Motorsport Sensors

Accelerometers; Force Sensors; Preamplifiers; Microphones; Torque Sensors; Pressure Sensors; Load Cells; Modally Tuned®, ICP®, Impact Hammers; and Signal Conditioners

PCB PIEZOTRONICS INC.
MTS SYSTEMS CORPORATION

Automotive Sensors Division ☎ Toll-Free in USA 888-684-0014 ☎ 716-684-0001 www.pcb.com

Motorsport Sensors

Motorsport encompasses more than just Formula 1 and NASCAR automobiles vying for first place glory as they power around a track at speeds topping 220 mph. The Motorsport industry also entails the racing of motorcycles, trucks, water craft, snowmobiles, go carts, and even lawn mowers. Whatever it is that's racing, these vehicles are high performance, finely-tuned, engineering marvels designed to win. Drivers, and the owners of these vehicles, continually seek to better understand and improve materials, components, and systems, as well as to ensure safety. This is accomplished by engineers spending painstakingly long hours in the design labs and testing tracks around the world.

In an industry where fractions of a second can mean the difference between victory and defeat, every effort is taken to gain and maintain a competitive advantage. To this end, motorsport companies routinely test and analyze current and newly developed materials, components, systems, and technologies to get increased efficiency and the highest performance achievable. When seconds count, nothing should go into a vehicle unless it adds to its performance. In order to verify positive performance, motorsport companies typically conduct tests and studies including:

- Ride & handling
- Powertrain development
- Component & system performance
- Vehicle and powertrain NVH
- Modal analysis

PCB® Piezotronics offers a complete line of sensors and instrumentation for the motorsport industry. Models 3711A03 and 3711A05 single axis DC response accelerometers are designed exclusively for data acquisition systems commonly used in the motorsport industry. Titanium housed and hermetically sealed, these units offer a single-ended 2.5V offset output signal for each channel with power and ground leads, and are ideal for use in both lab and test track situations. New Series 5300D TORKDISC® in-line rotary torque sensor systems have high torsional stiffness, are compact and low weight, and are used in powertrain development where axial space is at a premium, as it is in most motorsport vehicles. New Series 339A, triaxial ICP® accelerometers, with a temperature coefficient of less than 0.0125% / °F (0.02% / °C), are titanium housed and hermetically sealed 10 mm cubes that have a 10 mV/g sensitivity, a measurement frequency to 10 kHz, and an operating temperature range from -65 to +325 °F (-54 to +163 °C). These sensors provide precision amplitude data for test applications with large thermal shifts such as powertrain vibration testing, powertrain NVH, certain vehicle systems NVH tests, road load data acquisition, and durability testing in climatic chambers. PCB® also offers an extensive range of single and triaxial ICP® accelerometers; prepolarized and externally-polarized microphones; ICP® preamplifiers and array microphones; ICP® force sensors; ICP® quartz force rings; instrumented impact hammers; and ICP® sensor signal conditioners for use in numerous additional motorsport measurement scenarios. PCB® products are designed and manufactured in our state-of-the-art facilities, and together with our global distribution network and Total Customer Satisfaction guarantee, you can rely on us to deliver products and solutions for your demanding requirements.

DC Response Accelerometers for Motorsport Applications

PCB® Series 3741 DC response accelerometers are offered in a variety of full-scale ranges, from ± 2 to ± 200 g, to accommodate many motorsport testing requirements. The units feature silicon MEMS sensing elements for uniform, repeatable performance. Gas damping, mechanical over range stops, and a low profile, hard-anodized, aluminum housing are utilized for added durability. Electrically, the units offer a differential output signal for common-mode noise rejection.

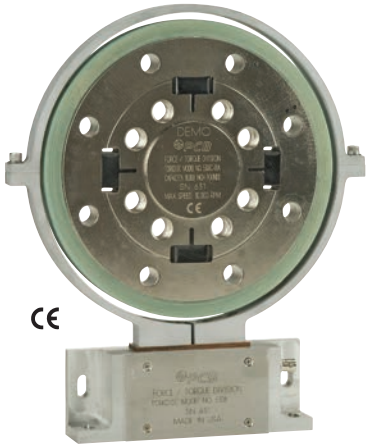
PCB® Series 3711 (single axis) and 3713 (triaxial) DC response accelerometers are designed to measure low-frequency vibration and motion, and are offered in full-scale ranges from ± 3 to ± 200 g, to accommodate a variety of motorsport testing requirements. The units feature gas-damped, silicon MEMS sensing elements that provide performance, while hermetically sealed titanium housings provide protection from harsh contaminants. These units are inherently insensitive to base strain and transverse acceleration effects, and offer high-frequency overload protection. Electrically, the units offer a single-ended output signal for each channel with power and ground leads.

PCB® Models 3711A03 and 3711A05 single axis DC response accelerometers are designed exclusively for data acquisition systems commonly used in the motorsport industry. Titanium housed and hermetically sealed, these units are ideal for use in both lab and test track situations.

DC Response Accelerometers for Motorsport Applications

Series 3741	Sensitivity	Measurement Range (pk)	Frequency (± 10%)	Broadband Resolution (rms)
CE 	10 mV/g	± 200 g	0 to 2000 Hz	5.1 mg
	20 mV/g	± 100 g	0 to 2000 Hz	4.5 mg
	40 mV/g	± 50 g	0 to 2000 Hz	2.5 mg
	66.7 mV/g	± 30 g	0 to 2000 Hz	2.5 mg
	200 mV/g	± 10 g	0 to 200 Hz	1.1 mg
	1000 mV/g	± 2 g	0 to 150 Hz	0.3 mg
Series 3711 and 3713				
CE  CE 	10 mV/g	± 200 g	0 to 1500 Hz	5.3 mg
	40 mV/g	± 50 g	0 to 1500 Hz	4.4 mg
	40 mV/g, 2.5 V offset	± 50 g	0 to 1500 Hz	4.4 mg
	100 mV/g	± 20 g	0 to 1500 Hz	3.6 mg
	100 mV/g, 2.5 V offset	± 20 g	0 to 1500 Hz	3.6 mg
	700 mV/g	± 3 g	0 to 150 Hz	1.1 mg

Model Number	3741 Single Axis	3711 Single Axis	3713 Triaxial
Overload Limit (Shock)	± 5,000 g pk	± 5000 g pk	± 5000 g pk
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54.0 to +121 °C	-65 to +250 °F -54 to +121 °C
Excitation Voltage	6 to 30 VDC	5 to 30 VDC	5 to 30 VDC
Housing Material	Anodized Aluminum	Titanium	Titanium
Sealing	Epoxy	Hermetic	Hermetic
Size	0.30 x 1.00 x 0.85 in 7.62 x 25.4 x 21.6 mm	0.45 x 0.85 x 0.85 in 11.4 x 21.6 x 21.6 mm	1.1 in Cube 28 mm Cube
Weight Connector style Integral cable style	— 10 gm	14 gm 78 gm	78 gm 169 gm
Electrical Connector	10 ft. (3 m) Integral Cable	1/4-28 4-Pin or 10 ft. (3 m) Integral Cable	9-Pin or 10 ft. (3 m) Integral Cable
Output Configuration	Differential	Single-Ended	Single-Ended
Supplied Accessories			
Easy Mount Clip	—	080A152	—
Adhesive Base	—	—	080A208
Mounting Screws/Studs	081A103 M081A103	081A64 M081A64	081A05 M081A05
Additional Accessories			
Triaxial Mounting Block	080A208	080A153	—
Mounting Cable Connectors	—	AY	EN

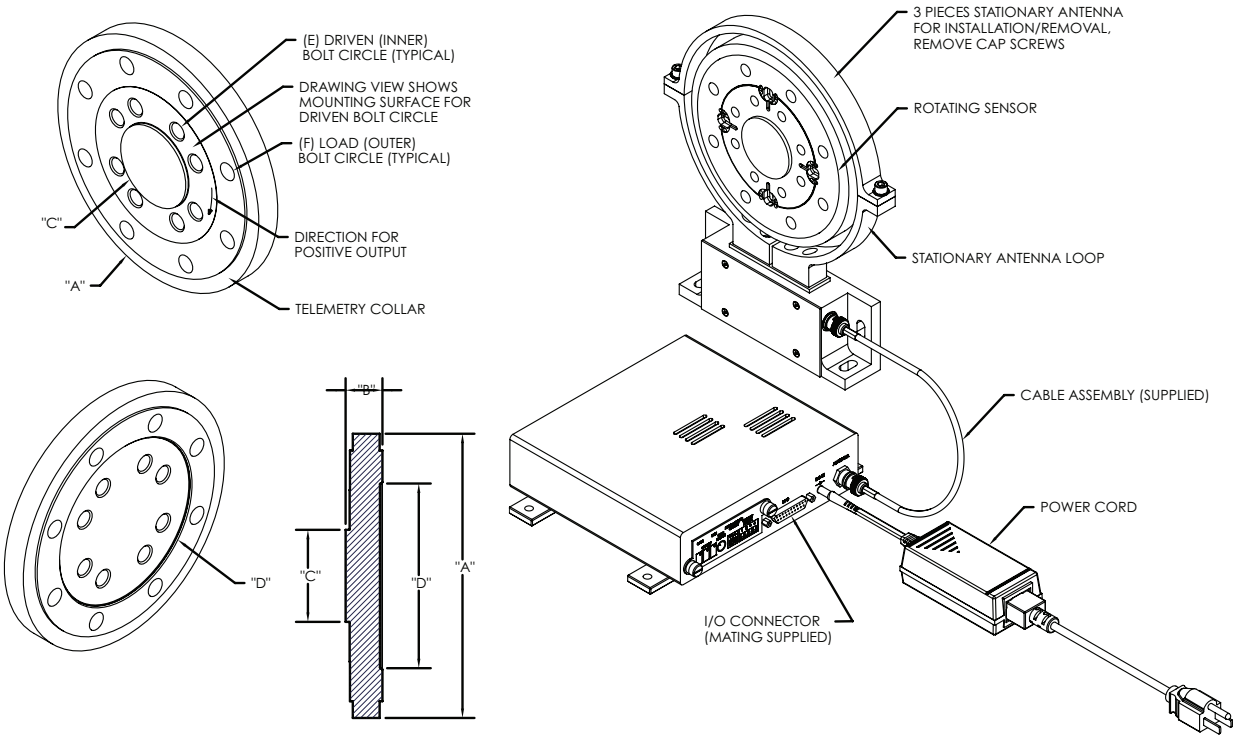


Series 5300D

TORKDISC® In-line Rotary Torque Sensor System for Motorsport Applications

PCB® Series 5300D sensors are designed for dynamometer and other test applications requiring a robust rotary torque transducer where axial space is at a premium. Onboard, the transducer is a field proven electronic module that converts the torque signals into a high-speed digital representation. Once in digital form, this data is transmitted to a non-contacting pick-up loop, with no risk of noise or data corruption. A remote receiver unit converts the digital data to a high-level analog output voltage, and a serial digital output.

Series 5300D incorporates dual high level analog outputs, AC and DC coupled, providing both static and dynamic torque measurement capability that can be recorded separately and independently scaled; which is particularly beneficial when high DC levels are present or when low levels of AC content is of particular interest. Series 5300D also features industry leading bandwidth, DC to 8500 Hz, resulting in increased dynamic response characteristics. The DC coupled output features an 8-pole low pass elliptical filter with user selectable frequencies for minimal roll off at each filter selection. A 2-pole Butterworth high pass filter with a wide range of user selectable cut off frequencies is included with the AC coupled output.



The TORKDISC® and receiver make up a complete system. No additional signal conditioning is required.
The receiver box provides voltage and digital output via a 25-pin I/O connector.

TORKDISC® In-line Rotary Torque Sensor System Dimensions

	A	B	C	D	E	F
Series	O.D. - Outside Diameter (including telemetry collar)	Overall Thickness	Pilot	Pilot	Driven (inner) Bolt Circle	Load (outer) Bolt Circle
5302D	7.00 in 177.8 mm	1.10 in 27.9 mm	1.999 in 50.8 mm	4.375 in 111.1 mm	(8) 3/8-24 threaded holes, spaced on a 3.00 in (76.20 mm) B.C.	(8) 0.406 in (10.31 mm) dia. through holes equally spaced on a 5.00 in (127.0 mm) B.C.
5308D	8.49 in 215.5 mm	1.10 in 27.9 mm	2.748 in 69.9 mm	5.513 in 140.0 mm	(8) 5/8-11 threaded holes, spaced on a 3.75 in (95.25 mm) B.C.	(8) 0.531 in (13.49 mm) dia. through holes equally spaced on a 6.5 in (165.0 mm) B.C.
5309D	10.49 in 241.0 mm	1.64 in 41.7 mm	3.998 in 101.5 mm	7.500 in 190.5 mm	(12) 5/8-11 threaded holes, spaced on a 6.0 in (152.4 mm) B.C.	(16) 0.531 in (13.49 mm) dia. through holes equally spaced on a 8.5 in (215.9 mm) B.C
5310D	17.98 in 456.7 mm	2.09 in 53.0 mm	5.499 in 139.7 mm	11.001 in 279.4 mm	(12) 7/8-14 threaded holes, spaced on a 9.0 in (288.6 mm) B.C.	(16) 0.780 in (19.8 mm) dia. through holes equally spaced on a 13.0 in (330.2 mm) B.C.

Notes [1] Extraneous load limits reflect the maximum axial load, lateral load, and bending moment that may be applied singularly without electrical or mechanical damage to the sensor. Where combined extraneous loads are applied, decrease loads proportionally. Request Application Note AP-1015 regarding the effects of extraneous loads on the torque sensor output

TORKDISC® Rotary Torque Sensor System

Model Number	Unit	5302D-05A	5302D-03A	5302D-01A	5302D-02A	5302D-04A	5308D-01A	5308D-02A
Continuous Rated Capacity	in-lb N-m	250 28	1000 113	2000 226	5000 565	6250 706	10k 1130	20k 2260
Bolt Joint Slip Torque	in-lb N-m	3300 373	3300 373	3300 373	10k 1130	10k 1130	35k 4000	35K 4000
Safe Overload	in-lb N-m	750 85	3000 339	6000 678	15k 1695	15k 1695	30k 3400	60k 6775
Failure Overload	in-lb N-m	1000 113	4000 452	8000 904	20k 2260	20k 2260	40k 4500	80k 9040
Torsional Stiffness	in-lb/rad N-m/rad	300k 34k	2.9M 328k	5.8M 655k	14.5M 1.6M	14.5M 1.6M	33.5M 3.8M	67M 7.6M
Torsional Angle @ Capacity	degrees	0.125	0.02	0.02	0.02	0.02	0.017	0.017
Rotating Inertia	in-lb sec^2 N-m sec^2	0.030 0.003	0.056 0.006	0.056 0.006	0.117 0.013	0.117 0.013	0.24 0.027	0.24 0.027
Axial Load Limit [1]	lb N	62.5 278	250 1112	500 2224	1000 4448	1000 4448	1350 6000	2700 12k
Lateral Load Limit [1]	lb N	62.5 278	250 1112	500 2224	1000 4448	1000 4448	1650 7300	3375 15k
Bending Moment Limit [1]	in-lb N-m	125 14	750 85	1500 169	3000 339	3000 339	5000 565	7500 850
Maximum Speed	RPM	15k	15k	15k	15k	15k	10k	10k
Rotor Weight	lb kg	2 0.91	3.5 1.59	3.5 1.59	9 4.08	9 4.08	10 4.5	10 4.5
Rotor Material		Aluminum	Aluminum	Aluminum	Steel	Steel	Steel	Steel

Model Number	Unit	5308D-03A	5309D-01A	5309D-02A	5310D-03A	5310D-01A	5310D-02A	5310D-04A
Continuous Rated Capacity	in-lb N-m	30k 3400	50k 5650	100k 11.3k	120k 13.6k	180k 20.3k	200k 22.5k	225k 25.4k
Bolt Joint Slip Torque	in-lb N-m	35k 4000	85k 9600	110k 12.4k	268k 30.3k	268k 30.3k	268k 30.3k	268k 30.3k
Safe Overload	in-lb N-m	75k 8475	100k 11.3k	200k 22.6k	360k 40.7k	540k 61.0k	600k 67.8k	675k 76.3k
Failure Overload	in-lb N-m	100k 11.3k	125k 14k	250k 28.2k	480k 54.2k	720k 81.3k	800k 90.4k	900k 101.7k
Torsional Stiffness	in-lb/rad N-m/rad	100M 11.3M	115M 13M	230M 26M	730k 82.5k	1.1B 24M	1.2B 138M	1.35B 152.5M
Torsional Angle @ Capacity	degrees	0.017	0.017	0.017	0.01	0.01	0.01	0.01
Rotating Inertia	in-lb sec^2 N-m sec^2	0.24 0.027	0.874 0.099	0.874 0.099	7.514 0.849	7.514 0.849	7.514 0.849	7.514 0.849
Axial Load Limit [1]	lb N	4000 17.8k	5000 22.2k	10k 44.5k	12k 53.4k	13.5k 60k	14k 62k	15k 66.7k
Lateral Load Limit [1]	lb N	5000 22.2k	5000 22.2k	10k 44.5k	12k 53.4k	13.5k 60k	14k 62k	15k 66.7k
Bending Moment Limit [1]	in-lb N-m	10k 1130	25k 2825	50k 5650	80k 9039	90k 10.2k	95k 10.7k	100k 11.3k
Maximum Speed	RPM	10k	10k	10k	4500	4500	4500	4500
Rotor Weight	lb kg	10 4.5	30 13.6	30 13.6	100 45	100 45	100 45	100 45
Rotor Material		Steel	Steel	Steel	Steel	Steel	Steel	Steel

Series 5300D Common Specifications

System Output	
Voltage Output A	AC Coupled, 0 to ± 10 volt w/ independent coarse gain control (16 increments)
Voltage Output B	DC Coupled, 0 to ± 10 volt w/ independent fine and coarse gain control
Digital Output:	QSPI
System Performance	
Accuracy	Overall, 0.1% FS, combined effect of Non-Linearity, Hysteresis, & Repeatability
Voltage Output A Filter (AC)	2-pole Butterworth high pass w/ selectable cutoff frequencies of 5, 10, 20, 200, 500, & 735 Hz, & 8-pole low pass determined by the DC coupled output cutoff frequency selection
Voltage Output B Filter (DC)	8-pole elliptical low pass w/selectable cutoff frequencies of > 8.5k, 5k, 2.5k, 1.25k, 625, 313, 10, & 1 Hz
Bandwidth	DC to 8500 Hz anti-alias
Digital resolution	16-bit
Analog Resolution	0.030% FS (10 volts/32,768)
Digital Sample Rate	26,484 samples/sec
Group Delay	110 microseconds at 10 kHz
Noise	≅10 mV at 10 kHz
Noise Spectral Density	< 0.0005%FS per root Hz typical

Temperature	
Rotor Temp. Range Compensated	+70 to +170 °F (+21 to +77 °C)
System Temp. Effect on Output [2]	± 0.002% FS/°F (± 0.0036% FS/°C)
System Temp. Effect on Zero [2]	± 0.002% FS/°F (± 0.0036% FS/°C)
Rotor/Stator Temp. Range Usable	+32 to +185 °F (0 to +85 °C)
Rotor/Stator Optional Temp. Range Usable	+32 to +250 °F (0 to +121 °C)
Receiver Temp. Range Usable	0 to +122 °F (-17 to +50 °C)
Mechanical	
Permissible Radial Float, Rotor to Stator	± 0.25 in (± 6.35 mm)
Permissible Axial Float, Rotor to Stator	± 0.25 in (± 6.35 mm)
Dynamic Balance	ISO G 2.5
Sensor Positional Sensitivity	0.1% FS (180° rotation)
Power	
Power Requirements	9 to 18 VDC, 15 watts (90 to 240VAC 50-60 Hz, adaptor is supplied)
Miscellaneous	
Symmetry Adjustment	Factory and user adjustable ± 0.5% FS
Supplied Cable, Stator to Receiver	24 ft. (7.3 m), RG 58/U (BNC plug/stator side, TNC plug/receiver side)
Optional Cable, Stator to Receiver	80 ft. (24.4 m), RG 58/U (contact factory for longer lengths)
Output Interface	DB-25 female connector (mating supplied w/backshell)
Calibration	Unipolar shunt calibration, invoked from the receiver front panel
Stator Assembly	Top half of loop is removable for easy installation over rotor
Notes	
[2] Within compensated range	

Microphones and Preamplifiers for Motorsport Applications

Series 130 ICP® Array Microphones provide a cost-effective method for large channel count sound pressure measurements such as beam forming holography and pressure mapping. Powered by standard ICP® sensor signal conditioners, these microphones are interchangeable with ICP® accelerometers and include an integrated preamplifier. Array kits are also available, complete with patch panel, cables, and signal conditioners.

Model 130D20
(BNC Connector)

Model 130D21
(10-32 Connector)

ICP® Array Microphones with Integral Preamplifier		
Model Number	**130D20**	**130D21**
Microphone Diameter	1/4 in	1/4 in
Response	Free-Field	Free-Field
Sensitivity (± 3 dB at 250 Hz)	45 mV/Pa	45 mV/Pa
Frequency Response (± 1 dB)	100 to 4000 Hz	100 to 4000 Hz
Frequency Response (-2, +5 dB)	20 to 15k Hz	20 to 15k Hz
Dynamic Range (10 Hz to 10 kHz, ref. 20 µPa)	< 30 to > 122 dB	< 30 to > 122 dB
Polarization Voltage	0 V	0 V
Temperatrure Range	+14 to +122 °F -10 to +55 °C	+14 to +122 °F -10 to + 55 °C
Connector	BNC Jack	10-32 Jack
TEDS IEEE P1451.4	Optional	Optional

Prepolarized (0V) Precision Condenser Microphone Cartridges	
Model Number	**377C01**
Diameter	1/4 in
Response	Free-Field
Open Circuit Sensitivity (at 250 Hz)	2 mV/Pa
Frequency Range (± 2 dB)	5.4 to 80k Hz
Dynamic Range - 3% Distortion Limit [1]	165 dB
Dynamic Range - Cartridge Thermal Noise [1]	41 dB (A)
Temperature Range	-40 to +248 °F -40 to +120 °C
Notes	
[1] re 20 µPa	

Model 377C01

Model 426B03
1/4" ICP® Preamplifier

Preamplifiers	
Model Number	**426B03**
Diameter	1/4 in
Gain (Attenuation) [1]	-0.08 dB
Frequency Response (± 0.1 dB)	5 to 126k Hz
Electrical Noise (A-weight) [1]	≤ 3.2 µV
Electrical Noise (Linear) [1]	≤ 5.6 µV
Output Voltage (Maximum)	± 8 V pk
Temperature Range	-40 to +158 °F -40 to +70 °C
Output Connector	10-32 Coaxial Jack
TEDS IEEE P1451.4	Yes
Notes	
[1] Measured with an 18 pF reference microphone	

Industry exclusive PCB® Model HT378B02 is the world's first IEC compliant microphone and preamplifier combination that has an operating capability to 120 °C (250 °F), perfect for acoustic measurements near high performance powertrain components, underhood, engine, manifold and other high temperature applications for the motorsport industry.

Model
HT378B02

High Temperature Acoustic Measurement System	
Model Number	**HT378B02**
Nominal Diameter	1/2 in 12.5 mm
Response Characteristic	Free-Field
Open Circuit Sensitivity at 250 Hz (± 1.7 dB)	50 mV/Pa
Frequency Range (± 1 dB)	5 to 10k Hz
Frequency Range (± 2 dB)	3.15 to 20k Hz
Lower Limiting Frequency (-3 dB Point)	1 to 2.4 Hz
Dynamic Range (3% Distortion Value)	146 dB [1]
Dynamic Range at Nominal Sensitivity	135 dB [1]
Noise Floor (Cartridge Thermal Noise)	17 dBA [1] [2]
Excitation Voltage	20 to 32 VDC
Polarization Voltage	0 Volts (Prepolarized Style)
Constant Current Excitation	2 to 10 mA, ICP® Sensor Power
Operating Temperature - System	-40 to +250 °F -40 to +120 °C
Connector	BNC Jack
Size (Diameter x Length, with Grid Cap)	0.52 x 3.88 in 13.2 x 98 mm
Microphone Component	377B20
Preamplifier Component	HT426E01
Notes	
[1] re 20 µV [2] 4.9 Vrms, minimum 7 Vpk	

Single and Triaxial, ICP® Accelerometers for Motorsport Applications

PCB® offers a complete line of single and triaxial, ICP® accelerometers for motorsport applications ranging from highly sensitive and lightweight sensors for low level inputs and mild environments to units with high ranges, hermetically sealed connectors, and rugged titanium construction for severe inputs and environments. With a variety of packages, mounting, and output cabling options, these sensors can accommodate virtually any motorsport testing situation. Optional "TEDS" circuitry offers 'smart sensing' solutions for automating sensor performance bookkeeping and structure coordinate mapping.

PCB® Series 339A Triaxial, ICP® accelerometers are designed with a low temperature coefficient, wide operating temperature range, and good broadband measurement resolution, making them ideal for any vibration measurement requiring tight control of amplitude sensitivity over a wide thermal gradient. To alleviate the effects of high frequency overloads caused by metal-to-metal inputs, a low pass filter has been incorporated, ensuring accurate data in the frequency range of interest. These sensors provide precision amplitude data for test applications with large thermal shifts such as powertrain vibration testing, powertrain NVH, certain vehicle systems NVH tests, road load data acquisition, and durability testing in climatic chambers. Sensors are available in both stud and adhesive mounting configurations.

Single Axis and Triaxial, ICP® Accelerometers for Motorsport Applications

	Single Axis		Triaxial			
Model Number	**352C23**	**352C22**	**356A01**	**339A30**	**339A31**	**356A15**
Sensitivity	5 mV/g	10 mV/g	5 mV/g	10 mV/g	10 mV/g	100 mV/g
Measurement Range	± 1000 g pk	± 500 g pk	± 1000 g pk	± 500 g pk	± 500 g pk	± 50 g pk
Broadband Resolution	0.003 g rms	0.002 g rms	0.003 g rms	0.008 g rms	0.008 g rms	0.0002 g rms
Frequency Range (± 10%)	1.5 to 15k Hz	0.7 to 13k Hz	2 to 8000 Hz [1]	2 to 10k Hz [1]	2 to 10k Hz [1]	1.4 to 6500 Hz
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +325 °F -54 to +163 °C	-65 to +325 °F -54 to +163 °C	-65 to +250 °F -54 to +121 °C
Temperatuare Coefficient	0.20%/ °F 0.11%/ °C	0.23%/ °F 0.13%/ °C	0.22%/ °F 0.12%/ °C	≤ 0.01 %/ °F ≤ 0.02 %/ °C	≤ 0.01 %/ °F ≤ 0.02 %/ °C	0.20%/ °F 0.11%/ °C
Electrical Connector	3-56 Coxial Jack	3-56 Coxial Jack	Integral Cable	8-36 4-Pin Jack	8-36 4-Pin Jack	1/4-28 4-Pin Jack
Sealing	Epoxy	Epoxy	Hermetic	Hermetic	Hermetic	Hermetic
Housing Material	Anodized Aluminum	Anodized Aluminum	Titanium	Titanium	Titanium	Titanium
Weight	0.2 gm	0.5 gm	1.0 gm	4.0 gm	5.5 gm	10.5 gm
Size	0.11 x 0.34 x 0.16 in 2.8 x 8.6 x 4.1 mm	0.14 x 0.45 x 0.25 in 3.6 x 11.4 x 6.4 mm	0.25 in Cube 6.35 mm Cube	0.4 in Cube 10.2 mm Cube	0.55 x 0.4 x 0.4 in 14.0 x 10.2 x 10.2 mm	0.55 in Cube 14.0 Cube
Mounting	Adhesive	Adhesive	Adhesive	Adhesive	5-40 Stud	10-32 Thread
Supplied Accessories						
Wax/Adhesive	080A109	080A109	080A109 080A90	080A109	080A109	080A109 080A90
Adhesive Mounting Base	—	—	—	—	080A	080A12
Removal Tool	039A26	039A27	—	—	—	—
Mounting Studs/Screws	—	—	—	—	081A27 M081A27 081A90	081B05 M081B05
Cable Assembly	030A10	030A10	034G05	034K10	034K10	–
Additional Versions						
Alternative Option	—	—	HT356A01 High Temperature	—	—	HT356A15 High Temperature
Additional Accessories						
Magnetic Mounting Base	—	—	—	—	—	080A27
Removal Tool	—	—	—	039A08	039A08	039A10
Connector Adaptor	070A02	070A02	—	—	—	—
Mating Cable Connectors	EK	EK	AY	EH	EH	AY
Recommended Cables	030	030	034	034	034	034
Notes						
[1] Range shown is ± 5%						

Pressure Transducers for Motorsport Applications

Manufactured with a unique thin-film process to "atomically fuse" sensitive resistive material behind a recessed diaphragm, PCB® Series 1500 Pressure Transducers achieve high accuracy repeatability, and the stability expected of today's measurement and control requirements. Series 1500 sensors are used for shock absorber, struts, and brake systems studies, as well as for DC line pressure with response time up to 1 msec, and intake manifold pressure.

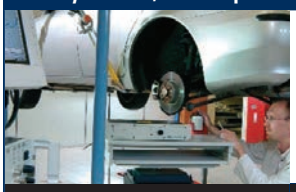
Pressure Sensors for Motorsport Applications

Series Number	1501	1502
Output	0 to 5 VDC FS	0 to 10 VDC FS
Supply Voltage (Vs)	6.5 to 30 VDC	11.5 to 30 VDC
Pressure Ranges [1]	From 0 to 10 psi (69 kPa) FS up to 0 to 6000 psi (41,370 kPa) FS	
Accuracy [1][2]	≤ ±0.25% FS or ≤ ±0.5% FS	
Response Time	≤ 1 ms	
Burst Pressure	> 35x for ≤ 100 psi (≤ 670 kPa) > 20x for ≤ 1000 psi (≤ 6,890 kPa) > 5x for ≤ 6000 psi (≤ 41,370 kPa)	
Operating Temperature [1]	-40 to +260 °F -40 to +125 °C	
Compensated Temperature Range	-5 to +180 °F -20 to +80 °C	
Thermal Error over Compensated Range	≤ 2% FS	
Acceleration Sensitivity	≤ ±0.03% FS/g	
Vibration Survivability Rating	35 g peak sinusoidal (5 to 2000 Hz)	
Pressure Ports [1]	English, NPT, SI, and "M" Threads	
Materials: Wetted parts Housing	 17-4 PJ SS 316/316L SS	
Electrical Connection [1]	Solder Tabs, Connector or Integral Cable	

Notes

[1] Consult your PCB Piezotronics representative for specific ordering information and options
[2] Accuracy is calculated as the square root of the sum of the squares of non-linearity, non-repeatability and hysteresis

Modally Tuned®, ICP® Impact Hammers for Motorsport Applications



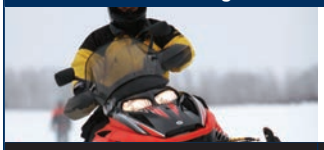
Model Number	086C03	086D05
Sensitivity	10 mV/lbf 2.25 mV/N	1 mV/lbf 0.23 mV/N
Measurement Range	500 lbf pk 2200 N pk	5000 lbf pk 22,000 N pk
Resonant Frequency	≥ 22 kHz	≥ 22 kHz
Hammer Mass	0.16 kg	0.32 kg
Tip Diameter	0.25 in 6.3 mm	0.25 in 6.3 mm
Hammer Length	8.5 in 215.9 mm	9.0 in 228.6 mm
Electrical Connection	BNC Jack	BNC Jack
Extender Mass Weight	75 gm	200 gm
Supplied Accessories		
Extender Mass	—	084A09
Mounting Studs	081B05	081B05
Aluminum Extender	084A08	—
Hard Tip	084B03	084B03
Medium Tip	084B04	084B04
Soft Tip	084C05	084C05

Modally Tuned®, ICP® Impact Hammers for Motorsport Applications

Modally Tuned®, ICP® Impact hammers are easy-to-use solutions for delivering impulse forces into automotive test structures. "Modal tuning" is a technology that ensures the structural characteristics of the hammer do not affect measurement results. This is accomplished by eliminating hammer resonances in the frequency range of interest from corrupting the test data, resulting in more accurate and consistent outcomes.

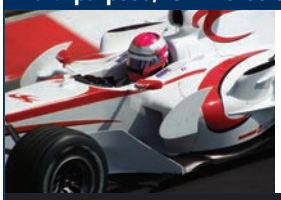
Modally Tuned®, ICP® impact hammers are also available in convenient kits which include the response accelerometers, signal conditioners, cables, and accessories needed for automotive component structural testing. Consult the PCB® web site at www.pcb.com for further details.

ICP® Quartz Force Ring for Motorsport Applications



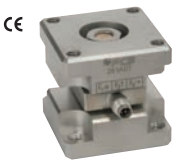
Model Number	201B02	201B03	201B04	201B05
Measurement Range (Compression)	100 lb 0.4448 kN	500 lb 2.224 kN	1000 lb 4.448 kN	5000 lb 22.24 kN
Sensitivity	50 mV/lb 11,240 mV/kN	10 mV/lb 2248 mV/kN	5 mV/lb 1124 mV/kN	1 mV/lb 224.8 mV/kN
Maximum Static Force (Compression)	600 lb 2.67 kN	3000 lb 13.34 kN	6000 lb 26.69 kN	8000 lb 35.59 kN
Broadband Resolution	0.002 lb-rms	0.01 lb-rms	0.02 lb-rms	0.10 lb-rms
Low Frequency Response (-5 %)	0.001 Hz	0.0003 Hz	0.0003 Hz	0.0003 Hz
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack
Sealing	Hermetic	Hermetic	Hermetic	Hermetic
Housing Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Weight	10 gm	10 gm	10 gm	10 gm
Size (Diameter x Height x Through Hole Diameter)	0.65 x 0.31 x 0.25 in 16.5 x 7.9 x 6.0 mm	0.65 x 0.31 x 0.25 in 16.5 x 7.9 x 6.0 mm	0.65 x 0.31 x 0.25 in 16.5 x 7.9 x 6.0 mm	0.65 x 0.31 x 0.25 in 16.5 x 7.9 x 6.0 mm
Mounting	10-32 Stud	10-32 Stud	10-32 Stud	10-32 Stud
Supplied Accessories				
Assembly Lubricant	080A82	080A82	080A82	080A82
Mounting Studs	081A11 M081A11	081A11 M081A11	081A11 M081A11	081A11 M081A11
Anti-Friction Washer	082B01	082B01	082B01	082B01
Pilot Bushing	083B01	083B01	083B01	083B01
Additional Accessories				
Mating Cable Connectors	EB, EJ	EB, EJ	EB, EJ	EB, EJ
Recommended Cables	002 Low Cost, 003 CE	002 Low Cost, 003 CE	002 Low Cost, 003 CE	002 Low Cost, 003 CE

Multi-purpose, ICP® Force Sensors for Motorsport Applications



Model Number	208C01	208C02	208C03	208C04	208C05
Measurement Range (Compression)	10 lb 0.04448 kN	100 lb 0.4448 kN	500 lb 2.224 kN	1000 lb 4.448 kN	5000 lb 22.24 kN
Sensitivity	500 mV/lb 112,410 mV/kN	50 mV/lb 11,241 mV/kN	10 mV/lb 2248 mV/kN	5 mV/lb 1124 mV/kN	1 mV/lb 224.82 mV/kN
Maximum Static Force (Compression)	60 lb 0.27 kN	600 lb 2.669 kN	3000 lb 13.5 kN	6000 lb 26.69 kN	8000 lb 35.59 kN
Broadband Resolution	0.0001 lb-rms	0.001 lb-rms	0.005 lb-rms	0.01 lb-rms	0.05 lb-rms
Low Frequency Response (-5 %)	0.01 Hz	0.001 Hz	0.0003 Hz	0.0003 Hz	0.0003 Hz
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack
Sealing	Hermetic	Hermetic	Hermetic	Hermetic	Hermetic
Housing Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Weight	22.7 gm	22.7 gm	22.7 gm	22.7 gm	22.7 gm
Size	5/8 x 0.5 in 5/8 in x 12.7 mm	5/8 x 0.5 in 5/8 in x 12.7 mm	5/8 x 0.5 in 5/8 in x 12.7 mm	5/8 x 0.5 in 5/8 in x 12.7 mm	5/8 x 0.5 in 5/8 in x 12.7 mm
Mounting	10-32 Thread	10-32 Thread	10-32 Thread	10-32 Thread	10-32 Thread
Supplied Accessories					
Thread Locker	080A81	080A81	080A81	080A81	080A81
Mounting Studs	081B05 M081A62	081B05 M081A62	081B05 M081A62	081B05 M081A62	081B05 M081A62
Impact Cap	084A03	084A03	084A03	084A03	084A03

Triaxial, ICP® Force Sensors for Motorsport Applications



Model Number	260A01	260A02	260A03	261A01
Measurement Range (z axis)	1000 lb 4.45 kN	1000 lb 4.45 kN	10,000 lb 44.48 kN	1000 lb 4.45 kN
Measurement Range (x or y axis)	500 lb 2.22 kN	1000 lb 4.45 kN	4000 lb 17.79 kN	500 lb 2.22 kN
Sensitivity (z axis)	2.5 mV/lb 0.56 mV/N	2.5 mV/lb 0.56 mV/N	0.25 mV/lb 0.06 mV/N	2.5 mV/lb 0.56 mV/N
Sensitivity (x or y axis)	10 mV/lb 2.25 mV/N	5 mV/lb 1.12 mV/N	1.25 mV/lb 0.28 mV/N	10 mV/lb 2.25 mV/N
Broadband Resolution (z axis)	0.006 lb-rms	0.006 lb-rms	0.05 lb-rms	0.006 lb-rms
Broadband Resolution (x or y axis)	0.002 lb-rms	0.006 lb-rms	0.01 lb-rms	0.002 lb-rms
Upper Frequency Limit	90 kHz	90 kHz	39 kHz	10 kHz
Non-Linearity	≤ 1 % FS	≤ 1 % FS	≤ 1 % FS	≤ 1 % FS
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Housing Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Sealing	Hermetic	Hermetic	Hermetic	Hermetic
Size	1.075 x 0.95 x 0.39 in 27.3 x 24.1 x 9.9 mm	1.35 x 1.25 x 0.39 in 34.3 x 31.8 x 9.9 mm	2.25 x 2.25 x 0.79 in 57.1 x 57.1 x 20.07 mm	1.66 x 1.66 x 1.96 in 42.04 x 42.04 x 41.96 mm
Weight	26 gm	45 gm	271 gm	386 gm
Supplied Accessories				
Mounting Stud	081A70	081A74	081A71	—
Anti-Friction Washer	082B02	082M12	082B06	—
Pilot Bushing	083A10	083A13	083A11	—
Additional Accessories				
Mating Cable Connectors	AY	AY	AY	AY
Recommended Cable	010	010	010	010
Notes				
Charge mode versions of each of these models are also available				

Series 1203

Low Profile Load Cell Sensors for Motorsport Applications

Model Number	1203-01A	1203-03A	1203-05A
Sensitivity	2 mV/V	2 mV/V	3 mV/V
Measurement Range	500 lb 2.224 kN	2000 lb 8.896 kN	10,000 lb 44.48 kN
Overload Limit	750 lb 3.336 kN	3000 lb 13.34 kN	15,000 lb 66.72 kN
Non-Linearity	≤ 0.05 % FS	≤ 0.05 % FS	≤ 0.05 % FS
Hysteresis	≤ 0.05 % FS	≤ 0.05 % FS	≤ 0.05 % FS
Non-Repeatability	≤ 0.02 % FS	≤ 0.02 % FS	≤ 0.02 % FS
Temperature Range	-65 to +200 °F -54 to +93 °C	-65 to +200 °F -54 to +93 °C	-65 to +200 °F -54 to +93 °C
Bridge Resistance	700 ohm	700 ohm	700 ohm
Excitation Voltage	10 VDC	10 VDC	10 VDC
Weight	1.31 kg	1.31 kg	1.31 kg
Size	4.12 x 1.37 in 104.6 x 34.8 mm	4.12 x 1.37 in 104.6 x 34.8 mm	4.12 x 1.37 in 104.6 x 34.8 mm
Mounting	5/8 - 18 Thread	5/8 - 18 Thread	5/8 - 18 Thread
Electrical Connector	PT02E-10-6P	PT02E-10-6P	PT02E-10-6P
Additional Versions			
Alternate Electrical Connector	1203-01B PC04E-10-6P	1203-03B PC04E-10-6P	1203-05B PC04E-10-6P
Alternate Mounting	M1203-01A M1203-01B Metric	M1203-03A M1203-03B Metric	M1203-05A M1203-05B Metric
Additional Accessories			
Mounting Base	084A100 M084A100	084A100 M084A100	084A100 M084A100

Recommended Signal Conditioners for Motorsport Applications

PCB® provides the appropriate signal conditioning necessary for sensor excitation and to prepare measurement signals for readout, recording, analysis, or control. Available features can include gain, integration, filtering, alarm relays, zero clamping, and conversion to rms or peak values. Additionally, essential cables and accessories to support a successful installation are available.

Recommended Signal Conditioners for Strain Gage Load Cell Sensors

Series 8159

Provides 5 or 10 VDC strain gage bridge excitation which delivers ± 10 VDC and 4 to 20 mA output signals, and operates from 115 or 230 VAC power

Series 8162

In-line, IP66 enclosure, operates from 12 to 18 VDC, provides 10 VDC strain gage sensor excitation, delivers ± 10 V and 4 to 20 mA outputs

Recommended ICP® Signal Conditioner for Force Sensors

Model 484B06

Single-channel, line powered with AC/DC coupling and BNC input/output connection

Recommended General ICP® Signal Conditioners

Model 482C05

4-channel, line powered, unity gain, BNC input/output connector

Model 482C16

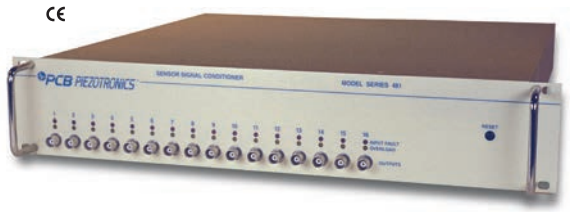
4-channel, line powered, incremental gain x0.1 to x200, digital control interface RS-232

Model 482C54

4-channel, line powered, charge, incremental gain, TEDS, digital control interface RS-232

Model 480C02

Single-channel, battery powered, BNC input/output connector



Series 481A

16-channel, line powered, can be configured with options including gain, filtering, switched outputs, integration, rms conversion, computer control, and more

Model 480B21

3-channel, battery powered, gain x1, x10, x100

Model 480E09

Single-channel, battery powered, gain x1, x10, x100, and BNC input/output connection

Recommended Signal Conditioner for Series 3741 DC Response Accelerometers

Model 482C27

Four-channel, line powered, bridge, incremental gain, digital control interface, RS-232 and ethernet

Recommended Signal Conditioners for Series 3711 & 3713 DC Response Accelerometers

Model 478A01

Single-channel with unity gain (internal battery powered)

Model 478B05

3-channel, unity gain, with 36 VDC power adaptor (optional external battery pack)






PCB® Automotive Sensors is a dedicated technical sales and support facility, located in Farmington Hills, Michigan, USA, devoted to the testing needs of the global transportation market. This team is focused on development and application of sensors and related instrumentation for specific vehicle development test programs, including modal analysis; driveability; ride & handling; component & system performance; durability; road load data acquisition; vehicle and powertrain NVH; legislative testing; quality control; powertrain development; and motorsport. PCB® offers exceptional customer service, 24-hour technical assistance, and a **Total Customer Satisfaction** guarantee.

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