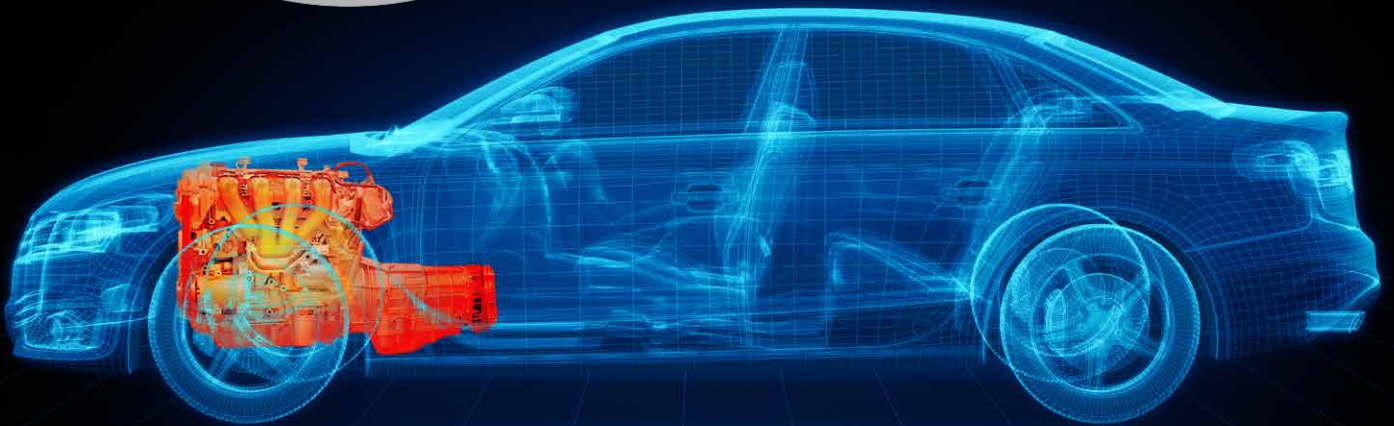


## Powertrain NVH – from sensor to answer



## Powertrain NVH

Acceleration sensors and KiNOVA: data acquisition hardware and analysis software

# Kistler's solution for powertrain NVH

## – from sensor to answer

As legislation pushes for more efficient and environment-friendly transportation and customer expectations regarding comfort increase, recent developments in automotive are strongly focused on new and more efficient propulsion systems, like hybrid and electric motors. In either case, reducing and controlling Noise, Vibration and Harshness (NVH) issues is becoming a priority for the automotive industry to improve the overall performance. This requires NVH measurement and analysis tools to be flexible, efficient and reliable.

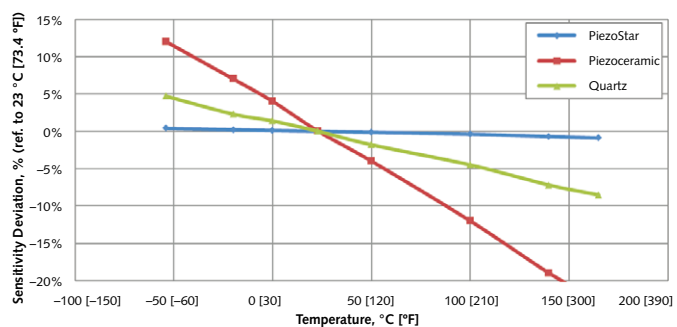
## Acceleration sensors

Accelerometers are commonly used to measure and evaluate the structural dynamic performance of the powertrain and in the vehicle. Depending on the application needs, Kistler can offer a complete portfolio of acceleration sensors covering a broad choice of measuring, frequency and operating temperature ranges.

### Kistler's crystal technologies

For more than 60 years, Kistler has been developing and manufacturing piezoelectric sensors that are used to measure pressure, force, torque and acceleration under extreme conditions. At the core of Kistler's acceleration sensors lies the piezoelectric effect: a crystal produces an electrical charge output when experiencing a change in load, which is then converted into a voltage signal with an electronic coupler that can be integrated into the sensor. Several Kistler's sensors incorporate ceramic and quartz sensing elements, meeting the industry standards and covering a broad range of applications. However, the need for further miniaturization and stability at high operating temperatures has led Kistler's researchers to develop the PiezoStar crystal.

PiezoStar IEPE accelerometers allow reaching high temperatures (up to 165°C) without the need for external compensation or correction, because of their high thermal stability. Additionally, PiezoStar allows the design of compact sensors, without constraints regarding signal-to-noise. As PiezoStar crystal generates up to three times higher voltage sensitivity compared to quartz, the sensor can be easily miniaturized.



In order to support this trend, Kistler provides a complete range of solutions for powertrain NVH testing. To complement its accurate and reliable acceleration sensor portfolio, Kistler has launched the KiNOVA product line, which consists of data acquisition and analysis tools specifically designed to evaluate and engineer powertrain NVH.



### Powertrain NVH and beyond

Optimizing the vibration performance of the driveline requires the measurement and analysis of the transfer path of the engine, gearbox, mounting points and exhaust.

For higher temperature applications the triaxial PiezoStar type 8766A and single-axis type 8715A provide the ideal thermal stability, minimizing errors related to temperature and needs for external compensation.

Hybrid and electric propulsion systems require ground and case isolated sensors. A wide variety of Kistler's accelerometers are able to meet these requirements and can be coupled with shielded cables.


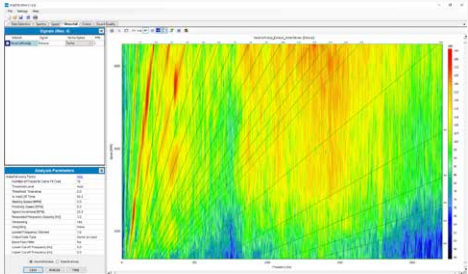

For body-in-white investigations and general NVH testing, Types 8763B... and 8688A... offer triaxial measurements sweeping complementary measuring ranges at low weight. Additionally, PiezoBeam Type 8688A... and Ceramic Shear Type 8762A..., offer ideal solutions for SIMO or MIMO structural testing.

The acceleration product line from Kistler covers a wide range of additional products that complement the measurement chain. Visit our website [www.kistler.com](http://www.kistler.com) for further information.











### Advantages of acceleration sensors by Kistler:


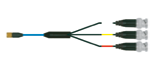


- Wide choice of sensors and configurations
- PiezoStar guarantees performance at high temperatures
- Reliability and accuracy


# Data acquisition hardware and analysis software packages

Package	Hardware	Software
KiNOVA HITS	 <p><b>KiNOVA Lite</b></p> <ul style="list-style-type: none"> <li>• Ultra-portable, pocket-size, light-weight</li> <li>• 4 channels of Voltage or IEPE inputs</li> <li>• Analog inputs configurable for dynamic analysis or tachometer</li> <li>• 24-bit resolution</li> <li>• 100 kHz max sampling frequency</li> <li>• Remarkable precision and signal conditioning</li> <li>• USB control and power</li> <li>• <b>Includes KiNOVA Capture: the software package containing data acquisition and signal processing tools for KiNOVA Lite</b></li> </ul>	<p><b>KiSUITE HITS</b></p> <p>KiSUITE HITS is the software for hammer impact testing. It enables to setup the KiNOVA Lite and guides the user through all necessary steps to perform a hammer impact test.</p> <ul style="list-style-type: none"> <li>• Step-by-step procedure for response acquisition</li> <li>• Natural frequencies and peak detection</li> <li>• Real-time calculation and comparison</li> <li>• Evaluation of damping factors from FRF</li> </ul>
	<p><b>KiNOVA NVH Lite</b></p>	 <p><b>KiSUITE NVH</b></p> <p>KiSUITE NVH is the App that answers all key needs of powertrain NVH engineering. It allows performing a broad range of functions to measure, analyze and process NVH for better and more efficient decision making.</p> <ul style="list-style-type: none"> <li>• Spectral analysis on both noise and vibration signals</li> <li>• Speed analysis with or without tacho signal</li> <li>• Waterfall analysis</li> <li>• Order analysis</li> <li>• Variety of sound quality analysis</li> </ul>
KiNOVA NVH Pro	 <p><b>KiNOVA Pro</b></p> <ul style="list-style-type: none"> <li>• Rugged and solid</li> <li>• 16 channels of Voltage or IEPE inputs</li> <li>• Up to 32 channels per unit and stackable</li> <li>• 24-bit resolution</li> <li>• 100 kHz max sampling frequency</li> <li>• 2 dedicated tachometer channels</li> <li>• USB and Ethernet communications</li> <li>• Programmable standalone function: built-in solid state storage</li> <li>• Internal battery</li> <li>• Additional cards available (2 per unit)</li> <li>• <b>Includes KiNOVA Acquisition: the software package comprehensive of data acquisition and signal processing tools for KiNOVA Pro</b></li> </ul>	<p><b>KiSUITE SCA</b></p> <p>Given the measured response and sources, KiSUITE Source Contribution Analysis allows identification and isolation of sources which contribute most to the response – without the need for multiple intermediate FRF measurement.</p> <ul style="list-style-type: none"> <li>• Source contribution analysis</li> <li>• Visualization of data and contributions</li> </ul>
	<p><b>KiNOVA SCA</b></p>	<p><b>Services</b></p> <ul style="list-style-type: none"> <li>• KiNOVA hardware calibration</li> <li>• Software maintenance</li> <li>• Training</li> <li>• Technical support</li> </ul>

# Selected acceleration sensors and accessories

	Type nr.	Sensing technology	Range [g]	Frequency response [Hz] ( $\pm 5\%$ )	Operating temperature [°C]	Mass [g]	TEDS option	Ground isolation option	Application			Description
									Powertrain	Structural testing	General purpose	
Triaxial accelerometer	 8766A050	PiezoStar	$\pm 50$	1 ... 6,000	-55 ... 165	7	yes	with pad	x			Miniature PiezoStar, high temperature, high thermal stability
	8766A500	PiezoStar	$\pm 500$	0.5 ... 10,000	-55 ... 165	4.5	yes	with pad	x			
	 8763B50	Ceramic	$\pm 50$	0.5 ... 7,000	-55 ... 100	4.5	yes	with pad		x	x	Miniature ceramic shear
	8763B500	Ceramic	$\pm 500$	1 ... 10,000	-55 ... 120	3.6	yes	with pad		x	x	
	 8688A5	Ceramic	$\pm 5$	0.5 ... 3,000	-40 ... 55	6.7	yes	with pad		x		Miniature PiezoBeam, high output
	8688A50	Ceramic	$\pm 50$	0.5 ... 5,000	-40 ... 65	6.5	yes	with pad		x		
	 8762A50	Ceramic	$\pm 50$	0.5 ... 6,000	-55 ... 80	23	yes	yes		x	x	Annular ceramic shear, rugged
	 8764A250	Ceramic	$\pm 250$	1 ... 10,000	-55 ... 100	6	yes	yes		x		PiezoStar, throughhole, high temperature, thermal stability
8765A250M5	PiezoStar	$\pm 250$	1 ... 9,000	-55 ... 165	6.4	no	yes	x				
Single-axis accelerometer	 8703A50	PiezoStar	$\pm 50$	0.5 ... 10,000	-196 ... 165	10	no	with pad	x	x	x	PiezoStar, high temperature, high thermal stability
	8705A50	PiezoStar	$\pm 50$	0.5 ... 10,000	-55 ... 165	7.6	no	with pad	x	x	x	
	 8702B500	Quarz	$\pm 500$	1 ... 10,000	-196 ... 165	8.2	yes	with pad		x	x	Quartz shear, high temperature
	8704B500	Quarz	$\pm 500$	1 ... 10,000	-55 ... 120	7.1	yes	with pad		x	x	Quartz shear, high temperature
	 8714B500	Ceramic	$\pm 500$	1 ... 10,000	-55 ... 165	4.2	yes	yes	x			Annular ceramic shear, through hole, high temperature
	 8715A250	PiezoStar	$\pm 250$	1 ... 10,000	-55 ... 165	2.4	yes	yes	x			Miniature PiezoStar, through hole, high temperature, high thermal stability
	8715A5000	PiezoStar	$\pm 5,000$	2 ... 10,000	-55 ... 165	2.1	yes	yes	x			
	 8774B50	Ceramic	$\pm 50$	0.5 ... 8,000	-55 ... 100	2.9	no	yes		x	x	Ceramic shear, general vibration
8776B50	Ceramic	$\pm 50$	0.5 ... 8,000	-55 ... 100	3.3	no	yes		x	x		

	Type nr.	Length [m]	Description
Cables	 1761B/C...	1/2/3/5/ custom	High temperature, with fluoropolymer jacket, single axis
	 1734A... K03/K04	1/3/5/10	High temperature, ultra flexible, with silicone jacket, triaxial
	 KIG4898C... Q1	3/7/15/ custom	High temperature, ultra flexible, with fluoropolymer, water tight (IP68), triaxial
	 1756C... K04	3/5/10/20/ custom	High temperature, ultra flexible, with fluoropolymer, triaxial

	Type nr.	Range [N]	Freq. resp. [Hz] ( $\pm 5\%$ )	Mass [g]
IEPE impact hammer	 9722A500	500	8,200	100
	9722A2000	2,000	9,300	100
	9724A2000	2,000	6,600	250

### The acceleration product line from Kistler also includes:

- MEMS capacitive accelerometers, for durability and ride quality testing
- Charge output piezoelectric accelerometers, for high temperature and high amplitude vibration testing
- Additional single axis and triaxial IEPE accelerometers, covering several applications
- IEPE impedance head, typically used for measurement of input forces in modal analysis
- Additional IEPE impact hammers
- Charge and IEPE force sensors
- Calibration equipment
- Accessories (mountings, cables, connector adaptors)

For further information on our acceleration sensor portfolio, visit our website [www.kistler.com](http://www.kistler.com).



## KiNOVA – data acquisition hardware and analysis software

The challenge for vehicle and powertrain manufactures is not only to measure NVH with high accuracy, but also to analyze and interpret data in the most efficient way. To support this approach, Kistler has launched the KiNOVA product line, specifically designed to assist NVH engineers in the key phases of powertrain development and refinement – and no matter if it is a conventional, hybrid or electrical propulsion system.

### Supporting NVH Engineering – anywhere

KiNOVA Lite is ideal when data needs to be captured on-the-spot and NVH has to be evaluated only at a few measurement points. Its light-weight and USB-powered format makes it an ultra-portable device, which does not compromise on accurate signal acquisition and processing.

When higher channel count is needed, KiNOVA Pro provides an extendable and rugged solution for more demanding NVH tasks. The standard 16 channels configuration can be extended up to 32 channels per unit or enriched with a variety of additional cards. KiNOVA Pro can be deployed in the lab, in vehicle or for mobile use, thanks to its standalone and programmable function (internal SSD). Both hardware's are easily configured for use with Kistler's IEPE acceleration sensors, as well as typical sensors for NVH measurements.

### Application-oriented solution

KiNOVA data acquisition systems are complemented by the appropriate acquisition software for data capture and KiSUITE analysis software, providing optimal support in the different phases of powertrain development.

KiSUITE HITS provides a step-by-step procedure to set-up, acquire and evaluate the dynamic response of a component to hammer impacts.

KiSUITE NVH allows performing order tracking, waterfall diagrams and sound metrics evaluations on the powertrain.

If the goal is to separate the main sources contributing to the perceived noise and vibration. KiSUITE SCA (Source Contribution Analysis) will support you with minimal amount of measurement information.

### Advantages of the KiNOVA products:

- Tailor-made for powertrain NVH requirements
- Meeting any mobility need: on-the-spot, at engine test bench, in-vehicle
- Quick setup and ease of use

Find out more about our applications:  
[www.kistler.com/applications](http://www.kistler.com/applications)

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