



Vehicle & Powertrain NVH Sensors

Accelerometers, Preamplifiers, Microphones, Signal Conditioners,
Sound Level Meters, and Accessories





NVH - Noise, Vibration & Harshness



NVH stands for Noise, Vibration, and Harshness and is an industry term associated with the treatment of vibration and audible sounds. Noise denotes unwanted sound; and hence the need to negate these sounds and vibrations.

Vibrations above and below a specific range may not be detectable to the human ear, but may still require treatments for improved product performance and longevity. The frequency of the noise is paramount, as it dictates which method of treatment or what material will work best. Harshness usually refers to treatments of transient frequencies or shock.

NVH refinement has become an essential vehicle development attribute, as it is directly related to legislative compliance, product quality, driving pleasure, brand image, and most importantly customer satisfaction.

Advanced NVH test methods and analytical simulation tools are prerequisites in today's fast paced automotive market to ensure front-end optimization of lowered levels of sound and vibration and enhanced design while still maintaining a balance with fuel efficiency, driveability, and system & component performance. PCB Piezotronics, Inc. offers a complete sensor and instrumentation solution for the measurement of NVH attributes from concept through to post production assessment. Due to shortened product development cycles, many automotive manufacturers and their suppliers are choosing to consolidate NVH testing with other development activities including: road load data acquisition, powertrain performance testing, and calibration development, to name a few. PCB® facilitates this trend with diverse sensor offerings in acceleration, acoustic, pressure, force, torque, load, and strain technologies allowing an efficient test and instrumentation strategy to capture performance and attribute measurements.

Concept Development

The concept stage of the vehicle development process not only determines the most fundamental architecture of the automotive structure, but also offers an opportunity to reduce the amount of downstream development effort needed to achieve performance and attribute targets by optimizing core structures and system configurations and striking a balance between fuel economy, emissions, performance, ride, and NVH. Typical NVH activities could include:

- Structural Computer Aided Engineering (CAE) and modal analyses
- Dynamic system simulations
- Powertrain mounting strategies
- Body mounting concepts
- Suspension configurations
- Vehicle simulations
- Competitor benchmarking

During the concept stage, performance and attribute targets are defined based on market expectations and cascaded down to system and component specifications.

Powertrain NVH Development

Due to the ever increasing importance of fuel economy, performance, and NVH in the development of today's engine, the NVH engineer must work closely with the engine and powertrain calibration and combustion engineers to strike a balance between the efficiency of combustion and the reduction of combustion forces that result in noise,

vibration, and driveability issues. This development often takes place in a performance and emissions test cell where a less than ideal acoustic environment predicates the use of accelerometers as an indication of relative engine forces and inferred noise strength. Engine component suppliers also play a strong role in overall powertrain noise target attainment. From structural members such as engine blocks, oil pans, valve covers, and mount brackets to integrated systems such as transmissions, fuel injectors, power steering pumps, and turbos; component and engine manufacturers alike spend significant test time in hemi-anechoic dynamometer test cells to develop systems to meet the NVH targets that cascaded from the concept phase. These tests could include:

- Engine NVH benchmarking
- Sound intensity mapping
- Source identification
- Modal analysis
- Ancillary noise development
- Turbo noise development
- Intake noise development

The impact of this development work is focused on achieving overall vehicle NVH targets, specifically targeting overall engine noise and sound design and inputs into the engine mounts. PCB® designs and manufactures a line of NVH and powertrain development sensors that take into account the harsh environment associated with powertrain testing offering high temperature microphone systems and accelerometers that are both rugged and hermetically sealed.

Vehicle NVH Development

The integration of the powertrain into a vehicle structure is the most critical activity in the development process. Reduction of structure-borne noise and vibration paths are minimized in this phase through fine-tuning of powertrain, exhaust, and body mounts. Airborne noise paths are reduced through sound package development. This fine-tuning, along with intake and exhaust development, account for the interior sound design of the vehicle. As with powertrain NVH development, the NVH engineer must also work with the calibration engineer to assess possible trade-offs with fuel economy, emissions, NVH, and driveability; and with the ride & handling engineer to assess trade-offs with ride quality and vehicle handling. Today's NVH engineer has numerous analytical and experimental tools and tests to aid in the systematic and continuous NVH development leading up to the production build of the vehicle, including:







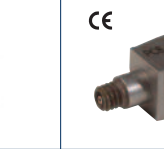
- Issue resolution using Noise Path Analysis (NPA)
- Sound Quality Analysis (SQA)
- Intake and exhaust orifice noise refinement for sound design
- Noise Transfer Functions (NTF)
- Modal analysis for structural optimization
- Engine mount tuning
- Transmission loss for acoustic package refinement
- End-of-line NVH test methods for quality control
- Noise masking studies for pass-by and curb-side noise reduction
- Acoustical array set-ups for noise identification

As levels of noise and vibration have decreased in today's cars, tractors, construction equipment, motorcycles, and snowmobiles, the expectations of today's consumers have increased. With this comes heightened requirements for attributes such as wind noise, road noise, powertrain noise, road idle quality, and driver comfort. These attributes are now indicators of quality and PCB® is there every step of the way with products and instrumentation designed to aid in your NVH testing now and into the future.



Single Axis and Triaxial, ICP® Accelerometers for NVH Applications

PCB® offers a complete line of single and triaxial ICP® accelerometers for NVH 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 NVH testing situation, including idle and ride quality. Optional "TEDS" circuitry offers 'smart sensing' solutions for automating sensor performance bookkeeping and structure coordinate mapping.




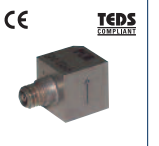



| Single Axis and Triaxial, ICP® Accelerometers for NVH Applications | | | | | | |
|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
| Model Number | 352C23 | 352A73 | 352C22 | 352B10 | 352A24 | 352A56 |
| Sensitivity | 5 mV/g | 5 mV/g | 10 mV/g | 10 mV/g | 100 mV/g | 100 mV/g |
| Measurement Range | 1000 g pk | 1000 g pk | 500 g pk | 500 g pk | 50 g pk | 50 g pk |
| Broadband Resolution | 0.003 g rms | 0.002 g rms | 0.002 g rms | 0.003 g rms | 0.0002 g rms | 0.0006 g rms |
| Frequency Range (± 10%) | 1.5 to 15k Hz | 1.5 to 25k Hz | 0.7 to 13k Hz | 1 to 17k Hz | 0.8 to 10k Hz | 0.3 to 15k 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 | -65 to +250 °F -54 to +121 °C |
| Electrical Connector | 3-56 Coaxial Jack | Integral Cable | 3-56 Coaxial Jack | Integral Cable | 3-56 Coaxial Jack | 5-44 Coaxial Jack |
| Sealing | Epoxy | Hermetic | Epoxy | Hermetic | Epoxy | Hermetic |
| Housing Material | Anodized Aluminum | Titanium | Anodized Aluminum | Titanium | Anodized Aluminum | Titanium |
| Weight | 0.2 gm | 0.3 gm | 0.5 gm | 0.7 gm | 0.8 gm | 1.8 gm |
| Size | 0.11 x 0.34 x 0.16 in 2.8 x 8.6 x 4.1 mm | 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 | 0.32 x 0.24 in 8.1 x 6.1 mm | 0.19 x 0.48 x 0.28 in 4.8 x 12.2 x 7.1 mm | 0.26 x 0.57 x 0.3 in 6.6 x 14.5 x 7.6 mm |
| Mounting | Adhesive | Adhesive | Adhesive | Adhesive | Adhesive | Adhesive |
| Supplied Accessories | | | | | | |
| Cable | 030A10 | — | 030A10 | — | 030A10 | — |
| Wax/Adhesive | 080A109 | 080A109 | 080A109 | 080A109 080A90 | 080A109 | 080A109 |
| Removal Tool | 039A26 | 039A26 | 039A27 | — | 039A28 | 039A31 |
| Additional Versions | | | | | | |
| Titanium Housing | — | — | 352A21 | — | — | — |
| Additional Accessories | | | | | | |
| Connector Adaptor | 070A02 | 070A02 | 070A02 | 070A02 | 070A02 | — |
| Mating Cable Connectors | EK | AL | EK | AL | EK | AG |
| Recommended Cables | 030 | — | 030 | — | 030 | 018 Flexible, 003 CE |





Vehicle & Powertrain NVH Sensors

Single Axis, ICP® Accelerometers for NVH Applications

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|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
| Model Number | 352C65 | 352C41 | 333B30 | 352C03 | 352C33 | 355B02 |
| Sensitivity | 100 mV/g | 10 mV/g | 100 mV/g | 10 mV/g | 100 mV/g | 10 mV/g |
| Measurement Range | 50 g pk | 500 g pk | 50 g pk | 500 g pk | 50 g pk | 500 g pk |
| Broadband Resolution | 0.00016 g rms | 0.0008 g rms | 0.00015 g rms | 0.0005 g rms | 0.00015 g rms | 0.0005 g rms |
| Frequency Range (± 10%) | 0.3 to 12k Hz | 0.5 to 10k Hz | 0.5 to 3000 Hz [1] | 0.3 to 15k Hz | 0.3 to 15k Hz | 0.6 to 12k Hz |
| Temperature Range | -65 to +200 °F -54 to +93 °C | -65 to +250 °F -54 to +121 °C | 0 to +150 °F -18 to +66 °C | -65 to +250 °F -54 to +121 °C | -65 to +200 °F -54 to +93 °C | -65 to +250 °F -54 to +121 °C |
| Electrical Connector | 5-44 Coaxial Jack | 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 | Hermetic |
| Housing Material | Titanium | Titanium | Titanium | Titanium | Titanium | Titanium |
| Weight | 2.0 gm | 2.8 gm | 4.0 gm | 5.8 gm | 5.8 gm | 10 gm |
| Size | 5/16 x 0.33 in 5/16 in x 8.4 mm | 3/8 x 0.38 in 3/8 in x 9.7 mm | 0.4 in Cube 10.2 mm Cube | 7/16 x 0.62 in 7/16 in x 15.7 mm | 7/16 x 0.62 in 7/16 in x 15.7 mm | 0.40 x 0.95 x 0.63 in 10.2 x 24.1 x 16.0 mm |
| Mounting | 5-40 Stud | Adhesive | 5-40 Thread | 10-32 Thread | 10-32 Thread | Through Hole |
| Supplied Accessories | | | | | | |
| Wax/Adhesive | 080A109 | 080A109 080A90 | 080A109 080A90 | 080A109 | 080A109 | 080A109 |
| Adhesive Mounting Base | 080A15 | — | 080A25 | 080A | 080A | — |
| Mounting Stud/Screw | — | — | 081A27 M081A27 | 081B05 M081B05 | 081B05 M081B05 | 081B45 |
| Additional Versions | | | | | | |
| Alternate Electrical | 352C67 - Integrated Cable | 352C43 Ground Isolated | — | — | — | — |
| Alternate Connector Position | 352C66 - Top | — | — | — | 352C34 - Top | — |
| Alternate Mounting | — | — | 333B32 - Adhesive | — | — | — |
| Alternate Sensitivity | 352C15 - 10 mV/g | — | — | — | — | — |
| Additional Accessories | | | | | | |
| Magnetic Mounting Base | 080A30 | — | — | 080A27 | 080A27 | — |
| Triaxial Mounting Adaptor | 080B16 080A196 | — | — | 080B10 | 080B10 | — |
| Removal Tool | — | — | 039A08 | — | — | — |
| Mating Cable Connectors | AG | EB | EB | EB | EB | EB |
| Recommended Cables | 018 Flexible, 003 CE | 002 Low Cost, 003 CE | 002 Low Cost, 003 CE | 002 Low Cost, 003 CE | 002 Low Cost, 003 CE | 002 Low Cost, 003 CE |
| Notes | | | | | | |
| [1] Range shown is ± 5% | | | | | | |










Vehicle & Powertrain NVH Sensors



Triaxial, ICP® Accelerometers for NVH Applications

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|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
| Model Number | 356A01 | 356A24 | 356B11 | 356B21 | 354C10 | 356A32 |
| Sensitivity | 5 mV/g | 10 mV/g | 10 mV/g | 10 mV/g | 10 mV/g | 100 mV/g |
| Measurement Range | ± 1000 g pk | ± 500 g pk | ± 500 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 | 0.003 g rms | 0.003 g rms | 0.0003 g rms |
| Frequency Range (± 10%) | 2 to 8000 Hz [1] | 0.5 to 12k Hz | 2 to 10k Hz [1] | 2 to 10k Hz [1] | 2 to 8000 Hz [1] | 0.7 to 5000 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 | -65 to +250 °F -54 to +121 °C |
| Electrical Connector | Integral Cable | 8-36 4-Pin Jack | Integral Cable | 8-36 4-Pin Jack | Integral Cable | 8-36 4-Pin Jack |
| Sealing | Hermetic | Hermetic | Hermetic | Hermetic | Hermetic | Hermetic |
| Housing Material | Titanium | Titanium | Titanium | Titanium | Titanium | Titanium |
| Weight | 1.0 gm | 3.1 gm | 4.0 gm | 4.0 gm | 5.0 gm | 5.4 gm |
| Size | 0.25 in Cube 6.35 mm Cube | 0.28 x 0.47 x 0.47 in 7 x 12 x 12 mm | 0.4 in Cube 10.2 mm Cube | 0.4 in Cube 10.2 mm Cube | 0.3 x 0.55 x 0.55 in 7.6 x 14 x 14 mm | 0.45 in Cube 11.4 mm Cube |
| Mounting | Adhesive | Adhesive | 5-40 Thread | 5-40 Thread | Through Hole | 5-40 Thread |
| Supplied Accessories | | | | | | |
| Cable Assembly | 034G05 | 034K10 | 034G05 | 034K10 | 034G05 | 034K10 |
| Wax/Adhesive | 080A109 080A90 | 080A109 080A90 | 080A109 | 080A109 | — | 080A109 |
| Adhesive Mounting Base | — | — | 080A | 080A | — | 080A |
| Mounting Studs/Screws | — | — | 081A27 M081A27 081A90 | 081A27 M081A27 081A90 | 081B93 | 081A27 M081A27 081A90 |
| Additional Versions | | | | | | |
| Alternate Cable Type | 356A13 099 Twisted 4-cond | — | — | — | — | — |
| Alternate Connector | — | — | — | 356A33 - 1/4-28 4-Pin | — | — |
| Alternate Sensitivity | — | — | — | 356B20 - 1 mV/g | — | — |
| Additional Accessories | | | | | | |
| Magnetic Mounting Base | — | — | 080A30 | 080A30 | — | 080A30 |
| Removal Tool | — | — | 039A08 | 039A08 | — | 039A09 |
| Mating Cable Connectors | AY | EH | AY | EH | AY | EH |
| Recommended Cables | 034 | 034 | 034 | 036 | 034 | 034 |
| Notes | | | | | | |
| [1] Range shown is ± 5% | | | | | | |

Triaxial, ICP® Accelerometers for NVH Applications

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|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
| Model Number | 356A16 | 356A17 | 356A02 | 356A15 | M354C02 | 356B18 |
| Sensitivity | 100 mV/g | 500 mV/g | 10 mV/g | 100 mV/g | 10 mV/g | 1000 mV/g |
| Measurement Range | ± 50 g pk | ± 10 g pk | ± 500 g pk | ± 50 g pk | ± 500 g pk | ± 5 g pk |
| Broadband Resolution | 0.0001 g rms | 0.00006 g rms | 0.0005 g rms | 0.0002 g rms | 0.0005 g rms | 0.00005 g rms |
| Frequency Range (± 10%) | 0.3 to 6000 Hz | 0.3 to 4000 Hz | 0.5 to 6000 Hz | 1.4 to 6500 Hz | 0.3 to 4000 Hz | 0.3 to 5000 Hz |
| Temperature Range | -65 to +176 °F -54 to +80 °C | -65 to +176 °F -54 to +80 °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 | -20 to +170 °F -29 to +77 °C |
| Electrical Connector | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack |
| Sealing | Epoxy | Epoxy | Hermetic | Hermetic | Hermetic | Epoxy |
| Housing Material | Anodized Aluminum | Anodized Aluminum | Titanium | Titanium | Titanium | Anodized Aluminum |
| Weight | 7.4 gm | 9.3 gm | 10.5 gm | 10.5 gm | 15.5 gm | 25.0 gm |
| Size | 0.55 in Cube 14 mm Cube | 0.55 in Cube 14 mm Cube | 0.55 in Cube 14 mm Cube | 0.55 in Cube 14 mm Cube | 13/16 x 0.45 in 13/16 in x 11.4 mm | 0.8 in Cube 20.3 mm Cube |
| Mounting | 10-32 Thread | 5-40 Thread | 10-32 Thread | 10-32 Thread | Through Hole | 10-32 Thread |
| Supplied Accessories | | | | | | |
| Wax/Adhesive | 080A109 080A90 | 080A109 | 080A109 080A90 | 080A109 080A90 | 080A109 | 080A109 |
| Adhesive Mounting Base | 080A12 | 080A145 | 080A12 | 080A12 | — | 080A68 |
| Mounting Stud/Screw | 081B05 M081B05 | 081A27 M081A27 | 081B05 M081B05 | 081B05 M081B05 | 081B60 | 081B05 M081B05 |
| Additional Versions | | | | | | |
| High Temperature Option | — | — | — | — | HT354C02 | — |
| Additional Accessories | | | | | | |
| Magnetic Mounting Base | 080A27 | — | 080A27 | 080A27 | 080M162 | 080A27 |
| Removal Tool | 039A10 | 039A10 | 039A10 | 039A10 | — | — |
| Mating Cable Connectors | AY | AY | AY | AY | AY | AY |
| Recommended Cables | 034 | 034 | 034 | 034 | 034 | 034 |



Vehicle & Powertrain NVH Sensors

Charge Output Accelerometers for NVH Applications

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|--|---|------------------------------------|-----------------------------------|--|--|----------------------------------|
| | | | | | | |
| | Single Axis | | | Triaxial | | |
| Model Number | 357A08 | 357B11 | 357B03 | 356A70 | 356A71 | 357C71 |
| Sensitivity | 0.35 pC/g | 3.0 pC/g | 10 pC/g | 2.7 pC/g | 10 pC/g | 10 pC/g |
| Measurement Range | ± 1000 g pk | ± 2300 g pk | ± 2000 g pk | ± 500 g pk | ± 500 g pk | ± 1000 g pk |
| Broadband Resolution | [1] | [1] | [1] | [1] | [1] | [1] |
| Frequency Range (+ 10%) | 20k Hz | 16k Hz | 12k Hz | 7000 Hz | 7000 Hz | 4000 Hz [2] |
| Temperature Range | -100 to +350 °F -73 to +177 °C | -95 to +500 °F -71 to +260 °C | -95 to +500 °F -71 to +260 °C | -95 to +490 °F -70 to +254 °C | -95 to +490 °F -70 to +254 °C | -65 to +900 °F -54 to +482 °C |
| Electrical Connector | 3-56 Coaxial Jack | 5-44 Coaxial Jack | 10-32 Coaxial Jack | 5-44 Coaxial Jack | 10-32 Coaxial Jack | 7/16-27 2-Pin Jack |
| Sealing | Epoxy | Hermetic | Hermetic | Hermetic | Hermetic | Hermetic |
| Housing Material | Anodized Aluminum | Titanium | Titanium | Titanium | Titanium | Inconel |
| Weight | 0.16 gm | 2.0 gm | 11.0 gm | 7.9 gm | 22.7 gm | 75.0 gm |
| Size | 0.11 x 0.16 x 0.27 in 2.8 x 4.1 x 6.9 mm | 5/16 x 0.33 in 5/16 in x 8.4 mm | 1/2 x 0.81 in 1/2 in x 20.6 mm | 0.73 x 0.9 x 0.4 in 18.5 x 22.9 x 10.2 mm | 0.96 x 1.0 x 0.5 in 24.4 x 25.4 x 12.7 mm | 1.0 x 0.75 in 25.4 x 19 mm |
| Mounting | Adhesive | 5-40 Stud | 10-32 Thread | Through Hole | Through Hole | Through hole |
| Supplied Accessories | | | | | | |
| Cable Assembly | 030A10 | — | — | — | — | — |
| Wax/Adhesive | 080A109 | — | 080A109 | 080A90 | 080A90 | — |
| Removal Tool | 039A29 | — | — | — | — | — |
| Adhesive Mounting Base | — | — | — | — | 080A170 | — |
| Mounting Stud/Screw | — | — | 081B05 M081B05 | 081A46 | 081A94 | 081A99 |
| Additional Versions | | | | | | |
| Alternate Connection Position | — | 357B14 - Top | 357B04 - Top | — | — | — |
| Alternate Electrical Connector | — | 357B14 10-32 Coaxial Jack | — | — | — | — |
| Alternate Mounting | — | — | — | 340A50 - Metric | — | — |
| Additional Accessories | | | | | | |
| Adhesive Mounting Base | — | — | 080A | — | — | — |
| Magnetic Mounting Base | — | 080A30 | 080A27 | — | — | — |
| Triaxial Mounting Adaptor | 080A194 | 080B16 080A196 | 080B10 | — | — | — |
| Connector Adaptor | 070A02 | — | — | — | — | — |
| Mating Cable Connectors | EK | AG | EB | AF, AG | EB | GN |
| Recommended Cables | 030 | 018 Flexible, 003 | 003 | 003 | 003 | 013 |
| Notes | | | | | | |
| [1] Resolution is dependent upon cable length and signal conditioner [2] Range shown is + 5% | | | | | | |

Triaxial, ICP® Seat Pad Accelerometer

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|---------------------------|---------------------------------|
| | |
| Model Number | 356B41 |
| Sensitivity | 100 mV/g |
| Measurement Range | ± 10 g pk |
| Broadband Resolution | 0.0002 g rms |
| Frequency Range (± 5 %) | 0.5 to 1000 Hz |
| Temperature Range | +14 to +122 °F -10 to +50 °C |
| Electrical Connector | Integral Cable |
| Sealing | Hermetic |
| Weight | 272 gm |
| Size | 7.87 x 0.472 in 200 x 12 mm |
| Supplied Accessory | |
| Cable Assembly | 010G05 |

Airbag Deployment ICP® Pressure Sensor

PCB's high intensity acoustic pressure sensor is specially designed for measuring automotive airbag deployment noise and total impulse of airbag noise, to aid in systems designs which minimize these damaging hearing events. This rugged pressure microphone is hermetically sealed and features ICP® output for ease of use and set up time.

Airbag Deployment ICP® Pressure Sensor

| | |
|-----------------------------|---------------------------------------|
| | |
| Model Number | 106M160 |
| Sensitivity (± 25 %) | 79.8 mV/kPa |
| Measurement Range | 189 dB |
| Frequency Range (-3 dB) | 25 kHz |
| Temperature Range | - 100 to + 250 °F - 73 to + 121 °C |
| Electrical Connector | 10-32 Coaxial Jack |
| Sealing | Welded Hermetic |
| Diaphragm | Stainless Steel |
| Housing Material | Stainless Steel |
| Weight (with clamp nut) | 18.0 gm |
| Supplied Accessories | |
| Clamp Nut, Thread & Hex | 060A12 |
| Seal Ring | 065A37 |



Filtered, Triaxial, ICP® Accelerometers for Powertrain NVH Applications

High frequency, metal-to-metal impacts are common during the combustion events of today's powertrain. These impacts can excite the high frequency resonance of the piezoelectric crystal in any accelerometer (PCB® or otherwise) to saturate the signal and cause clipping in the contained ICP® signal conditioning amplifier. Any system, once driven nonlinear, will produce spurious frequencies at, above, and below the frequencies contained in its input stimulus. If not recognized, this frequency production results in erroneous test data when it extends into the frequency range of interest. To help alleviate this event, PCB® offers low pass filtering in select triaxial accelerometers which suppresses the effects of any crystal resonance before they can enter and over range the ICP® signal conditioning amplifier. This prefiltering minimizes the opportunity for erroneous frequency content to be generated and accepted as valid data. This filtering, however, causes slight phase shifts in the higher frequency data. If phase is important in your analysis (e.g. operating mode shapes, transfer path analysis, vibroacoustics, etc.) then a single reference channel can be used to extract correct phase in post processing routines. A more automated solution may be possible with some of the data acquisition units. Contact PCB® for additional information.

In addition to filtering, PCB® Series 339A Triaxial ICP® accelerometers are designed with a temperature coefficient of less than 0.0125 % / °F (0.02 % / °C), which allows for 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.

Filtered, Triaxial, ICP® Accelerometers for Powertrain NVH Applications

|  |  |  |  |  |  |  |
|---|---|---|---|--|---|---|
| Model Number | 356A61 | 339A30 | 339A31 | 356A63 | 356A66 | 356A67 |
| Sensitivity | 10 mV/g | 10 mV/g | 10 mV/g | 10 mV/g | 10 mV/g | 10 mV/g |
| Measurement Range | ± 500 g pk | ± 500 g pk | ± 500 g pk | ± 500 g pk | ± 500 g pk | ± 500 g pk |
| Broadband Resolution | 0.008 g rms | 0.008 g rms | 0.008 g rms | 0.008 g rms | 0.002 g rms | 0.0005 g rms |
| Frequency Range (± 5%) (y or z axis) | 2 to 4000 Hz | 2 to 9000 Hz | 2 to 9000 Hz | 2 to 4000 Hz | 2 to 4000 Hz | 0.5 to 2500 Hz |
| Frequency Range (± 5%) (x axis) | 2 to 4000 Hz | 2 to 10k Hz | 2 to 10k Hz | 2 to 4000 Hz | 2 to 4000 Hz | 0.5 to 3000 Hz |
| Temperature Range | -65 to +325 °F -54 to +163 °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 | -65 to +250 °F -54 to +121 °C | -65 to +250 °F -54 to +121 °C |
| Temperature Coefficient | 0.20 %/ °F 0.11 %/ °C | ≤ 0.01 %/ °F ≤ 0.02 %/ °C | ≤ 0.01 %/ °F ≤ 0.02 %/ °C | 0.25 %/ °F 0.14 %/ °C | 0.20 %/ °F 0.11 %/ °C | 0.22 %/ °F 0.12 %/ °C |
| Electrical Connector | Integral Cable | 8-36 4-Pin Jack | 8-36 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack | 1/4-28 4-Pin Jack |
| Sealing | Welded Hermetic | Hermetic | Hermetic | Hermetic | Hermetic | Hermetic |
| Housing Material | Titanium | Titanium | Titanium | Titanium | Titanium | Titanium |
| Weight | 4.0 gm | 4.0 gm | 5.5 gm | 5.3 gm | 9.0 gm | 10.5 gm |
| Size | 0.4 in Cube 10.2 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 | 0.4 in Cube 10.2 mm Cube | 0.55 in Cube 14.0 mm Cube | 0.55 in Cube 14.0 mm Cube |
| Mounting | 5-40 Thread | Adhesive | 5-40 Stud | 5-40 Thread | 10-32 Thread | 10-32 Thread |
| Supplied Accessories | | | | | | |
| Wax/Adhesive | 080A109 | 080A109 | 080A109 | 080A109 | 080A109 080A90 | 080A109 |
| Adhesive Mounting Base | 080A | — | 080A | 080A | 080A12 | 080A12 |
| Mounting Studs/Screws | 081A27 M081A27 081A90 | — | 081A27 M081A27 081A90 | 081A27 M081A27 081A90 | 081B05 M081B05 | 081B05 M081B05 |
| Cable Assembly | 034G05 | 034K10 | 034K10 | — | — | — |
| Additional Versions | | | | | | |
| High Temperature Option | — | — | — | HT356A63 | HT356A66 | HT356A67 |
| Additional Accessories | | | | | | |
| Magnetic Mounting Base | 080A30 | — | — | 080A30 | 080A27 | 080A27 |
| Removal Tool | 039A08 | 039A08 | 039A08 | 039A08 | 039A10 | 039A10 |
| Mating Cable Connectors | AY | EH | EH | AY | AY | AY |
| Recommended Cables | 034 | 034 | 034 | 034 | 034 | 034 |





Vehicle & Powertrain NVH Sensors









Microphones & Preamplifiers for NVH Applications

PCB® offers a variety of acoustic measurement products complemented by an assortment of preamplifiers, signal conditioners, A-weighting filters, handheld calibrators, and accessories all designed to assist in obtaining the highest quality measurement data possible for your NVH testing needs.







Modern Pre-polarized & Traditional, Externally Polarized Precision Condenser Microphones for NVH Applications

A wide variety of traditional externally polarized and modern pre-polarized free-field, pressure, and random incidence precision condenser microphones are available from PCB®. For measurement tests such as buzz, squeak and rattle (BSR), noise path analysis/transfer path analysis (NPA/TPA), and pass-by noise, these microphones offer the rugged design and exceptional performance in high humidity needed for NVH testing.

Pre-polarized (0V) Precision Condenser Microphone Cartridges for NVH Applications

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| Model Number | 377C01 | 377C10 | 377A12 | 377B02 | 377B11 | 377A13 | 377B20 |
| Diameter | 1/4 in | 1/4 in | 1/4 in | 1/2 in | 1/2 in | 1/2 in | 1/2 in |
| Response | Free-Field | Pressure | Pressure | Free-Field | Pressure | Pressure | Random Incidence |
| Open Circuit Sensitivity | 2 mV/Pa | 1 mV/Pa | 0.25 mV/Pa | 50 mV/Pa | 50 mV/Pa | 12.5 mV/Pa | 50 mV/Pa |
| Frequency Range (± 2 dB) | 5.4 to 80k Hz | 4 to 70k Hz | 4 to 20k Hz | 3.15 to 20k Hz | 3.15 to 10k Hz | 4 to 20k Hz | 3.14 to 12.5k Hz |
| Dynamic Range - 3% Distortion Limit [1] | 165 dB | 165 dB | 178 dB | 146 dB | 146 dB | 155 dB | 146 dB |
| Dynamic Range - Cartridge Thermal Noise [1] | 41 dB (A) | 41 dB (A) | 68 dB (A) | 15 dB (A) | 15 dB (A) | 20 dB (A) | 15 dB (A) |
| Temperature Range | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C | -40 to +248 °F -40 to +120 °C |
| Notes | | | | | | | |
| [1] re 20 μ Pa | | | | | | | |

Externally Polarized (200V) Precision Condenser Microphone Cartridges for NVH Applications

|  |  |  |  |  |  |
|---|---|---|--|---|---|
| Model Number | 2540 | 2541 | 2560 | 2570 | 2575 |
| Diameter | 1/2 in | 1/2 in | 1/2 in | 1 in | 1 in |
| Response | Free-Field | Free-Field | Random Incidence | Free-Field | Random Incidence |
| Open Circuit Sensitivity | 14.5 mV/Pa | 44.5 mV/Pa | 45.2 mV/Pa | 48 mV/Pa | 45 mV/Pa |
| Frequency Range (± 2 dB) | 4 to 40k Hz | 3.15 to 20k Hz | 2.6 to 10k Hz | 2.6 to 20k Hz | 2.6 to 8000 Hz |
| Dynamic Range - 3% Distortion Limit [1] | 160 dB | 146 dB | 146 dB | 146 dB | 146 dB |
| Dynamic Range - Cartridge Thermal Noise [1] | 20 dB (A) | 15 dB (A) | 15 dB (A) | 10 dB (A) | 10 dB (A) |
| Temperature Range | -40 to +302 °F -40 to +150 °C | -40 to +302 °F -40 to +150 °C | -40 to +302 °F -40 to +150 °C | -40 to +302 °F -40 to +150 °C | -40 to +302 °F -40 to +150 °C |
| Notes | | | | | |
| [1] re 20 μ Pa | | | | | |

Recommended ICP® Signal Conditioners

|  |  |  |
|---|---|---|
| Model 480C02 | Series 481A | Model 485B36 |
| Single channel, battery powered, with BNC input/output connection | 16-channel, line powered (DC power optional) | USB powered, dual channel |



ICP® Preamplifiers for Prepolarized (0V) & Externally Polarized (200V) Microphones for NVH Applications

PCB® designs and manufactures both ICP® preamplifiers for prepolarized microphones and traditional preamplifiers for use with externally polarized microphones. Small and rugged, with a low noise floor and a large dynamic range, these stainless steel preamplifiers are needed for NVH testing such as 1m hemi-sphere acoustic measurements, pass-by noise testing and more.

The industry exclusive Model HT426E01 high temperature microphone preamplifier is designed to overcome specific high temperature challenges associated with powertrain and vehicle systems NVH testing such as exhaust and induction noise testing and turbo noise testing.

Model HT378B02, as seen in the photograph on the right, is PCB®'s high-value/high-temperature microphone system which includes a preamplifier (Model HT426E01) and a microphone (Model 377B02).



Preamplifiers for NVH Applications

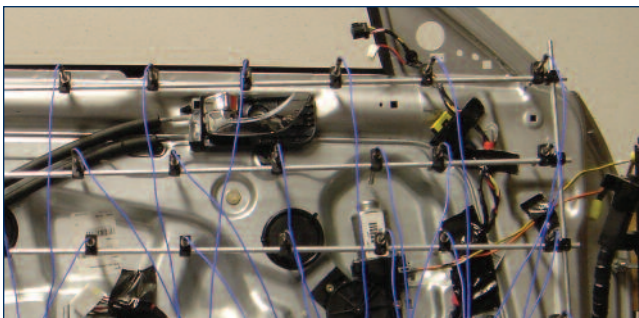
| | Prepolarized | | | | | Externally Polarized | |
|------------------------------------|---------------------------------|---------------------------------|----------------------------------|---------------------------------|--------------------------------|---------------------------------|--------------------------------|
| Model Number | 426B03 | 426E01 | HT426E01 | 426A10 | 426A11 | 426A30 | 426B31 |
| Diameter | 1/4 in | 1/2 in | 1/2 in | 1/2 in | 1/2 in | 1/2 in | 1/4 in |
| Gain (Attenuation) | -0.08 dB [1] | -0.05 dB [1] | -0.06 dB [2] | -0.1 dB [1] | -0.16 dB [1] | -0.2 dB [1] | -0.14 dB [3] |
| Frequency Response (± 0.1 dB) | 5 to 126k Hz | 6.3 to 125k Hz | 6.3 to 126k Hz | 80 to 125k Hz | 5 to 125k Hz | 10 to 126k Hz | 10 to 126k Hz |
| Electrical Noise (A-weight) | $\leq 3.2 \mu V$ [1] | $\leq 2.8 \mu V$ [1] | $\leq 4.9 \mu V$ [2] | $\leq 3.6 \mu V$ | $\leq 7.5 \mu V$ [1] | $\leq 2.8 \mu V$ [1] | $\leq 4.8 \mu V$ [3] |
| Electrical Noise (Linear) [1] | $\leq 5.6 \mu V$ [1] | $\leq 5 \mu V$ [1] | $\leq 13.4 \mu V$ [2] | $\leq 11.2 \mu V$ | $\leq 5.7 \mu V$ [1] | $\leq 5 \mu V$ [1] | $\leq 12 \mu V$ [3] |
| Output Voltage (Maximum) | $\pm 8 V$ pk | $\pm 7 V$ pk | $\pm 7 V$ pk | $\pm 7 V$ pk | $\pm 5 V$ pk | $\pm 14 V$ pk | $\pm 25 V$ pk |
| Temperature Range | -40 to +158 °F -40 to +70 °C | -40 to +176 °F -40 to +80 °C | -40 to +248 °F -40 to +120 °C | -40 to +176 °F -40 to +80 °C | -4 to +158 °F -20 to +70 °C | -40 to +185 °F -40 to +85 °C | -4 to +167 °F -20 to +75 °C |
| Output Connector | 10-32 Coaxial Jack | BNC Jack | BNC Jack | BNC Jack | BNC Jack | 7-Pin LEMO | Integral Cable with 7-Pin LEMO |
| TEDS IEEE P1451.4 | Yes | Yes | Yes | Yes | Yes | No | Yes |

Notes

[1] Measured with an 18 pF reference microphone [2] Measured with a 12 pF reference microphone [3] Measured with a 6.8 pF reference microphone

TEDS Microphone & Preamplifier Systems, IEEE 1451.4 Compliant

| Mated System Pair | 377C01 426B03 | 377B02 426E01 | 377B02 HT426E01 | 377B11 426E01 | 377A13 426E01 | 377B20 426E01 |
|-------------------|------------------|------------------|--------------------|------------------|------------------|------------------|
| TEDS Version 0.9 | 378C01 | 378B02 | HT378B02 | 378B11 | 378A13 | 378B20 |
| TEDS Version 1.0 | TLD378C01 | TLD378B02 | HTTLD378B02 | TLD378B11 | TLD378A13 | TLD378B20 |



Microphone Power Supply

- 0 and 200 volt polarization voltage
- Extended battery life (40 hours)
- 0, 20, and 40 dB gain
- Selectable flat (Z), A, and C-weighting



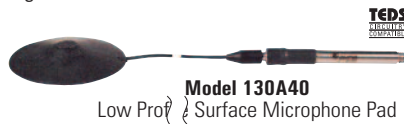
Model 480A25



Vehicle & Powertrain NVH Sensors

ICP® Array Microphones for NVH Applications

PCB® Series 130 ICP® Array Microphones provide a cost-effective method for large channel count sound pressure measurements such as beam forming, holography and sound 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 130A40
Low Profile Surface Microphone Pad



Model 130D21
(10-32 Connector)



Model 130D20
(BNC Connector)

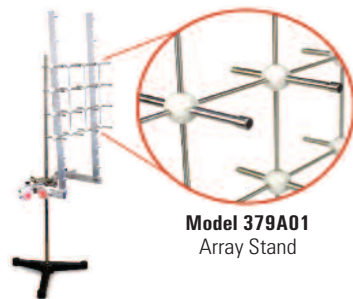


Model 130D22
(SMB Connector)



ICP® Array Microphones with Integral Preamplifier for NVH Applications

| Model Number | 130A40 | 130D20 | 130D21 | 130D22 |
|--|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Microphone Diameter | 1/4 in | 1/4 in | 1/4 in | 1/4 in |
| Response | Pressure | Free-Field | Free-Field | Free-Field |
| Sensitivity (± 3 dB at 250 Hz) | 45 mV/Pa | 45 mV/Pa | 45 mV/Pa | 45 mV/Pa |
| Frequency Response (± 1 dB) | 100 to 4000 Hz | 100 to 4000 Hz | 100 to 4000 Hz | 100 to 4000 Hz |
| Frequency Response (-2 to +5 dB) | 20 to 10k Hz (± 2 dB) | 20 to 15k Hz | 20 to 15k Hz | 20 to 15k Hz |
| Dynamic Range (10 to 10k Hz, ref. 20 μ Pa) | < 30 to > 122 dB | < 30 to > 122 dB | < 30 to > 122 dB | < 30 to > 122 dB |
| Polarization Voltage | 0 V | 0 V | 0 V | 0 V |
| Temperature Range | +14 to +122 °F -10 to +55 °C | +14 to +122 °F -10 to +55 °C | +14 to +122 °F -10 to +55 °C | +14 to +122 °F -10 to +55 °C |
| Connector | 10-32 Jack | BNC Jack | 10-32 Jack | SMB Socket |
| TEDS IEEE P1451.4 | Optional | Optional | Optional | Optional |



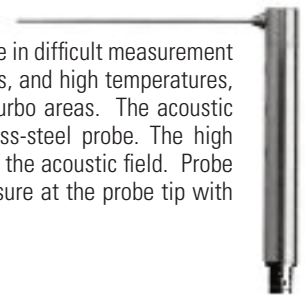
Model 379A01
Array Stand

Array Stand

Model 379A01 array microphone stand & holders - Grid holds array microphones with a fixed spacing of 8 cm, and can be configured from 4x4 square to 1x16 line. The array system can be expanded for more microphones with purchase of additional microphone holders. Tilts and rotates for easy positioning.

High Temperature Probe Microphone

Model 377A26 probe microphones are compact units designed for use in difficult measurement situations, such as those found in small cavities, harsh environments, and high temperatures, such as NVH measurement testing in transmissions, exhaust and turbo areas. The acoustic signal is guided to the microphone through a detachable, stainless-steel probe. The high acoustic input impedance of the probe tip minimizes its influence on the acoustic field. Probe microphones are internally compensated to equalize the static pressure at the probe tip with the internal microphone pressure.



Model 426B02
A-weighting Filter

In-line "A-weighting" Filter

The Model 426B02 in-line A-weighting filter is powered by constant current excitation and is compatible with ICP® microphone preamplifiers. When using this filter, however, a minimum of 4 mA excitation current is required of the ICP® sensor signal conditioner or readout device, which incorporates ICP® sensor power.

Recommended Precision Handheld Acoustic Calibrators

PCB® offers calibrators for microphones that meet IEC and ANSI standards. These units are easy to use and available with optional adaptors for use with a variety of microphone diameters. These units are lightweight, portable, and battery operated.



Model CAL200
Acoustic Calibrator



Model CAL250
Acoustic Calibrator

Precision Calibrators

| Model Number | CAL200 | CAL250 |
|----------------------------------|----------------------------|----------------------|
| Microphone Size | 1/2 in | 1 in |
| Optional Adaptors | 1/4 and 3/8 in | 1/4, 3/8, and 1/2 in |
| Frequency | 1000 Hz $\pm 1\%$ | 250 Hz $\pm 0.8\%$ |
| Output Level (re 20 μ Pa) | 94 dB, 114 dB ± 0.2 dB | 114 ± 0.1 dB |
| Barometric Pressure Compensation | Automatic | Automatic |
| ANSI S1.40-2006 Compliant | Yes | Yes |
| IEC 60942-2003 Class 1 | Yes | Yes |



Recommended Sound Level Meter

Model 831 handheld sound level meter features a small, lightweight ergonomic design; real-time 1/1 and 1/3 octave spectra, and comes standard with a 120 dB dynamic range. Ten customizable markers are provided to annotate time history data. The sound level meter also has audio and voice recording with replay, supported by up to 2 GB of on-board memory and optional USB 2.0 data stick. The unit features one-hand operation, and has an easy-to-read backlit display. Plus, when used with a PC, the USB cable provides instrument power and recharges batteries. A full line of accessories is available including software, sound level calibrators, outdoor microphone systems with electrostatic actuators, weatherproof enclosures for short and long-term monitoring and a variety of tripods and tilt-down poles.

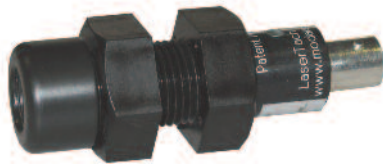


For complete specifications on Model 831, please visit Larson Davis at www.larsondavis.com/model831.htm.

As a division of PCB Piezotronics, Inc., Larson Davis provides complete solutions for noise and vibration measurement and analysis.



Recommended LaserTach™



The LaserTach™ ICP® tachometer senses the speed of rotating equipment and outputs an analog voltage signal for referencing vibration signals to shaft speed. The sensor allows for measurements in excess of 30,000 RPM from distances as far as 20 inches (51 cm). A status LED provides positive, visual indication of proper signal pickup. The standard BNC jack connects the sensor to any constant current excitation source (> 3mA). Unlike magnetic tachometer pickups, the LaserTach™ does not require the rotating equipment to be a ferrous material – only a visually contrasting section of the shaft needs to be available. This is typically accomplished with a small piece of reflective or retro-reflective tape. The unit powers from standard ICP® sensor signal

conditioning and requires only a single coaxial or twisted pair cable connection. This facilitates deployment of multiple speed sensors using the same cabling and signal conditioning as your other ICP® sensor arrays.

- Operates with standard ICP® sensor signal conditioning
- Easy to install – 20 inch range in a standard bolt package offers flexibility
- One pulse per revolution eliminates need to oversample all channels for a high frequency tachometer signal
- Simplifies cable management for dynamic testing of rotating equipment

For complete specifications on the LaserTach™, please visit www.modalshop.com



Recommended Sensor Accessories



Adhesive Mounting Base
Model 080A



Triaxial Mounting Adaptor
Model 080B16



Adhesive
Model 080A90



Petro Wax
Model 080A109



Removal Tool
Model 039A08



Adaptor
Model ADP043



Preampifier Holder
Model 079A11



Swivel Head Adaptor
Model 079B23



Nose Cone
Model 079B21



Windscreen
Model 079A06
Model 079A07



Microphone Cable
Model EXA010



Microphone Clamp
Model 079A18



Microphone Stand
Model 079A15



Vehicle & Powertrain NVH Sensors



PCB® Automotive Sensors is a dedicated technical sales and support group, located in Novi, 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 **Lifetime Warranty Plus guarantee**.

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40000 Grand River Avenue, Suite 201, Novi, MI 48375

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Fax 248-478-2094 **E-mail** automotivesales@pcb.com

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Toll-Free in USA 866-816-8892
E-mail aerosales@pcb.com



Toll-Free in USA 800-959-4464
E-mail imi@pcb.com



Toll-Free in USA 800-828-8840
E-mail info@pcb.com



Toll-Free in USA 888-258-3222
E-mail sales@larsondavis.com



Toll-Free in USA 800-860-4867
E-mail info@modalshop.com



Corporate Headquarters

3425 Walden Avenue, Depew, NY 14043-2495 USA

Toll-Free in USA 800-828-8840

24-hour SensorLineSM 716-684-0001

Fax 716-684-0987 **E-mail** info@pcb.com

Web Site www.pcb.com

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