Input
BLACK	Pwr / Sig Ground
YELLOW	Sig Output

### Ordering Information:

SA-122R(+/- X G )

Standard Accelerometer  
Range +/- X G (Required)



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# Linear Accelerometers

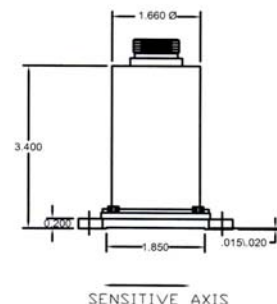
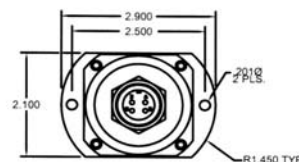
## SA-107WPBI, SA-107WPBIHP

The Columbia Models SA-107WPBI and SA-107WPBIHP are waterproof versions of Columbia's popular Models SA-107BI and SA-107BIHP. These waterproof sensors are designed with an output circuit configuration made for use with 4-20 mA data transmission systems used extensively in industrial installations in order to transmit data over long distances in rough environments.

The Models SA-107WPBI and SA-107WPBIHP contain special desensitization circuitry to provide accurate static acceleration data while in substantial vibration environments. The incorporation of Columbia's patented HP suspension system into Model SA-107WPBIHP provides added accuracy and ruggedness. A single +15 volt supply powers both the sensor and 4-20 mA line driver. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Waterproof
- \* 4 To 20 mA Output
- \* Low Cost and High Performance



Specifications	SA-107WPBI	SA-107WPBIHP
<b>Operational</b>		
Ranges Available	$\pm 1$ G To $\pm 10$ G	$\pm 0.25$ G To $\pm 10$ G
Current Output	4 To 20 mA Corresponding to F.S. Range into a Maximum Load of 600 Ohms	
Excitation	+15 $\pm 1$ VDC 50 mA Max.	
Output Impedance	50 Megohm Typical	
Sensitive Axis Alignment	<0.5%	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	12 $\pm 0.05$ mA	
Null Temp Sensitivity	$\pm 0.002\%$ F.R. / Deg C	$\pm 0.001\%$ F.R. / Deg C
Frequency Response	DC To 50 Hz $\pm 5\%$	
Damping	0.7 $\pm 0.2$	
Cross Axis Sensitivity	0.002 G/G	
Non-Linearity	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R.
Hysteresis & Non-Repeatability	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R.
Threshold & Resolution	$\pm 0.01\%$ F.R.	$\pm 0.001\%$ F.R.

Environmental		
Temperature, Operating	-40 To +85 Deg C	
Temperature, Storage	-40 To +85 Deg C	
Vibration Survival (2 To 2,000 Hz)	5 G RMS, 0.25" Disp D.A.	15 G RMS, 0.25" Disp D.A.
Shock Survival	125 G, 5 mSec	1000 G, 1 mSec
Ambient Pressure	65 psig	
Waterproof Depth	150 Ft Depth Max.	

Physical	
Weight	18 Oz (510.3 Gm)
Size	2.90 In x 2.10 In x 3.95 (7.37 cm. x 5.34 cm x 10.04 cm)
Case Material	316L Stainless Steel
Sealing	TIG Welded & O Ring Static Seals
Electrical Interface	Waterproof Connector #RSF-40-693
Optional Cable Assemblies	WC-(x) & EC-(x) - See Ordering Info IP68 & NEMA 6P Ratings

### Output Connector Pin Functions:

Models SA-107WPBI and SA-107WPBIHP	
Pin	Function
A	Power Ground
B	+15 VDC
C	Current Output
D	Current Return

### Ordering Information:

SA-107WPBI ( +/- X G )

SA-107WPBIHP ( +/- X G )

Standard Accelerometer  
Range +/- X G (Required)

Optional Cable Assemblies:  
(Separate Purchase)

Interface Cable, P/N WC - ( X )  
X = Cable Length in Meters, Maximum 20 Meters

Extension Cable, P/N EC - ( X )  
X = Cable Length in Meters, Maximum 10 Meters



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# Linear Accelerometers

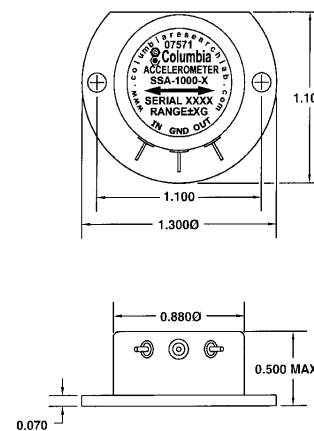
## SSA-1000-1, SSA-1000-2

The Columbia Series SSA-1000 Solid State Silicon Accelerometers utilize military-grade assembly line construction techniques with the production controls and inspection associated with a Military Certified Quality System. These sensors offer improved performance, smaller size and added features at comparable prices to existing MEMs competition.

Electrical connections are made directly to solder terminals or via an integral shielded cable. Frequency response is factory pre-set at DC to 100 Hz with wideband response. Military-grade packaging techniques have reduced the size of the rugged, lightweight case design, allowing this sensor to withstand the most demanding environmental conditions. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Solid State Sensor
- \* Wide Range Input Power
- \* Choice of Output Configurations
- \* Small Size & Low Cost



### Specifications

	SSA-1000-1	SSA-1000-2
<b>Operational</b>		
Range	±2 G	±10 G
Standard Bipolar Output Voltage	±5 Volts Into 100K Load	
Optional Unipolar Output Voltage	0 To +5 VDC	
Excitation	+7.5 To +32 VDC 7 mA Max	
Output Impedance	150 Ohms Nominal	
Sensitive Axis Alignment	< ±0.5° Max.	
Scale Factor Tolerance	±1%	
Scale Factor Temp Coefficient	±0.02% /Deg C Typical	
Zero Bias (Standard)	0 Volt ±40mV	0 Volt ±25mV
Zero Bias (Unipolar)	2.500 Volts ±40mV	2.500 Volts ±25mV
Frequency Response	0 To 100 Hz (±0.5 dB)	
Damping	-3dB @ 350 Hz Typical	
Output Noise	< 0.3% F.S.	< 0.1% F.S.
Cross Axis Sensitivity	<1%	
Non-Linearity	±0.12% FR	

### Environmental

Temperature, Operating	0 To +70 Deg C
Temperature, Storage	-40 To +85 Deg C
Vibration Survival (2 To 2,000 Hz)	20 G RMS
Shock Survival	1200 G, 1 mSec
Humidity	95% R.H.

### Physical

Weight	0.35 Oz (10 Gm)
Size (Excluding Flange)	0.88 In Dia. x 0.500 In H (2.24 cm Dia. x 1.27 cm H)
Case Material	Aluminum / Black Anodize
Sealing	Environmental
Electrical Interface: Standard	3 Terminal Pins
Optional	Integral Cable, 2 Ft. Long

### Ordering Information:

SSA - 1000 - 1	U	C2F
SSA - 1000 - 2	U	C2F
Accelerometer		
Standard Output Voltage		
Standard Zero Bias		
Standard Terminal Pins		
Optional Unipolar Output 0 To +5VDC		
Optional Integral Cable, 2 Ft Long		
Custom Length Integral Cable		
Specify Length in Feet: C x F		
Specify Length in Meters: C x M		



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# Accelerometer Switch

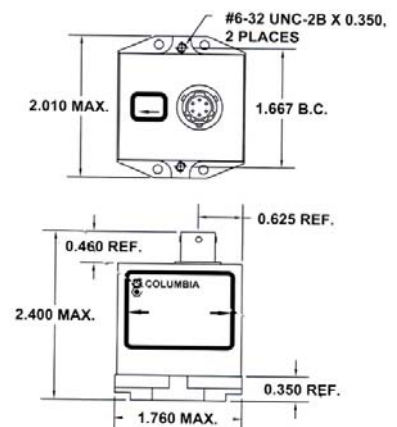
## SS-108

The Columbia Model SS-108 Accelerometer Switch is designed to interface with electrical or mechanical systems to control, safeguard or warn of undesirable variations in DC and low frequency acceleration. This model uses Columbia's patented HP suspension system, which assures high accuracy and ruggedness. No signal conditioning is required to the analog output in most applications.

The accelerometer switch contacts can be configured to trigger in one or both directions along the sensitive axis, at a specified G level within a selected operating range. The solid-state relay switching capacity is 500mA at 60VDC and is available with normally open or normally closed contacts. **Consult the factory for customized versions of this sensor.**

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Selectable Switch Point
- \* Single or Bi-Polar Switch
- \* Choice of Input Power



### Specifications

	SS-108
<b>Operational</b>	
Ranges Available	$\pm 2$ G To $\pm 30$ G
G Level Switch Point	Within Selected Operating Range Single G Level -or- Bi-Polar Point
Switch Point Tolerance	$\pm 10\%$ Including Hysteresis
Switch Contacts	Single Pole / Single Throw Normally Open -or- Normally Closed, As Specified
Switch Contact Ratings	0 To 60 VDC, 0.5 Amp, 0.15 Ohm ON Resistance Typical, 100 Ohm OFF Resistance, Bounce Free Operation
Signal Output Voltage	0.200 To 9.800 VDC into 100K Load
Input Power:	+24 To +32 VDC @ 50 mA Max. -or- +12 To +18 VDC @ 50 mA Max.
Zero Bias	+5.000 $\pm$ 0.020 VDC
Bias Temp Coefficient	0.005% F.R./ Deg C
Scale Factor Temp Coefficient	0.02% / Deg C
Accuracy	$\pm 0.15\%$ F.R.
Repeatability	$\pm 0.075\%$ F.R.
Threshold & Resolution	0.001% F.R.
Case Alignment	0.25 Deg. Max
Frequency Response / Roll-off	0 To 100 Hz, As Specified -24 dB / Octave Roll-off

### Environmental

Temperature, Operating	-30 To +70 Deg C
Temperature, Storage	-50 To +85 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS, 0.25" Disp D.A.
Shock Survival	100 G, 10 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	4.6 Oz (130 Gm)
Size (Including Connector)	1.74 In L x 1.90 In W x 2.37 In H (4.4 cm L x 4.8 cm W x 6.0 cm H)
Case Material	Nickel-Plated Aluminum
Sealing	Environmental
Electrical Interface	Connector PTIH-10-6P or Equivalent
Optional Mating Connector	PT06A-10-6S(SR) or Equivalent

Pin	Connector Pin Assembly	
	Function	
A	+28VDC Power Supply	
B	Power & Signal Ground	
C	Analog Output	
D	Spare	
E	(+) POS Switch Contact	
F	(-) NEG Switch Contact	

### Ordering Information:

**Model SS-108 Accelerometer Switch**  
Configured as follows:

Required Data	Options
Range:	$\pm 2$ G To $\pm 30$ G ( $\pm$ X G)
G Level Switch Point:	Within Selected Operating Range A. (+X G) Single B. ( $\pm$ X G) Bi-Polar
Switch Contacts:	A. Normally Open B. Normally Closed
Frequency Response:	Up To 100 Hz (0 To X Hz) Upper Limit Response Required
Input Power	A. +24 To +32 VDC @ 50 mA Max. B. +12 To +18 VDC @ 50 mA Max.
Mating Connector	A. Supplied B. Not Supplied



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# Angular Accelerometers

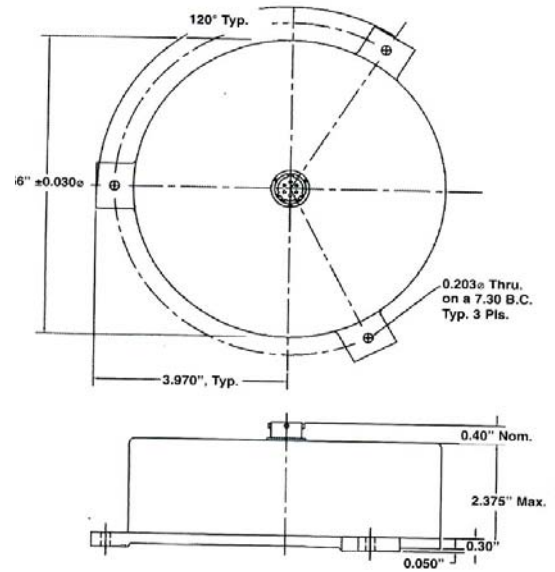
## SR-100FR, SR-200RFR

The Columbia Models SR-100FR and SR-200RFR Angular Accelerometers are designed for low level near DC applications. These sensors incorporate the fluid rotor concept to provide extremely high sensitivity and full scale ranges as low as  $\pm 0.01$  radians/second<sup>2</sup>. The high performance torquer design maintains ruggedness and reliability in severe shock and vibration environments.

The Model SR-100FR operates from a  $\pm 15$  volt power source and has an output span of  $\pm 5$  volts for full scale input. The Model SR-200RFR features the same sensor system as the SR-100FR but provides electronics that operate from a +24 to +32 volt aircraft supply and delivers 0 to 5 volt output. Both units are completely self-contained and require no additional amplification or conditioning.

Applications for these high sensitivity accelerometers include rotational studies or stabilization of structures, platforms, antennas and ships. *Consult the factory for customized versions of these sensors.*

- \* High Sensitivity
- \* High Performance Fluid Rotor Design



### Specifications

	SR-100FR	SR-200RFR
<b>Operational</b>		
Ranges Available	$\pm 0.1$ To $\pm 5$ Rad/Sec <sup>2</sup>	
Output Voltage	$\pm 5$ Volts into 100K Load	0.2 To 4.8 VDC into 100K Load
Excitation	$\pm 15$ VDC <20 mA	+24 To +32 VDC <30 mA
Output Impedance	5,000 Ohms Typical	
Sensitive Axis Alignment	0.5 Deg	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	0.054% / Deg C	0.07% / Deg C
Zero Bias	2 mRad / Sec <sup>2</sup> Max.	2.5 $\pm 0.01$ VDC
Null Temp Sensitivity	45 $\mu$ Rad/Sec <sup>2</sup> /Deg C	60 $\mu$ Rad/Sec <sup>2</sup> /Deg C
Natural Frequency	10 Hz Min.	
Damping Ratio	0.6 To 1	
Linear Acceleration Sensitivity	10 mRad / Sec <sup>2</sup> / G	
Cross Axis Sensitivity	<0.5%	
Output Noise	2 mRad / Sec <sup>2</sup> RMS	
Non-Linearity	$\pm 0.1\%$ F.R.	
Hysteresis & Non-Repeatability	$\pm 0.1\%$ F.R.	$\pm 0.2\%$ F.R.
Threshold & Resolution	0.001% F.R.	

### Environmental

Temperature, Operating	-40 To +71 Deg C
Temperature, Storage	-40 To +71 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS, 0.5" Disp D.A.
Linear Acceleration Survival	100 G
Shock Survival	100 G, 11 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	3.5 Lbs. Max (1.58 KG)	
Size	6.56 In. Dia. x 2.375 In. H (16.7 cm Dia. x 6.0 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Connector	DT07H-12-8PN or Equiv.	PT1H-10-6P or Equiv.
Optional Mating Connector	PT06A-12-8S or Equiv.	PT06A-10-6S or Equiv.

### I/O Connector Pin Functions:

SR-100FR		SR-200RFR	
Pin	Function	Pin	Function
A	Sig & Pwr Return	A	Sig & Pwr Grd
B	Current Output	B	+28V Input
C	Signal Output	C	Test
D	Test -	D	EO (Voltage Out)
E	-15 VDC	E	IO (Current Out)
F	+15 VDC	F	IO (Current Ret)
G	Test +		
H	Spare		

### Ordering Information:

SR-100FR (+/- X Rad/Sec<sup>2</sup>) **M**  
 SR-200RFR (+/- X Rad/Sec<sup>2</sup>) **M**  
 Std Accelerometer w/Connector  
 Range +/- X Rad/Sec<sup>2</sup> (Required)  
 Mating Connector Supplied (Optional)



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# Angular Accelerometer

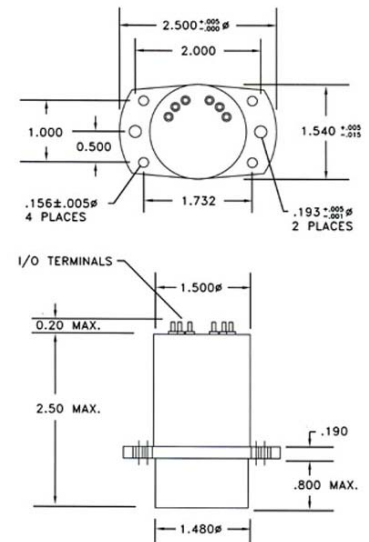
## SR-107VFR

The Columbia Model SR-107VFR Angular Accelerometer is a selectable range sensor that allows the user to easily change the scale factor and range to obtain optimum accuracy and readout match. This accelerometer incorporates the force balance fluid rotor technology, which produces high level output with excellent accuracy, stability and linear acceleration rejection without additional costly signal conditioning.

Full measurement range is adjusted from +/-1 to +/-100 radians per second squared with a single external resistor change. In addition, since virtually all angular acceleration measurements are either transitory or periodic, the user also has the ability to select a DC blocking option and define the associated cutoff frequency. This accelerometer can be used for a variety of applications previously requiring many fixed-range configurations.

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

- \* Variable Range Sensor
- \* High Performance Fluid Rotor Design

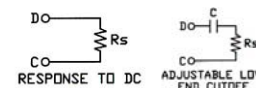


### I/O Terminal Pin Functions:

Pin	Function	Pin	Function
A	+15 VDC Input	D	Gain Adj. Output
B	-15 VDC Input	E	Eo (Voltage Out)
C	Gain Return	F	Sig & Pwr Ground

Note: The low end response is adjustable from DC to  $f_c$  (-3 dB). The values in Column 2 represent DC attenuation obtained when the DC cutoff facility is used.

$R_s$  = Range Selection Resistor  
 $C$  = Capacitor in series with  $R_s$   
 $C$  should be non-polarized.



$$f_c (-3dB) = \frac{1}{2\pi R_s C}$$

Range	TABLE 1	
	Column 1 RS Selection Resistor	Column 2 DC Rejection
±1	10K	-36 dB
±2	20K	-30 dB
±5	52.3K	-24 dB
±10	110K	-18 dB
±20	243K	-12 dB
±50	1 MEG	-6 dB
±100	OPEN	0 dB

### Ordering Information:

**SR-107VFR** (Preset Range +/- X Rad/Sec<sup>2</sup>)  
 Standard Variable Range Accelerometer  
 Default Preset Range is +/-2 Rad/Sec<sup>2</sup> unless otherwise specified.

### Specifications

Operational	SR-107VFR
Full Ranges (User Selectable)	±1.0 To ±100 Rad/Sec <sup>2</sup>
Output Voltage	±5 Volts into 100K Load
Excitation	±15 VDC <30 mA
Output Impedance	<100 Ohms
Sensitive Axis Alignment	0.5 Deg
Scale Factor Tolerance	±1%
Scale Factor Temp Coefficient	0.07% / Deg C Max.
Zero Bias	< ±20 mRad / Sec <sup>2</sup> DC Mode < ±10 mV AC Mode
Null Temp Sensitivity	±0.4 mV / Deg C
Natural Frequency	20 Hz Min.
Damping	1.0 ±0.3
Linear Acceleration Sensitivity	< 25 mRad / Sec <sup>2</sup> / G
Cross Axis Sensitivity	1% Max.
Output Noise	-60 dB Below F.R. Output
Non-Linearity	±0.01% F.R.
Hysteresis & Non-Repeatability	±0.2% F.R.
Threshold & Resolution	0.005% F.R.

### Environmental

Temperature, Operating	-40 To +80 Deg C
Temperature, Storage	-40 To +80 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS, 1.0" Disp D.A.
Linear Acceleration Survival	100 G
Shock Survival	500 G, 1 mSec
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.

### Physical

Weight	10 Oz (283 Gm)
Size	1.48 In. Dia. (Excluding Mtg Flange) x 2.5 In. H (3.6 cm Dia. Excluding Mtg Flange x 6.3 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	Solder Pins



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# Angular Accelerometers

## SR-220RNP, SR-220RNC

The Columbia Models SR-220RNP and SR-220RNC are precision force balance angular accelerometers designed for applications where space is at a premium. The Columbia patented HP suspension system provides extreme ruggedness and excellent rejection of linear acceleration. The two designs differ only in their electrical interface. The SR-220RNP provides solder pins and the SR-220RNC incorporates a 4-pin connector.

These accelerometers do not depend on fluid damping or rotational inertia but are electrically damped. This results in exceptional high frequency characteristics for an angular accelerometer in its range of sensitivity. The servo loop design guarantees exceptional thermal stability of zero bias, scale factor and frequency characteristics. *Consult the factory for customized versions of these sensors.*

Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

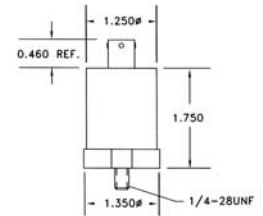
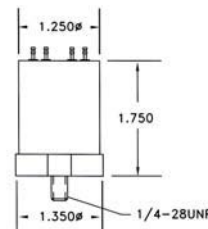
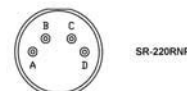
- \* Small Size / Lightweight
- \* Electronic Damping
- \* Rugged Construction



SR-220RNP



SR-220RNC



### Specifications

	SR-220RNP	SR-220RNC
<b>Operational</b>		
Ranges Available	$\pm 100, \pm 500, \pm 1000, \pm 5000$ Rad/Sec <sup>2</sup>	
Output Voltage	$\pm 5$ Volts into 100K Load	
Excitation	$\pm 15$ VDC <20 mA	
Output Impedance	<500 Ohms	
Sensitive Axis Alignment	0.5 Deg	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	0.05% / Deg C Max.	
Zero Bias	$\pm 10$ mV	
Null Temp Sensitivity	$\pm 0.1$ mV / Deg C	
Natural Frequency	50 To 200 Hz Dependent Upon Range	
Damping	0.7 $\pm$ 0.2	
Linear Acceleration Sensitivity	0.3% F.R. / G	
Cross Axis Sensitivity	$\pm 2\%$	
Output Noise (DC To 400 Hz)	<0.02% F.R.	
Non-Linearity	$\pm 0.01\%$ F.R.	
Hysteresis & Non-Repeatability	$\pm 0.25\%$ F.R.	
Threshold & Resolution	0.005% F.R.	

### Environmental

Temperature, Operating	-50 To +85 Deg C
Temperature, Storage	-55 To +95 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS, 0.5" Disp D.A.
Linear Acceleration Survival	100 G
Range $\pm 100$ Rad/Sec <sup>2</sup>	150 G
All Other Ranges	
Shock Survival	500 G, 1 mSec
Ambient Pressure	0 To 7 Atmospheres
Humidity	95% R.H.

### Physical

Weight	4 Oz (113 Gms)	4.3 Oz (122 Gms)
Size (Excluding Stud Mount & I/O Termination)	1.35 In. Dia. x 1.75 In. H (3.4 cm Dia. x 4.5 cm H)	
Case Material	Stainless Steel	
Sealing	Environmental	
Connector	Solder Pins	PT1H-8-4P or Equiv.
Optional Mating Connector	N/A	PT06A-8-4S or Equiv.

### I/O Pin Functions:

Model SR-220RNP	
Pin	Function
A	+15 VDC
B	Ground
C	-15 VDC
D	Eo (Voltage Out)

Model SR-220RNC	
Pin	Function
A	Sig & Pwr Grd
B	+15 VDC
C	-15 VDC
D	Signal Output

### Ordering Information:

SR-220RNP (+/- X Rad/Sec<sup>2</sup>)

SR-220RNC (+/- X Rad/Sec<sup>2</sup>)

Standard Accelerometer  
Range +/- X Rad/Sec<sup>2</sup> (Required)

Mating Connector Supplied (Optional)

M



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# Inclinometers

## SI-701B, SI-701BHP

The Columbia Models SI-701B and SI-701BHP are electronic tilt sensors based upon force balance accelerometer technology. They produce a high level low impedance output proportional to the sine of the tilt angle. Unique electronic damping and desensitization circuitry allows tilt measurements in strong vibration and shock environments.

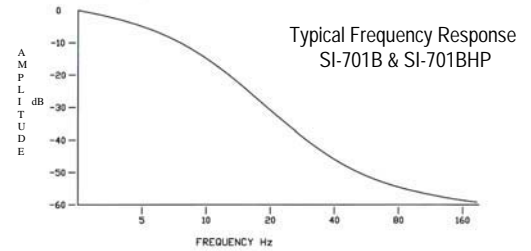
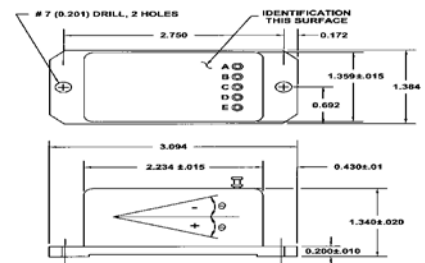
These inclinometers are self-contained requiring no additional signal conditioning in most applications. The Model SI-701B is well suited for many OEM and industrial applications. The Model SI-701BHP uses the Columbia patented HP suspension system and provides added accuracy and ruggedness. These sensors are intended for applications such as platform stabilization, surface mapping and measuring tilt angles in remote locations. *Consult the factory for customized versions of these sensors.*

- \* High Accuracy
- \* +/-15 VDC Operation
- \* Low Cost and High Performance



### Specifications

	SI-701B	SI-701BHP
<b>Operational</b>		
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 10^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Voltage	$\pm 5$ VDC at Full Range Output Proportional to the Sine of the Angle	
Recommended Load	100K Ohms or Greater	
Excitation	$\pm 12$ VDC to $\pm 15$ VDC <15 mA Each Supply	
Output Impedance	<100 Ohms	
Output Noise	<3 mV RMS	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R.
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Zero Bias Temp. Coefficient	0.001% F.R. / Deg. C	
Resolution	0.001% F.R.	
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	<0.5%
Case Alignment	$\pm 0.5^\circ$	$\pm 0.25^\circ$
Vibration Overload vs. Frequency	See Figure 1	See Figure 2



Vibration Overload vs. Frequency

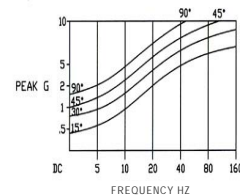


Figure 1

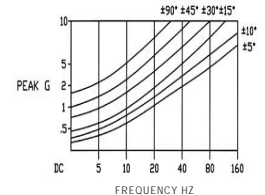


Figure 2

### Environmental

Temperature, Operating	-50 To +85 Deg C	
Temperature, Storage	-50 To +100 Deg C	
Random Vibration (2 To 2,000 Hz)	10 G P/P	30 G P/P
Shock Survival	125 G, 1 mSec Half Sine	1000 G, 0.5 mSec Half Sine
Humidity	95% R.H.	

### Physical

Weight	4 Oz (113.4 Gm)	
Size	3.09 In L x 1.38 In W x 1.34 In H (78.5 cm L x 35.1 cm W x 34.1 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	5 Terminal Pins	

### I/O Terminal Pin Functions:

SI-701B and SI-701BHP	
Pin	Function
A	+15 VDC
B	Ground
C	-15 VDC
D	Output
E	Test

### Sensitive Axis:



### Ordering Information:

SI-701B (+/- X Deg )  
 SI-701BHP (+/- X Deg )  
 Standard Inclinometer  
 Range +/- X Deg (Required)



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# Inclinometers

## SI-701BC, SI-701BHPC

The Columbia Models SI-701BC and SI-701BHPC are electronic tilt sensors based upon force balance accelerometer technology. They produce a high level low impedance output proportional to the sine of the tilt angle. Unique electronic damping and desensitization circuitry allows tilt measurements in strong vibration and shock environments.

These inclinometers are self-contained requiring no additional signal conditioning in most applications. The Model SI-701BC is well suited for many OEM and industrial applications. The Model SI-701BHPC uses the Columbia patented HP suspension system and provides added accuracy and ruggedness. Both sensors incorporate a convenient 4-pin connector and are intended for applications such as platform stabilization, surface mapping and measuring tilt angles in remote locations. *Consult the factory for customized versions of these sensors.*

- \* High Accuracy
- \* +/-15 VDC Operation
- \* Low Cost and High Performance



### Specifications

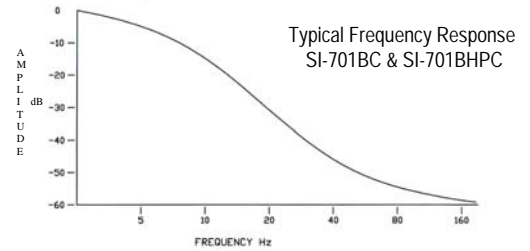
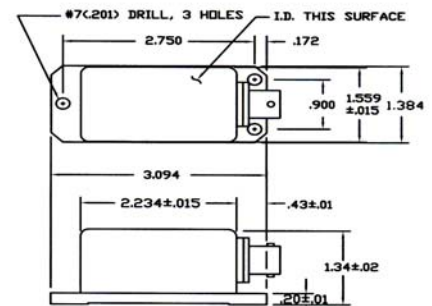
	SI-701BC	SI-701BHPC
<b>Operational</b>		
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 10^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Voltage	$\pm 5$ VDC at Full Range Output Proportional to the Sine of the Angle	
Recommended Load	100K Ohms or Greater	
Excitation	$\pm 12$ VDC to $\pm 15$ VDC <15 mA Each Supply	
Output Impedance	<100 Ohms	
Output Noise	<3 mV RMS	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R.
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Zero Bias Temp. Coefficient	0.001% F.R. / Deg. C	
Resolution	0.001% F.R.	
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	<0.5%
Case Alignment	$\pm 0.5^\circ$	$\pm 0.25^\circ$
Vibration Overload vs. Frequency	See Figure 1	See Figure 2

### Environmental

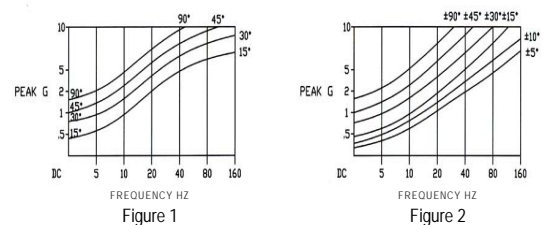
Temperature, Operating	-50 To +85 Deg C	
Temperature, Storage	-50 To +100 Deg C	
Random Vibration (2 To 2,000 Hz)	10 G P/P	30 G P/P
Shock Survival	125 G, 1 mSec Half Sine	1000 G, 0.5 mSec Half Sine
Humidity	95% R.H.	

### Physical

Weight	4 Oz (113.4 Gm)
Size	3.09 In L x 1.38 In W x 1.34 In H (78.5 cm L x 35.1 cm W x 34.1 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	Connector PT02A-8-4P or Equivalent
Mating Connector (Optional)	PT06A-8-4S(SR)



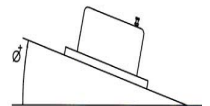
Vibration Overload vs. Frequency



### I/O Connector Pin Functions:

Pin	Function
A	+15 VDC
B	Ground
C	-15 VDC
D	Output

### Sensitive Axis:



### Ordering Information:

SI-701BC (+/- X Deg )  
 SI-701BHPC (+/- X Deg )  
 Standard Inclinometer  
 Range +/- X Deg (Required)  
 Optional Mating Connector

M  
M



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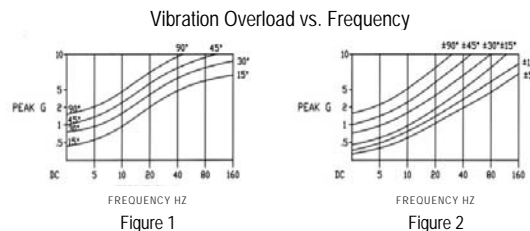
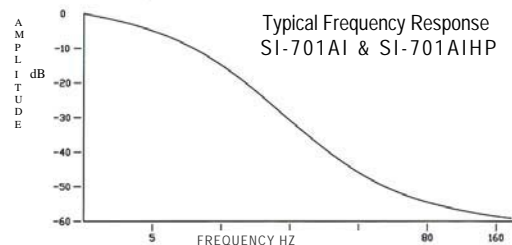
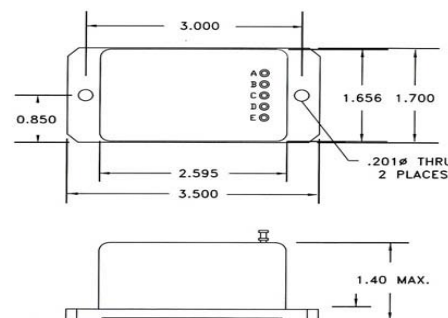
# Inclinometers

## SI-701AI, SI-701AIHP

The Columbia Models SI-701AI and SI-701AIHP are force balance inclinometers designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem.

A single +15 volt supply powers both the sensor and 4-20 mA line driver. Special desensitization circuitry allows these devices to provide accurate tilt data while in substantial vibration environments. Both configurations are also available with a convenient 6-pin electrical interface – Refer to Columbia Models SI-701AIC and SI-701AIHPC. Models SI-701BI and SI-701BIHP Inclinometers are similar configurations that provide voltage output in addition to current output. Consult the factory for customized versions of these sensors.

- \* 4-20 mA Output
- \* +15 VDC Operation
- \* Low Cost and High Performance



### I/O Terminal Pin Functions:

SI-701AI and SI-701AIHP	
Pin	Function
A	+15 VDC Power
B	Power Ground / Current Return
C	Current Output
D	Spare
E	Spare

### Ordering Information:

SI-701AI (+/- X Deg )  
 SI-701AIHP (+/- X Deg )  
 Standard Inclinometer  
 Range +/- X Deg (Required)

### Specifications

Operational	SI-701AI	SI-701AIHP
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 10^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Current	4-20 mA	
Output Function	$I_o = 12 + K \sin \theta$ (mA) $\pm 0.5\%$ of Normal Into a Maximum Load of 600 Ohms	
Excitation	+15 $\pm 1$ VDC <50 mA	
Output Impedance	50 Megohm Typical	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	12 $\pm 0.02$ mA	
Zero Bias Temp. Coefficient	$\pm 0.002\%$ F.R. / Deg C	
Resolution	0.01% F.R.	0.001% F.R.
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	
Case Alignment	$\pm 0.5$ Deg	$\pm 0.25$ Deg
Vibration Overload vs. Frequency	See Figure 1	See Figure 2

### Environmental

Temperature, Operating	-40 To +85 Deg C	
Temperature, Storage	-40 To +85 Deg C	
Random Vibration (2 To 2,000 Hz)	5 G RMS, 0.25" Disp. D.A.	15 G RMS, 0.25" Disp. D.A.
Shock Survival	125 G, 5 mSec	1000 G, 1 mSec
Humidity	95% R.H.	

### Physical

Weight	5 Oz (141.8 Gm)	
Size	3.50 In L x 1.70 In W x 1.40 In H (8.89 cm L x 4.32 cm W x 3.56 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	5 Terminal Pins	





# Inclinometers

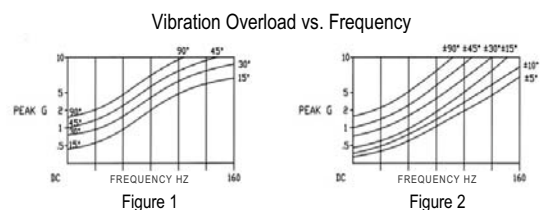
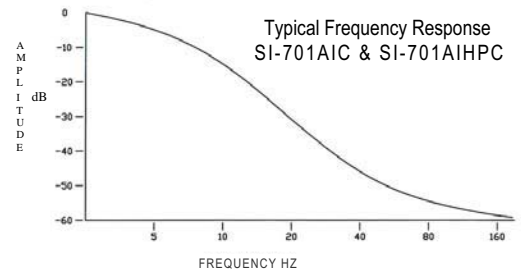
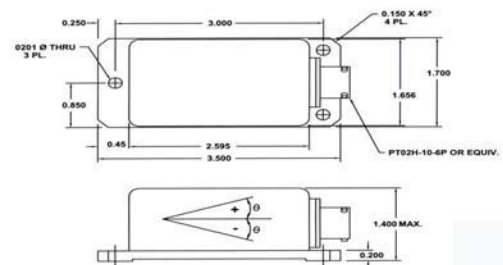
## SI-701AIC, SI-701AIHPC

The Columbia Models SI-701AIC and SI-701AIHPC are force balance inclinometers designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem.

A single +15 volt supply powers both the sensor and 4-20 mA line driver. Special desensitization circuitry allows these devices to provide accurate tilt data while in substantial vibration environments. Both configurations provide a convenient 6-pin electrical interface. Models SI-701BIC and SI-701BIHPC Inclinometers are similar configurations that provide voltage output in current output.

*Consult the factory for customized versions of these sensors.*

- \* 4-20 mA Output
- \* +15 VDC Operation
- \* Low Cost and High Performance



### I/O Connector Pin Functions:

SI-701AIC and SI-701AIHPC			
Pin	Function	Pin	Function
A	+15 VDC	D	Spare
B	Ground	E	Spare
C	$I_o$	F	Spare

### Ordering Information:

SI-701AIC (+/- X Deg )  
SI-701AIHPC (+/- X Deg )  
Standard Inclinometer  
Range +/- X Deg (Required)

Optional Mating Connector

M  
M

### Specifications

Operational	SI-701AIC	SI-701AIHPC
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 10^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Current	4-20 mA	
Output Function	$I_o = 12 + K \text{ Sin } \theta$ (mA) $\pm 0.5\%$ of Normal Into a Maximum Load of 600 Ohms	
Excitation	+15 $\pm 1$ VDC <50 mA	
Output Impedance	50 Megohm Typical	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	12 $\pm 0.02$ mA	
Zero Bias Temp. Coefficient	$\pm 0.002\%$ F.R. / Deg C	
Resolution	0.01% F.R.	0.001% F.R.
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	
Case Alignment	$\pm 0.5$ Deg	$\pm 0.25$ Deg
Vibration Overload vs. Frequency	See Figure 1	See Figure 2

### Environmental

Temperature, Operating	-40 To +85 Deg C	
Temperature, Storage	-40 To +85 Deg C	
Random Vibration (2 To 2,000 Hz)	5 G RMS, 0.25" Disp. D.A.	15 G RMS, 0.25" Disp. D.A.
Shock Survival	125 G, 5 mSec	1000 G, 1 mSec
Humidity	95% R.H.	

### Physical

Weight	6 Oz (141.8 Gm)	
Size	3.50 In L x 1.70 In W x 1.40 In H (88.9 cm L x 43.2 cm W x 35.6 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	Connector PT02H-10-6P of Equivalent	
Mating Connector (Optional)	PT06A-10-6S(SR)	

Cable Options: AFB04438



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# Inclinometers

## SI-724BIHPC

The Columbia Model SI-724BIHPC is a force balance inclinometer designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem.

A single supply voltage powers both the sensor and 4-20 mA line driver. The Model SI-724BIHPC incorporates Columbia's patented HP suspension system and special desensitization circuitry allowing this device to provide accurate tilt data while in substantial vibration environments. This sensor is intended for applications such as platform stabilization, surface mapping and measuring tilt angles in remote locations. *Consult the factory for customized versions of this sensor.*

- \* 4-20 mA Output
- \* +18 To +28 VDC Operation
- \* High Performance



### Specifications

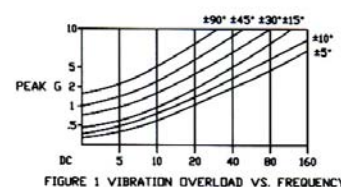
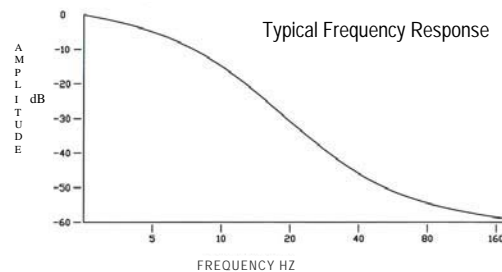
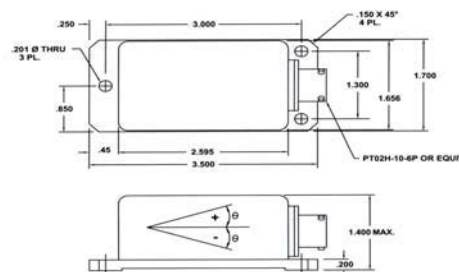
Operational	SI-724BIHPC
Ranges Available	$\pm 5^\circ$ , $\pm 15^\circ$ , $\pm 30^\circ$ , $\pm 45^\circ$ , $\pm 90^\circ$
Output Current	4-20 mA
Output Function	$I_o = 12 + K \sin \theta$ (mA) $\pm 0.5\%$ of Normal Into a Maximum Load of 600 Ohms
Output Voltage	$\pm 1$ V $\pm 0.5\%$ at Rated Range, Differential
Excitation	+18 To +28 VDC <50 mA
Output Impedance	50 Megohm Typical
Non-Linearity	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.
Scale Factor Tolerance	$\pm 1\%$
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C
Zero Bias	12 $\pm 0.02$ mA
Zero Bias Temp. Coefficient	$\pm 0.002\%$ F.R. / Deg C
Resolution	0.001% F.R.
Bandwidth	0 To 3 Hz $\pm 5\%$ (-18 dB / Octave Rolloff)
Orthogonal Sensitivity	<1%
Case Alignment	$\pm 0.25$ Deg
Vibration Overload vs. Frequency	See Figure 1

### Environmental

Temperature, Operating	-40 To +85 Deg C
Temperature, Storage	-40 To +85 Deg C
Random Vibration (2 To 2,000 Hz)	15 G RMS, 0.25" Disp. D.A.
Shock Survival	1000 G, 1 mSec
Humidity	95% R.H.

### Physical

Weight	7 Oz (198 Gm)
Size	3.50 In L x 1.70 In W x 1.40 In H (8.89 cm L x 4.32 cm W x 3.56 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	Connector PT02H-10-6P of Equivalent
Mating Connector (Optional)	PT06A-10-6S(SR)



### I/O Connector Pin Functions:

SI-724BIHPC			
Pin	Function	Pin	Function
A	+ VDC	D	$E_o$ HI
B	Ground	E	$E_o$ LO
C	$I_o$	F	Spare

### Ordering Information:

**SI-724BIHPC (+/- X Deg)**  
 Standard Inclinometer  
 Range +/- X Deg (Required)

Optional Mating Connector

M



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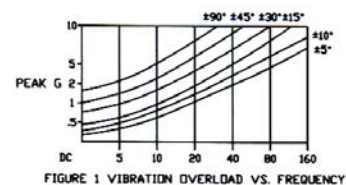
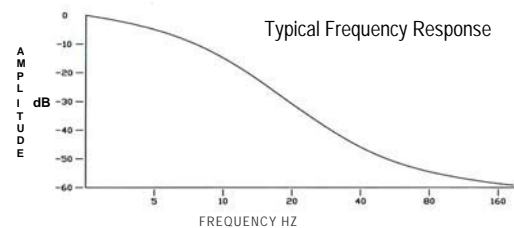
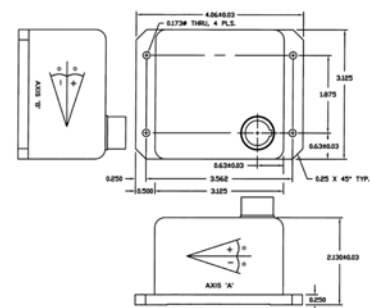
# Inclinometers

## SI-726BIHPC

The Columbia Model SI-726BIHPC is a biaxial force balance inclinometer designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem.

The Model SI-726BIHPC incorporates Columbia's patented HP suspension system and special desensitization circuitry allowing this device to provide accurate tilt data while in substantial vibration environments. This sensor is intended for applications such as platform stabilization, surface mapping and measuring tilt angles in remote locations. *Consult the factory for customized versions of this sensor.*

- \* Biaxial Tilt Sensor
- \* 4-20 mA Output
- \* +18 To +28 VDC Operation
- \* High Performance



### I/O Connector Pin Functions:

SI-726BIHPC			
Pin	Function	Pin	Function
A	+ VDC	F	Spare
B	Power Ground	G	Current Output B
C	Current Output A	H	Current Return B
D	Current Return A	J	Spare
E	Spare	K	Spare

### Ordering Information:

**SI-726BIHPC (+/- X Deg)**  
 Standard Biaxial Inclinometer  
 Range +/- X Deg (Required)

Optional Mating Connector

M

### Specifications

SI-726BIHPC	
<b>Operational</b>	
Ranges Available	±5°, ±15°, ±30°, ±45°, ±90°
Output Current	4-20 mA
Output Function	$I_0 = 12 + K \sin \theta$ (mA) ±0.5% of Normal Into a Maximum Load of 600 Ohms
Excitation	+18 To +28 VDC <50 mA
Output Impedance	50 Megohm Typical
Non-Linearity	±0.1% F.R.
Non-Repeatability	±0.1% F.R.
Scale Factor Tolerance	±1%
Scale Factor Temp Coefficient	±0.02% / Deg C
Zero Bias	12 ±0.02 mA
Zero Bias Temp. Coefficient	±0.002% F.R. / Deg C
Resolution	0.001% F.R.
Bandwidth	0 To 3 Hz ±5% (-18 dB / Octave Rolloff)
Orthogonal Sensitivity	<1%
Case Alignment	±0.25 Deg
Vibration Overload vs. Frequency	See Figure 1

### Environmental

Temperature, Operating	-40 To +85 Deg C
Temperature, Storage	-40 To +85 Deg C
Random Vibration (2 To 2,000 Hz)	15 G RMS, 0.25" Disp. D.A.
Shock Survival	1000 G, 1 mSec
Humidity	95% R.H.

### Physical

Weight	12 Oz ( 340.2 Gm)
Size	4.06 In L x 3.13 In W x 2.13 In H (1.3 cm L x 7.6 cm W x 5.4 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	Connector PT06A-12-10S(SR)
Mating Connector (Optional)	PTIH-12-10P or Equivalent



# Inclinometers

## SI-702B, SI-702BHP

The Columbia Models SI-702B and SI-702BHP are biaxial electronic tilt sensors based upon force balance accelerometer technology. They produce a high-level low-impedance output proportional to the sine of the tilt angle. Unique electronic damping and desensitization circuitry allows tilt measurements in strong vibration and shock environments.

These inclinometers are self-contained requiring no additional signal conditioning in most applications. The Model SI-702B is well suited for many OEM and industrial applications requiring dual axis tilt measurements. The Model SI-702BHP uses the Columbia patented HP suspension system and provides added accuracy and ruggedness. These sensors are intended for applications such as platform stabilization, surface mapping and measuring tilt angles in remote locations. *Consult the factory for customized versions of these sensors.*

- \* Biaxial Sensors
- \* +/-15 VDC Operation
- \* Low Cost and High Performance



### Specifications

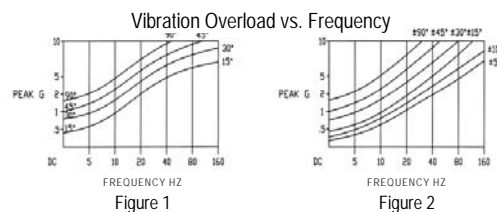
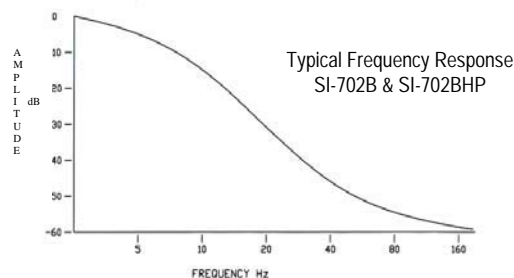
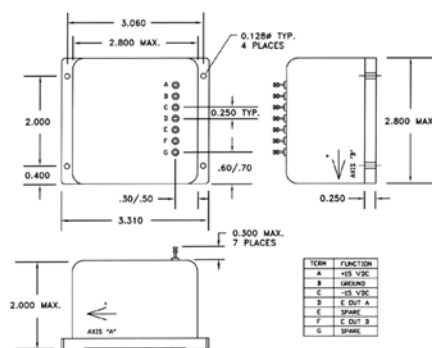
	SI-702B	SI-702BHP
<b>Operational</b>		
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 10^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Voltage	$\pm 5$ VDC at Full Range Output Proportional to the Sine of the Angle	
Recommended Load	100K Ohms or Greater	
Excitation	$\pm 12$ VDC to $\pm 15$ VDC <30 mA Each Supply	
Output Impedance	<100 Ohms	
Output Noise	<3 mV RMS	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	$\pm 0.05\%$ F.R.
Scale Factor	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Zero Bias Temp. Coefficient	0.001% F.R. / Deg. C	
Resolution	0.001% F.R.	
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	<0.5%
Case Alignment	$\pm 1^\circ$	$\pm 0.5^\circ$
Vibration Overload vs. Frequency	See Figure 1	See Figure 2

### Environmental

Temperature, Operating	-50 To +85 Deg C	
Temperature, Storage	-50 To +100 Deg C	
Random Vibration (2 To 2,000 Hz)	5 G RMS, 0.5" Disp. D.A.	10 G RMS, 0.5" Disp. D.A.
Shock Survival	125 G, 1 mSec Half Sine	1000 G, 1 mSec Half Sine
Humidity	95% R.H.	

### Physical

Weight	8 Oz (226.8 Gm)
Size	3.31 In L x 2.80 In W x 2.00 In H (8.41 cm L x 7.11 cm W x 5.08 cm H)
Case Material	Anodized Aluminum
Sealing	Environmental
Electrical Interface	7 Terminal Pins



### Output Terminal Pin Functions:

SI-702B and SI-702BHP			
Pin	Function	Pin	Function
A	+15 VDC	E	Spare
B	Ground	F	E <sub>O</sub> B
C	-15 VDC	G	Spare
D	E <sub>O</sub> A		

### Ordering Information:

SI-702B(+/- X Deg )  
SI-702BHP(+/- X Deg )

Standard Inclinometer  
Range +/- X Deg (Required)

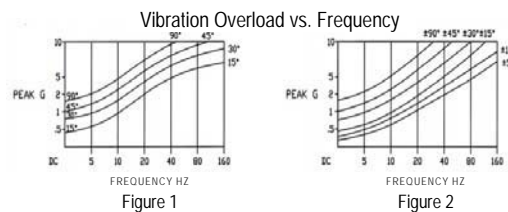
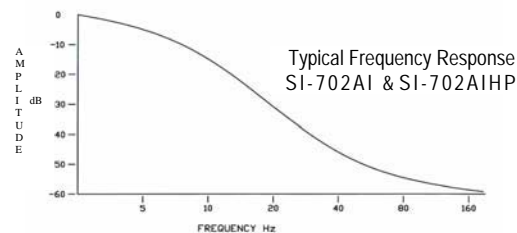
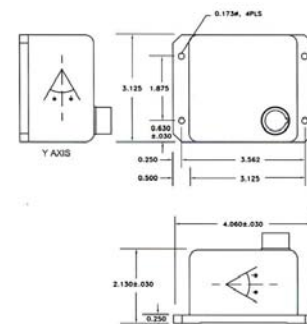
# Inclinometers

## SI-702AI, SI-702AIHP

Columbia Models SI-702AI and SI-702AIHP are biaxial force balance inclinometers designed with an output circuit configuration made for use in 4-20 mA data transmission systems. The 4-20 mA system is used extensively in industrial installations in order to transmit data over long distances in environments where interference from nearby electrical power lines could be a problem.

A single +15 volt supply powers both the sensor and 4-20 mA line driver. Special desensitization circuitry allows these devices to provide accurate tilt data while in substantial vibration environments. Models SI-702BI and SI-702BIHP Biaxial Inclinometers are similar configurations that provide voltage output in addition to current output. Consult the factory for customized versions of these sensors.

- \* Biaxial Tilt Sensor
- \* 4-20 mA Output
- \* Low Cost and High Performance



### Output Connector Pin Functions:

SI-702AI and SI-702AIHP			
Pin	Function	Pin	Function
A	+15 VDC Power	F	Spare
B	Power Ground	G	Spare
C	Current Return	H	Spare
D	$I_o - X$ Axis	J	Spare
E	$I_o - Y$ Axis	K	Spare

### Ordering Information:

SI-702AI (+/- X Deg) M  
 SI-702AIHP (+/- X Deg) M  
 Standard Inclinometer  
 Range +/- X Deg (Required)

Optional Mating Connector

### Specifications

	SI-702AI	SI-702AIHP
<b>Operational</b>		
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Current	4-20 mA	
Output Function	$I_o = 12 + K \sin \theta$ (mA) $\pm 0.5\%$ of Normal Into a Maximum Load of 600 Ohms	
Excitation	+15 $\pm 1$ VDC <50 mA	
Output Impedance	50 Megohm Typical	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	
Scale Factor Tolerance	$\pm 1\%$	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	12 $\pm 0.02$ mA	
Zero Bias Temp. Coefficient	$\pm 0.002\%$ F.R. / Deg C	
Resolution	0.01% F.R.	0.001% F.R.
Bandwidth	0 To 3 Hz (-18 dB / Octave Roll-off)	
Orthogonal Sensitivity	<1%	
Case Alignment	$\pm 0.5$ Deg	
Vibration Overload vs. Frequency	See Figure 1	See Figure 2

### Environmental

Temperature, Operating	-40 To +85 Deg C	
Temperature, Storage	-40 To +85 Deg C	
Random Vibration (2 To 2,000 Hz)	5 G RMS, 0.25" Disp. D.A.	15 G RMS, 0.25" Disp. D.A.
Shock Survival	125 G, 5 mSec	1000 G, 1 mSec
Humidity	95% R.H.	

### Physical

Weight	12 Oz (340.2 Gm)	
Size	4.06 In L x 3.125 In W x 2.13 In H (10.31 cm L x 7.94 cm W x 5.41 cm H)	
Case Material	Anodized Aluminum	
Sealing	Environmental	
Electrical Interface	Connector MS3443412-10P or Equiv.	
Mating Connector (Optional)	PT06A-12-10S(SR) or Equiv.	



# Inclinometers

## SI-701FND, SI-701FNE

The Columbia Models SI-701FND is a premium performance force balance inclinometer designed to yield exceptional performance and long life under extreme shock and vibration conditions. A fluid-damped sensor system makes this sensor virtually uninfluenced by shock and vibration encountered in the most severe applications.

The Models SI-701FND inclinometer is capable of producing accurate tilt data in the presence of vibration, which would saturate most other accelerometer-based sensor designs. The closed loop servo system maintains scale factor and zero bias stability over the entire operating temperature range.

- \* High Performance
- \* Extremely Rugged
- \* +/-15 VDC Operation



*Consult the factory for customized versions of these sensors.*

### Specifications

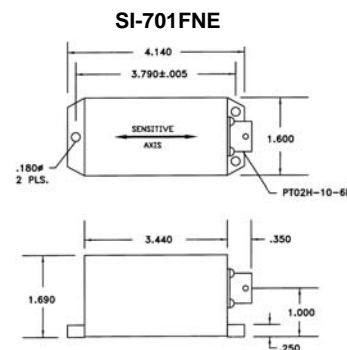
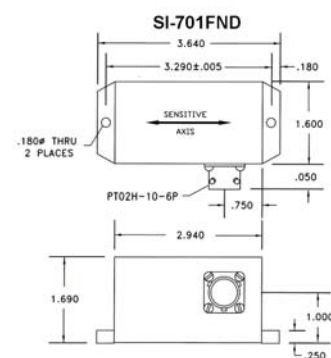
Operational	SI-701FND
Ranges Available	$\pm 1^\circ$ , $\pm 5^\circ$ , $\pm 15^\circ$ , $\pm 30^\circ$ , $\pm 45^\circ$ , $\pm 90^\circ$
Output Voltage	$\pm 5$ VDC at Rated Range
Recommended Load	100K Ohms or Greater
Excitation	$\pm 15$ VDC 20 mA Max.
Output Impedance	<5000 Ohms
Output Noise	<2 mV RMS
Non-Linearity	$\pm 0.05\%$
Non-Repeatability	<0.5 Min. of Arc
Scale Factor Tolerance	$\pm 1\%$
Scale Factor Temp Coefficient	$\pm 0.02\%$ F.R.
Zero Bias	1 Min. of Arc or 0.01 Volts (Greater Value Applies)
Zero Bias Temp. Coefficient	0.05 Min. of Arc / Deg. C
Resolution	0.005% F.R.
Bandwidth	0 To 3 Hz (-18dB / Octave Rolloff)
Orthogonal Sensitivity	0.001 G/G Exclusive of Sensitive Axis Alignment
Case Alignment	$\pm 0.1^\circ$
Vibration Rectification	50 $\mu$ G/G <sup>2</sup>

### Environmental

Temperature, Operating	-20 To +75 Deg C
Temperature, Storage	-40 To +85 Deg C
Random Vibration (2 To 2,000 Hz)	35 G RMS
Constant Vibration	50 G RMS
Shock Survival	1500 G, 1 mSec
Humidity	95% R.H.

### Physical

Weight	12 Oz (340.2 Gm)
Size (Including Connector)	3.64 In L x 2.10 In W x 1.69 In H (92.5 cm L x 53.4 cm W x 49.0 cm H)
Case Material	Aluminum
Sealing	Environmental
Connector	PT02H-10-6P (Side)
Mating Connector (Optional)	PT06A-10-6S(SR)



### I/O Connector Pin Functions:

Pin	Function	Pin	Function
A	+15 VDC	D	Eo
B	Ground	E	Spare
C	-15 VDC	F	Spare

### Ordering Information:

**SI-701FND (+/- X Deg)**

**SI-701FNE (+/- X Deg)**

Standard Inclinometer

Range +/- X Deg (Required)

Optional Mating Connector

M  
M



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# Inclinometers

## SI-701WPBI, SI-701WPBIHP

The Columbia Models SI-701WPBI and SI-701WPBIHP are waterproof versions of Columbia's popular Model SI-701BI and SI-701BIHP. These waterproof sensors are designed with an output circuit configuration made for use with 4-20 mA data transmission systems used extensively in industrial installations in order to transmit data over long distances in rough environments.

The general purpose Model SI-701BI and high performance Model SI-701BIHP Inclinometers and optional waterproof cable assemblies allow remote tilt sensing in a variety of applications such as dam gate control, drawbridge control and platform stabilization. *Consult the factory for customized versions of these sensors.*

- \* **Waterproof Tilt Sensor**
- \* **4-20 mA Output**
- \* **Low Cost and High Performance**

### Specifications

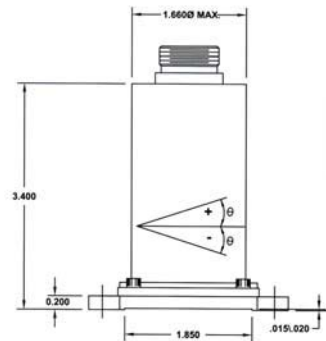
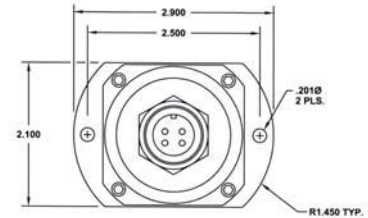
	SI-701WPBI	SI-701WPBIHP
<b>Operational</b>		
Ranges Available	$\pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$	$\pm 5^\circ, \pm 15^\circ, \pm 30^\circ, \pm 45^\circ, \pm 90^\circ$
Output Current	4-20 mA	
Output Function	$I_o = 12 + K \sin \theta$ (mA) $\pm 0.5\%$ of Normal Into a Maximum Load of 600 Ohms	
Excitation	+15 $\pm 1$ VDC <50 mA	
Output Impedance	50 Megohm Typical	
Non-Linearity	$\pm 0.2\%$ F.R.	$\pm 0.1\%$ F.R.
Non-Repeatability	$\pm 0.1\%$ F.R.	
Scale Factor	$\pm 1\%$ F.R.	
Scale Factor Temp Coefficient	$\pm 0.02\%$ / Deg C	
Zero Bias	12 $\pm 0.02$ mA	
Zero Bias Temp. Coefficient	$\pm 0.002\%$ F.R. / Deg C	
Resolution	0.01% F.R.	0.001% F.R.
Bandwidth	0 To 3 Hz (-18 dB / Octave Rolloff)	
Orthogonal Sensitivity	<1%	
Case Alignment	$\pm 0.5$ Deg	$\pm 0.25$ Deg

### Environmental

Temperature, Operating	-40 To +85 Deg C	
Temperature, Storage	-40 To +85 Deg C	
Random Vibration (2 To 2,000 Hz)	5 G RMS, 0.25" Disp. D.A.	15 G RMS, 0.25" Disp. D.A.
Shock Survival	125 G, 5 mSec	1000 G, 1 mSec
Waterproof Depth	150 Ft. Max.	

### Physical

Weight	18 Oz (510.3 Gm)
Size	2.90 In L x 2.10 In W x 3.95 In H (73.7 cm L x 53.4 cm W x 100.4 cm H)
Case Material	316L Stainless Steel
Sealing	TIG Welded & O-Ring Static Seals
Electrical Interface	Waterproof Connector #RSF-40-693
Optional Cable Assemblies	#WC-(x) & EC-(x) --See Ordering Info IP68 & NEMA 6P Ratings



### I/O Connector Pin Functions:

Models SI-701WPBI and SI-701WPBIHP			
Pin	Function	Pin	Function
A	Power Ground	C	Current Output
B	+15 VDC	D	Current Return

### Ordering Information:

SI-701WPBI (+/- X Deg)

SI-701WPBIHP (+/- X Deg)

Standard Inclinometer

Range +/- X Deg (Required)

Optional Cable Assemblies:

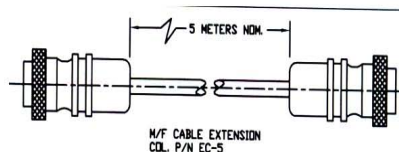
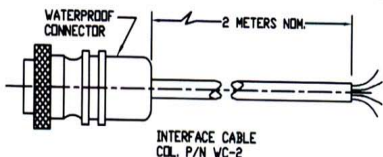
(Separate Purchase)

Interface Cable, P/N WC - (X)

X = Cable Length in Meters; Maximum 20 Meters

Extension Cable, P/N EC - (X)

X = Cable Length in Meters; Maximum 10 Meters



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# Inclinometer Systems

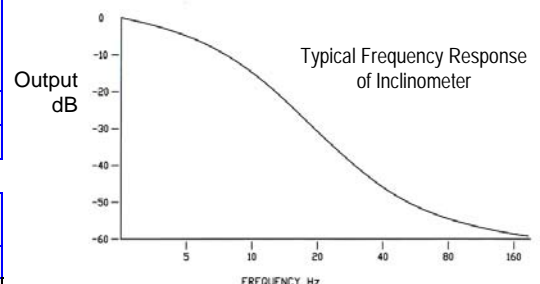
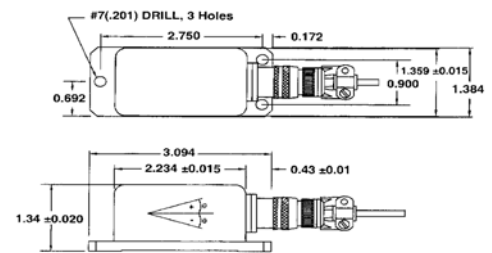
## DIS-7001, DIS-7012

Columbia Models DIS-7001 and DIS-7012 Inclinometer Systems include a temperature-compensated force balance inclinometer in conjunction with a power module and convenient digital display. Linearization is supplied in the readout module which eliminates the need for conversion from the inclinometer sine output to degrees. Both systems are available with optional analog output via a BNC connector. The optional carrying case enhances portability. *Consult the factory for customized versions of these systems.*

- \* Superior Force Balance Technology
- \* Choice of Input Power & Cable Configurations

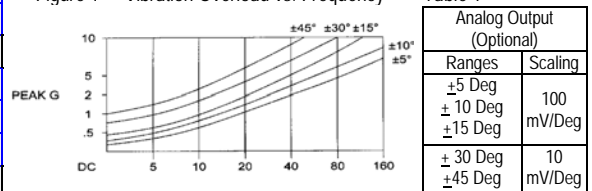


### Sensor Outline



Note: The frequency response is intentionally limited in order to eliminate ripple on the output signal.

Figure 1 - Vibration Overload vs. Frequency



Analog Output (Optional)	
Ranges	Scaling
±5 Deg	100 mV/Deg
±10 Deg	
±15 Deg	
±30 Deg	10 mV/Deg
±45 Deg	

### Ordering Information:

<b>DIS-7001 (+/- X Deg) - Digital Inclinometer System For 115V Operation</b> Range +/- X Deg (Required)	10	A	C	
<b>DIS-7012 (+/- X Deg) - Digital Inclinometer System For 10-28VDC Operation</b> Range +/- X Deg (Required)	10	A	C	-X

Sensor Interface Cable (Indicate Length in Ft)  
Standard Length = 10 Ft.  
Optional Lengths: 5 Ft. thru 50 Ft.  
Optional Analog Output (BNC) – See Table 1

Optional Carrying Case

Optional Input Power Cable without Lighter Plug  
Indicate X Length in Ft: 6 Ft. thru 20 Ft.

### Specifications Readout

	DIS-7001	DIS-7012
Input Power:	115V, 60 Hz, 1 Amp Max.	10 VDC To 28 VDC, 12.6 VDC Nom., 1 Amp Max.
Available Ranges & Corresponding System Accuracy	Range ±5 Degrees: ±0.03 Deg Accuracy Range ±10 Degrees: ±0.05 Deg Accuracy Range ±15 Degrees: ±0.10 Deg Accuracy Range ±30 Degrees: ±0.20 Deg Accuracy Range ±45 Degrees: ±0.30 Deg Accuracy	
Display	3-1/2 Digit LCD Readout	
Offset Range	Adjustable to Zero	
Controls	AC Power Switch Null Potentiometer Input Power Fuse	DC Power Switch Null Potentiometer Input Power Fuse
Operating Temperature	0 Deg. C To +52 Deg. C	
Sensor Interface Cable	10 Ft. (Standard Length) Optional Lengths: 5 Ft. To 50 Ft.	
Input Power Cable	6 Ft. Cord	Standard: 6 Ft. Cord with DC Lighter Plug Optional: Selectable Length without Lighter Plug (6 Ft. thru 20 Ft)
Size	7.5 In. L x 5.9 In. W x 2.7 In. H	
Weight	28 Oz (0.8 KG)	23 Oz (0.65 KG)

### Sensor

Output Voltage	±5 VDC at Full Range Output Proportional to the Sine of the Angle
Output Noise	<3 mV RMS
Non-Linearity	±0.15% F.R.
Non-Repeatability	±0.05% F.R.
Scale Factor Tolerance	±1%
Scale Factor Temp Coefficient	±0.02% / Deg C
Zero Bias	±0.15% F.R.
Zero Bias Temp. Coefficient	0.001% F.R. / Deg. C
Resolution	0.001% F.R.
Bandwidth	0 – 3 Hz: -18 dB / Oct Roll-off
Orthogonal Sensitivity	<0.5%
Case Alignment	±0.3°
Vibration Overload vs. Frequency	See Figure 1
Temperature, Operating	-50 To +85 Deg C
Temperature, Storage	-60 To +100 Deg C
Vibration Survival (2 To 2,000 Hz)	10 G RMS, 0.5" Disp D.A.
Shock Survival	125 G, 1 mSec, Half Sine
Ambient Pressure	0 To 5 Atmospheres
Humidity	95% R.H.
Weight	4.6 Oz (130 Gm)
Size (Excluding Connector)	2.27 In L x 1.39 In W x 1.37 In H (8.3 cm L x 3.6 cm W x 3.5 cm H)
Case Material	Black Anodize Aluminum
Sealing	Environmental



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# Differential Inclinator System

## DI-100-10-DFD-1R

The Columbia Model DI-100-10-DFD-1R Inclinator System is a unique Differential tilt measuring device which allows matching the slope of two remotely located surfaces. It is particularly useful in construction and shipbuilding. The readout can be set to indicate the absolute tilt of either sensor or the differential angle between them.

**Consult the factory for customized versions of these sensors.**

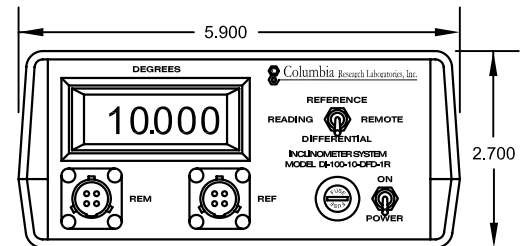
Note: Exports of accelerometers from the United States are subject to the licensing requirements of the Export Administration Regulations (EAR) and/or the International Traffic in Arms Regulations (ITAR).

SPECIFICATIONS	DI-100-10-DFD-1R
<b>Readout</b>	
Input Requirements	117 Volts AC @ 49-63Hz, 2.5 Watts Typ.
Operating Range	±10.000°
System Accuracy (All Modes)	±0.010° From 0 to 5°; ±0.030° from 5 to 10°
System Resolution	> 0.001°
System Null Stability	±0.005° Short Term. ±0.020° Long Term
Operating Temperature Range	+40°F to +110°F (+5°C to +45°C)
Storage Temperature Range	+30°F to +125°F (0°C to +52°C)
Operating Controls	AC Power switch. Display selection switch
Display	<ul style="list-style-type: none"> <li>4 1/2 Digit, 7 Segment 0.4" High readout indicating ±10.000° Full Scale</li> <li>Switch selects either sensor output of differential mode</li> <li>Display Blanks if one or both sensors are not connected</li> </ul>
Input Power Wire	6' Long
Input Connectors	PT02A-8-4P [ Sensors & Readout ]
Sensor Interface Cables	(1) 15' Long, (1) 150' Long PT08E-8-4S [ 90° Plug ] & PT06A-8-4S (SR) [ Straight Plug ]

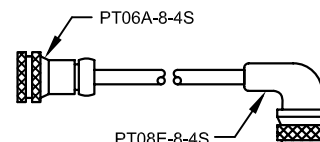
### Sensor

Output Voltage	±5VDC @ Full Range Output
Output Noise	<2mV RMS
Non-Linearity	±0.05%
Non-Repeatability	<0.5 Min. of Arc
Scale Factor Tolerance	±1%
Scale Factor Temp. Coefficient	±0.02% F.R.
Zero Bias	0.01 Volts
Zero Bias Temp. Coefficient	0.05 Min. of Arc / °C
Resolution	0.005% F.R.
Bandwidth	0 to 3Hz (-18dB / Octave Rolloff)
Orthogonal Sensitivity	0.001 G/G Exclusive of Sensitive Axis Alignment
Case Alignment	±0.1°
Vibration Rectification	50µ G/G <sup>2</sup>
Temperature, Operating	-20 to +75°C
Temperature, Storage	-40 to +85°C
Random Vibration (2 to 2000 Hz)	35G RMS
Shock Survival	50G RMS
Ambient Pressure	1500G, 1mSec
Humidity	95% R.H.
Weight	12oz. (340gm)
Size	3.64" L x 2.10" W x 1.69" H (92.5cm L x 53.4cm W x 49.0cm H)
Case Material	Aluminum
Sealing	Environmental

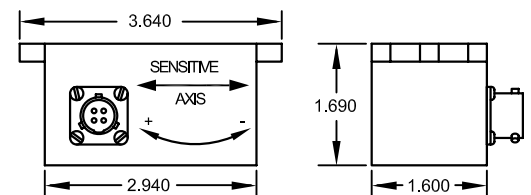
- Superior Force Balance Technology
- Extremely Rugged Inclinatorometers
- High Resolution



System (Depth 7.500)



Cable Assembly



Sensor

Ordering Information:  
DI-100-10-DFD-1R



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## APPLICATIONS

The force balance design represents without a doubt the most accurate accelerometer technology available. In addition to inherent DC response, force balance accelerometers can be configured to produce the highest sensitivity of any available accelerometer technology. They are capable of making measurements from micro-G levels up to hundreds of G's.

The force balance accelerometer has a classical critically-damped, second-order frequency response. There is no peaking in the response but simply a smooth roll-off above the natural frequency. This property along with the excellent characteristics of the "HP" torquer design makes Columbia accelerometers the best choice for demanding applications where precise DC and near-DC measurements are needed in demanding shock and wide band vibration environments.

Columbia force balance accelerometers are available to cover virtually all applications. Low noise, high output units can be used for seismic structure motion studies while miniature, high range versions are optimum for measuring more violent high G environments encountered in many industrial, aircraft and missile applications.

The extremely rugged construction of the "HP" family of Columbia accelerometers allows them to be used for many operational applications where other accelerometers would degrade and fail from the many hours of exposure to fatigue-inducing environments.

Model SA-122R miniature Force Balance Accelerometer is a lightweight sensor designed to survive severe mechanical environments without degradation to unit performance. The Model SA-120RHT is capable of operation at extreme high temperatures for applications such as down-hole mapping and engine monitoring.

The same high performance systems that are used in the linear accelerometers are incorporated into comparable lines of angular accelerometers and inclinometers. These devices are used for precise tilt, angular vibration or change of rate measurements.

Columbia force balance accelerometers and inclinometers are frequently combined with secondary electronics to produce systems performing specialized functions. These include G level switching, special output configurations and system control.

This bulletin represents a cross section of the most popular configurations of accelerometers and inclinometers in the Columbia force balance product repertoire. Columbia's experienced engineering staff is available to assist in creating unique packages or optimizing performance characteristics for specialized applications.

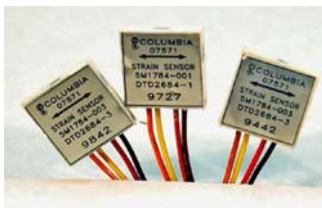
## OTHER PRODUCT LINES OFFERED BY COLUMBIA RESEARCH LABORATORIES, INC.



The Columbia product line of piezoelectric accelerometers is widely known for reliable performance, quality and ruggedness and is always expanding to meet the unique challenging and ever changing requirements of our customers. The selection of specifications, sizes and configurations is large and diverse and suitable for use on many applications requiring features such as, high performance, high accuracy, high temperature, seismic event, 4-20mA output, airborne, miniature size and general purpose use.



Columbia's product line of piezoelectric pressure sensors is extensive, with a variety of features for many pressure applications including very high and low pressure, wide frequency response, vibration compensated, general purpose, high temperature, choice of sensitivities, choice of electrical interface, electrical isolated, choice of pipe thread, or straight thread mounting, hermetically sealed, low output impedance, corrosion-resistant and fast pressure variations, surges and dynamic blasts.



Columbia's foil strain sensors monitor the fatigue loading experienced by tactical aircraft under various conditions of speed, weight and missions configuration. Critical undercarriage structures and control surfaces may be monitored for fatigue damage induced by high-G maneuvers and high stress landings. These sensors are self-temperatures compensating, environmental resistant, have a high output, two active arms and are easily installed. Developed for the demanding requirements associated with tactical military aircraft, they are equally useful performing many of the more common strain measurements encountered in the material testing laboratory. Columbia's foil strain sensors are considered the standard for the industry.



Columbia's series of linear variable differential transformers are designed for applications demanding the highest level of performance and reliability under the rugged conditions and harsh environments characteristic of military and industrial environments and construction equipment and where maximum life under adverse conditions is required. Columbia's line of LVDT's includes many displacement ranges and core sizes, high stroke/length ratio, frequency ranges, and units with sensitivity and extended temperature range for high temperature environments.



Bulletin - 103

Other product bulletins available from:



Bulletin 100: "Piezoelectric Products Division,  
Pressure Transducers and Acoustic Sensors"

Bulletin 103: "Inertial Products"

Bulletin 106: "Foil Strain Sensors"

Bulletin 107: "L.V.D.T.'s"

Bulletin 108: "Short Form Catalog"

Request these informational bulletins from your local Representative or directly from Columbia.

Visit Columbia on the web: [www.crlsensors.com](http://www.crlsensors.com)

# INERTIAL

Specifications definitions are consistent with accepted industry standards.

All Columbia Accelerometers are supplied with standard Columbia Test and Calibration Data. Other test data can be supplied at additional cost.

Continued product improvements necessitate that specifications are subject to change without notice. Please consult our website for the latest specifications.



ISO 9001:2008 with Design & AS 9100

[www.crlsensors.com](http://www.crlsensors.com)

