



KISTLER

measure. analyze. innovate.

Acceleration

**Providing Quick,
Accurate and Reliable
Measurements**

Kistler Has a Wide Acceleration Product Offering

This catalog provides comprehensive information on all Kistler products for the measurement of acceleration.

The overview of the Kistler range is followed by detailed information on our products in tabular form and a presentation of the company as a whole.

Detailed catalogs are also available on the full range of Kistler products for the measurement of force and pressure.

As Kistler measuring instruments are used in a great variety of fields, separate brochures are also available for the following applications:

- Engines
- Vehicles
- Manufacturing
- Plastics Processing
- Biomechanics

The aim of this series of brochures is to you support to make the right choice from our wide range of products and to suggest ways of optimizing your application.

Please contact us for any brochures you require. You will find the address of your nearest Kistler branch on the back page of the catalog. Alternatively, you can email us at info@kistler.com.

We wish you every success with Kistler measurement instruments and thank you for your confidence and interest.



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K-Beam®, K-Shear®, PiezoBeam®, PiezoStar® and Piezotron® are registered trademarks of Kistler Holding AG. Ceramic Shear and Picotron are products of Kistler Holding AG.

Kistler Measures Acceleration

Accelerometers are used in every avenue of the dynamic test environment and Kistler has developed families of products covering this expansive range of application. From ultra low motions encountered in wafer fabrication technology to shock spectra reconstruction experienced in pyrotechnic separation event studies, and everywhere between, an optimal sensor solution is available. Static events are captured with the K-Beam® static and low frequency product offerings. Very high frequency activity is routinely measured using any of several miniature piezoelectric single axis or triaxial types. Many sensing technologies including piezoceramic, natural quartz and variable capacitance approaches have been extensively explored and are employed as needed to accommodate the demands of the application.

Some applications include:

Structural Testing

Mechanical devices, assemblies, and constructions of all types are investigated using accelerometers to measure their dynamic response when subjected to a known input. The deformation pattern, when the specimen experiences resonance, can be computed from the measured data.

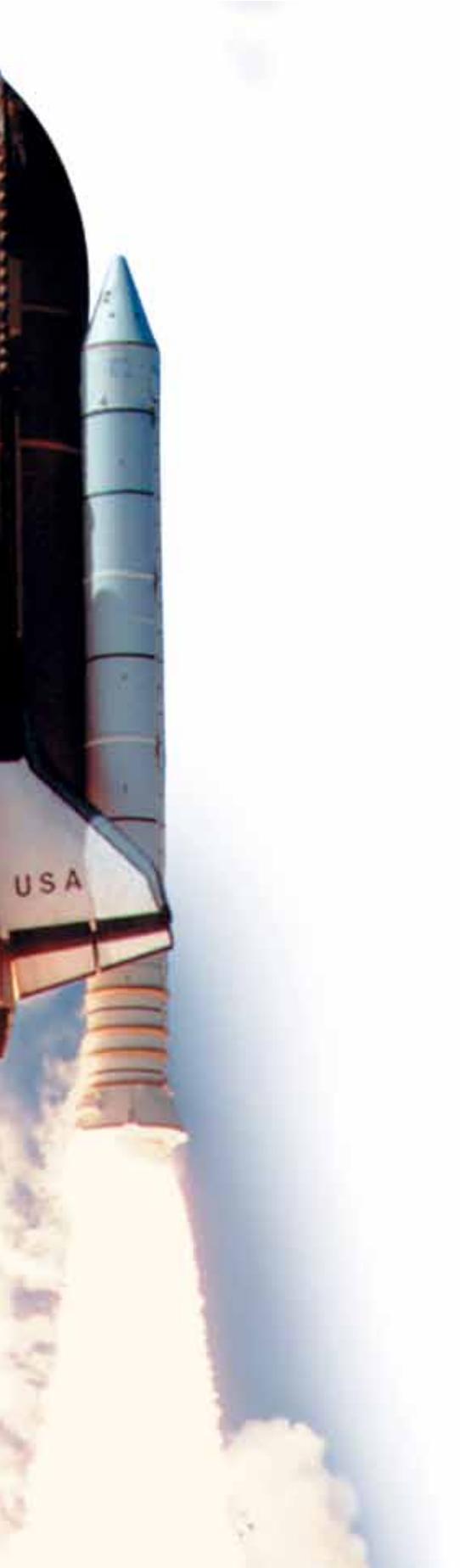
Known as Experimental Modal Analysis (EMA), this field of study often uses a member of the PiezoBeam® family or Ceramic Shear family where their general characteristics have been adapted to accommodate most requirements of common tests. Typical highlight features include high output from a low weight sensor, ground isolated, and an inexpensive package providing an economical solution for large channel count application.

Aerospace and Military

Very demanding application are encountered in the military and aerospace industry where any error may present a life-threatening situation. This category also covers a tremendous range of application and nearly all accelerometer product offerings have been used in these important investigations.

Flutter testing, rocket launch pad dynamics, aircraft EMA, ammunition investigations, helicopter rotor reactions, etc. are a few of the common measurements performed.





Automotive/Transportation

Ride quality has been receiving tremendous attention in recent years. New vehicle designs are presenting less noise to the occupants and the subtle details of the intricacies of road/tyre interaction, bump & jar response, and the overall feel of the ride are important to even the common customer. The K-Beam family covers the low to mid frequency range of many investigations and the many piezoelectric offerings extend into the higher frequency areas of interest.

Civil Engineering

Very low frequency activity is of interest when studying extremely large structures such as bridges, buildings or dams. These specimens require DC capable accelerometers since most dynamic activity is in the very low frequency realm often in the range of a few hertz. The K-Beam product family is commonly used to measure vibration and acceleration in this arena.

Environmental Stress Screening

Computer components, automotive electronics, and miniature mechanical assemblies are often exposed to an aggressive life test or actual functional tests under extreme environmental conditions. This may involve multiple impact drop testing or wide range thermal cycling and many of the K-Shear® product offerings have been tailored to survive and perform extremely well even under incredibly abusive conditions. The M5- and M8-suffixes provide extreme high and low temperature capabilities respectively and the shear shock Type 8742 and 8743 survive after many exposures to high-level cyclic inputs.

Kistler Measures Acceleration

Remarkable lifetime under any condition



Precise, ultra-low frequency, measurements are common using a K-Beam® solution



Modal studies easily accomplished using an array of inexpensive accelerometers



Tilt and comfort controlled using K-Beam® feedback



Space quality measurements are routine



Flight safety issues measured accurately with K-Beam® family



Harsh environments present negligible concern when using K-Shear® accelerometers



On site or factory calibration solutions available



Acceleration Measuring Systems

Acceleration Measuring Systems

Economical measurement solutions offered by the low impedance approach



Low impedance piezoelectric system

- Low output impedance, $<100 \Omega$
- Low Noise output signal
- Fixed accelerometer range and voltage sensitivity
- Simple two-wire system for power and signal with no special cable conductor requirements
- Lower cost per channel
- Simple and inexpensive signal conditioning; power supply/coupler and standard cables
- Coupler for setting of gain, range, filtering and time constant
- Frequency response from 0,5 ... 20 000 Hz
- Operating temperature range $-196 \dots 165 \text{ }^\circ\text{C}$

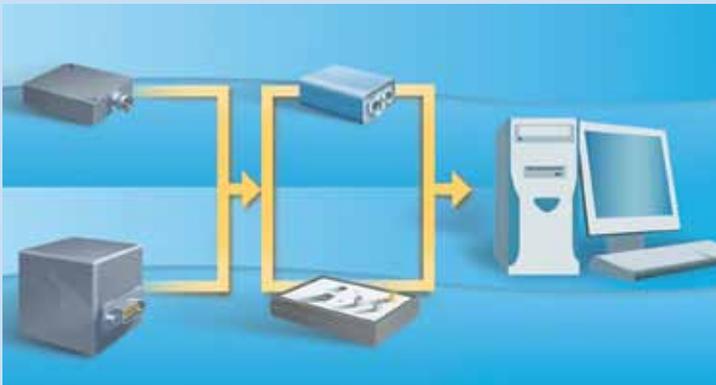
Versatile system configurations provided through charge amplifier functionality



Systems with charge amplifier

- Wide measuring range
- One accelerometer can be used over its entire measuring range by selecting an appropriate charge amplifier range
- Push-button, electronic or computer-controlled resetting of charge amplifier
- Sensors having operational temperature range up to $250 \text{ }^\circ\text{C}$ and above
- Charge amplifier for setting of range, filtering and time constant
- Frequency response from 0,5 ... 20 000 Hz

DC acceleration system easily configured



Silicon micro-machined variable capacitance system

- True static and dynamic measuring
- Frequency response from 0 ... 300 Hz
- Both acceleration and inclination information possible using AC or DC coupled output
- Output signals can be either single-ended, bipolar, differential, voltages or current
- Operating temperature range $-40 \dots 85 \text{ }^\circ\text{C}$

Kistler Calibration

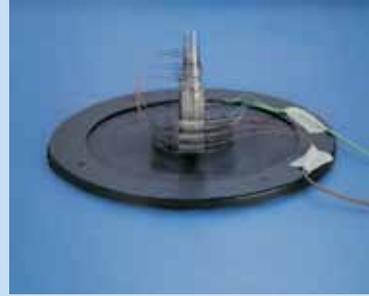
Kistler accelerometers are calibrated in the factory and delivered with a calibration certificate. The reference sensors are cross-referenced to national standards. Kistler operates a NIST traceable calibration center and the calibration laboratory No. 049 of the Swiss Calibration Service for the measurands: force, pressure, acceleration and electric charge. Kistler and some of its group companies offer a recalibration service and the company records in its archives the details of when and how often a particular sensor was calibrated. Kistler offers an on-site service for recal-

ibrating built-in sensors, thereby helping to keep downtimes to a minimum. In addition, Kistler offers a whole range of instruments for use in calibration laboratories.

Our calibration service receives the highest marks. The calibration of your instruments, manufactured by Kistler or someone else, is performed with the most care and precision. Our standard prompt service is exceptional.

Kistler operates numerous calibration laboratories accredited to ISO/IEC 17025.

Calibration



On site, traceable, calibration systems



National referenced calibration services available

Product Overview

Charge Accelerometers																				
Type	Range	Sensitivity	Frequency response	Operating temp. range	Mass	Ground isolated	Connector	Features						Mounting	Page					
	g	pC/g	Hz	°C	grams		Location	triaxial	high g shock	modal	mini	TEDS	high temp	cryo		stud	adhesive	clip	magnetic	screw
8278A500	±500	-1,3	1 ... 10 000	-75 ... 180	0,7	yes	10-32 neg. l side						x			x				12
8203A50	±1 000	-50	5 ... 4 000	-70 ... 245	44,5	with pad	10-32 neg. l side						x		x			x		12
8290A25M5	±1 000	-25	5 ... 4 000	-70 ... 250	53	no	10-32 neg. l side	x					x		x					22
8202A10	±2 000	-10	5 ... 10 000	-70 ... 245	14,5	with pad	10-32 neg. l side						x		x			x		12
8274A5	±2 000	-5,5	1 ... 12 000	-55 ... 165	4	with pad	10-32 neg. l top						x		x					12
8276A5	±2 000	-5,5	1 ... 7 000	-55 ... 165	4	no	10-32 neg. l side						x			x				12
8044	-20 000 ... 30 000	-0,3	1 ... 8 000	-195 ... 200	7	no	10-32 neg. l top		x				x	x	x	x		x		12

Low Frequency Accelerometers																					
Type	Range	Sensitivity	Frequency response	Operating temp. range	Threshold	Mass	Ground isolated	Connector	Features						Mounting	Page					
	g	mV/g	Hz	°C	mg _{rms}	grams		Location	triaxial	high g shock	modal	mini	TEDS	high temp	cryo		stud	adhesive	clip	magnetic	screw
8315A2D0	±2	2 000	0 ... 250	-55 ... 125	0,35	15	Yes	4 pin pos. l side									x	x	x	x	13
8395A2D0	±2	2 000	0 ... 250	-55 ... 125	0,35	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22
8330B3	±3	1 200	0 ... 500	-40 ... 85	0,0013	95	Yes	4 pin pos. l side									x		x		13
8315A010	±10	400	0 ... 1 000	-55 ... 125	1,75	15	Yes	4 pin pos. l side									x	x	x		13
8395A010	±10	400	0 ... 1 000	-55 ... 125	1,8	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22
8315A030	±30	133,3	0 ... 1 000	-55 ... 125	3,85	15	Yes	4 pin pos. l side									x	x	x		13
8395A030	±30	133,3	0 ... 1 000	-55 ... 125	3,9	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22
8315A050	±50	80	0 ... 1 000	-55 ... 125	8,75	15	Yes	4 pin pos. l side									x	x	x	x	13
8395A050	±50	80	0 ... 1 000	-55 ... 125	8,8	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22
8395A100	±100	40	0 ... 1 000	-55 ... 125	18	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22
8315A100	±100	40	0 ... 1 000	-55 ... 125	17,5	15	Yes	4 pin pos. l side									x	x	x		13
8315A200	±200	20	0 ... 1 000	-55 ... 125	35	15	Yes	4 pin pos. l side									x	x	x		13
8395A200	±200	20	0 ... 1 000	-55 ... 125	35	30	Yes	9 pin pos. l side	x							x	x	x	x	x	22

IEPE Accelerometers																					
Type	Range	Sensitivity	Frequency response	Operating temp. range	Threshold	Mass	Ground isolated	Connector	Features						Mounting	Page					
	g	mV/g	Hz	°C	mg _{rms}	grams		Location	triaxial	high g shock	modal	mini	TEDS	high temp	cryo		stud	adhesive	clip	magnetic	screw
8640A5	±5	1 000	0,5 ... 3 000	-40 ... 55	0,14	3,5	with pad	10-32 neg. l side			x	x	x			x	x	x	x		14
8688A5	±5	1 000	0,5 ... 3 000	-40 ... 55	0,14	6,7	with pad	4 pin pos. l side	x		x	x	x			x	x	x			23
8712A5M1	±5	1 000	0,5 ... 8 000	-55 ... 100	0,4	51	yes	10-32 neg. l side								x	x	x	x		17
8762A5	±5	1 000	0,5 ... 6 000	-55 ... 80	0,3	23	yes	4 pin pos. l side					x			x	x				23
8772A5	±5	1 000	1 ... 5 000	0 ... 65	0,4	8	yes	10-32 neg. l side			x		x				x				20
8784A5	±5	1 000	1 ... 6 000	-55 ... 80	0,4	21	with pad	10-32 neg. l top								x	x		x		21
8786A5	±5	1 000	1 ... 6 000	-55 ... 80	0,4	21	with pad	10-32 neg. l side								x	x		x		21
8640A10	±10	500	0,5 ... 3 000	-40 ... 65	0,16	3,5	with pad	10-32 neg. l side			x	x	x			x	x	x	x		14
8688A10	±10	500	0,5 ... 3 000	-40 ... 65	0,16	6,7	with pad	4 pin pos. l side	x		x	x	x			x	x	x	x		23
8762A10	±10	500	0,5 ... 6 000	-55 ... 80	0,35	23	yes	4 pin pos. l side					x			x	x				23
8772A10	±10	500	1 ... 5 000	0 ... 65	0,5	8	yes	10-32 neg. l side			x		x				x				20
8702B25	±25	200	1 ... 8 000	-55 ... 100	2	8,7	pad/M1	10-32 neg. l side					x			x	x		x		15
8704B25	±25	200	1 ... 8 000	-55 ... 100	2	7,5	pad/M1	10-32 neg. l top					x			x	x		x		16
8792A25	±25	200	1 ... 5 000	-55 ... 100	2	29	yes	4 pin pos. l side	x				x				x				25
8640A50	±50	100	0,5 ... 5 000	-40 ... 65	0,36	3,5	with pad	10-32 neg. l side			x	x	x			x	x	x	x		14
8688A50	±50	100	0,5 ... 5 000	-40 ... 65	0,36	6,5	with pad	4 pin pos. l side	x		x	x	x			x	x	x			23
8702B50	±50	100	0,5 ... 10 000	-55 ... 100	4	8,7	pad/M1	10-32 neg. l side					x			x	x		x		15
8703A50M1	±50	100	0,5 ... 10 000	-55 ... 165	1,2	10	yes	10-32 neg. l side					x			x	x		x		15

Product Overview

IEPE Accelerometers																					
Type	Range	Sensitivity	Frequency response	Operating temperature range	Threshold	Mass	Ground isolated	Connector	Features						Mounting			Page			
	g	mV/g	Hz	°C	mg _{rms}	grams		Location	triaxial	high g shock	modal	mini	TEDS	high temp	cryo	stud	adhesive		clip	magnetic	screw
8703A50M8	±50	100	0,5 ... 10 000	-195 ... 100	4	7,5	pad/M1	10-32 neg. l top							x	x	x		x		16
8704B50	±50	100	0,5 ... 10 000	-55 ... 100	4	7,5	pad/M1	10-32 neg. l top					x			x	x		x		16
8705A50M1	±50	100	0,5 ... 10 000	-55 ... 165	1,2	7,6	pad/M1	10-32 neg. l top						x		x	x		x		16
8762A50	±50	100	0,5 ... 6 000	-55 ... 80	1,2	23	yes	4 pin pos. l side					x			x	x				23
8763B050	±50	100	0,5 ... 7 000	-55 ... 100	0,4	4,5	with pad	4 pin pos. l side	x			x	x			x	x				24
8766A50	±50	100	0,5 ... 5 000	-55 ... 120	1	16	with pad	4 pin pos. l side	x			x	x	x		x	x				25
8772A50	±50	100	1 ... 5 000	0 ... 65	2	8	yes	10-32 neg. l side			x		x								20
8774A50	±50	100	1 ... 10 000	-55 ... 120	2,5	4	with pad	10-32 neg. l top			x					x	x				20
8776A50	±50	100	1 ... 7 000	-55 ... 120	2,5	4	M1/M3	10-32 neg. l side			x										20
8792A50	±50	100	0,5 ... 5 000	-55 ... 100	4	29	yes	4 pin pos. l side	x				x							x	25
8795A50M8	±50	100	1 ... 4 000	-195 ... 120	1	32	with pad	4 pin pos. l side	x						x						26
8702B100	±100	50	0,5 ... 10 000	-55 ... 100	6	8,7	pad/M1	10-32 neg. l side					x			x	x		x		15
8704B100	±100	50	0,5 ... 10 000	-55 ... 100	6	7,5	pad/M1	10-32 neg. l top					x			x	x		x		16
8714B100M5	±100	50	1 ... 10 000	-55 ... 165	2	5	yes	10-32 neg. l side					x	x					x		17
8763B100	±100	50	0,5 ... 7 000	-55 ... 100	0,6	4,5	with pad	4 pin pos. l side	x			x	x			x	x				24
8792A100	±100	50	0,5 ... 5 000	-55 ... 100	6	29	yes	4 pin pos. l side	x				x						x		25
8763B250	±250	20	1 ... 10 000	-55 ... 100	1	4,1	with pad	4 pin pos. l side	x			x	x			x	x				24
8765A250M5	±250	20	1 ... 9 000	-55 ... 165	0,002	6,4	yes	4 pin pos. l side						x					x		24
8766A250	±250	20	0,5 ... 10 000	-55 ... 120	6	4	with pad	4 pin pos. l side	x			x	x			x	x				25
8703A250M1	±250	20	0,5 ... 10 000	-55 ... 165	6	8,1	yes	10-32 neg. l side						x		x	x		x		15
8705A250M1	±250	20	0,5 ... 10 000	-55 ... 165	6	6,7	pad/M1	10-32 neg. l top						x		x	x		x		16
8702B500	±500	10	1 ... 10 000	-55 ... 120	10	8,2	pad/M1	10-32 neg. l side					x			x	x		x		15
8704B500	±500	10	1 ... 10 000	-55 ... 120	10	7,1	pad/M1	10-32 neg. l top					x			x	x		x		16
8714B500M5	±500	10	1 ... 10 000	-55 ... 165	3	4,2	yes	10-32 neg. l side					x	x					x		17
8720A500	±500	10	1 ... 10 000	-55 ... 120	10	4,9	yes	10-32 neg. l side													17
8728A500	±500	10	2 ... 10 000	-55 ... 120	20	1,6	no	10-32 neg. l side				x									18
8730A500	±500	10	2 ... 10 000	-55 ... 120	20	1,9	with pad	10-32 neg. l top				x				x	x				15
8730A500M8	±500	10	2 ... 10 000	-195 ... 120	10	1,9	with pad	10-32 neg. l top				x			x	x					18
8763B500	±500	10	1 ... 10 000	-55 ... 100	2	4,1	with pad	4 pin pos. l side	x			x	x			x	x				24
8766A500	±500	10	0,5 ... 10 000	-55 ... 165	10	4	with pad	4 pin pos. l side	x			x	x	x		x	x				25
8778A500	±500	10	2 ... 9 000	-55 ... 120	10	0,4	yes	10-32 neg. l side				x									21
8792A500	±500	10	1 ... 5 000	-55 ... 120	10	27	yes	4 pin pos. l side	x				x						x		25
8793A500	±500	10	2,5 ... 10 000	-55 ... 120	2	11	with pad	4 pin pos. l side	x				x	x					x		26
8793A500M8	±500	10	2,5 ... 10 000	-195 ... 120	2	11	with pad	4 pin pos. l side	x				x	x	x				x		26
8794A500	±500	10	2,5 ... 10 000	-75 ... 120	2	7,6	with pad	4 pin pos. l side	x					x						x	26
8763B1K0A	±1 000	5	1 ... 10 000	-55 ... 120	3	3,6	with pad	4 pin pos. l side	x			x	x			x	x				24
8763B2K0A	±2 000	2,5	1 ... 10 000	-55 ... 120	6	3,6	with pad	4 pin pos. l side	x			x	x			x	x				24
8704B5000	±5 000	1	1 ... 10 000	-55 ... 120	130	7,1	pad/M1	10-32 neg. l top		x						x	x		x		16
8715A5000M5	±5 000	1	2 ... 10 000	-55 ... 165	40	2,1	yes	5-44 neg. l side		x		x	x	x					x		17
8742A5	±5 000	1	1 ... 10 000	-55 ... 120	130	4,5	M1	10-32 neg. l top		x						x	x				19
8743A5	±5 000	1	1 ... 10 000	-55 ... 120	130	4,5	with pad	10-32 neg. l top		x						x	x				19
8742A10	±10 000	0,5	1 ... 10 000	-55 ... 120	250	4,5	M1	10-32 neg. l top		x						x	x				19
8743A10	±10 000	0,5	1 ... 10 000	-55 ... 120	250	4,5	with pad	10-32 neg. l top		x						x	x				19
8742A20	±20 000	0,25	1 ... 10 000	-55 ... 120	500	4,5	M1	10-32 neg. l top		x						x	x				19
8743A20	±20 000	0,25	1 ... 10 000	-55 ... 120	500	4,5	with pad	10-32 neg. l top		x						x	x				19
8742A50	±50 000	0,1	1 ... 10 000	-55 ... 120	1 300	4,5	M1	10-32 neg. l top		x						x	x				19
8743A50	±50 000	0,1	1 ... 10 000	-55 ... 120	1 300	4,5	with pad	10-32 neg. l top		x						x	x				19
8743A100	±100 000	0,05	0,5 ... 10 000	-55 ... 120	2 600	4,5	M1	10-32 neg. l top		x						x	x				19

Product Overview

IEPE Impedance Head														
Type	Range Vibration	Sensitivity	Force range	Sensitivity	Operating temperature range	Threshold	Mass	Connector	Mounting					Page
	g	mV/g	N·m	mV/N·m	°C	mg _{rms} /N·m	grams	Location	stud	adhesive	clip	magnetic	screw	
8770A5	±5	1 000	±6,8	227	-55 ... 80	0,4/0,18	34	10-32 neg. l side	x			x	x	28
8770A50	±50	100	±68	23	-55 ... 120	1/1,8	34	10-32 neg. l side	x			x	x	28

IEPE Impulse Hammers							
Type	Range	Sensitivity	Frequency response	Operating temperature range	Mass	Connector	Page
	N	mV/N	Hz	°C	grams	Location	
9722A500	500	10	8 200	-20 ... 70	100	BNC neg. l bottom	35
9722A2000	2 000	2	9 300	-20 ... 70	100	BNC neg. l bottom	35
9724A2000	2 000	2	6 600	-20 ... 70	250	BNC neg. l bottom	35
9724A5000	5 000	1	6 900	-20 ... 70	250	BNC neg. l bottom	35
9726A5000	5 000	1	5 000	-20 ... 70	500	BNC neg. l bottom	35
9726A20000	20 000	0,2	5 400	-20 ... 70	500	BNC neg. l bottom	35
9728A20000	20 000	0,2	1 000	-20 ... 70	1 500	BNC neg. l bottom	35

Charge Force Sensors									
Type	Range Compression	Range Tension	Sensitivity	Operating temperature range	Mass	Connector	Mounting		Page
	N	N	pC/N	°C	grams	Location	stud	adhesive	
9212	22 000	-2 200	-11	-240 ... 150	18	10-32 neg. l side	x		29
9222	22 000	-2 200	-4,3	-195 ... 150	19	10-32 neg. l side	x		29

* Threshold depends on charge amp settings

IEPE Force Sensors									
Type	Range Compression	Range Tension	Sensitivity	Operating temperature range	Threshold	Connector	Mounting		Page
	N	N	mV/N	°C	mN	Location	stud	adhesive	
9712B5	22	-22	180	-50 ... 120	0,4	10-32 neg. l side	x		29
9712B50	220	-220	22	-50 ... 120	4	10-32 neg. l side	x		29
9712B250	1 100	-1 100	4,5	-50 ... 120	20	10-32 neg. l side	x		29
9712B500	2 200	-2 200	2,25	-50 ... 120	40	10-32 neg. l side	x		29
9712B5000	22 000	-22 000	0,225	-50 ... 120	400	10-32 neg. l side	x		29

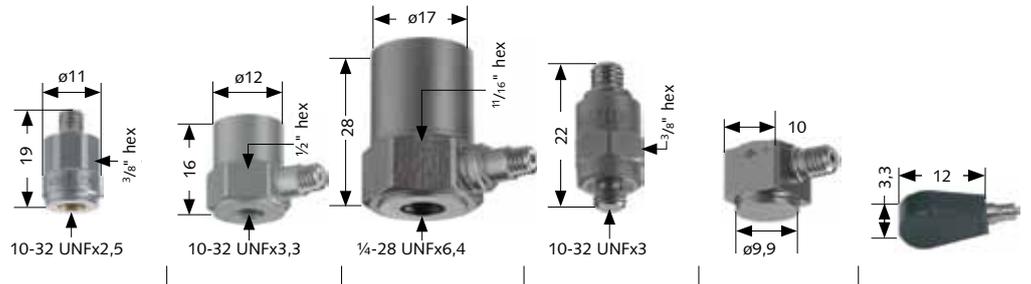
Product Overview

Rotational Accelerometers														
Type	Range	Sensitivity	Frequency response	Operating temperature range	Threshold	Mass	Ground Isolated	Connector	Mounting					Page
	krads/s ²	µV/rad/s ²	Hz	°C	rads/s ²	grams		Location	stud	adhesive	clip	magnetic	screw	
8838	±150	35	1 ... 2 000	-55 ... 120	4	18,5	yes	4 pin pos. I side					x	28
8840	±150	35	1 ... 2 000	-55 ... 120	4	18,5	yes	4 pin pos. I side					x	28

Acoustic Emission Sensors													
Type	Sensitivity	Frequency response	Operating temperature range	Mass	Ground Isolated	Connector	Mounting					Page	
	dBref 1V/(m/s)	kHz (±10 dB)	°C	grams		Location	stud	adhesive	clip	magnetic	screw		
8152B211/221	48	100 ... 900	-40 ... 60	29	yes	integral cable pigtails I side						x	27
8152B111/121	57	50 ... 400	-40 ... 60	29	yes	integral cable pigtails I side						x	27

Cables					
Type	Connection A	Connection B	Length (m) sp = customer specified length	Diameter (in)	Page
1511	BNC pos.	BNC pos.	1/sp	0,25	38
1576	¼-28, 4 pin neg.	(3x) BNC pos.	0,20	0,07	38
1578	¼-28, 4 pin neg.	¼-28, 4 pin neg.	2/sp	0,10	38
1592A	¼-28, 4 pin neg.	¼-28, 4 pin neg.	2/4/sp	0,10	38
1592M1	¼-28, 4 pin neg.	pigtail	2/sp	0,10	38
1601B	BNC pos.	BNC pos.	sp	0,12	38
1603B	BNC neg.	BNC pos.	sp	0,12	38
1631C	10-32 pos.	BNC pos.	1/2/3/5/8/sp	0,08	38
1635C	10-32 pos.	10-32 pos.	1/2/3/5/8/sp	0,08	38
1641	10-32 pos.	BNC pos.	sp	0,08	38
1734A...K03	¼-28, 4 pin neg.	(3x) BNC pos.	1/3/5/10	0,07	38
1756C...K03	¼-28, 4 pin neg.	(3x) BNC pos.	0,5/3/10/sp	0,10	38
1761B	10-32 pos.	BNC pos.	1/2/3/5/sp	0,08	38
1762B	10-32 pos.	10-32 pos.	1/2/3/5/sp	0,08	38
1766AK01	5-44 pos.	10-32 neg.	sp	0,06	38
1768A...K01	10-32 pos.	BNC pos.	1/2/3/5/sp	0,08	38
1768A...K02	10-32 pos.	10-32 pos.	1/2/3/5/sp	0,08	38
1534A...K00	¼-28, 4 pin neg.	pigtail	2/5/10/sp	0,10	38
1784AK02	M4,5, 4 pin neg.	¼-28, 4 pin pos.	0,50/sp	0,06	39
1784B...K03	M4,5, 4 pin neg.	(3x) BNC pos.	1/3/5/10	0,06	39
1786C	¼-28, 4 pin neg.	(3x) Banana Jacks for power, (2x) BNC pos. signal out	2/5/10	0,1	39
1788A	¼-28, 4 pin neg.	(3x) Banana Jacks for power, BNC pos. signal out	2/5/10	0,1	39
1792A...K01	9 pin circular	9 pin D-Sub	2/5/10/sp	0,18	39
1792A...K00	9 pin circular	pigtail	2/5/10/sp	0,18	39
1794A	9 pin D-Sub neg.	(2x) Banana Jacks for power, (3x) BNC pos. signal out	2	0,1	39

Ceramic Shear, Charge Accelerometers – Single Axis

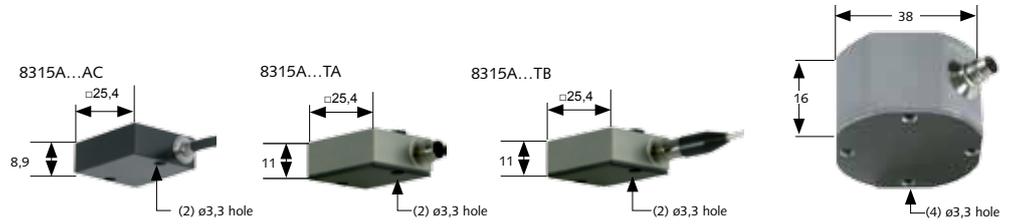


		Type 8044	Type 8202...	Type 8203...	Type 8274...	Type 8276...	Type 8278...
Technical Data		...A10		...A50	...A5	...A5	...A500
Range	g	-20 000 ... 30 000	±2 000	±1 000	±2 000	±2 000	±500
Sensitivity, ±5 %	pC/g	-0,3	-10 (±15 %)	-50 (±15 %)	-5,5	-5,5	-1,3
Frequency response, ±5 %	Hz	1 ... 8 000	5 ... 10 000	5 ... 4 000	1 ... 12 000 (7 %)	1 ... 7 000	1 ... 10 000
Threshold	mg _{rms}	depends on charge amplifier settings					
Transverse sensitivity	%	≤5	1,5	1,5	1,5	1,5	3
Non-linearity	%FSO	±1	±1	±1	±1	±1	±1
Temp. coeff. sensitivity	%/°C	-0,02	0,13	0,13	0,11	0,11	0,18
Operating temp. range	°C	-195 ... 200	-70 ... 245	-70 ... 245	-55 ... 165	-55 ... 165	-75 ... 180
Connector		10-32 neg.	10-32 neg.	10-32 neg.	10-32 neg.	10-32 neg.	10-32 neg.
Housing/base	material	17-4 PH St, Stl,	Stainless steel	Stainless steel	Titanium	Titanium	Anodized Al,
Sealing	Type	epoxy	hermetic	hermetic	hermetic	hermetic	epoxy
Mass	grams	7	14,5	44,5	4	4	0,7
Ground isolated		no	with pad	with pad	with pad	no	yes
Data sheet		8044_000-209	8202A_000-212	8203A_000-212	8274A_000-213	8274A_000-213	8278A_000-611

Properties	Wide measuring range, stable quartz element, lightweight, miniature package.	High temp. (245 °C), ceramic shear sensing element, low transverse sensitivity.	Ceramic shear sensing element, wide frequency response, low transverse sensitivity, lightweight, rugged connector, ideal for OEM applications.	Ultra low base strain, wide frequency response, ground isolated, high sensitivity, -1,3 pC/g, integral cable (user specified length), high temperature.
Application	Measuring and analyzing shock and vibration with high amplitudes.	Automotive, aerospace and environmental testing where low impedance sensors are limited by Operating temperature.	Impact and vibration related applications including condition monitoring and vehicle testing.	Precision vibration measurements; modal analysis on small, thin walled structures or where space is limited and mass loading is of primary concern.
Accessories	Cable: Type 1631C Charge amp.: Type 5000 series	Cable: Type 1631C Charge converter: Type 5050 Coupler: Type 5100 series Mounting pad: Type 8436	Cable: Type 1631C Charge converter: Type 5050 Coupler: Type 5100 series Adh. mounting pad: Type 8436 Mounting magnet: Type 8452A Mounting cube: Type 8524	Extension cable: Type 1631C Charge converter: Type 5050 Coupler: Type 5100 series

Static and Low Frequency Vibration

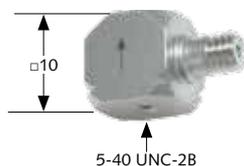
K-Beam® MEMS Capacitive, Low Frequency Accelerometers – Single Axis



		Type 8315...						Type 8330...
Technical Data		...A2D0	...A010	...A030	...A050	...A100	...A200	...B3
Range	g	±2	±10	±30	±50	±100	±200	±3
Sensitivity, ±5 % (±4 V FSO version) (2,5 ±2 V FSO version) (±8 V FSO differential version)	mV/g							1 200 (±10 %)
	mV/g	2 000	400	133,3	80	40	20	
	mV/g	1 000	200	66,6	40	20	10	
Zero g output (±4 V FSO version) (2,5 ±2 V FSO version) (±8 V FSO differential version)	mV							0 ±260
	mV	0 ± 60	0 ± 60	0 ± 60	0 ± 60	0 ± 60	0 ± 60	
	mV	2 500 ±60	2 500 ±60	2 500 ±60	2 500 ±60	2 500 ±60	2 500 ±60	
Frequency response, ±5 %	Hz	0 ... 250	0 ... 1 000					0 ... 500
	%FSO	±1						±0,1
Resolution/threshold	mg _{rms}	0,35	1,75	3,85	8,75	17,5	35	0,0013
Transverse sensitivity	%	1						0,4
Shock half sine	g _{pk}	6 000 (200 μs)						1 500 (500 μs)
Temp. coefficient bias	mg/°C	±0,1	±0,50	±1,5	±2,5	±5	±10	0,1
Temp. coefficient sensitivity	%/°C	0,01						0,01
Operating temp. range	°C	-55 ... 125 (TA or TB)						-40 ... 85
Phase shift max., @ 100 Hz	°	20	10					-0,25
Current nom.	mA	1,6						12
Voltage	VDC	6 ... 50 (T ≤100 °C)						±6 ... ±12
Connector		4 pin pos.						4 pin pos.
Housing/base	material	Titanium (TA, TB housing), Aluminum (AC housing)						Titanium
Sealing	Type	environmental (AC housing)/hermetic (TA, TB housing)						hermetic
Mass	grams	15 (TA, TB)/12 (AC)						95
Ground isolated		yes						yes
Data sheet		8315A_000-859						8330B_000-897

Properties	Small, lightweight variable capacitance sensing element, CE compliant. Integral cable and connector options.	Closed loop servo accelerometer, zero volt output at zero g, ultra low noise.
Application	Low frequency vibration measurements for automotive ride quality and aerospace structural testing.	Low frequency, low amplitude vibration measurements such as background vibration and seismic measurements.
Accessories	Power supply: Type 5210 Mounting cube: Type 8516	Cable: Type 1592M1, 1788A
Versions	...AO: 0 ±4 V FSO ...AT: 0 ±4 V FSO, with temp. output ...BO: 2,5 ±2 V FSO ...BT: 2,5 ±2 V FSO, with temp. output	...DO: 0 ±8 V FSO differential ...AC: Aluminum, with integral cable ...TA: Ti., with 4 pin connector ...TB: Ti., with integral cable

IEPE Accelerometers – Single Axis



Type 8640...

Technical Data		...A5	...A10	...A50
Range	g	±5	±10	±50
Sensitivity, ±5 %	mV/g	1 000	500	100
Frequency response, ±5 %	Hz	0,5 ... 3 000		0,5 ... 5 000
Threshold	mg _{rms}	0,14	0,16	0,36
Transverse sensitivity	%	1,5		
Non-linearity	%FSO	±1		
Shock (1 ms pulse)	g _{pk}	7 000		10 000
Temp. coefficient sensitivity	%/°C	0,13	0,16	
Operating temp. range	°C	-40 ... 55	-40 ... 65	
Power supply current	mA	2 ... 20		
Power supply voltage	VDC	22 ... 30		
Connector		10-32 neg.		
Housing/base	material	Titanium		
Sealing	Type	hermetic		
Mass	grams	3,5		
Ground isolated		with pad		
Data sheet		8640A_000-842		

Properties

High sensitivity, low mass, low noise, low transverse sensitivity and ground isolated, CE compliant.

Application

Modal analysis or structural investigations.

Accessories

Cable: Type 1761B
 Coupler: Type 5100 series
 Mounting clip: Type 800M156
 Mounting base, ground isolated: Type 800M158
 Mounting magnetic base: Type 800M160

Versions

...T: TEDS option

Vibration

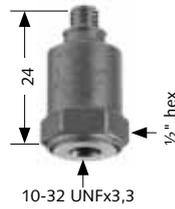
IEPE Accelerometers – Single Axis



		Type 8702...			Type 8703...		
Technical Data		...B25	...B50	...B100	...B500	...A50M1	...A250M1
Range	g	±25	±50	±100	±500	±50	±250
Sensitivity, ±5 %	mV/g	200	100	50	10	100	20
Frequency response, ±5 %	Hz	1 ... 8 000	0,5 ... 10 000		1 ... 10 000	0,5 ... 10 000	
Threshold	mg _{rms}	2	4	6	10	1,2	6
Transverse sensitivity	%	1,5			3		
Non-linearity	%FSO	±1			±1		
Shock (1 ms pulse)	g _{pk}	2 000			5 000	2 000	
Temp. coefficient sensitivity	%/°C	-0,06			0,004		
Operating temp. range	°C	-55 ... 100			-55 ... 120	-55 ... 165	
Power supply current	mA	4			4		
Power supply voltage	VDC	20 ... 30			20 ... 36		
Connector		10-32 neg.			10-32 neg.		
Housing/base	material	Titanium/Stainless steel			Titanium		
Sealing	Type	hermetic			hermetic		
Mass	grams	8,7			8,2	10	8,1
Ground isolated		with pad/M1			yes		
Data sheet		8702B_000-239			8702B_000-238	8703A_000-557	

Properties	Ultra low base strain, low thermal transient response, quartz-shear sensing elements, CE compliant.	Low impedance voltage output, ultra low base strain, ultra low temp. coefficient of sensitivity with PiezoStar®, CE compliant
Application	General purpose vibration measurement, vehicle or environmental testing, ESS and modal analysis.	Dynamic temperature environments. General purpose vibration measurement, vehicle or environmental testing, ESS and modal analysis.
Accessories	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436
Versions	...T: TEDS option ...M1: ground isolated	...M1: ground isolated ...M5: high temp. (165 °C) ...M8: cryo temp. (-195 °C) ...T: TEDS option

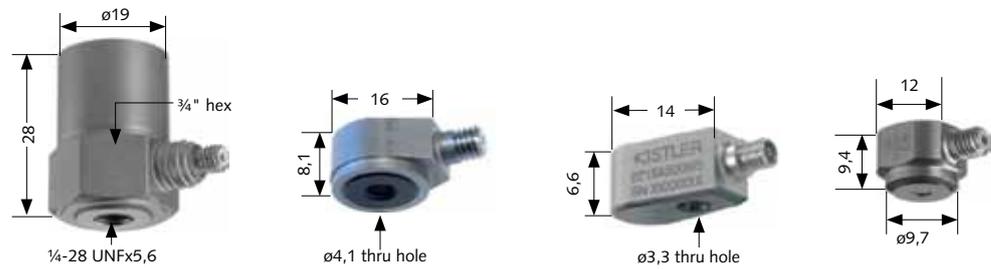
IEPE Accelerometers – Single Axis



		Type 8704...				Type 8705...			
Technical Data		...B25	...B50	...B100	...B500	...B5000	...A50M1	...A250M1	
Range	g	±25	±50	±100	±500	±5 000	±50	±250	
Sensitivity, ±5 %	mV/g	200	100	50	10	1	100	20	
Frequency response, ±5 %	Hz	1 ... 8 000	0,5 ... 10 000		1 ... 10 000		0,5 ... 10 000		
Threshold	mg _{rms}	2	4	6	10	130	1,2	6	
Transverse sensitivity	%	1,5				3			
Non-linearity	%FSO	±1				±1			
Shock (1 ms pulse)	g _{pk}	2 000			5 000	10 000	2 000		
Temp. coefficient sensitivity	%/°C	-0,06				0,0036			
Operating temp. range	°C	-55 ... 100				-55 ... 120		-55 ... 165	
Power supply current	mA	4				4			
Power supply voltage	VDC	20 ... 30				20 ... 30			
Connector		10-32 neg.				10-32 neg.			
Housing/base	material	Titanium/Stainless steel				Titanium			
Sealing	Type	hermetic				hermetic			
Mass	grams	7,5			7,1		7,6	6,7	
Ground isolated		with pad/M1				with pad/M1			
Data sheet		8704B_000-239			8704B_000-238	8704B_000-240	8705A_000-557		

Properties	Ultra low base strain, low thermal transient response, quartz-shear sensing elements, CE compliant.	Low impedance voltage output, ultra low base strain, low thermal transient response, ultra low temp. coefficient of sensitivity with PiezoStar, CE compliant .
Application	General purpose vibration measurement, vehicle or environmental testing, ESS and modal analysis, shock measurement.	Dynamic temperature environments. General purpose vibration measurement, vehicle or environmental testing, ESS and modal analysis.
Accessories	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436
Versions	...T: TEDS option ...M1: ground isolated	...M1: ground isolated ...M5: high temp. (165 °C) ...M8: cryo temp. (-195 °C) ...T: TEDS option

IEPE Accelerometers – Single Axis



	Type 8712...	Type 8714...	Type 8715...	Type 8720...		
Technical Data	...A5M1	...B100M5	...B500M5	...A5000M5	...A500	
Range	g	±5	±100	±500	±5 000	±500
Sensitivity, ±5 %	mV/g	1 000	50	10	1	10
Frequency response, ±5 %	Hz	0,5 ... 8 000	1 ... 10 000		2 ... 10 000	1 ... 10 000 (±10 %)
Threshold	mg _{rms}	0,4	2	3	40	10
Transverse sensitivity	%	1,5	3		3	1,5
Non-linearity	%FSO	±1	±1		±1	±1
Shock (1 ms pulse)	g _{pk}	1 000	5 000		8 000	5 000
Temp. coefficient sensitivity	%/°C	-0,06	-0,14	-0,16	-0,01	-0,06
Operating temp. range	°C	-55 ... 100	-55 ... 165		-55 ... 165	-55 ... 120
Power supply current	mA	4	2 ... 18		2 ... 18	4
Power supply voltage	VDC	20 ... 30	20 ... 30		20 ... 30	20 ... 30
Connector		10-32 neg.	10-32 neg.		5-44 neg.	10-32 neg.
Housing/base	material	Stainless steel	Titanium/Aluminum		Titanium	Titanium
Sealing	Type	hermetic	hermetic		hermetic	hermetic
Mass	grams	51	5	4,2	2,1	4,9
Ground isolated		yes	yes		yes	yes
Data sheet		8712A_000-244	8714B_000-602		8715A_000-603	8720A_000-246

Properties	Very high sensitivity, quartz-shear accuracy & stability, high immunity to thermal transients, welded hermetic construction, ground isolated, CE compliant.	Low profile, high temperature ceramic annular shear accelerometer. CE compliant.	Unique PiezoStar element, ultra low temperature sensitivity, ground isolated, lightweight, hermetically sealed, CE compliant.	Quartz-shear sensing element, ultra low base strain sensitivity, lightweight, small size, ground isolated, CE compliant.
Application	Applications involving low amplitude vibrations over a wide frequency range, including heavy structures, suspension vibration building and machines.	Provides measurement solutions in hard to mount locations when cable orientation is important or height restrictions apply.	Shock and vibration measuring in dynamic temperature conditions. General applications include: environmental testing (ESS) product acceptance/qualification, and aviation testing.	Shock and vibration measurement on light structures. The small size allows for installation on items with limited mounting space.
Accessories	Cable: Type 1761B Coupler: Type 5100 series	Cable: Type 1761B Coupler: Type 5100 series	Cable: Type 1766A Coupler: Type 5100 series	Cable: Type 1761B Coupler: Type 5100 series
Versions		...T: TEDS option	...T: TEDS option	

IEPE Accelerometers – Single Axis

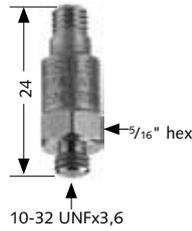


		Type 8728...	Type 8730...
		...A500	...A500
Technical Data			
Range	g	±500	±500
Sensitivity, ±5 %	mV/g	10	10 (±10 %)
Frequency response, ±5 %	Hz	2 ... 10 000	2 ... 10 000
Threshold	mg _{rms}	20	20
Transverse sensitivity	%	1,5	1,5
Non-linearity	%FSO	±1	±1
Shock (1 ms pulse)	g _{pk}	5 000	5 000
Temp. coefficient sensitivity	%/°C	-0,06	-0,06
Operating temp. range	°C	-55 ... 120	-55 ... 120
Power supply current	mA	2 ... 20	2 ... 18
Power supply voltage	VDC	20 ... 30	20 ... 30
Connector		10-32 neg.	10-32 neg.
Housing/base	material	Titanium	Titanium
Sealing	Type	welded/epoxy	hermetic
Mass	grams	1,6	1,9
Ground isolated		no	yes
Data sheet		8728A_000-247	8730A_000-248

Properties	Small, lightweight, 2 m integral cable, quartz-shear stability and precision, CE compliant.	Quartz-shear sensing element, low impedance output, ultra low base strain sensitivity, CE compliant.
Application	Precision measurements on small, thin-walled structures or where space is limited, ideal for high frequency vibration measurements.	Precision measurements on small, thin-walled structures and environmental testing.
Accessories	Extension Cable: Type 1761B Coupler: Type 5100 series	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8434
Versions		...AE: metric thread. (M3x0,5) 8 mm hex ...M1: ground isolated ...M8: cryo temp. (-195 °C)

Vibration

IEPE Accelerometers – Single Axis



		Type 8742...				Type 8743...				
Technical Data		...A5	...A10	...A20	...A50	...A5	...A10	...A20	...A50	...A100
Range	g	±5 000	±10 000	±20 000	±50 000	±5 000	±10 000	±20 000	±50 000	±100 000
Sensitivity, ±5 %	mV/g	1	0,5	0,25	0,1	1	0,5	0,25	0,1	0,05
Frequency response	Hz	1 ... 10 000 (±7 %)				1 ... 10 000 (±7 %)				0,5 ... 10 000 (±7 %)
Threshold	mg _{rms}	130	250	500	1 300	130	250	500	1 300	2 600
Transverse sensitivity	%	1,5				1,5				
Non-linearity	%FSO	±1				±1				
Shock (1 ms pulse)	g _{pk}	50 000	50 000	50 000	100 000	50 000			100 000	120 000
Temp. coefficient sensitivity	%/°C	-0,06				-0,06				
Operating temp. range	°C	-55 ... 120				-55 ... 120				
Power supply current	mA	2 ... 20				18 ... 30				
Power supply voltage	VDC	18 ... 30				2 ... 20				
Connector		10-32 neg.				10-32 neg.				
Housing/base	material	Titanium/Stainless steel				Stainless steel				
Sealing	Type	hermetic				hermetic				
Mass	grams	4,5				4,5				
Ground isolated		yes (M1)				yes (M1)				
Data sheet		8742A_000-250				8743A_000-564				

Properties	Unique quartz-shear sensing element, low transverse sensitivity, wide bandwidth, high resonant frequency, CE compliant,	Unique quartz-shear sensing element, low transverse sensitivity, wide bandwidth, high resonant frequency, CE compliant,
Application	Impact and vibration related applications including shock and vehicle testing.	Impact and vibration related applications including shock and vehicle testing.
Accessories	Cable: Type 1761B Coupler: Type 5100 series	Cable: Type 1761B Coupler: Type 5100 series

IEPE Accelerometers – Single Axis



		Type 8772...			Type 8774...		Type 8776...
Technical Data		...A5	...A10	...A50	...A50	...A50	
Range	g	±5	±10	±50	±50	±50	
Sensitivity, ±5 %	mV/g	1 000	500	100	100	100	
Frequency response, ±5 %	Hz	1 ... 5 000			1 ... 10 000		1 ... 7 000
Threshold	mg _{rms}	0,4	0,5	2	3		3
Transverse sensitivity	%	<5			1,5		1,5
Non-linearity	%FSO	±1			±0,5		±1
Shock (1 ms pulse)	g _{pk}	5 000	7 000		5 000		5 000
Temp. coefficient sensitivity	%/°C	-0,15	-0,1		-0,14		-0,14
Operating temp. range	°C	0 ... 65			-55 ... 120		-55 ... 120
Power supply current	mA	2 ... 18			2 ... 20		2 ... 20
Power supply voltage	VDC	20 ... 30			18 ... 30		18 ... 30
Connector		10-32 neg.			10-32 neg.		10-32 neg.
Housing/base	material	Aluminum hard anodized			Titanium		Titanium
Sealing	Type	IP66			hermetic		hermetic
Mass	grams	8			4		4
Ground isolated		yes			with pad		with M1 or M3 option
Data sheet		8772A_000-253			8774A_000-255		8774A_000-255

Properties	Lightweight, ceramic shear sensing element, cube shaped for mounting flexibility, CE compliant.	High sensitivity, high resolution ceramic shear sensing element, CE compliant.	
Application	Modal analysis applications exposed to environmental factors.	General purpose vibration measurement.	Modal/structural analysis.
Accessories	Cable: Type 1761B Coupler: Type 5100 series Mounting clip: Type 8474	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436 Mounting cube: Type 8524	Cable: Type 1761B Coupler: Type 5100 series Mounting cube: Type 8526
Versions	T: TEDS option		M1: ground isolated M3: extended low frequency and ground isolated M6: integral stud

Vibration

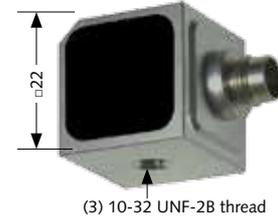
IEPE Accelerometers – Single Axis



	Type 8778...	Type 8784...	Type 8786...
Technical Data	...A500	...A5	...A5
Range	g	±500	±5
Sensitivity, ±5 %	mV/g	10	1 000 (±10 %)
Frequency response, ±5 %	Hz	2 ... 9 000	1 ... 6 000
Threshold	mg _{rms}	10	0,4
Transverse sensitivity	%	3	1,5
Non-linearity	%FSO	±1	±1
Shock (1 ms pulse)	g _{pk}	5 000	2 500
Temp. coefficient sensitivity	%/°C	-0,14	-0,05
Operating temp. range	°C	-55 ... 120	-55 ... 80
Power supply current	mA	2 ... 20	2 ... 20
Power supply voltage	VDC	18 ... 30	18 ... 30
Connector		10-32 neg.	10-32 neg.
Housing/base	material	Aluminum/Titanium	Titanium
Sealing	Type	epoxy	hermetic
Mass	grams	0,4	21
Ground isolated		yes	with pad
Data sheet		8778A_000-256	8786A_000-257

Properties	Ultra low base strain, low mass ground isolated, CE compliant, integral cable (user specified length).	Ceramic shear sensing element, low impedance, voltage mode, high sensitivity, high resolution, CE compliant.	Ceramic shear sensing element, low impedance, voltage mode, high sensitivity, high resolution, CE compliant.
Application	Environmental/product testing on small, thin walled structures or where space is limited and mass loading is of primary concern.	Low level vibration and impact testing for applications including condition monitoring and vehicle testing.	Low level vibration and impact testing for applications including condition monitoring and vehicle testing.
Accessories	Extension Cable: Type 1761B Coupler: Type 5100 series Removal tool: Type 1378	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436	Cable: Type 1761B Coupler: Type 5100 series Mounting pad: Type 8436
Versions	M14: twisted pair cable		

IEPE Accelerometers – Triaxial



Type 8290...		
Technical Data		...A25M5
Range	g	±1 000
Sensitivity, ±15 %	pC/g	-25
Frequency response	Hz	5 ... 4 000 (10 %)
Threshold	mg _{rms}	1
Transverse sensitivity	%	1,5
Non-linearity	%FSO	±1
Temp. coefficient sensitivity	%/°C	0,13
Operating temperature range	°C	-70 ... 250
Connector		10-32 neg.
Housing/base	material	Stainless steel
Sealing	Type	hermetic/ceramic
Mass	grams	53
Ground isolated		no
Data sheet		8290A_000-215

Properties

Ceramic Shear sensing element, low transverse sensitivity, extended temperature operation.

Application

General vibration measurements with varying test conditions, vehicle vibration and NVH testing, general lab/R&D and ESS.

Accessories

Cable: Type 1631C
Charge converter: Type 5050
Coupler: Type 5100 series
Mounting stud: Type 8402, 8411

Type 8395...							
Technical Data		...A2D0	...A010	...A030	...A050	...A100	...A200
Range	g	±2	±10	±30	±50	±100	±200
Sensitivity, ±5 %	mV/g	2 000	400	133,3	80	40	20
Zero g output, ±5	mV	±60					
Frequency response, ±5 %	Hz	0 ... 250	0 ... 1 000				
Non-linearity	%FSO	±1					
Resolution/threshold	mg _{rms}	0,35	1,8	3,9	8,8	18	35
Transverse sensitivity	%	1					
Shock half sine	g _{pk}	6 000					
Temp. coeff. bias	mg/°C	±0,1	±0,5	±1,5	±2,5	±5,0	±10
Temp. coefficient sensitivity	%/°C	±0,01					
Operating temperature range	°C	-55 ... 125					
Phase shift max., @ 100 Hz	°	20	10				
Current nom.	mA	4,2					
Voltage	VDC	6 ... 50					
Connector		9 pin pos. circular					
Housing/base	material	Titanium					
Sealing	Type	hermetic					
Mass	grams	30					
Ground isolated		yes					
Data sheet		8395A_000-860					

Properties

Bipolar output, 0 ±4 V FS, zero volt output at zero g, ground isolated, low noise, operating from voltage supply. CE compliant.

Application

Instrument grade triaxial accelerometer well suited for automotive, aerospace, civil engineering, R&D, OEM and structural analysis.

Accessories

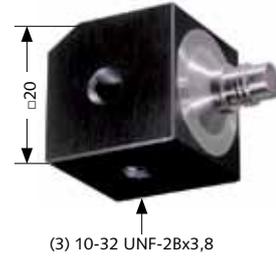
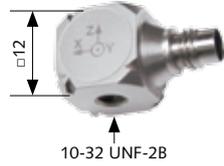
Cable: Type 1792A...K00, Type 1792A...K01
Mounting: adhesive mounting base Type 8466K01
Mounting: stud mounting base Type 8466K02
Mounting: magnetic mounting base Type 8466K03

Versions

...AT: 0 ±4 V FSO, with temp. output
...TA: Titanium, hermetic, 9 pin pos. circular

Vibration

IEPE Accelerometers – Triaxial



		Type 8688...			Type 8762...		
Technical Data		...A5	...A10	...A50	...A5	...A10	...A50
Range	g	±5	±10	±50	±5	±10	±50
Sensitivity, ±5 %	mV/g	1 000	500	100	1 000	500	100
Frequency response, ±5 %	Hz	0,5 ... 3 000		0,5 ... 5 000	0,5 ... 6 000		
Threshold	mg _{rms}	0,14	0,16	0,36	0,3	0,35	1,2
Transverse sensitivity	%	1,5			<5		
Non-linearity	%FSO	±1			±1		
Shock (1 ms pulse)	g _{pk}	7 000		10 000	5 000	7 000	
Temp. coefficient sensitivity	%/°C	0,17	0,23		-0,06	-0,02	
Operating temp. range	°C	-40 ... 55	-40 ... 65		-55 ... 80		
Power supply current	mA	2 ... 20			2 ... 18		
Power supply voltage	VDC	22 ... 30			20 ... 30		
Connector		4 pin pos.			4 pin pos.		
Housing/base	material	Titanium			Aluminum hard anodized		
Sealing	Type	hermetic			welded/epoxy		
Mass	grams	6,7		6,5	23		
Ground isolated		with pad			yes		
Data sheet		8688A_000-843			8762A_000-456		

Properties	Miniature high sensitivity, low mass, low transverse and ground isolated, CE compliant.	High sensitivity, low noise, triaxial cube, ground isolated, (3) 10-32 thread mounting holes.
Application	Modal analysis or structural testing.	Modal analysis, automotive bodies and aircraft structures, general vibrations.
Accessories	Cable: Type 1756C Extension cable: Type 1734A Coupler: Type 5100 series Mounting clip: Type 800M15...	Cable: Type 1756C Extension cable: Type 1578A Coupler: Type 5100 series
Versions	...T: TEDS option	...T: TEDS option

IEPE Accelerometers – Triaxial



		Type 8763...				Type 8765...		
Technical Data		...B050	...B100	...B250	...B500	...B1K0A...	...B2K0A...	...A250M5
Range	g	±50	±100	±250	±500	±1 000	±2 000	±250
Sensitivity, ±15 %	mV/g	100	50	20	10	5	2,5	20
Frequency response, ±5 %	Hz	0,5 ... 7 000			1 ... 10 000			1 ... 9 000
Threshold	mg _{rms}	0,4	0,6	1	2	3	6	0,002
Transverse sensitivity	%				2,5			2,5
Non-linearity	%FSO				±1			±1
Shock (1 ms pulse)	g _{pk}				5 000			5 000
Temp. coefficient sensitivity	%/°C	0,06			0,02			-0,0036
Operating temp. range	°C	-55 ... 100			-55 ... 120			-55 ... 165
Power supply current	mA				2 ... 18			2 ... 20
Power supply voltage	VDC				22 ... 30			18 ... 30
Connector		Mini 4,5 4 pin pos. (8763B...A), 1/4-28 4 pin pos. (8763B...B)						M4,5 4 pin pos.
Housing/base	material	Titanium						Titanium
Sealing	Type	hermetic						hermetic
Mass	grams	4,5 (8763B...A) 5 (8763B...B)		4,1 (8763B...A) 4,6 (8763B...B)		3,6		6,4
Ground isolated		with pad						yes
Data sheet		8763B_000-928						8765A_000-472

Properties

Mini cube design, (3) 5-40 thread holes, low mass, mini 4 pin connector, CE compliant, ceramic element.

PiezoStar ultra low thermal sensitivity variation, hermetic, ground isolated, mini 4 pin connector. CE compliant.

Application

Dynamic vibration, shock measurement, lightweight structures. Including automotive and aerospace R&D.

Modal analysis, automotive and aircraft structures, with dynamic temperatures.

Accessories

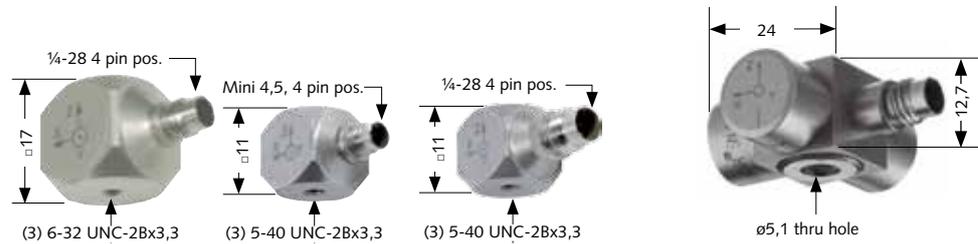
Cable: Type 1784B...K03, Type 1756C...K03, Type 1734A
 Coupler: Type 5100 series
 Mounting pad: Type 8434
 Mounting stud: Type 8400K04, ground isolated 5-40 stud to M6 stud
 Mounting stud: Type 8400K06, ground isolated 5-40 stud to 10-32 stud
 Mounting stud: Type 8440K01, adhesive mounted, ground isolated, 5-40 stud

Adhesive mounting base: Type 8462K01, 8462K02
 Cable: Type 1784BK03
 Coupler: Type 5100 series

Versions

...T: TEDS option
 ...B...A...: M4,5 4 pin pos.
 ...B...B...: 1/4-28 4 pin pos.

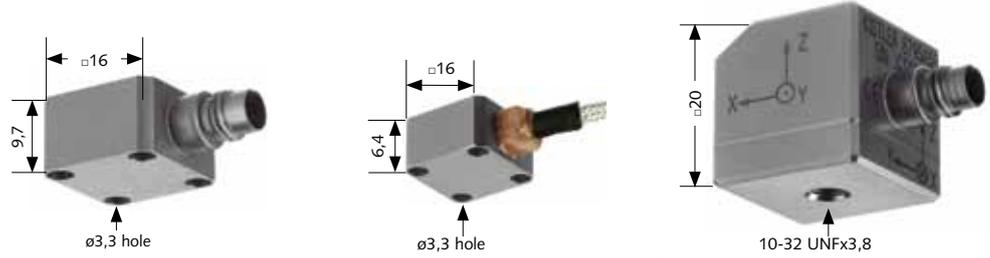
IEPE Accelerometers – Triaxial



		Type 8766...			Type 8792...			
Technical Data		...A50	...A250	...A500	...A25	...A50	...A100	...A500
Range	g	±50	±250	±500	±25	±50	±100	±500
Sensitivity, ±5 %	mV/g	100	20	10	200	100	50	10
Frequency response, ±5 %	Hz	0,5 ... 5 000	0,5 ... 10 000	0,5 ... 10 000	1 ... 5 000	0,5 ... 5 000		1 ... 5 000
Threshold	mg _{rms}	1	6	10	2	4	6	10
Transverse sensitivity	%	1,5	1,5		1,5			
Non-linearity	%FSO	±1	±1		±1			
Shock (1 ms pulse)	g _{pk}	5 000	5 000		2 000			5 000
Temp. coeff. sensitivity	%/°C	-0,004	-0,0005	-0,0004	-0,06			
Operating temp. range	°C	-55 ... 120	-55 ... 120	-55 ... 165 (H)	-55 ... 100			-55 ... 120
Power supply current	mA	2 ... 18	2 ... 18		2 ... 20			
Power supply voltage	VDC	20 ... 30	20 ... 30		20 ... 30			
Connector		¼-28 4 pin pos.	Mini 4,5 4 pin pos. (8766A...A), ¼-28 4 pin pos. (8766A...B)		4 pin pos.			
Housing/base	material	Titanium	Titanium		Stainless steel			
Sealing	Type	hermetic	hermetic		hermetic			
Mass	grams	16	4		29			27
Ground isolated		with pad	with pad		yes			
Data sheet		8766A_000-472	8766A_000-607		8792A_000-260			

Properties	PiezoStar element, +165 °C operation, TEDS, hermetic, titanium construction, low temperature and base strain sensitivity, low impedance voltage output, CE compliant.	Center hole quartz shear triaxial, low base strain sensitivity, wide frequency range, ground isolated, low profile, CE compliant.
Application	Applications include automotive under the hood and under the vehicle testing as well as subsystem vibration testing for aerospace applications.	Center hole mounting capability allows orientation of exit cable or axis alignment. The low profile package accommodates restricted space environments.
Accessories	Cable: Type 1756C Coupler: Type 5134B series, 5100 series Mounting stud: Type 8400K02, ground isolated 6-32 stud to 10-32 stud Type 8400K04, ground isolated 5-40 stud to M6 stud Type 8400K05, ground isolated 6-32 stud to M6 stud Type 8400K06, ground isolated 5-40 stud to 10-32 stud Type 8440K01, adhesive, ground isolated, 5-40 stud Type 8440K02, adhesive, ground isolated, 6-32 stud	Socket cap screw: 10-32x0,75, M5x20 mm Cable: Type 1578A, 1756C Coupler: Type 5100 series
Versions	...M5: high temp. (165 °C) ...T: TEDS option ...A...A: M4,5 4 pin pos. ...A...B: ¼-28 4 pin pos. ...H: High temperature, 165 °C	...T: TEDS option

IEPE Accelerometers – Triaxial

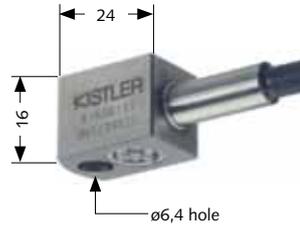


	Type 8793...	Type 8794...	Type 8795...
Technical Data	...A500	...A500	...A50M8
Range	g	±500	±50
Sensitivity, ±5 %	mV/g	10	100 (±10 %)
Frequency response, ±5 %	Hz	2,5 ... 10 000	1 ... 4 000
Threshold	mg _{rms}	2	1
Transverse sensitivity	%	1,5	1,5
Non-linearity	%FSO	±1	±1
Shock (1 ms pulse)	g _{pk}	5 000	5 000
Temp. coefficient sensitivity	%/°C	-0,03	-0,03
Operating temp. range	°C	-55 ... 120	-195 ... 120
Power supply current	mA	2 ... 18	2 ... 18
Power supply voltage	VDC	20 ... 30	20 ... 30
Connector		4 pin pos.	4 pin pos.
Housing/base	material	Stainless steel	Titanium
Sealing	Type	hermetic	hermetic
Mass	grams	11	32
Ground isolated		with pad	with pad
Data sheet		8793A_000-261	8795A_000-264

Properties	Low profile design, quartz shear stability, hermetically sealed, CE compliant.	Low profile design, quartz shear stability, CE compliant, 2 m integral cable.	Quartz triaxial, Hermetically sealed, CE compliant.
Application	Useful for measuring vibration and shock on small and lightweight structures, extreme temperature applications.	The low profile design provides an aerodynamic advantage for in-flight flutter testing as well as general shock and vibration.	Vehicle vibration and noise harshness (NVH) testing, general lab/R&D and modal testing, extreme temperature applications.
Accessories	Cap screws 4-40x½, M2,5x12 mm Cable: Type 1756C, 1734A Coupler: Type 5100 series Mounting pad: Type 800M144	Cable: Type 1756C, 1734A Extension cable: Type 1578A Coupler: Type 5100 series Mounting screw: 4-40x3/8" and M2,5x10 mm Mounting pad: Type 800M144	Cable: Type 1756C Extension cable: Type 1578A Coupler: Type 5100 series Mounting stud: Type 8402, 8411 Mounting pad: Type 8436
Versions	...T: TEDS option ...M5: high temp. (165 °C) ...M8: cryo temp. (-195 °C)	...M5: high temp. (165 °C)	

Acoustic Emission

Acoustic Emission Sensors/Conditioning



		Type 8152...	
		...B1...	...B2...
Technical Data			
Frequency range, ± 10 dB	kHz	50 ... 400	100 ... 900
Sensitivity, nom.	dBref 1V (m/s)	57	48
Shock (0,5 ms pulse)	g	2 000	
Operating temp. range	$^{\circ}\text{C}$	-40 ... 60	
Supply: power supply	mA	3 ... 6	
Voltage (coupler)	VDC	5 ... 36	
Output voltage (full scale)	V	± 2	4
Output bias	VDC	2,2	2,5
Mass	grams	29	
Case material		Stainless steel	
Sealing	Type	hermetic	
Ground isolated		yes	
Data sheet		8152B_000-204	

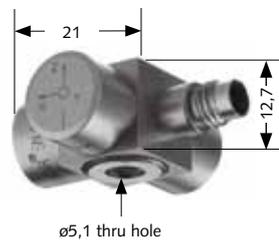
Properties	High sensitivity and wide frequency range, inherent highpass characteristic, robust, suitable for industrial use (degree of protection IP65 PUR or IP67 Viton [®]), ground isolated, CE compliant, 2 m integral cable.
Application	Measurement of very high frequency phenomena particularly on machine structures. Crack formation investigations, fatigue studies and machine tool diagnostics.
Accessories	Magnet clamp: Type 8443B AE Coupler: Type 5125B...
Versions	PUR Cable: Type 8152B1... Viton [®] Cable: Type 8152B2...

		Type 5125B...	
Technical Data			
Sensor excitation voltage	VDC	20	
Sensor excitation current	mA	4	
Frequency response	Hz	0,1 ... 30 000	
Output signal voltage	V	0 ... 10	
Gain		1, 10	
Power	Type	115/220	
Operating temp. range	$^{\circ}\text{C}$	0 ... 60	
Dimensions (WxHxD)	mm	114x64x36	
Mass	kg	0,27	
Connector		Input: BNC neg. or cable gland Output: 8 pin round connector DIN 45326	
Data sheet		5125B_000-322	

Properties	Built-in RMS converter and limit monitor, plug-in filter modules, rugged case, vibration-proof construction, CE compliant.
Application	Vibration and acoustic emission (AE) sensors.
Accessories	Plug-in Low/high pass filters 8 pin round connector: Type 1500A57
Versions	request data sheet for all options.

Rotational Accelerometers and Impedance Head

Rotational Accelerometers, IEPE Impedance Head



		Type 8838	Type 8840
Technical Data			
Range	krads/s ²	±150	±150
Sensitivity, ±10 %	μV/rad/s ²	35	35
Frequency response, ±5 %	Hz	1 ... 2 000	1 ... 2 000
Threshold	rad/s ²	4	4
Transverse sensitivity	%	1,5	1,5
Non-linearity	%FSO	±1	±1
Shock (1 ms pulse)	g _{pk}	5 000	5 000
Temp. coeff. sensitivity	%/°C	0,06	0,06
Operating temp. range	°C	-55 ... 120	-55 ... 120
Power supply current	mA	4	4
Power supply voltage	VDC	20 ... 30	20 ... 30
Connector		4 pin pos.	4 pin pos.
Housing/base	material	Titanium	Titanium
Sealing	Type	hermetic	hermetic
Mass	grams	18,5	18,5
Ground isolated		yes	yes
Data sheet		8838_000-271	8838_000-271

		Type 8770...	
Technical Data			
		...A5	...A50
ACCELERATION			
Range	g	±5	±50
Sensitivity, ±10 %	mV/g	1 000	100
Frequency response, ±5 %	Hz	1 ... 4 000	
Threshold	mg _{rms}	0,4	1
Transverse sensitivity, typ.	%	1,5	
Temp. coefficient sensitivity	%/°C	0,14	
FORCE			
Range	N	±22	±222
Sensitivity, ±10 %	mV/N	227	23
Threshold	N	0,6	6
Temp. coefficient sensitivity	%/°F	0,05	
Operating temp. range	°C	-55 ... 80	-55 ... 120
Power supply	mA	2 ... 18	
	VDC	20 ... 30	
Housing/base	Type	Titanium	
Sealing	Type	hermetic	
Mass	grams	34	
Connector		10-32 neg.	
Data sheet		8770A_000-252	

Properties

Shear quartz piezoelectric, axial oscillations, hermetic construction, lightweight and convenient thru hole mount, CE compliant.

Shear quartz piezoelectric, axial oscillations, hermetic construction, lightweight and convenient thru hole mount, CE compliant.

Application

Axial or shaft type measurements on an oscillating but non-rotating specimen.

Lateral type measurements on an oscillating but non-rotating specimen.

Accessories

Cable: Type 1592M1, 1578A, 1786C

Cable: Type 1592M1, 1578A, 1786C

Properties

Low impedance voltage mode, sensitivity unaffected by mounting torque, wide frequency range, CE compliant.

Application

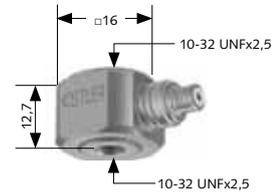
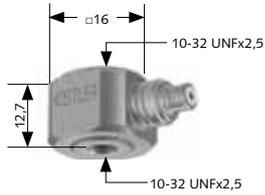
Modal analysis, typically installed on a test article and connected by a threaded stinger to a shaker. Measures input force and acceleration simultaneously.

Accessories

Cable: Type 1761B
Coupler: Type 5100 series

Force

Charge and IEPE Force Sensors



		Type 9212	Type 9222
Technical Data			
Range compression	N	22 000	22 000
Range tension	N	-2 200	-2 200
Threshold	N	*	*
Sensitivity	pC/N	-11	-4,3
Non-linearity	%FSO	±0,5	±0,5
Rigidity	kN/μm	>0,88	>0,88
Temp. coeff. sensitivity	%/°C	0,018	0,036
Operating temp. range	°C	-240 ... 150	-195 ... 150
Connector		10-32 neg.	10-32 neg.
Housing/base	material	Stainless steel	Stainless steel
Sealing	Type	welded/epoxy	welded/epoxy
Mass	grams	18	19
Data sheet		9212_000-418	

Properties

High impedance, charge mode output, rugged quartz sensor, wide measuring ranges for compression and tension, quasi-static response.

Application

Force applications such as press fit assembly, crimping and impact force testing; can be used with shakers for modal analysis, machine tool measurements or various automotive, aerospace and robotic testing.

Accessories

Cable: Type 1631C
Charge amp.: Type 5000 series
Impact mounting pad: Type 900A1

* Threshold depends on charge amp settings

		Type 9712...				
Technical Data		...B5	...B50	...B250	...B500	...B5000
Range compression	N	22	220	1 100	2 200	22 000
Range tension	N	-22	-220	-1 100	-2 200	-22 000
Threshold	mN	0,4	4	20	40	400
Sensitivity	mV/N	180	22	4,5	2,25	0,225
Non-linearity	%FSO	±1				
Rigidity	kN/μm	>0,88				
Temp. coeff. sensitivity	%/°C	0,036				
Operating temp. range	°C	-50 ... 120				
Power supply current	mA	4				
Power supply voltage	VDC	20 ... 32				
Connector		10-32 neg.				
Housing/base	material	Stainless steel				
Sealing	Type	hermetic				
Mass	grams	19				
Data sheet		9712B_000-417				

Properties

Low impedance voltage mode, rugged quartz sensor, wide measuring range, uses standard low impedance cables, CE compliant.

Application

Force applications where high sensitivity, high rigidity and fast responses are required.

Accessories

Cable: Type 1761B
Charge amplifier: Type 5100 series
Impact pad: Type 900A1

IEPE Sensor Power Supply



		Type 5108A	Type 5110	Type 5114	Type 5118B2
Technical Data		IEPE	IEPE	IEPE	IEPE
Channels	number	1	1	1	1
Sensor excitation voltage	VDC	20	20	20	±5
Sensor excitation current	mA	4	2	2	2
Frequency response	Hz	0,02 ... 87 000	0,07 ... 60 000	0,07 ... 60 000	0,02 ... 40 000
Output signal voltage	V	20	18	20	±10
Gain		1	1	1	1, 10, 100
Power	Type	Banana jacks (22 ... 30 VDC)	battery: 9 V alkaline (IEC 6LR61)	battery: 9 V alkaline (IEC 6LR61)	4x1,5 V AA, alkaline
Operating temp. range	°C	0 ... 50	-10 ... 55	-10 ... 55	-20 ... 50
Dimensions (WxHxD)	mm	58x22x22	109x61x25	81x150x36	97x48x190
Mass	kg	0,064	0,15	0,25	0,50
Connector		Input: BNC neg. Output: BNC pos. Power: bananajacks, polarity (+ red, - black)	Input/output: BNC neg.	Input/output: BNC neg.	Input/output: BNC neg.
Data sheet		5108A_000-328	5110_000-329	5114_000-330	5118B_000-331

Properties	Simple to operate, AC coupled, reverse polarity protection, CE compliant. Use with low impedance Piezotron® sensors with built-in electronics.	Turn a digital multimeter into a hand-held relative vibration measurement system or verify sensor and cable integrity with this portable, low cost, battery operated coupler.	Provides constant current excitation, monitors condition of sensors and cables, 3,5" digital LCD display AC-DC or battery powered, CE compliant.	Selectable gain and low pass, plug-in filters, panel selectable, high pass filtering, exclusive "Rapid Zero" feature AC-DC or battery powered, CE compliant.
Application	Provide DC power to sensors that contain miniature impedance converting circuits and to couple the signal generated in each to an electronic measurement instrument.	Transforms an ordinary digital voltmeter into a simple measuring tool, ideal for troubleshooting sensors, cable or vibration problems in an industrial environment for low impedance sensors.	Power and monitor Piezotron, low impedance sensors.	Powering low impedance sensors where test conditions require flexible signal conditioning
Accessories	Cable: Type 1761B		AC-DC power adapter: Type 5752 (120 V), Type 5757 (230 V)	AC-DC power adapter: Type 5752 (120 V), Type 5757 (230 V) Panel mounting kit: Type 5702 Plug-in low pass filters: Type 5326A..., 5327A...
Versions		Type 5110S1 kit: with case, mounting wax and 9 V battery	Type 5114: 9 V alkaline battery Type 5114S1: 9 V alkaline battery, 115 VAC power adapter and carrying case Type 5114S1(E): as S1 with 230 VAC power adapter	

IEPE/MEMS Capacitive Sensor Power Supply



		Type 5134B...	Type 5148	Type 5210	Type 5127
Technical Data		IEPE	IEPE	MEMS Capacitive	IEPE
Channels	number	4	16	1	1
Sensor excitation voltage	VDC	24	24	9	-
Sensor excitation current	mA	0 ... 15	2	25	-
Frequency response	Hz	0,1 ... 68 000	0,05 ... 50 000	0 ... 750	0,1 ... 30 000
Output signal voltage	V	±5/±10 selectable	±10	±5	0 ... 10
Gain		0,5 ... 150	1	1, 2, 10, 20	1, 10
Power	Type	115/230 VAC	115/230 VAC	9 V Battery	22 ... 30 V
Operating temp. range	°C	0 ... 60	0 ... 50	-9 ... 55	0 ... 60
Dimensions (WxHxD)	mm	94x150x195	483x45x222	147x91x33	115x64x35
Mass	kg	1,8	2,5	0,26	0,27
Connector		Input/output: 4 BNC neg.	Input/output: 16 BNC neg.	Sensor: 4 pin, Microtech pos. Output signal: BNC neg. External DC input: 2,1 mm jack (tip+)	Input: BNC neg. or cable strain relief Output: 8 pin round connector DIN 45326
Data sheet		5134B_000-605	5148_000-333	5210_000-334	5127_000-323

Properties	Multidrop USB 2.0 for remote control and monitoring. Front panel LEDs for fault/status of each channel, non volatile memory to store settings, vernier gain and selectable 4 pole low pass filters, TEDS compatible, CE compliant.	Provides constant current excitation for Piezotron and voltage mode piezoelectric sensors, LED's indicate circuit integrity, convenient front/rear BNC connectors, standard rack mountable, CE compliant.	Adjustable offset control for higher resolution measurements, battery or external power, gain and filtering options, low battery indicator, complete kit available/ R&D, CE compliant.	Built-in RMS converter and limit monitor, plug-in filter modules, rugged case, vibration-proof construction, CE compliant.
Application	General vibration lab/R&D use with single axis or triaxial accelerometers.	Multi-channel low impedance sensor power at economical price per channel.	Power single axis K-Beam accelerometer from a casual check to an in-depth study.	Vibration and acoustic emission (AE) sensors.
Accessories		AC-DC power adapter: Type 5754 (115 V) Type 5764 (230 V)	AC-DC power adapter: Type 5752 (120 V), Type 5757 (230 V)	Plug-in low/high pass filters 8 pin round connector: Type 1500A57
Versions	With case: Type 5134B1 Without case: Type 5134B0		Type 5210: 9 V battery Type 5210S1: 9 V battery, 115 V power adapter Type 5752 and carrying case Type 5210S1(E): as S1 with 230 V power adapter Type 5757	request data sheet for all ordering options

Charge Amplifiers



		Type 5010B	Type 5015A
Technical Data		Dual Mode Charge/IEPE	Dual Mode Optional
Measuring range	pC	±10 ... 999 000	±2 ... 2 200 000
Sensor sensitivity	pC	0,01 ... 9 990	
Scale	mV/MU	0,0002 ... 10 000 000	
Frequency response (standard filter)	Hz	180 000	200 000
Output voltage	V	±10	±2 ... ±10
Output current	mA	5	2
Accuracy	%	<0,5	<±0,5 (FS%/100 pC)
Power	VAC	115	115/230
Operating temp. range	°C	0 ... 50	0 ... 50
Remote control	Type	6 pin; DIN 45322 RS-232C: 9 pin D-Sub	6 pin; DIN 45322 RS-232C: 9 pin D-Sub
Dimensions (WxHxD)	mm	94x150x196 (with case)	104x142x252 (with case)
Mass	kg	1,5	2,3
Connector		Input/output: BNC neg.	Input/output: BNC neg.
Data sheet		5010B_000-387	5051A_000-297

Properties	High and low impedance sensors, dynamic and quasi-static measurement, automatic zero adjustment, RS-232C interface, ultra high accuracy. For quartz high impedance sensors (charge amplifier).	Single-channel charge amplifier, LCD menu as well as read out for signal evaluation optional Piezotron input, CE compliant.
Application	Measure dynamic pressure, force strain and acceleration from piezoelectric sensors.	Measure dynamic pressure, force, strain and acceleration from piezoelectric sensors.
Accessories	Rack adapter: Type 5730 Remote control box: Type 56663 Plug-in low pass filters: optional	
Versions	...B0: without case ...B1: with case 5814: 3-channel	

Signal Conditioning

In-line IEPE Signal Conditioning



		Type 5050...			Type 557	Type 558
Technical Data		...A0,1	...A1	...A10		
Output signal voltage	V _{pp}	10			10	10
Gain	mV/pC	0,1	1	10	0,97	0,97
Noise (broadband 1 ... 10 kHz)	μV _{rms}	5	10	70	25	25
Input resistance min.	kΩ	100			5x10 ⁸	5x10 ⁸
Input capacitance	pF	30 000			3	3
Frequency response, -5 %	Hz	1 ... 20 000			0,1 ... 100 000	0,1 ... 100 000
Constant current	mA	2 ... 20			4	4
Compliance voltage	VDC	20 ... 30			20 ... 30	20 ... 30
Operating temp. range	°C	-40 ... 80			-55 ... 120	-55 ... 120
Signal polarity		inverted				
Sealing	Type	welded/epoxy			welded/epoxy	
Housing/base	material	Stainless steel			304 Stainless steel	304 Stainless steel
Mounting	Type	in-line			on sensor	in-line
Input connector	Type	10-32 neg.			10-32 pos.	10-32 neg.
Output connector	Type	BNC neg.			10-32 neg.	10-32 neg.
Dimensions (WxDia.)	mm	71x16			20x6,4	24x6,4
Mass	grams	28			2,1/2,6	2,6
Data sheet		5050A_000-452			557_000-388	558_000-388

Properties	Two wire, single-ended charge converter, rugged, stainless steel case, wide frequency response, three gain versions, CE compliant. Ideal for ceramic high impedance accelerometers.	Compatible with high impedance, quartz sensors used with optional range capacitance (Type 571A) to tailor the output signal. Requires constant current source for operation. Ideal for quartz sensors.
Application	In-line charge converter for high impedance ceramic accelerometers ideal for remote signal conditioning for high temperature vibration measurements.	Conversions of charge signals from quartz piezoelectric sensors into proportional voltage signals. Ideal for remote signal conditioning for high temperature, high impedance sensors.
Accessories	Cable: Type 1635C.... Coupler: Type 5100 series	Range capacitor: Type 571A...

Ancillary Electronics

Equipment Calibration and Test



Type 8921...

Technical Data		...Y26
Frequency	Hz (rads)	159,2 (1 000)
Acceleration $rms, \pm 3 \%$	g	1,019
Velocity $rms, \pm 3 \%$	in/sec	0,394
Displacement $rms, \pm 3 \%$	mils	0,394
Mass	grams	300
Operating temp. range	°C	10 ... 40
Power supply current	mA	300
Power supply voltage	VDC	12
Battery	Type	built-in rechargeable
Mass	kg	2,0
Dimensions (WxHxD)	mm	107x76x178
Data sheet		8921Y_000-362

Properties

Test measurement system integrity, convenient self-contained and portable, rechargeable battery, tests sensors up to 300 grams, CE compliant.

Application

The Type 8921 reference shaker can be used to confirm the sensitivity of acceleration, velocity, and displacement sensors.

Accessories

10-32 to M5 stud: Type 8451 ¼-28 to M5 stud: Type 8453

Versions

Type 8921Y26: with 115 VAC battery charger
Type 8921: with 230 VAC battery charger



Type 5493

Technical Data		
Measuring range	Ω	$10^{11} \dots 4 \times 10^{13}$
Measuring voltage	V	5
Admissible voltage, max.	V	700
Measurement display		logarithmic
Battery power	VDC	9
Dimensions	mm	79x150x36
Mass	kg	0,29
Connector		pigtails
Data sheet		5493_000-354

Properties

Small, robust, for measuring high insulation resistance on the spot; low measuring voltage of 5 V, logarithmic indication avoids the need for range switching, automatic switch-off, CE compliant.

Application

Measure insulation resistance of cables and equipment.

Impulse

IEPE Impulse Hammers



		Type 9722...		Type 9724...		Type 9726...		Type 9728...
Technical Data		...A500	...A2000	...A2000	...A5000	...A5000	...A20000	...A20000
Force range	N	0 ... 500	0 ... 2 000	0 ... 2 000	0 ... 5 000	0 ... 5 000	0 ... 20 000	0 ... 20 000
Frequency response, -10 dB	Hz	8 200*	9 300*	6 600*	6 900*	5 000*	5 400*	1 000
Resonant frequency	kHz	27		27		27		20
Sensitivity	mV/N	10	2	2	1	1	0,2	0,2
Rigidity	kN/μm	0,8		0,8		0,8		0,015
Time constant	sec	500		500		500		500
Operating temp. range	°C	-20 ... 70		-20 ... 70		-20 ... 70		-20 ... 70
Power supply current	mA	2 ... 20		2 ... 20		2 ... 20		2 ... 20
Power supply voltage	VDC	20 ... 30		20 ... 30		20 ... 30		20 ... 30
Length of handle	mm	188		231		236		343
Hammer head: diameter	mm	17,5		23		32		51
Hammer head: length	mm	61		89		94		154
Mass	grams	100		250		500		1 500
Connector		BNC neg.		BNC neg.		BNC neg.		BNC neg,
Data sheet		9722A_000-272		9724A_000-273		9726A_000-274		9728A_000-275

Properties	Low impedance voltage mode, quartz force sensing element integrated to hammer handle, CE compliant.	Low impedance voltage mode, quartz force sensing element integrated to handle of hammer, CE compliant.	Low impedance voltage mode, quartz force sensing element integrated to hammer handle, CE compliant.	Low impedance voltage mode, quartz force sensing element integrated to handle of hammer, CE compliant.
Application	Modal analysis	Modal analysis	Modal analysis	Modal analysis
Accessories	Cable: Type 1601B... Coupler: Type 5100 series	Cable: Type 1601B... Coupler: Type 5100 series	Cable: Type 1601B... Coupler: Type 5100 series	Cable: Type 1601B... Coupler: Type 5100 series

* Low frequency point depends upon the system time constant and tip in use, call Kistler for details

Accessories

Mounting and Cables

Common accessories extend the flexibility of the accelerometer families often adapting to less than optimal conditions.

For instance, the variety of adhesive mounting pads provide ground isolation while permitting a reasonable attachment in situations where tapping a threaded hole is unacceptable. A series of magnet

mounts provides an alternate solution if the structure is a ferrous material. Also included in this section are a variety of conversion studs to accommodate a previous mounting site to a different accelerometer with different threads. Mounting cubes provide a means of obtaining accurate orthogonal measurements at a reasonable cost.



Mounting

Magnetic Mounting – see Data Sheet 000-281

Technical Data	Type	A (mm)	B (mm)	C (mm)	Thread X	Holding force (N-m)	Material
	8450A	7,6	12,7	11,2	5-40	8	17-4 PH Stainless steel
	8452A	11,2	17,8	16,0	10-32	16	17-4 PH Stainless steel
	8456	11,2	24,9	–	¼-28 stud	40	17-4 PH Stainless steel
	8458	26,9	47,2	–	¼-28 hole	55	17-4 PH Stainless steel

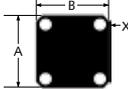
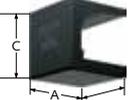
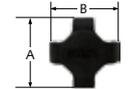
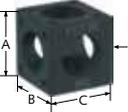
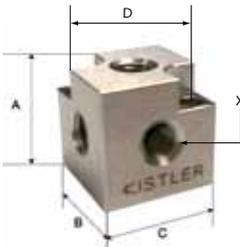
Mounting – see Data Sheet 000-281

Technical Data	Type	A (mm)	B (mm)	C (mm)	Thread X	Thread Y	Material
	8402	7,1	2,5	2,5	10-32	10-32	BeCu
	8404	7,1	2,5	2,5	10-32	10-32	17-4 PH St. steel
	8410	6,4	2,0	3,3	¼-28	10-32	BeCu
	8411	10,9	6,4	3,3	10-32	M6	BeCu
	8416	6,6	3,3	2,3	5-40	10-32	316 St. steel
	8418	7,1	3,8	2,3	5-40	M6	316 St. steel
	8421	13,2	6,4	4,6	M8	¼-28	BeCu
	8451	8,9	5,1	2,8	10-32	M5	BeCu
	8412	9,7	–	–	¼-28	¼-28	18-8 St. steel
	8420	9,7	–	–	5-40	5-40	18-8 St. steel
	8414	8,9	8,1	–	¼-28	10-32	17-4 PH St. steel
	8434	4,8	12,4	11,2	5-40	–	Al. anodized
	8436	4,8	15,7	14,2	10-32	–	Al. anodized
	8438	7,9	21,1	19,1	¼-28	–	Al. anodized

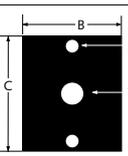
Accessories

Mounting

Mounting – see Data Sheet 000-281

Technical Data	Type	A (mm)	B (mm)	C (mm)	D (mm)	Thread X	Material
	800M144	16,0	16,0	–	–	4-40	Aluminum hard anodized, for Types 8793A, 8794A
	8474	19,6	17,8	18,5	–	–	Delrin®, for Type 8772A
	800M156	16,3	16,3	0,0	0,0		Poly carbonate, for Type 8640A
	800M155	20,1	20,1	0,0	0,0		Poly carbonate, for Type 8688A
	8522	26,9	26,9	26,9	15,0	4-40	Aluminum hard anodized, for Type 8315A
	8530K01	39,6	39,6	39,6	25,4	4-40	Aluminum hard anodized, for Type 8330B3
	8502	25,4	25,4	25,4	25,4	10-32	303 Stainless steel
	8504	14,5	14,5	14,5	14,0	10-32	303 Stainless steel
	8506	28,7	28,7	28,7	29,2	¼-28	303 Stainless steel
	8508	6,4	6,4	6,4	–	–	17-4 PH Stainless steel
	8510	14,5	14,5	14,5	14,2	5-40	316 Stainless steel
	8514	17,3	17,3	17,3	18,5	10-32	303 Stainless steel
	8524	11,2	11,2	11,2	–	10-32	Aluminum hard anodized
8526	11,2	11,2	11,2	–	–	Aluminum hard anodized	

Mounting – see Data Sheet 000-281

Technical Data	Type	A (mm)	B (mm)	C (mm)	D (mm)	Hex (mm)	Thread X	Thread Y	Material
	8400K01	3,4	–	11,6	14,0	12,7	87,1	10-32	Al. hard anodized
	8400K02	5,9	–	12,4	20,8	19,1	150,3	6-32	Al. hard anodized
	8400K03	5,5	–	12,8	20,8	19,1	140,6	M6	Al. hard anodized
	8400K04	5,2	–	12,3	14,0	12,7	132,3	M6	Al. hard anodized
	8400K05	5,9	–	13,3	20,8	19,1	150,3	M6	Al. hard anodized
	8400K06	5,3	–	11,4	14,0	12,7	135,5	5-40	Al. hard anodized
	8440K01	5,2	–	8,0	14,0	12,7	132,3	5-40	Al. hard anodized
	8440K02	5,7	–	9,0	20,8	19,1	143,9	6-32	Al. hard anodized
	8440K03	5,0	–	8,3	15,7	14,3	125,8	10-32	Al. hard anodized
	8462K01	4,8	–	–	20,6	19,1	122,6	–	Al. hard anodized, for Types 8715, 8765
	8462K02	4,8	–	–	20,8	19,1	122,6	–	Al. hard anodized, for Types 8715, 8765
	8464K01	7,6	21,6	25,4	–	–	193,5	–	Al. hard anodized
	8464K02	7,6	21,6	25,4	–	–	193,5	10-32(1)	Al. hard anodized
	8464K03	7,6	21,6	25,4	–	–	193,5	–	17-4 PH St. steel
	8466K01	6,4	–	8,9	24,6	22,2	161,3	–	Al. hard anodized
	8466K02	6,4	–	8,9	24,6	22,2	161,3	10-32	Al. hard anodized
	8466K03	6,4	–	8,9	24,6	22,2	161,3	–	303 St. stl., w. magnet
	800M158	2,5	–	5,1	9,4	–	64,5	–	Al. anod., Type 8640A
	800M157	3,8	–	6,4	11,1	–	96,8	–	Al. anod., Type 8688A

In the printed version several values in table above have been misprinted.
In this PDF the values are displayed correctly.

Accessories

Cables

Cables – see Data Sheet 1511_000-471

Technical Data	Types	Connection A	Connection B	Length (m)	Dia. (in)	Use
	1511	BNC pos.	BNC pos.	1/sp	0,25	Used for charge amplifier and coupler output signals
	1576	¼-28, 4 pin neg.	(3x) BNC pos.	0,20	0,07	Distribution cable, Teflon® jacket
	1578	¼-28, 4 pin neg.	¼-28, 4 pin neg.	2/sp	0,10	Extension cable, Teflon®
	1592A	¼-28, 4 pin neg.	¼-28, 4 pin neg.	2/4/sp	0,10	General purpose extension cable, Teflon®
	1592M1	¼-28, 4 pin neg.	pigtail	2/sp	0,10	Teflon® jacketed cables
	1601B	BNC pos.	BNC pos.	sp	0,12	High impedance charge mode cables, commonly used as extension cables
	1603B	BNC neg.	BNC pos.	sp	0,12	High impedance charge mode cables, commonly used as extension cables
	1631C	10-32 pos.	BNC pos.	1/2/3/5/8/sp	0,08	High impedance charge mode cables, Teflon®
	1635C	10-32 pos.	10-32 pos.	1/2/3/5/8/sp	0,08	High impedance charge mode cables, Teflon®
	1641	10-32 pos.	BNC pos.	sp	0,08	High impedance charge mode cables, Teflon®
	1734A...K03	¼-28, 4 pin neg.	(3x) BNC pos.	1/3/5/10	0,07	High temperature, ultra flexible IEPE triaxial cable with silicone jacket
	1756C...K03	¼-28, 4 pin neg.	(3x) BNC pos.	0,5/3/10/sp	0,10	High temperature, triaxial accelerometer breakout cable, Teflon® jacket
	1761B	10-32 pos.	BNC pos.	1/2/3/5/sp	0,08	Teflon® insulated, voltage mode cables
	1762B	10-32 pos.	10-32 pos.	1/2/3/5/sp	0,08	Teflon® insulated, voltage mode cables
	1766AK01	5-44 pos.	10-32 neg.	sp	0,06	8715A... mating cable
	1768A...K01	10-32 pos.	BNC pos.	1/2/3/5/sp	0,08	Flexible PVC jacketed cables
	1768A...K02	10-32 pos.	10-32 pos.	1/2/3/5/sp	0,08	Flexible PVC jacketed cables
	1534A...K00	¼-28, 4 pin neg.	pigtail	2/5/10/sp	0,10	Flexible silicon jacketed cables

Accessories

Cables

Cables – see Data Sheet 1511_000-471

Technical Data	Types	Connection A	Connection B	Length (m)	Dia, (in)	Use
	1784AK02	M4,5, 4 pin neg.	¼-28, 4 pin pos.	0,50/sp	0,06	Sensors with the Kistler M4,5, 4 pin connector (Types 8763,8765,8766)
	1784B...K03	M4,5, 4 pin neg.	(3x) BNC pos.	1/3/5/10	0,06	Sensors with the Kistler M4,5, 4 pin connector (Types 8763,8765, 8766), in triaxial applications, Teflon®
	1786C	¼-28, 4 pin neg.	(3x) Banana Jacks for power, (2x) BNC pos. signal out	2/5/10	0,1	Breakout power supply cable, Teflon® jacketed
	1788A	¼-28, 4 pin neg.	(3x) Banana Jacks for power, BNC pos. signal out	2/5/10	0,1	Breakout power supply cable, Teflon® jacketed
	1792A...K01	9 pin circular	9 pin D-Sub	2/5/10/sp	0,18	Mating cable: Type 8395A
	1792A...K00	9 pin circular	pigtail	2/5/10/sp	0,18	Mating cable: Type 8395A
	1794A	9 pin D-Sub neg.	(2x) Banana Jacks for power, (3x) BNC pos. signal out	2	0,1	Breakout power supply cable, Teflon® jacketed

Sensors and Signal Conditioning



		Type 8802A1	Type 8804A1
Technical Data			
Acceleration range	g	±250	±250
Acceleration limit	g	±1 000	±1 000
Threshold	mg _{rms}	20	10
Ref. voltage sensitivity (@ 100 Hz, 75 °F ±10 g)	mV/g	10 ±0,01	10 ±0,01
Frequency response	Hz	10 ... 10 000	10 ... 10 000
Transverse sensitivity, @ 100 Hz	%	2	2
Time constant	s	1	1
Non-linearity	%	±0,5	±0,5
Operating temp. range	°C	4 ... 40	4 ... 40
Temp. coefficient sensitivity	%/°C	-0,036	-3,6
Output signal voltage, FSO	V	±2,5	±2,5
Ground isolated		no	yes
Output impedance	Ω	<15	<15
Power supply voltage	VAC	115/230	115/230
Connector		10-32 neg. BNC neg.	10-32 neg. BNC neg.
Mass (sensor)	grams	20	80
Data sheet		8802A_000-520	8802A_000-521

Properties

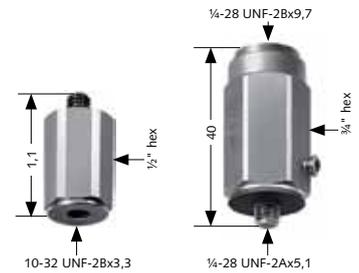
This calibration system features unique stability, linearity and repeatability. The Type 8802 includes Type 8002K and Type 5022 charge amp calibrated as a system, CE compliant.

This calibration system features unique stability, linearity and repeatability. The Type 8804 includes Type 8076K and Type 5022 charge amp calibrated as a system, CE compliant.

Application

System for lab/R&D primary calibration.

System for back-to-back calibration.



		Type 8002K	Type 8076K
Technical Data			
Range	g	±1 000	±1 000
Sensitivity, ±0,1	pC/g	-1	1
Frequency response	Hz	≈0 ... 6 000 (-1, ±5 %)	0,5 ... 5 000 (±4 %)
Threshold	mg _{rms}	20	10
Transverse sensitivity	%	≤2	≤2
Non-linearity	%FSO	±0,5	±0,5
Temp. coeff. sensitivity	%/°C	-0,03	0,02
Operating temp. range	°C	-70 ... 120	-20 ... 65
Connector		10-32 neg.	10-32 neg.
Housing/base material		Stainless steel	Stainless steel
Sealing	Type	epoxy	epoxy
Mass	grams	20	80
Sensing element	Type	Quartz	Quartz
Data sheet		8002K_000-205	8076K_000-210

Properties

High impedance, charge mode, quartz stability and repeatability, with wide operating temperature.

High impedance charge mode, quartz accuracy and stability, rugged design, low base strain sensitivity, ground isolated.

Application

Used with Type 5022 to form a complete calibration primary standard.

Used with Type 5022 to form a complete back-to-back calibration transfer standard.

Accessories

Mounting stud: Type 8402
Cable: Type 1631C
Charge amp.: Type 5022

Mounting stud: Type 8410
Cable: Type 1631C
Charge amp.: Type 5022

Versions

8767K IEPE style version of 8076K

Piezoelectric Theory

Piezoelectric Effect

Although the piezoelectric effect was discovered by Pierre and Jacques Curie in 1880, it remained a mere curiosity until the 1940's. The property of certain crystals to exhibit electrical charges under mechanical loading was of no practical use until very high input impedance amplifiers enabled engineers to amplify their signals. In the 1950's, electrometer tubes of sufficient quality became available and the piezoelectric effect was commercialized. Walter P. Kistler patented the charge amplifier principle in 1950 and gained practical significance in the 1960's. The introduction of highly insulating materials such as Teflon® and Kapton® greatly improved performance and propelled the use of piezoelectric sensors into virtually all areas of modern technology and industry. Piezoelectric measuring systems are active electrical systems. That is, the crystals produce an electrical output only when they experience a change in load. For this reason, they cannot perform true static measurements. However, it is a misconception that piezoelectric instruments are suitable for only dynamic measurements. Quartz transducers, paired with adequate signal conditioners, offer excellent quasi-static measuring capability. There are countless examples of applications where quartz based sensors accurately and reliably measure quasi-static phenomena for minutes and even hours.

Applications of Piezoelectric Instruments

Piezoelectric measuring devices are widely used today in the laboratory, on the production floor and embedded within as original equipment. They are used in almost every conceivable application requiring accurate measurement and recording of dynamic changes in mechanical variables such as pressure, force and acceleration. The list of applications continues to grow and now includes:

- Aerospace: Modal testing, wind tunnel and shock tube instrumentation, landing gear hydraulics, rocketry, structures, ejection systems and cutting force research
- Ballistics: Combustion, explosion, detonation and sound pressure distribution
- Biomechanics: Multi-component force measurement for orthopedic gait and posturography, sports, ergonomics, neurology, cardiology and rehabilitation
- Engine Testing: Combustion, gas exchange and injection, indicator diagrams and dynamic stressing
- Engineering: Materials evaluation, control systems, reactors, building structures, ship structures, auto chassis structural testing, shock and vibration isolation and dynamic response testing
- Industrial/Factory: Machine systems, metal cutting, press and crimp force, automation of force-based assembly operations and machine health monitoring
- OEMs: Transportation systems, plastic molding, rockets, machine tools, compressors, engines, flexible structures, oil/gas drilling and shock/vibration testers

Piezoelectric Sensors (Quartz Based)

The vast majority of Kistler sensors utilize quartz as the sensing element. As discussed in other sections of this catalog, Kistler also manufactures sensors which utilize piezoceramic elements and micro machined silicon structures. However, the discussion in this section will be limited to quartz applications. Quartz piezoelectric sensors consist essentially of thin slabs or plates cut in a precise orientation to the crystal axes depending on the application. Most Kistler sensors incorporate a quartz element, which is sensitive to either compressive or shear loads. The shear cut is used for patented multi-component force and acceleration measuring sensors. Other specialized cuts include the transverse cut for some pressure sensors and the patented polystable cut for high temperature pressure sensors. See Fig. 1 and 2 (on next page).

Although the discussion which follows focuses on acceleration applications, the response function for force and pressure sensors has essentially the same form. In fact, many force applications are closely related to acceleration. On the other hand, pressure sensors are designed to minimize or eliminate (by direct compensation of the charge output) the vibration effect. Call Kistler directly for more information on this subject.

Piezoelectric Theory

The finely lapped quartz elements are assembled either singularly or in stacks and usually preloaded with a spring sleeve. The quartz package generates a charge signal (measured in pico Coulombs) which is directly proportional to the sustained force. Each sensor type uses a quartz configuration which is optimized and ultimately calibrated for its particular application (force, pressure, acceleration or strain). Refer to the appropriate section for important design aspects depending on application.

Quartz sensors exhibit remarkable properties which justify their large scale use in research, development, production and testing. They are extremely stable, rugged and compact. Of the large number of piezoelectric materials available today, quartz is employed preferentially in sensor designs because of the following excellent properties:

- High material stress limit, approximately 150 N/mm²
- Temperature resistance up to 500 °C
- Very high rigidity, high linearity and negligible hysteresis
- Almost constant sensitivity over a wide temperature range
- Ultra high insulation resistance

High and low impedance

Kistler supplies two types of piezoelectric sensors: high and low impedance. High impedance units have a charge output which requires a charge amplifier or external impedance converter for charge-to-voltage conversion. Low impedance types use the same piezoelectric sensing element as high impedance units and also incorporate a miniaturized built-in charge-to-voltage converter. Low impedance types require an external power supply coupler to energize the electronics and decouple the subsequent DC bias voltage from the output signal.

Dynamic Behavior of Sensors

Piezoelectric sensors for measuring pressure, force and acceleration may be regarded as under-damped, spring mass systems with a signal degree of freedom. They are modeled by the classical second order differential equation whose solution is:

$$\frac{a_o}{a_b} \cong \frac{1}{\sqrt{\left[1 - \left(\frac{f}{f_n}\right)^2\right]^2 + \left(\frac{1}{Q^2}\right) \left(\frac{f}{f_n}\right)^2}}$$

Where:

- f_n undamped natural (resonant) frequency (Hz)
- f frequency at any given point of the curve (Hz)
- a_o output acceleration
- a_b mounting base or reference acceleration ($f/f_n = 1$)
- Q factor of amplitude increase at resonance

Quartz sensors have a Q of approximately 10 ... 40 and therefore the phase angle can be written as:

$$\text{phase lag (deg)} \cong \frac{60}{Q} \left(\frac{f}{f_n}\right) \text{ for } \frac{f}{f_n} \leq \frac{2}{5}$$

A typical Frequency response curve is shown in Fig. 3. As shown, about 5% amplitude rise can be expected at approximately 1/5 of the resonant frequency (f_n). Low-pass (LP) filtering can be used to attenuate the effects of this. Many Kistler signal conditioners (charge amplifiers and couplers) have plug-in filters for this purpose.

Piezoelectric Theory

Fig. 1: Quartz bar

- 1 = compression cut
- 2 = Polystable® cut
- 3 = transverse cut
- 4 = shear cut

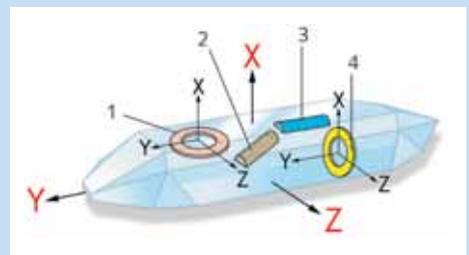


Fig. 2: Piezoelectric effect

- 1 = longitudinal effect
- 2 = transverse effect
- 3 = shear effect

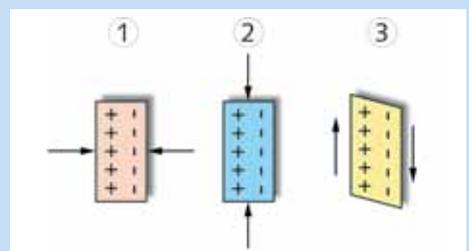
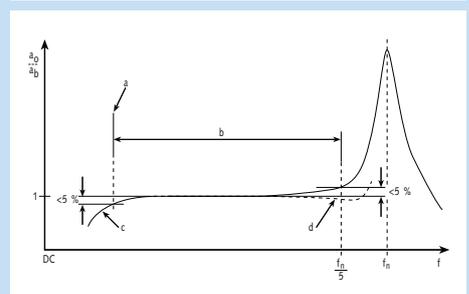


Fig. 3: Typical frequency response curve

- a = low frequency limit determined by RC roll-off characteristics
- b = useable frequency range
- c = HP filter
- d = LP filter



Piezoelectric Theory

Charge Amplifiers

Basically the charge amplifier consists of a high-gain inverting voltage amplifier with a MOSFET or J-FET at its input to achieve high insulation resistance. A simplified model of the charge amplifier is shown in Fig. 4.

The effects of R_t and R_j will be discussed below. Neglecting their effects, the resulting output voltage becomes:

$$V_o = \frac{-q}{C_r} \times \frac{1}{1 + \frac{1}{AC_r} (C_t + C_r + C_c)}$$

For sufficiently high open loop gain, the cable and sensor capacitance can be neglected and the output voltage depends only on the input charge and the range capacitance:

$$V_o = \frac{-q}{C_r}$$

In summary, the amplifier acts as a charge integrator which compensates the sensor's electrical charge with a charge of equal magnitude and opposite polarity and ultimately produces a voltage across the range capacitor. In effect, the purpose of the charge amplifier is to convert the high impedance charge input (q) into a useable output voltage (V_o).

Time constant and drift

Two of the more important considerations in the practical use of charge amplifiers are time constant and drift. The time constant is defined as the discharge time of an AC coupled circuit. In a period of time equivalent to one time constant, a step input will decay to 37% of its original value.

Time Constant (TC) of a charge amplifier is determined by the product of the range capacitor (C_r) and the time constant resistor (R_t):

$$TC = R_t C_r$$

Drift is defined as an undesirable change in output signal over time, which is not a function of the measured variable. Drift in a charge amplifier can be caused by low insulation resistance at the input (R_i) or by leakage current of the input MOSFET or J-FET.

Drift and time constant simultaneously affect a charge amplifier's output. One or the other will be dominant. Either the charge amplifier output will drift towards saturation (power supply) at the drift rate or it will decay towards zero at the time constant rate.

Many Kistler charge amplifiers have selectable time constants which are altered by changing the time constant resistor (R_t). Several of these charge amplifiers have a "Short", "Medium" or "Long" time constant selection switch. In the "Long" position, drift dominates any time constant effect. As long as the input insulation resistance (R_i) is maintained at greater than $10^{13} \Omega$, the charge amplifier (with MOSFET input) will drift at an approximate rate of 0,03 pC/s. Charge amplifiers with J-FET inputs are available for industrial applications but have an increased drift rate of about 0,3 pC/s. In the "Short" and "Medium" positions, the time constant effect dominates normal leakage drift. The actual value can be determined by referring to the appropriate operation/instruction manual which is supplied with the unit. Kistler charge amplifiers without "Short", "Medium" or "Long" time constant selection, operate in the "Long" mode and drift at the rates listed above. Some of these units can be internally modified for shorter time constants to eliminate the effects of drift.

Frequency and time domain considerations

When considering the effects of time constant, the user must think in terms of either frequency or time domain.

The longer the time constant, the better the low-end Frequency response and the longer the useable measuring time. When measuring vibration, time constant has the same effect as a single pole, highpass (HP) filter whose amplitude and phase are:

$$\frac{V_o}{V_{in}} = \frac{2\pi f (TC)}{\sqrt{1 + [2\pi f (TC)]^2}}$$

$$\text{phase lead (deg)} = \arctan \frac{1}{2\pi f (TC)} \cong 80 \sqrt{\frac{V_{in} - V_o}{V_{in}}}$$

For example, the output voltage has declined approximately 5 % when $f \times (TC)$ equals 0,5 and the phase lead is 18 degrees.

When measuring events with wide (or multiple) pulse widths the time constant should be at least 100 times longer than the total event duration. Otherwise, the DC component of the output signal will decay towards zero before the event is completed.

Selection matrix

Other design features incorporated into Kistler charge amplifiers include range normalization for whole number output, low-pass filters for attenuating sensor resonant effects, electrical isolation for minimizing ground loops and digital/computer control of setup parameters.

Low Impedance Piezoelectric Sensors

Piezoelectric sensors with miniature, built-in charge-to-voltage converters are identified as low impedance units throughout this catalog. These units utilize the same types of piezoelectric sensing element(s) as their high impedance counterparts. Piezotron, Picotron, PiezoBeam, Ceramic Shear and K-Shear are all forms of Kistler low impedance sensors.

Piezoelectric Theory

In 1966, Kistler developed the first commercially available piezoelectric sensor with internal circuitry. This internal circuit is a patented design called Piezotron. This circuitry employs a miniature MOSFET input stage followed by a bipolar transistor stage and operates as a source follower (unity gain). A monolithic integrated circuit is utilized which incorporates these circuit elements. This circuit has very high input impedance ($10^{14} \Omega$) and low output impedance (100Ω) which allows the charge generated by the quartz element to be converted into a useable voltage. The Piezotron design also has the great virtue of requiring only a single lead for power-in and signal-out. Power to the circuit is provided by a Kistler coupler (Power supply), which supplies a source current (2 ... 18 mA) and energizing voltage (20 ... 30 VDC). Certain (extreme) combinations of other manufacture's supply current and energizing voltage (i.e. 20 mA and 18 VDC, respectively), together with actual bias level, may restrict operating temperature range and voltage output swing. Call Kistler for details. Connection is as shown in Fig. 5. A Kistler coupler and cable is all that is needed to operate a Kistler low impedance sensor. The steady state output voltage is essentially the input voltage at the MOSFET gate plus any offset bias adjustment. The voltage sensitivity of a Piezotron unit can be approximated by:

$$V_o \cong \frac{q}{C_q + C_r + C_G}$$

The range capacitance (C_r) and time constant resistor (R_t) are designed to provide a predetermined sensitivity (mV/g) and upper and lower useable frequency. The exact sensitivity is measured during calibration and its value is recorded on each unit's calibration certificate.

Since its invention, the Piezotron design has been adapted by manufactures worldwide and has become a widely used standard for design of sensors which measure acceleration, force and pressure. The concept has become known by many names besides Piezotron such as low impedance or voltage mode. Also, a number of "brand names" have emerged by other manufactures. Picotron is a miniature accelerometer whose circuitry is very similar to the Piezotron. PiezoBeam incorporates a bimorph ceramic element and a miniature hybrid charge amplifier for the charge-to-voltage conversion. K-Shear is the newest member of the Kistler low impedance family and utilizes a shear quartz element together with the Piezotron circuitry.

Time constant

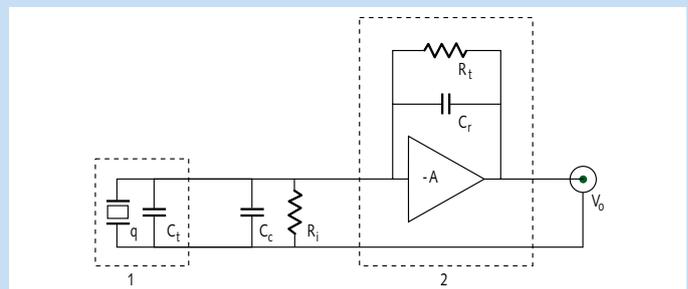
The time constant of a Piezotron or Picotron sensor is:

$$TC = R_t (C_q + C_r + C_G)$$

A PiezoBeam's time constant is the product of its hybrid charge amplifier's range capacitor and time constant resistor. Time constant effects in low impedance sensors and in charge amplifiers are the same. That is, both act as a single pole, highpass filter as discussed previously.

Piezoelectric Theory

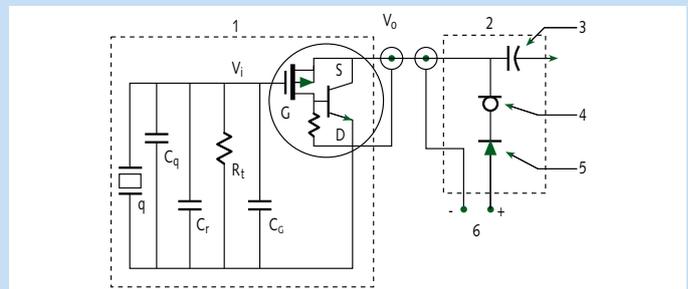
Fig. 4
Simplified charge amplifier model



- 1 = piezoelectric accelerometer
- 2 = charge amplifier
- V_o = output voltage
- A = open loop gain
- C_t = sensor capacitance

- C_c = cable capacitance
- C_r = range (or feedback) capacitor
- R_i = insulation resistance of input circuit (cable and sensor)
- q = charge generated by the sensor

Fig. 5
Piezotron®
circuit & coupler



- 1 = accelerometer
- 2 = coupler
- 3 = decoupling capacitor
- 4 = constant current diode
- 5 = reverse polarity protection diode
- 6 = DC source
- q = charge generated by piezoelectric element

- V_i = input signal at gate
- V_o = output voltage (usually bias decoupled)
- C_q = sensor capacitance
- C_r = range capacitance
- C_G = MOSFET GATE capacitance
- R_t = time constant resistor

Capacitive Accelerometer Theory

The fundamental principle of operation for a capacitive accelerometer is the property that a repeatable change in capacitance exists when a sensing structure is deflected due to an imposed acceleration.

The acceleration creates a force (F) acting on a suspended flexure of known mass (m). The flexure moves predictably and in a controlled manner dictated by its stiffness (k). A gas filled gap exists between surrounding electrodes as shown in Fig. 1. The inertial force can be calculated from Newton's Second Law of Motion as:

$$F = ma \quad [\text{Eq. 1}]$$

Knowing the force, a displacement of the flexure can be estimated using a simple spring calculation:

$$x = F/k \quad [\text{Eq. 2}]$$

However, in practice, Finite Element Analysis (FEA) is employed to model the complicated spring designs. This displacement alters the gaps on either side of the flexure in an equal but opposite proportion. The distance between the flexure and surrounding electrodes (l), is then the nominal [zero g] spacing (d) ± the spring deflection (x) or:

$$l_1 = d + x \quad \& \quad l_2 = d - x \quad [\text{Eq. 3}]$$

Knowing the electrode area (A) and the permittivity constant of the gas (E), the capacitance formed by the gaps can be determined from:

$$C_1 = A \epsilon / l_1 \quad \& \quad C_2 = A \epsilon / l_2 \quad [\text{Eq. 4}]$$

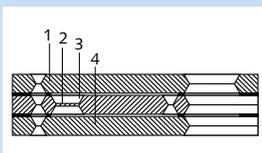
This capacitance difference causes an imbalance in a bridge network of the internal electronic circuit. Internal signal conditioning incorporates AC excitation and synchronous demodulation. In addition, it provides power for the accelerometer element and outputs an analog voltage proportional to the acceleration signal. The key operating principle of Fig. 2 is that a variable capacitive element unbalances a bridge relative to applied acceleration. The electronic action is summarized as follows:

- A voltage regulator stabilizes the accelerometer sensitivity and assures internal functions remain constant despite the supply voltage level
- A square wave generator produces excitation for the bridge circuit
- A capacitive bridge produces two signals with amplitudes relative to the applied acceleration
- The opposing signals are summed by the synchronous demodulator, to form a voltage proportional to applied acceleration
- A preamplifier provides gain
- A built-in low pass filter attenuates unwanted signals above the operating frequency range

Kistler micromachined K-Beam accelerometer sensing elements consist of very small inertial mass and flexure elements chemically etched from a single piece of silicon. The seismic mass is supported by flexure elements between two plates, which act as electrodes. As the mass deflects under acceleration, the capacitance between these plates changes. Under very large accelerations (or shocks), the motion of the mass is limited by the two stationary plates thereby limiting the stress placed on the suspension and preventing damage. The typical design is shown in Fig. 3.

The damping of the mass by an entrapped gas creates a "squeeze film" providing an optimized frequency response over a wide temperature range. Additionally, its differential capacitive design assures immunity to thermal transients. The affect of damping is shown in Fig. 4a and appropriate damping is tuned with a specific spring mass system to achieve optimal frequency response (Fig. 4b).

Capacitive Theory



1 = top electrode
2 = spring
3 = mass
4 = bottom electrode

Fig. 1: Typical capacitive accelerometer arrangement

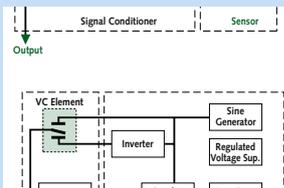


Fig. 2: Electrical schematic



1 = top electrode
2 = frame
3 = spring
4 = mass
5 = bottom electrode
6 = glass layer

Fig. 3: MEMS variable capacitance accelerometer

Capacitive Theory

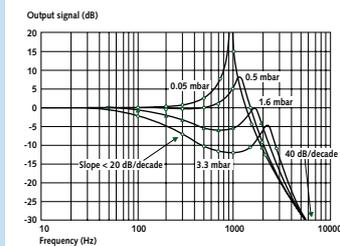


Fig. 4a
Effect of damping

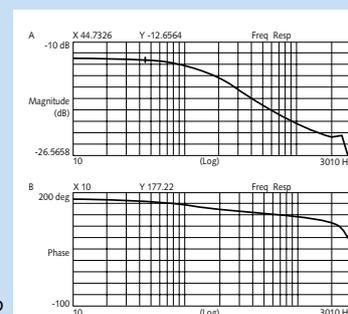


Fig. 4b
Tuned system

Glossary

Bias voltage

DC (no load or quiescent) output level of a low impedance sensor powered by constant current excitation.

Ceramic Shear

Kistler piezoelectric accelerometer family which utilizes ceramic shear sensing elements.

Charge amplifier

Part of a measuring chain which converts the charge signal from the sensor into a proportional voltage signal or current signal.

Charge output

Output in pico Coulombs (pC) from a piezoelectric sensor without a built-in charge-to-voltage converter (see High impedance).

Circuit integrity indication

A quick-look reference on couplers or dual mode charge amplifier for identifying whether a low impedance system has the proper bias voltage. Analog meters and multi-color LEDs are the most commonly used indicators.

Constant current excitation

Method of powering low impedance sensors to insure minimal sensitivity variation over a wide voltage range. A Piezotron coupler or any other IEPE type power supply may be used for this purpose.

Coupler

Electronic unit which supplies constant current excitation to low impedance sensors and decouples the subsequent bias voltage.

Crosstalk

Signal at the output of a sensor, produced by a measurand acting on the sensor, which is different from the measurand assigned to this output. For example, when a load in the F_y direction produces an F_z signal in a three-component sensor. In terms of electrical devices, it is a measure for the signal impact acting from a channel to the neighbouring ones.

Drift

Unwanted changes in the output signal independent of the measurand as a function of time.

Dual mode

Refers to a charge amplifier which can be used either with high impedance, charge output or with low impedance, voltage output sensors.

Ground isolation

High electrical resistance of a sensor between signal line and ground, or of a charge amplifier between connector screen and ground.

High impedance

Another term for a piezoelectric sensor with charge output (i.e. pC/mechanical unit).

Hysteresis

The maximum difference in output, at any measurand value within the specified range, when the value is approached first increasing and then decreasing measurand (source: ANSI/ISA-S37.1).

Note: The quartz crystal itself has a scarcely measurable hysteresis. However, the mechanical construction of the sensor can result in slight hysteresis. If the hysteresis is above the specified values (in %FSO), then the sensor is faulty or has not been correctly installed.

IEPE

Integrated Electronic PiezoElectric

Impedance converter

A miniature electronic unit with MOSFET input and bipolar output for converting high impedance, charge outputs (from a sensor) into low impedance, voltage outputs. Impedance converters can be built into the sensor (see Low impedance) or can be used externally for special applications.

Impedance head

Sensor that simultaneously measures both force and acceleration during modal analysis testing.

Insulation resistance

Electric resistance of a sensor, cable or the input of a charge amplifier measured between the signal line and the connection ground (sensor body), while the test voltage is stated accordingly. The insulation resistance applies for piezoelectric sensor, strain gauge sensors and semiconductor sensors.

K-Beam®

Kistler's solid-state, variable capacitance based line of accelerometers, which are suitable for measuring low frequencies or even steady-state conditions.

K-Shear®

Kistler's piezoelectric accelerometer family. Low impedance accelerometer, which utilizes quartz shear sensing element.

Linearity

Linearity is defined as the closeness of the calibration curve to a specified line (source: ANSI/ISA-S37.1).

Linearity represents the maximum deviation between ideal and actual output signal characteristics in relation to the measurand in a specific measuring range. It is expressed in percentage of the range of measurement signal (full scale output). Note: Quartz crystals produce an electric charge, which is exactly proportional to the load. However, certain unavoidable deviations occur due to the mechanical construction of the sensor.

Low impedance

Another name for a piezoelectric sensor with a miniature, built-in charge to voltage converter. Output is typically in mV/mechanical unit. K-Shear, Piezotron, Picotron and PiezoBeam are all forms of low impedance sensors.

Low-pass filter

Special type of a filter that the high frequency components of a measurement signal hides (electronic, mechanical, digital).

Measurand

Physical quantity, state or characteristic which is measured, e.g. force, torque, pressure etc.

Glossary

Natural frequency

Frequency of free (not forced) oscillations of the entire sensor. In practice the (usually lower) natural frequency of the entire mounting structure governs the frequency behaviour.

Newton (N)

A metric unit of force measurement equivalent to 0,305 N·m.

pico Coulomb (pC)

A unit of electrical charge equivalent to 1×10^{-12} ampere second.

Picotron

Mini accelerometer with Piezotron circuitry.

PiezoBeam®

Low impedance accelerometer. Incorporates a bimorph ceramic element that generates an electrical charge when mechanically loaded.

Piezoelectric sensor

Sensor with element that generates an electrical charge when mechanically loaded.

PiezoStar®

Kistler proprietary crystal used with IEPE accelerometers to provide ultra low sensitivity with temperature.

Piezotron®

Patented Kistler piezoelectric sensors with miniature, built-in impedance converters (see Impedance converter).

Polystable®

Patented Kistler quartz element incorporated into pressure sensor designs for operating temperatures up to 660 °F.

Quasi-static

Describes the ability of Kistler sensors, charge amplifiers, and electrical devices to undertake time-variable and nearly time-constant measurements (e.g. long-term measurements or DC-similar measurements).

Resonance frequency

Resonance frequency corresponds the frequency of an oscillating system, at which a resonance case is observed. Frequencies are called resonance frequencies of a system, when the amplitude of a system oscillation responds with a local maximum at constant excitation (forced oscillation).

Rise time

The length of time for the output of a sensor to rise from 10 % to 90 % of its final value as a result of a step-change of measurand.

Sealing

The degree of sealing as per EN60529 is IP 66 (commonly denoted as "Epoxy" sealing) IP 67 ("epoxy/welded"), and IP 68 ("Hermetic").

Sensitivity

Nominal value or calibrated value stated in the calibration certificate of the change in the response of a sensor divided by the corresponding change in the value of the measurand.

TEDS

Transducer Electronic Data Sheet. Characteristic data stored digitally internal to sensor, IEEE 1451.4 compliant.

TEDS Versions

T	Default, IEEE 1451.4 V0.9 Template 0 (UTID 1)
T01	IEEE 1451.4 V0.9 Template 24 (UTID 116225)
T02	LMS Template 117, Free format Point ID
T03	LMS Template 118, Automotive Format (Field 14 Geometry = 0)
T04	LMS Template 118, Aerospace Format (Field 14 Geometry = 1)
T05	P1451.4 v1.0 template 25 - Transfer Function Disabled
T06	P1451.4 v1.0 template 25 - Transfer Function Enabled

Temperature coefficient of sensitivity

Change in the sensitivity, i.e. the slope of the best straight line, as a function of temperature. The temperature distribution

in the sensor is assumed to be homogeneous, and in thermal equilibrium with the environment.

The temperature coefficient of the sensitivity is typically only approx. 0,02 %/°C, and is thus mostly negligible compared with other influence quantities.

Time constant (TC)

The time constant describes the behaviour of a high-pass filter and represents the time after which the signal is reduced to 1/e of the output value.

Note: The time constant enables the measuring error to be estimated in relation to the measuring duration. You will find detailed information on time constants and sensitivity ranges in the operating instructions for your charge amplifier. Example: The time constant depends on the measuring range selected on the charge amplifier. Possible values vary from approx. 0,01 s in the most sensitive range to approx. 100 000 s in the least sensitive range. The largest possible time constant must be selected for quasi-static measurements.

Threshold

Largest change in the measurand that produces a measurable change in the sensor output, while the change of the measurand takes place slowly and monotonically.

Note: In practice, the rule of thumb applies that the threshold is about two to three times as large as the typical noise signal of a charge amplifier. This value can, however, only be achieved in dynamic measurements, whereas with quasi-static measurements, drift and environmental influences are limiting factors.

Transverse sensitivity

The output of an accelerometer caused by acceleration perpendicular to the measuring axis.

Voltage output

Output (in mV) from a piezoelectric sensor with a built-in charge-to-voltage converter (see Low impedance).

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