



Helicopter Health & Usage Monitoring Accelerometers 直升机健康与使用监控系统（HUMS）

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用于直升机健康与使用监控系统的加速度计

用于直升机健康与使用监控系统的加速度计通常需要具备如下两个功能：

- 直升机动力传动系统的机械故障诊断
- 旋翼轨迹和平衡计算

PCB®公司生产的传感器均具有上述两个功能，并且针对上述应用进行不断的更新。本文仅概括性的介绍了 PCB®公司最常用于 HUMS 的加速度计产品。

在本中某些型号参数和图纸是为某客户特殊需求定制的，所以并没有显示型号，如欲了解更多产品信息，请联系 PCB®公司进行更深层面的交流。

用于机械故障诊断的加速度计

动力传动系统健康监测(有时叫做“机械故障监测”)加速度计测量包络和峰值检测算法，要求传感器具有很宽的频率带宽。这些传感器还必须保证在整个 HUMS 系统中单点接地，并确保在恶劣的环境下能够长年和可靠的服务。

为了这个目的，PCB®公司用于机械故障诊断/动力传动系统的加速度计具有如下特点：

- 具有高频带宽(可达 20 kHz) ，用于支持机械故障诊断算法；
- 同样，具有高动态量程(达到 120 dB)。因为传动系统故障可能会引起超过 100G 的高频振动，所以此类加速度计通常具有 500G 的量程（灵敏度为 10 mV/g）加速度计的本底噪声一般在毫 G 量级；
- 鉴于直升机狭小的空间和重量限制，这些传感器结构紧凑，外壳隔离达到精确的平衡；
- 传感器均具有激光焊接、气密封装并且使用寿命长；
- 所有这些传感器均符合各种标准。请注意，这些标准从一般的军用标准和 RTCA，直到满足个别 HUMS 供应商的定制要求。

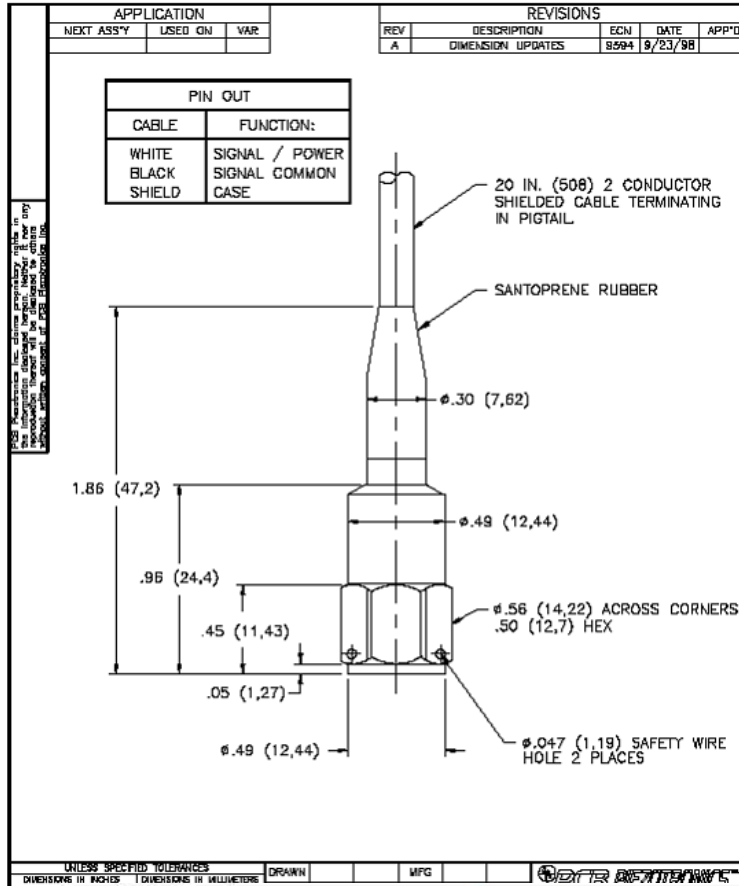
PCB®最早如何进入 HUMS 市场

十几年前，PCB®按照客户的设计、验证以及合格标准要求给某振动分析测试装置（Vibration Analysis Test Set (VATS)）设计并提供数百支加速度计。VATS 将这些传感器同时用于旋翼锥体和平衡以及传动系统的故障隔离应用。而故障隔离的应用需要传感器满足带宽和动态范围的要求。

考虑到这些传感器被有规律地安装和拆卸并且经受长时间的高振动环境，所以可以认为这些加速度计在给定时间段上比永久安装的加速度计承受更多的损坏。也就是说，交付的加速度计套件在十多年中具有非常可靠的现场使用记录。

该加速度计的图纸和规格如下所示：

PCB Piezotronics 用于直升机健康与使用监控系统的加速度计

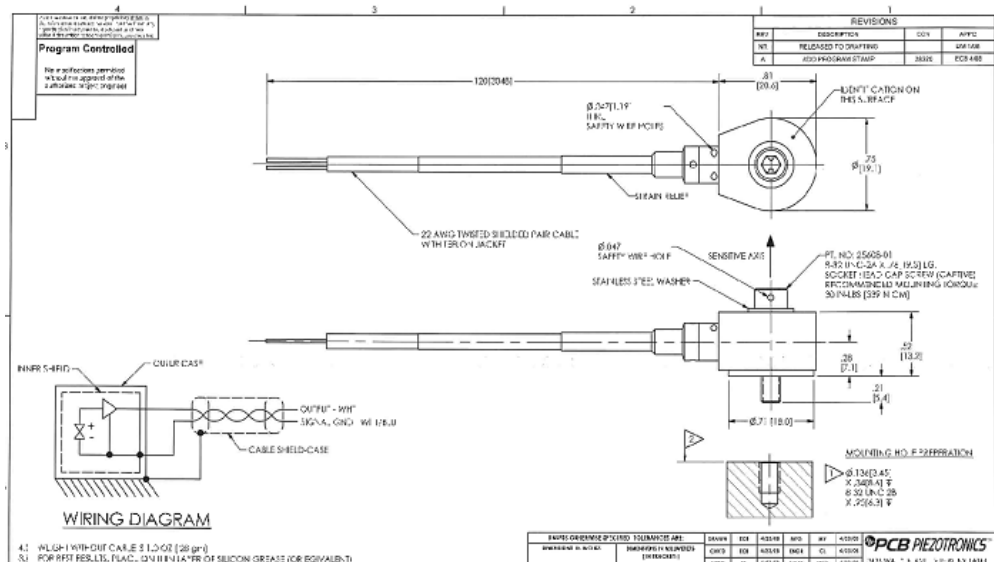


DIMENSIONS IN INCHES		DIMENSIONS IN MILLIMETERS		DRAWN	MFG	PCB PIEZOTRONICS	Revision: B
CERAMIC SHEAR ICP® ACCELEROMETER							ECN #:
DYNAMIC PERFORMANCE				OPTIONAL VERSIONS			
Voltage Sensitivity	mV/g [mV/(ms ⁻²)]	10 [1.02]	(±10%)	Optional versions have identical specifications and accessories as listed for the standard model except where noted by the letter prefixes below. More than one option may be used.			
Measurement Range	±g pk [±ms ⁻² pk]	500 [4 905]		<input type="checkbox"/> M - Metric Mount			
Frequency Range: (±1 dB)	Hz	2 to 15,000		(1) Model M081B20 Mounting Stud			
Frequency Range: (±1.5 dB)	Hz	2 to 20,000	[3]				
Mounted Resonant Frequency	kHz	>32					
Phase Response:							
Absolute: (at 2.5 Hz, 70 °F [21 °C])	°	<-8					
Relative: (at 2.5 Hz, 70 °F [21 °C])	°	±2 Maximum					
Amplitude Linearity: (100 g)	%	±1 Maximum	[1]				
Amplitude Linearity: (300 g)	%	±1.5 Maximum	[1]				
Transverse Sensitivity	%	±5					
ENVIRONMENTAL				TEST DATA SUPPLIED			
Shock Limit - All Axes (maximum)	±g pk [±ms ⁻² pk]	10,000 [98 100]		All Units			
Operating Temperature Range	°F [°C]	-30 to +250 [-34 to +121]		Voltage Sensitivity (100 Hz, 10 gm), Transverse Sensitivity, Resonant Frequency, Output Bias Level, Time Constant, Frequency Response (100 to 20,000 Hz), Case Isolation (R/F)			
Temperature Response	%/F [%/°C]	±0.18 [±0.28]					
Strain Sensitivity	µg/g [(ms ⁻²)/µε]	<0.005 [<0.046]					
Electromagnetic Sensitivity:	µg/gauss	<300					
Acoustic Sensitivity:	[(µms ⁻²)/gauss]	[<2 843]					
	g/100 dB SPL	<0.004		Production Sample (10% of Production Lot)			
	[(ms ⁻²)/100 dB SPL]	[<0.038]		Broadband Noise, Spectral Noise			
ELECTRICAL				Design Verification (4 Units from First Production Run)			
Excitation Voltage/Constant Current	VDC/mA	18 to 30/1.5 to 20		Amplitude Linearity, Shock Limit, Temperature Response, Strain Sensitivity, Electromagnetic Sensitivity, Acoustic Sensitivity, Excitation Voltage, Constant Current Supply, Output Impedance, Weight, Phase Response			
Output Impedance	ohms	<800					
Output Bias	VDC	6.5 to 8.5					
Time Constant	sec	0.5 to 2.0					
Broadband Noise: (2 to 25,000 Hz)	g rms [ms ⁻² rms]	<0.002 [<0.02]	[2]				
Spectral Noise: (2.5 Hz)	µg/√Hz [(µms ⁻²)/√Hz]	160 [1 570]	[2]				
(10 Hz)	µg/√Hz [(µms ⁻²)/√Hz]	40 [382]	[2]				
(100 Hz)	µg/√Hz [(µms ⁻²)/√Hz]	20 [196]	[2]				
(1,000 Hz)	µg/√Hz [(µms ⁻²)/√Hz]	8 [78.5]	[2]				
Case Isolation	ohms	>10 ⁷					
MECHANICAL				NOTES:			
Sensing Element	material/geometry	Ceramic/Shear		[1] Zero-based, least-squares, straight line method.			
Housing	material/sealing	Stainless Steel/Hermetic		[2] Acceleration level equivalent.			
Size (hex x height)	in [mm]	0.5 x 2.0 [12.7 x 50.8]		[3] Typical, <2dB maximum.			
Weight (without cable)	oz [gms]	<1.1 [<31]					
Integral Cable:	in [mm]	>18 [>457]					
Mounting Thread	style	2 Cond. Shielded					
	size	1/4-28 Tapped Hole					
All specifications are at room temperature unless otherwise specified.							
In the interest of constant product improvement, we reserve the right to change specifications without notice.							
ICPB is a registered trademark of PCB Piezotronics, Inc.							
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Drawn:	Eng:	Sales:	Appd:	Spec Number:			
Date:	Date:	Date:	Date:	7541			

PCB®当前高保有量的传动系统监测的加速度计，型号 355A40

PCB®公司最高保有量机械诊断加速度计的规格和图纸如下所示。该传感器的通孔螺栓安装设计解决了直升机上受限的空间带来的挑战。对于外壳隔离加速度计来讲，它的结构非常紧凑。其带宽是迄今为止外壳隔离设计的传感器中最高的。

成千上万的只此类型的合格传感器正在不同的 HUMS 系统上使用。



Model Number	ICP® ACCELEROMETER		Revision F
Performance	ENGLISH	SI	Optional Versions (Optional versions have identical specifications and accessories as listed for standard model except where noted below. More than one option maybe used.)
Sensitivity (±5%)	10 mV/g	1.02 mV/(m/s ²)	Notes
Measurement Range	±500 g pk	±4905 m/s ² pk	[1] Typical.
Frequency Range (±5%)	1 to 20000 Hz	1 to 20000 Hz	[2] Typical, -8#177; 1 dB Maximum
Resonant Frequency	>40 kHz	>40 kHz	[3] Zero-based, least-squares, straight line method.
Transverse Sensitivity	≤5.0%	≤5.0%	[4] See PCB Declaration of Conformance P5023 for details.
Broadband Resolution (2 to 30000 Hz)	< 0.005 g rms	< 0.05 m/s ² rms	
Non-Linearity	≤1.0%	≤1.0%	
Environmental			Supplied Accessories
Overload Limit	±5000 g pk	±49050 m/s ² pk	25508-01 sst hd cap screw, 8-32 x .76 (1)
Temperature Range	-65 to 257 °F	-53.9 to 125 °C	Mounting Washer (1)
Temperature Response	See Graph	See Graph	
Thermal Transient Sensitivity	≤0.05 g/°F	≤0.863 m/s ² /°C	
Base Strain Sensitivity	≤0.04 g/με	≤0.4 (m/s ²)/με	
Electrical			
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
Output Impedance (at 4 mA constant current supply)	≤150 ohm	≤150 ohm	
Output Bias Voltage	8.5 to 11.5 VDC	8.5 to 11.5 VDC	
Discharge Time Constant	.5 to 2 sec	.5 to 2 sec	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Settling Time (within 10% of bias)	≤5 sec	≤5 sec	
Electrical Isolation (Case)	>50 Mohm	>50 Mohm	
Physical			
Sensing Element	Quartz	Quartz	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Hermetic	Hermetic	
Weight (without cable)	1.0 oz	28 gm	
Electrical Connector	Integral Cable	Integral Cable	
Electrical Connection Position	Side	Side	
Cable Termination	Pigtail Ends	Pigtail Ends	
Cable Length	8 ft	2.4 m	
Mounting	Through Hole	Through Hole	
Mounting Torque	30 in-lb	339 N-cm	

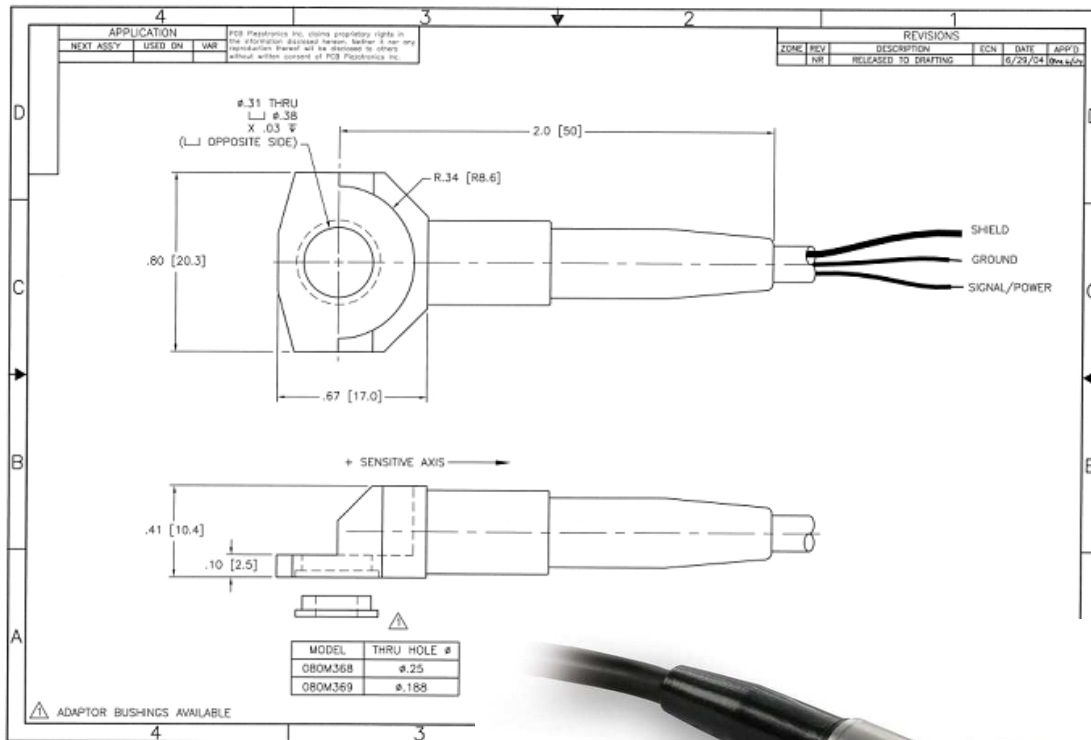
在支架上安装具有高带宽的加速度计带来的影响

虽然经常被忽视，即使是具有最高带宽加速度计，传感器安装也会限制测量带宽：

- 几乎每个加速度计必须通过某种支架连接到传动系统
- 真正重要带宽是加速度计和支架的组合带宽，而不仅仅是加速度计本身。

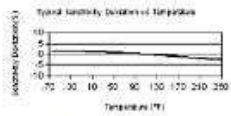
下面的两个加速度计将加速度计与它的支架作为同一部件进行加工。这样可以具有明确的安装带宽：这种配置是目前合格的，并在军用直升机飞行使用。

此配置中的测量元件可以在多个不同方向上定向。在下面和后面两页中有两种配置の説明。第一个配置中，灵敏轴与电缆方向一致：



PCB Piezotronics 用于直升机健康与使用监控系统的加速度计

Model Number	ICP® ACCELEROMETER		Revision NR ECN #:
Performance	ENGLISH	SI	Optional Versions (Optional versions have identical specifications and accessories as listed for standard model except where noted below. More than one option maybe used.) Notes: [1] Typical. [2] Zero-based, least-squares, straight line method. [3] See PCB Declaration of Conformance #5023 for details. Supplied Accessories 060M368 Thru hole bushing, .25 Dia. (1) 060M369 Thru hole bushing, .188 Dia. (1)
Sensitivity (±5%)	10 mV/g	1.02 mV/(m/s ²)	
Measurement Range	±500 g pk	±4905 m/s ² pk	
Frequency Range (±5%)	1.0 to 1000 Hz	1.0 to 1000 Hz	
Frequency Range (±10%)	0.5 to 2000 Hz	0.5 to 2000 Hz	
Resonant Frequency	>20 kHz	>20 kHz	
Bandwidth Resolution (1 to 10000 Hz Hz)	0.003 g rms	0.03 m/s ² rms	
Non-Linearity	±1%	±1%	
Transverse Sensitivity	±5%	±5%	
Environmental			
Overload Limit	±3000 g pk	±29430 m/s ² pk	
Temperature Range	-65 to +200 °F	-53 to +121 °C	
Temperature Response	See Graph	See Graph	
Base Strain Sensitivity	0.0007 g/μin	0.007 (m/s ²)/μin	
Electrical			
Excitation Voltage	18 to 30 VDC	18 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	≤10 ohms	≤10 ohms	
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
Discharge Time Constant	0.5 to 2.0 sec	0.5 to 2.0 sec	
Settling Time (within 10% of bias)	<10 sec	<10 sec	
Spectral Noise (1 Hz)	2900 μg/√Hz	24525 (μm/s ²)/√Hz	
Spectral Noise (10 Hz)	300 μg/√Hz	2443 (μm/s ²)/√Hz	
Spectral Noise (100 Hz)	60 μg/√Hz	491 (μm/s ²)/√Hz	
Spectral Noise (1 kHz)	20 μg/√Hz	198 (μm/s ²)/√Hz	
Electrical Isolation (Case)	≥10 ⁸ ohm	≥10 ⁸ ohm	
Physical			
Sensing Element	Quartz	Quartz	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Welded Hermetic	Welded Hermetic	
Size (Height x Length x Width)	.41 in x 1.22 in x .80 in	10.4 mm x 31.0 mm x 20.3 mm	
Weight (without cable)	0.53 oz	15 gm	
Cable Termination	Pigtail Ends	Pigtail Ends	
Cable Length	10 ft	3.1 m	
Cable Type	042 2-concd Shielded	042 2-concd Shielded	
Mounting	Through Hole	Through Hole	
Mounting Torque	25 to 35 in-lb	280 to 390 N-cm	



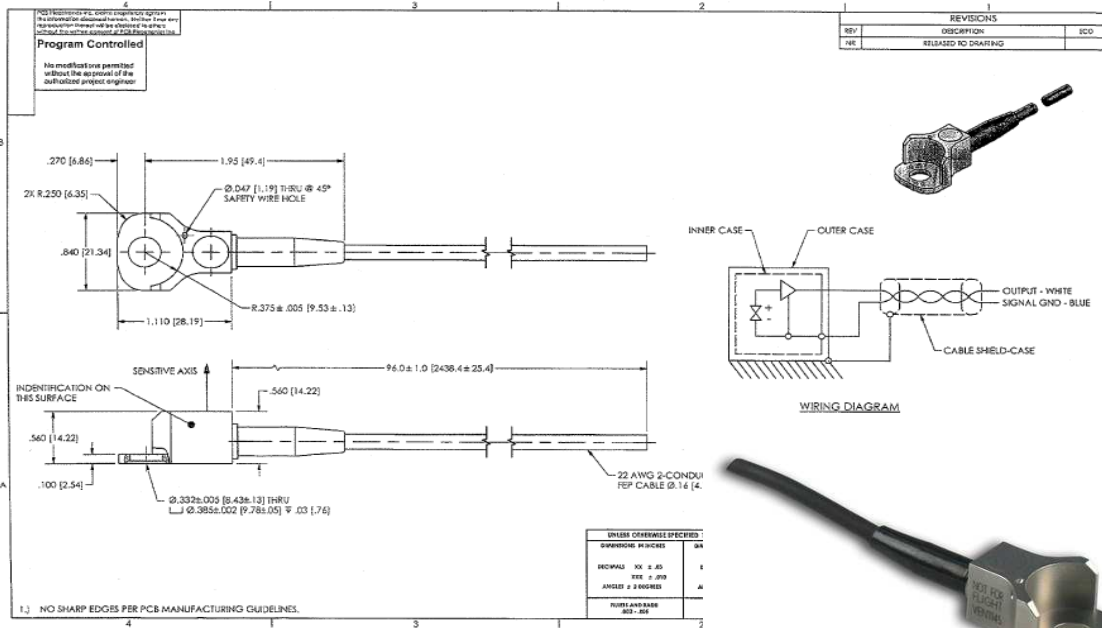
Entered: BLS	Engineer: JJB	Sales: WDC	Approved: BAM	Spec Number:
Date: 10/18/2004	Date: 10/19/2004	Date: 10/19/2004	Date: 10/19/2004	25174



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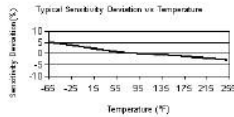
All specifications are at room temperature unless otherwise specified. In the interest of constant product improvement, we reserve the right to change specifications without notice.

第二个配置中加速度计和支架集成在一起的配置中，敏感轴与传感器/支架的安装螺栓平行。



PCB Piezotronics 用于直升机健康与使用监控系统的加速度计

Model Number	ICP® ACCELEROMETER		Revision C ECN #:
Performance	ENGLISH	SI	Optional Versions (Optional versions have identical specifications and accessories as listed for standard model except where noted below. More than one option maybe used.)
Sensitivity (±5 %)	10 mV/g	1.02 mV/(m/s ²)	Notes
Measurement Range	±500 g pk	±4905 m/s ² pk	[1] Typical.
Frequency Range (±5 %)	1 to 2000 Hz	1 to 2000 Hz	[2] Zero-based, least-squares, straight line method.
Frequency Range (±10 %)	.5 to 5000 Hz	.5 to 5000 Hz	[3] Estimated value.
Resonant Frequency	>60 kHz	>50 kHz	[4] See PCB Declaration of Conformance PS023 for details.
Broadband Resolution (1 to 10000 Hz)	.01 g rms	.10 m/s ² rms	
Non-Linearity	≤1 %	≤1 %	
Transverse Sensitivity	≤5 %	≤5 %	
Environmental			
Overload Limit	±5000 g pk	±49033 m/s ² pk	
Temperature Range	-67 to 257 °F	-55 to 125 °C	
Temperature Coefficient of Sensitivity	≤.02 g/°F	≤.35 m/s ² /°C	
Temperature Response	See Graph	See Graph	
Base Strain Sensitivity	.04 g/με	.40 (m/s ²)/με	
Electrical			
Excitation Voltage	18 to 30 VDC	18 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance (@4mA)	≤150 ohm	≤150 ohm	
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
Discharge Time Constant	.5 to 2 sec	.5 to 2 sec	
Settling Time (within 10% of bias)	<5 sec	<5 sec	
Electrical Isolation (Case)	≥200 Mohm	≥200 Mohm	
Physical			
Sensing Element	Quartz	Quartz	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Welded Hermetic	Welded Hermetic	
Size (Height x Length x Width)	.58 in x 1.16 in x .84 in	14.2 mm x 29.5 mm x 21.3 mm	
Weight (with cable)	3.5 oz	99 gm	
Cable Termination	Blunt cut	Blunt cut	
Cable Length	96 in	2438.4 mm	
Cable Type	2-cond Shielded	2-cond Shielded	
Mounting	Through Hole	Through Hole	



All specifications are at room temperature unless otherwise specified.
In the interest of constant product improvement, we reserve the right to change specifications without notice.
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Entered: DMW	Engineer: GJR	Sales: MO	Approved: EB	Spec Number:
Date: 08/18/2010	Date: 08/18/2010	Date: 08/18/2010	Date: 08/18/2010	



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用于旋翼锥体及动平衡监测的加速度计

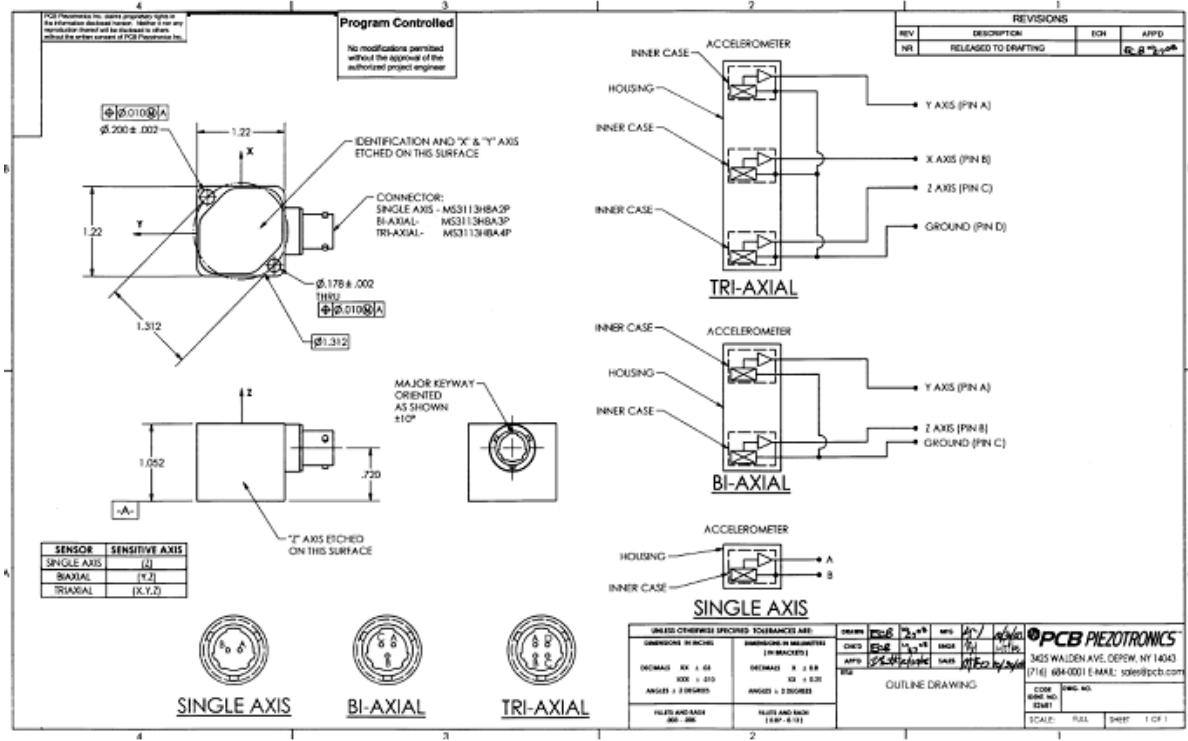
相对于传动系统加速度计的宽频响应和高幅值测量能力，用于旋翼锥体及动平衡加速度计需要具有与转子的叶片通过频率一致的更窄的带宽。它们也比传动系统传感器具有更高的灵敏度，典型的最大测量幅值为 50 g (100mV/g)。

总之，这类加速度计的特点如下：

- 频率范围由转子的叶片通过频率决定；
- 适当的最大测量量程；
- 通常，采用低通滤波可降低由于带外高振幅振动引起的放大器饱和的可能性；
- 外壳隔离；
- 气密性，坚固的设计；
- 为了最大程度的保证安装的灵活性，旋翼锥体及动平衡传感器通常提供相同封装形式的单轴、双轴和三轴版本。

PCB®最高保有量的旋翼锥体及动平衡型号如下图所示：

PCB Piezotronics 用于直升机健康与使用监控系统的加速度计



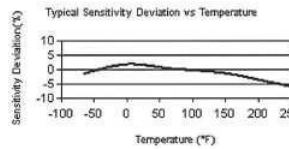
PCB Piezotronics 用于直升机健康与使用监控系统的加速度计

Model Number	ICP® ACCELEROMETER		Revision: F ECN #:
Performance	ENGLISH	SI	OPTIONAL VERSIONS Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.
Sensitivity(± 5%)	10 mV/g	1.02 mV/(m/s ²)	
Measurement Range	± 500 g pk	± 4905 m/s ² pk	NOTES: [1] Typical. [2] Typical, <± 1 dB Maximum [3] Zero-based, least-squares, straight line method.
Frequency Range(± 5%)	1 to 20,000 Hz	1 to 20,000 Hz	
Resonant Frequency	> 40 kHz	> 40 kHz	
Transverse Sensitivity	≤ 5.0 %	≤ 5.0 %	
Broadband Resolution(2 to 30,000 Hz)	< 0.005 g rms	< 0.05 m/s ² rms	
Non-Linearity	≤ 1.0 %	≤ 1.0 %	
Environmental			
Overload Limit	± 5000 g pk	± 49,050 m/s ² pk	
Temperature Range	-65 to 257 °F	-53.9 to 125 °C	
Temperature Response	See Graph	See Graph	
Thermal Transient Sensitivity	≤ 0.05 g/°F	≤ 0.883 m/s ² /°C	
Base Strain Sensitivity	≤ 0.04 g/μt	≤ 0.4 (m/s ²)/μt	
Electrical			SUPPLIED ACCESSORIES: Model 25508-01 skt hd cap screw, 8-32 x .76 (1) Model Mounting Washer (1)
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
Output Impedance(at 4 mA constant current supply)	≤ 150 ohm	≤ 150 ohm	
Output Bias Voltage	8.5 to 11.5 VDC	8.5 to 11.5 VDC	
Discharge Time Constant	.5 to 2 sec	.5 to 2 sec	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Settling Time(within 10% of bias)	< 5 sec	< 5 sec	
Electrical Isolation(Case)	≥ 50 Mohm	≥ 50 Mohm	
Physical			
Sensing Element	Quartz	Quartz	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Hermetic	Hermetic	
Weight(without cable)	1.0 oz	28 gm	
Electrical Connector	Integral Cable	Integral Cable	
Electrical Connection Position	Side	Side	
Cable Termination	Pigtail Ends	Pigtail Ends	
Cable Length	8 ft	2.4 m	
Mounting	Through Hole	Through Hole	
Mounting Torque	30 in-lb	339 N-cm	
			ENTERED: JH ENGINEER: WSD SALES: MEO APPROVED: EB DATE: 11-17-09 DATE: 11-4-09 DATE: 11-17-09 DATE: 11-10-09 SPEC NUMBER: 25634
All specifications are at room temperature unless otherwise specified. In the interest of constant product improvement, we reserve the right to change specifications without notice. ICP® is a registered trademark of PCB Group, Inc.			
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Model Number	BIAXIAL ICP® ACCELEROMETER		Revision: D ECN #:
Performance	ENGLISH	SI	OPTIONAL VERSIONS Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.
Sensitivity(± 5%)(@ 100 Hz)	100 mV/g	10.2 mV/(m/s ²)	
Measurement Range	± 50 g pk	± 490 m/s ² pk	NOTES: [1] Typical. [2] Conversion Factor 1g = 9.81 m/s ² . [3] Zero-based, least-squares, straight line method. [4] ≤ 1% to 22g, ≤ 3% to 50g (@ 100Hz) [5] Maximum.
Frequency Range(± 1/2 dB)(± 5 dB)	3 to 2000 Hz	3 to 2000 Hz	
Resonant Frequency	1 to 7000 Hz	1 to 7000 Hz	
Transverse Sensitivity	≤ 2.0 kHz	≤ 20 kHz	
Broadband Resolution(2 to 20,000 Hz)	2 mg rms	19.6 m/s ² rms	
Non-Linearity	≤ 1 %	≤ 1 %	
Transverse Sensitivity	≤ 7 %	≤ 7 %	
Environmental			
Overload Limit(Shock)	± 5000 g pk	± 49,050 m/s ² pk	
Temperature Range	-65 to +250 °F	-64 to +121 °C	
Temperature Response	See Graph	See Graph	
Electrical			SUPPLIED ACCESSORIES: Model 25508-01 skt hd cap screw, 8-32 x .76 (1) Model Mounting Washer (1)
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
Constant Current Excitation	2 to 4 mA	2 to 4 mA	
Output Impedance	≤ 125 ohm	≤ 125 ohm	
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
Settling Time(within 10% of bias)	≤ 2.0 sec	≤ 2.0 sec	
Spectral Noise(10 Hz)	24.0 μg/√Hz	23.5 (μm/s ²)/√Hz	
(100 Hz)	9.4 μg/√Hz	92.0 (μm/s ²)/√Hz	
(1 kHz)	4.4 μg/√Hz	43.0 (μm/s ²)/√Hz	
Electrical Isolation(Case)	> 10 Mohm	> 10 Mohm	
Physical			
Sensing Element	Ceramic	Ceramic	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Hermetic	Hermetic	
Size (Height x Length x Width)	1.05 in x 1.87 in x 1.22 in	26.7 mm x 47.5 mm x 31.0 mm	
Weight	5.3 oz	150 gm	
Electrical Connector	3-Pin	3-Pin	
Electrical Connection Position	Side	Side	
Electrical Connections(Pin A)	Y axis	Y axis	
(Pin B)	Z axis	Z axis	
(Pin C)	Ground	Ground	
Mounting	Through Hole	Through Hole	
All specifications are at room temperature unless otherwise specified. In the interest of constant product improvement, we reserve the right to change specifications without notice. ICP® is a registered trademark of PCB Group, Inc.			ENTERED: JH ENGINEER: SAM SALES: IC APPROVED: EB DATE: 5-18-11 DATE: 5-12-11 DATE: 5-18-11 DATE: 5-13-11 SPEC NUMBER: 42431

PCB Piezotronics 用于直升机健康与使用监控系统的加速度计

Model Number	TRIAxIAL ICP® ACCELEROMETER		Revision: D ECN #:
Performance	ENGLISH	SI	OPTIONAL VERSIONS
Sensitivity(± 5 %)(@ 100 Hz)	100 mV/g	10.2 mV/(m/s²)	[2]
Measurement Range	± 50 g pk	± 490 m/s² pk	
Frequency Range(± 1/2 dB)	3 to 2000 Hz	3 to 2000 Hz	
(± 3 dB)	1 to 7000 Hz	1 to 7000 Hz	
Resonant Frequency	≥ 20 kHz	≥ 20 kHz	[1]
Broadband Resolution(2 to 20,000 Hz)	2 mg rms	19.6 mm/s² rms	[1]
Non-Linearity	≤ 1 %	≤ 1 %	[3][4]
Transverse Sensitivity	≤ 7 %	≤ 7 %	[3][4]
Environmental			
Overload Limit(Shock)	± 5000 g pk	± 49,050 m/s² pk	
Temperature Range	-65 to +250 °F	-64 to +121 °C	
Temperature Response	See Graph	See Graph	[1]
Electrical			
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
Constant Current Excitation	2 to 4 mA	2 to 4 mA	
Output Impedance(@4mA constant current)	≤ 125 ohm	≤ 125 ohm	
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
Settling Time(within 10% of bias)	≤ 2 sec	≤ 2 sec	
Spectral Noise(10 Hz)	24.0 µg/√Hz	235 (µm/sec²)/√Hz	[1]
(100 Hz)	9.4 µg/√Hz	92 (µm/sec²)/√Hz	[1]
(1 kHz)	4.4 µg/√Hz	43 (µm/sec²)/√Hz	[1]
Electrical Isolation(Case)	>10 Mohm	>10 Mohm	
Physical			
Sensing Element	Ceramic	Ceramic	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Hermetic	Hermetic	
Size (Height x Length x Width)	1.05 in x 1.87 in x 1.22 in	26.7 mm x 47.5 mm x 31.0 mm	[5]
Weight	5.3 oz	150 gm	
Electrical Connector	4-Pin	4-Pin	
Electrical Connection Position	Side	Side	
Electrical Connections(Pin A)	Y axis	Y axis	
(Pin B)	X axis	X axis	
(Pin C)	Z axis	Z axis	
(Pin D)	Ground	Ground	
Mounting	Through Hole	Through Hole	
<p>NOTES:</p> <p>[1] Typical.</p> <p>[2] Conversion Factor 1g = 9.81 m/s².</p> <p>[3] Zero-based, least-squares, straight line method.</p> <p>[4] ≤ 1% to 22g, ≤ 3% to 50g (@ 100Hz).</p> <p>[5] Maximum.</p>			
<p>Entered: <i>JCT</i> Engineer: <i>BAM</i> Sales: <i>JC</i> Approved: <i>EB</i> Spec Number:</p> <p>Date: <i>5/13-11</i> Date: <i>5/12-11</i> Date: <i>5/13-11</i> Date: <i>5/13-11</i> 42432</p>			
<p>PCB PIEZOTRONICS VIBRATION DIVISION 3425 Walden Avenue, Depew, NY 14043</p> <p>Phone: 716-684-0001 Fax: 716-685-3886 E-Mail: vibration@pcb.com</p>			
<p><small>All specifications are at room temperature unless otherwise specified. In the interest of constant product improvement, we reserve the right to change specifications without notice. ICP® is a registered trademark of PCB Group, Inc.</small></p>			



其它在直升机上的永久性安装应用

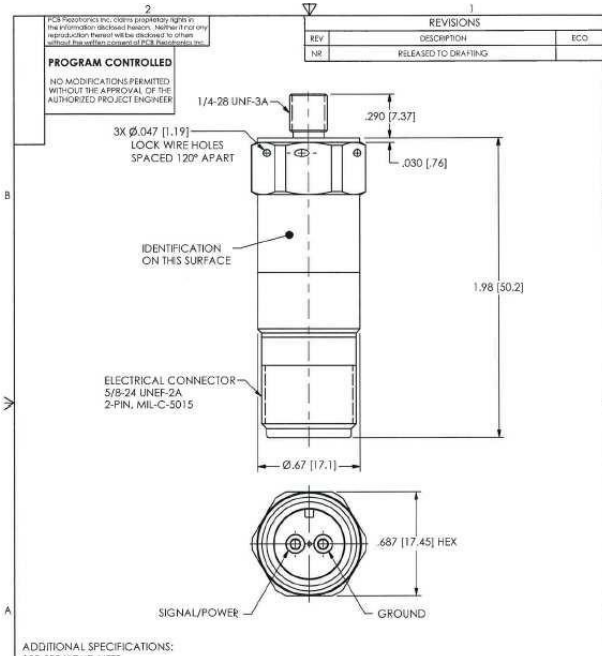
主动振动控制和平衡加速度计

主动振动控制和主动平衡加速度计在以下特性上与旋翼锥体及动平衡传感器有相似之处:

- 相对较高的灵敏度; 高达 200 mV / g (25 g 量程);
- 相对较低的频带宽度, 通常由内部低通滤波控制;
- 在某些情况下, 需要集成防雷保护;
- 箱体隔离;
- 密封, 坚固, 可靠性。

这些加速度计符合各种标准, 其中有一些是按照系统集成商定制的。以下指标和图例为典型的 PCB®主动振动控制和主动平衡加速度计。

PCB Piezotronics 用于直升机健康与使用监控系统的加速度计



ADDITIONAL SPECIFICATIONS:
100,000 HOUR MITF
5V FULL SCALE OUTPUT VOLTAGE

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS
DECIMALS .XX ±.01	DECIMALS .X ±.02
ANGLES ±.3 DEGREES	ANGLES ±.3 DEGREES
FILLET AND RADIUS .001 - .002	FILLET AND RADIUS .017 - 0.13

Model Number	Preliminary ICP® ACCELEROMETER		Revision: A ECN #:	
	Performance	ENGLISH	SI	
	Sensitivity (± 10 %) (@18Hz)	200 mV/g	20.4 mV/(m/s ²)	
	Measurement Range	± 25 g pk	± 245 m/s ² pk	
	Frequency Range (± 5 %)	10 to 70 Hz	10 to 70 Hz	
	(± 10 %)	5 to 100 Hz	5 to 100 Hz	
	Electrical Filter Corner Frequency (-3 dB)	300 Hz	300 Hz [2]	
	Resonant Frequency	25 kHz	25 kHz	
	Broadband Resolution (1 to 10,000 Hz)	350 µg	3432 m/s ² rms	
	Non-Linearity	± 1 %	± 1 % [3]	
	Transverse Sensitivity	± 7 %	± 7 % [3]	
	Environmental			
	Overload Limit	± 5000 g pk	± 49,030 m/s ² pk	
	Temperature Range (Operating)	30 to 198 °F	-1 to 93 °C	
	(Survivable Limit)	-45 to 250 °F	-45 to 121 °C	
	Temperature Response	See Graph	See Graph [1]	
	Base Strain Sensitivity	<.001 g/µε	<.0098 (m/s ²)/µε [1]	
	Electrical			
	Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
	Constant Current Excitation	2 to 20 mA	2 to 20 mA	
	Output Impedance	<150 ohm	<150 ohm	
	Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
	Discharge Time Constant	≥ .07 sec	≥ .07 sec	
	Settling Time (within 10% of bias)	<2 sec	<2 sec	
	Spectral Noise (10 Hz)	8 µg/√Hz	78.5 (µm/sec ²)/√Hz	
	(100 Hz)	5 µg/√Hz	49.1 (µm/sec ²)/√Hz	
	(1 kHz)	4 µg/√Hz	39.2 (µm/sec ²)/√Hz	
	Electrical Isolation	>10 Mohm	>10 Mohm	
	Physical			
	Sensing Element	Ceramic	Ceramic	
	Sensing Geometry	Shear	Shear	
	Housing Material	Stainless Steel	Stainless Steel	
	Sealing	Welded Hermetic	Welded Hermetic	
	Size (Hex x Height)	11/16 in x 2.0 in	18 mm x 50 mm [1][4]	
	Weight	2.2 oz	70 gm	
	Electrical Connector	2-Pin MIL-C-5015	2-Pin MIL-C-5015	
	Electrical Connection Position	Top	Top	
	Mounting	Integral Stud	Integral Stud	
	Mounting Thread	1/2-28 Male	No Metric Equivalent	
	Mounting Torque	2 to 5 ft-lb	2.7 to 6.8 N-m	
	<p>Typical Sensitivity Deviation vs Temperature</p>			
	<p>Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.</p>			
	<p>NOTES:</p> <p>[1] Typical.</p> <p>[2] Electrical filter is a first order low pass filter.</p> <p>[3] Zero-based, least-squares, straight line method.</p> <p>[4] Estimated value.</p>			
Entered:	Engineer:	Sales:	Approved:	Spec Number:
Date:	Date:	Date:	Date:	43734
<p>PCB PIEZOTRONICS™ VIBRATION DIVISION 3425 Walden Avenue, Depew, NY 14043</p>			<p>Phone: 716-684-0901 Fax: 716-685-3886 E-Mail: vibration@pcb.com</p>	

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其它飞行应用程序

PCB®的 HUMS 传感器只是 PCB®大量飞行测试体系传感器中的一支。PCB®产品目前用于：

- 某新型民用直升机开发；
- 两个宽体固定翼飞机型号的开发；
- 两个窄体固定翼飞机型号的开发；
- 某固定翼商务飞机开发；
- 几个军用和民用机型升级和故障排除应用。

涉及的主要产品包括：

- 多款信号调理器，包括多通道和在线电荷放大器以及 ICP®电源；
- DC (MEMS 压阻式) 加速度计；
- 具有内部放大电路的压电加速度计 (ICP®和 28V 供电)；
- 外部放大的加速度计，可在 482 °C 的环境中使用。

这些产品都符合各个客户指定的要求，并具有非常可靠的性能。事实上，鉴于它们相对频繁地安装和卸载，从客户服务的角度可能比许多涉及永久性安装的应用更具挑战性。

更多 PCB®航空航天应用传感器，请登录官网 [http://pcb-china.cn/Aerospace\(zh-CN\).aspx](http://pcb-china.cn/Aerospace(zh-CN).aspx) 查询，或发邮件至 pcbchina@pcb.com 了解。