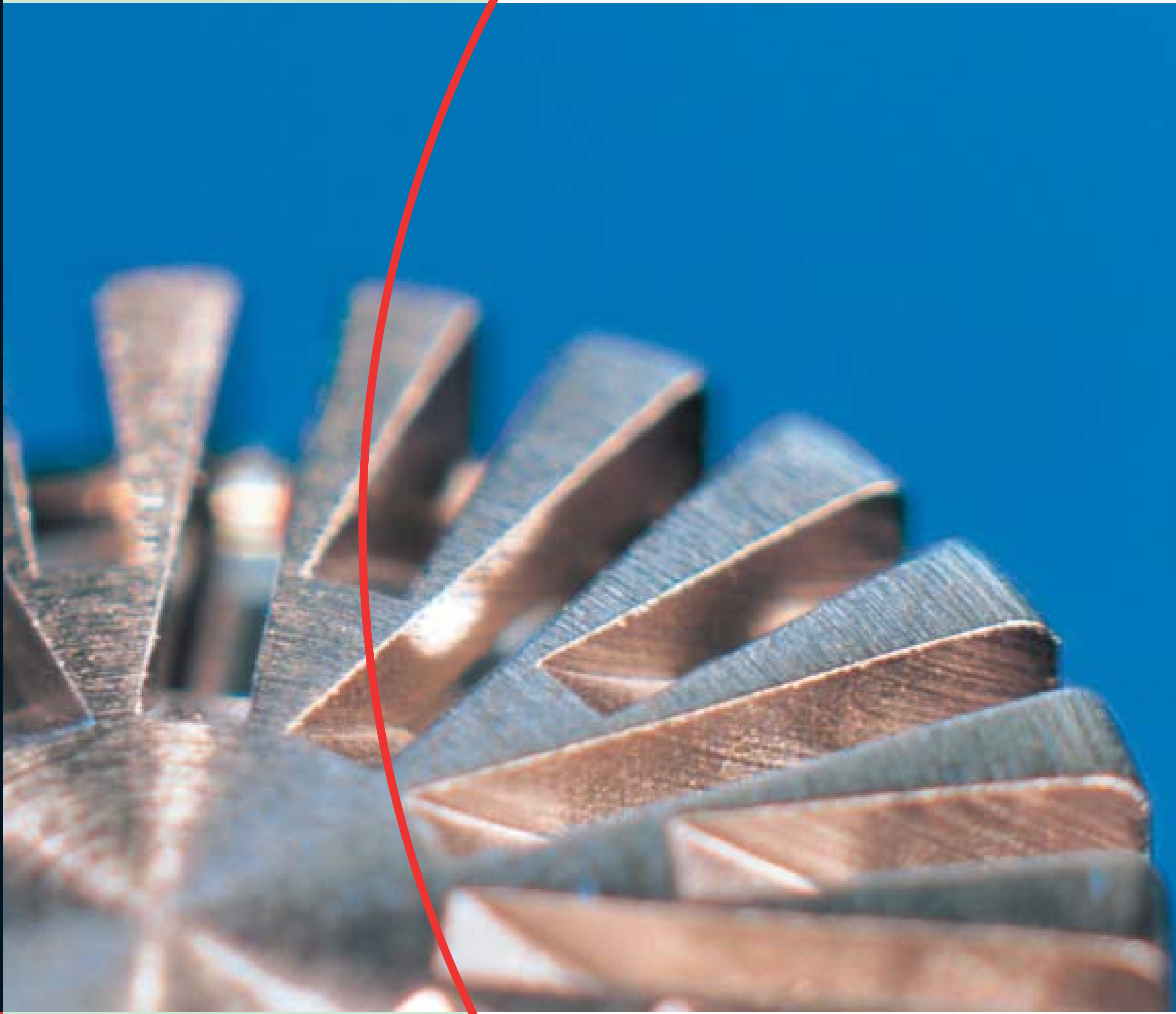
Microphones *& Conditioning*



Product *Catalogue 2002*

Brüel & Kjær

WELCOME

Welcome to Brüel & Kjær's Microphones & Conditioning Catalogue covering our full range of Microphones, Preamplifiers, Accessories, Hydrophones and Acoustic Conditioning Amplifiers. The products are sorted individually into easy to follow tables listing the most important specifications and making it easy for you to select the right product for your particular measurement needs.

Innovative Solutions

At Brüel & Kjær we are in the business of innovation. We always have been – from the first range of measurement microphones to the first multi-analyzer and the first Non-stationary STSF system. We're proud of this tradition and continue to develop and face the challenges posed to us by our customers. In fact we're focusing more and more on our customers' needs and in most instances supply whatever they need covering the whole measurement chain – from a single transducer to a complete turnkey system. This has, in part, been made possible by strategic alliances that enable us and our partners to find newer and more efficient ways for our customers to improve their products' quality and stay at the cutting edge of competitiveness. Technology has no limits – if our customers can imagine it then we can develop it.

Wealth of Experience

Knowledge and experience go hand-in-hand and we have accumulated over 60 years' worth. In fact, many of our employees are world-renowned experts in their respective fields and are often asked to speak at seminars, conferences, advise on new Standards, etc. But our expertise doesn't only come from within our organisation; it also comes from working closely together with our partners. In this way we can further our declared mission – to enhance the environment, the quality and the joy of life for everyone by improving sound and reducing vibration. With all this expertise we have been able to establish our knowledge centre – the Brüel & Kjær University – from which we can build and spread sound and vibration related knowledge worldwide for the benefit of our partners, employees and, not least, our customers.

Top Quality

In all aspects of sound and vibration there are challenges to be met. For example, making sure that the car, bus or train that one takes to work each day can withstand the mechanical shocks imposed on it demands measurements of great accuracy and precision. This requires instruments with the performance and quality to match. All our products are thoroughly tested, often in the harshest environmental conditions. Extremely high standards are met in all aspects of product and service provision, as reflected in our status as an ISO 9001 certified company. In fact, you'll find that our products usually come with a service period of 5 years after the end of production, such is their reliability, quality and robustness. And it is not only customer demands that need to be satisfied – legislation also sets exacting standards. This often means documented results that are traceable to known sources, such as a national calibration laboratory. And it goes without saying that the support customers receive must always be the most reliable they can find. If things go wrong, Brüel & Kjær is there.

Brüel & Kjær's Vision

Our vision is to be the preferred partner and solution provider to all leading companies and institutions who care about sound and vibration, and be the global competence centre for sound and vibration.

CONTENTS

SELECTING THE RIGHT MICROPHONE

When selecting a measurement microphone, it is important to understand the measurement requirements and the demands they impose on the microphone. This is necessary because, although measurement microphones are precision instruments that are optimised for particular measurement tasks, they still offer a wide operational range. In fact, such is the versatility of Brüel & Kjær microphones, that you might be tempted into a "that one will do" philosophy when selecting a microphone, simply because a microphone comes within the required general performance parameters. However, if you have a good understanding of the measurement requirement, it is possible to choose the best microphone for the measurement task in hand.

Type of Sound Field

A good way of narrowing down the choice of microphone is to consider the type of sound field in which the measurements are being made. For measurements made away from reflecting surfaces or in acoustically well-damped indoor environments, e.g., when making outdoor measurements with a sound level meter or in an office providing a lot of natural acoustic damping, a free-field microphone is clearly best. But for measurements made in small closed couplers or close to hard, reflective surfaces, a pressure-field microphone is more appropriate. An example of this could be, for example, a set of pressure-sensing microphones positioned at different points across an aircraft wing. A complete picture of the pressure variations across the wing surface can then be established. For measurements in enclosed areas where reverberation is likely, pressure-field microphones adapted for random-incidence measurements are best. This is because the random-incidence response of a pressure-field microphone is much "flatter" or constant across the frequency range, than that of a free-field response microphone.

Dynamic Range

The lower limit of the dynamic range is dictated by the inherent noise of the microphone and preamplifier combination. The upper limit of the dynamic range is dictated by the maximum sound pressure level (3% total harmonic distortion). Due to the very wide dynamic range of the microphone, it is normally either the lower or the upper limit of the dynamic range that is of interest.

Frequency Response

Although particular types of microphone are optimised for particular purposes, they still have a wide operational frequency range. The frequency range is very interdependent with other parameters and the frequency response should therefore be considered in relation to other selection requirements such as the type of sound field and the dynamic range.

Polarization

There are two different types of microphone construction, one that employs an external voltage supply to polarize the backplate to the diaphragm air gap (externally polarized), and one where the polarization charge is stored in an electret layer on the backplate of the microphone (prepolarized). Generally there are only small differences between the specifications for externally polarized and prepolarized microphones, but these differences make them suitable for different purposes. Prepolarized microphones are used for portable sound level meters and with DeltaTron® preamplifiers. Prepolarized microphones also offer slightly better performance in very humid environments. Externally polarized microphones are generally more useful for general field and laboratory use and for high-temperature measurements. And for special measurements, externally polarized microphones offer a broader range to choose from.

Standards

Abbreviations used for Standards in the Tables

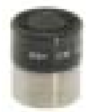
	IEC 61094 – 4		IEC 61672		ANSI
A	IEC 61094 – 4 WS1F	I	IEC 61672 Class 1	K	ANSI S1.4 Type 1
B	IEC 61094 – 4 WS2F	J	IEC 61672 Class 2	L	ANSI S1.4 Type 2
C	IEC 61094 – 4 WS3F			M	ANSI S1.12 Type M
D	IEC 61094 – 4 WS1P				
E	IEC 61094 – 4 WS2P				
F	IEC 61094 – 4 WS3P				
G	IEC 61094 – 1 LS1P				
H	IEC 61094 – 1 LS2P				

It is also worth considering other parameters such as phase response, venting, environmental exposure and documentation.

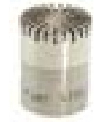
MICROPHONES

Free-field Microphones

Free-field microphones are particularly suitable for making measurements away from reflecting surfaces, e.g., when making outdoor measurements with a sound level meter, or in an acoustically well-damped indoor environment, e.g., in an office with natural acoustic damping.

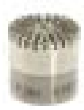







Type Number		4939	4130	4176	4188	4189	4190
Diameter	inch	1/4	1/2	1/2	1/2	1/2	1/2
Optimised		Free-field	Free-field	Free-field	Free-field	Free-field	Free-field
Standards		C	J	I, K	I, K	B, I, L	B, I, L
Nominal Open-circuit Sensitivity	mV/Pa	4	10	50	31.6	50	50
Polarization Voltage*	V	200	28	0	0	0	200
Optimised Frequency Response ±2 dB	Hz	4 to 100000	6.5 to 8000	7 to 12500	8 to 12500	6.3 to 20000	3.15 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	35 to 164 (2670)	33 to 142 (2642)	14 to 142 (2669)	15.8 to 146 (2669)	15.2 to 146 (2669)	15 to 147 (2669)
Inherent Noise	dB (A)	28	13.5	13.5	14.2	14.6	14.5
Capacitance	pF	6.1	14	12.5	12	13	16
Venting		Side	Rear	Rear	Rear	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	0.5 to 5	0.5 to 5	1 to 5	2 to 4	1 to 2
Operating Temperature Range	°C	–40 to 150	–30 to 100	–30 to 100	–30 to 125	–30 to 150	–30 to 150
Temperature Coefficient	dB/°C	+0.003	–0.007	–0.004	+0.005	–0.001	–0.007
Pressure Coefficient	dB/kPa	–0.007	–0.02	–0.02	–0.021	–0.01	–0.01
Preamplifier Included		No	No	No	No	No	No

* 0 V = Prepolarized microphone




Type Number		4191	4145
Diameter	inch	1/2	1
Optimised		Free-field	Free-field
Standards		B, I, L, M	A, I
Nominal Open-circuit Sensitivity	mV/Pa	12.5	50
Polarization Voltage*	V	200	200
Optimised Frequency Response ±2 dB	Hz	3.15 to 40000	2.6 to 18000
Dynamic Range with Preamplifier Type	dB(A) to dB	21.4 to 161 (2669)	10.2 to 146 (2669)
Inherent Noise	dB (A)	20	10
Capacitance	pF	18	66
Venting		Side	Rear
Lower Limiting Frequency (–3 dB)	Hz	1 to 2	1 to 2
Operating Temperature Range	°C	–30 to 300	–30 to 100
Temperature Coefficient	dB/°C	–0.002	–0.002
Pressure Coefficient	dB/kPa	–0.007	–0.015
Preamplifier Included		No	No

* 0 V = Prepolarized microphone

Earlier Microphones	Compatible Brüel & Kjær Microphones
4133	4191
4134	4192
4135	4939
4136	4938
4147	4193
4155	4189
4165	4190
4166	4943

Diffuse-field Microphones

A diffuse-field microphone, also called a random-incidence microphone, is designed to have a flat response when signals arrive simultaneously from all directions. They should, therefore, not only be used for making-measurements in reverberation chambers, but also in all situations where the sound field is diffuse, or where several sources contribute to the sound pressure at the measurement position. Examples include indoor measurements where the sound is reflected by walls, ceilings, and objects in the room, or measurements made inside a car.

Type Number		4942	4943
Diameter	inch	1/2	1/2
Optimised		Diffuse-field	Diffuse-field
Standards		K	K
Nominal Open-circuit Sensitivity	mV/Pa	50	50
Polarization Voltage*	V	0	200
Optimised Frequency Response ±2 dB	Hz	6.3 to 16000	3.15 to 10000
Dynamic Range with Preamplifier Type	dB(A) to dB	15.2 to 146 (2669)	15.9 to 147 (2669)
Inherent Noise	dB (A)	14.6	15.5
Capacitance	pF	13	16
Venting		Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	2 to 4	1 to 2
Operating Temperature Range	ºC	–40 to 150	–40 to 150
Temperature Coefficient	dB/ºC	–0.001	–0.010
Pressure Coefficient	dB/kPa	–0.01	–0.008
Preamplifier Included		No	No

* 0 V = Prepolarized microphone

Pressure-field Microphones

A pressure-field microphone is appropriate for making measurements in small, closed couplers or close to hard, reflective surfaces, for example, a set of pressure-sensing microphones positioned at different points across an aircraft wing. A complete picture of the pressure variations across the wing surface can then be established.

Type Number		4138	4938	4944	4947	4192	4144
Diameter	inch	1/8	1/4	1/4	1/2	1/2	1
Optimised		Pressure-field	Pressure-field	Pressure-field	Pressure-field	Pressure-field	Pressure-field
Standards		–	F	F	K	E, K, M	D, L
Nominal Open-circuit Sensitivity	mV/Pa	1	1.6	1	12.5	12.5	50
Polarization Voltage*	V	200	200	0	0	200	200
Optimised Frequency Response ±2 dB	Hz	6.5 to 140000	4 to 70000	4 to 70000	8 to 10000	3.15 to 20000	2.6 to 8000
Dynamic Range with Preamplifier Type	dB(A) to dB	52.2 to 168 (2670/UA 0160)	42 to 172 (2670)	46 to 170 (2670)	21.4 to 160 (2669)	20.7 to 161 (2669)	10 to 146 (2669)
Inherent Noise	dB (A)	43	30	30	17.5	19	9.5
Capacitance	pF	3.5	6.1	5	14	18	55
Venting		Side	Side	Side	Rear	Side	Side
Lower Limiting Frequency (–3 dB)	Hz	0.5 to 5	0.3 to 3	0.3 to 3	1 to 5	1 to 2	1 to 2
Operating Temperature Range	ºC	–30 to 100	–40 to 150	–40 to 150	–30 to 125	–30 to 150	–30 to 100
Temperature Coefficient	dB/ºC	–0.01	+0.003	+0.008	+0.006	–0.002	–0.003
Pressure Coefficient	dB/kPa	–0.01	–0.003	–0.003	–0.006	–0.007	–0.016
Preamplifier Included		No	No	No	No	No	No

* 0 V = Prepolarized microphone

Special Microphones

Our special microphones include microphones optimised for calibration, low-noise, low-frequency, array, outdoor, probe and high-level applications.

Calibration Microphone Types 4160 and 4180 are high-quality condenser microphones intended for use as laboratory standard microphones, and in laboratory coupler applications where high accuracy and long-term stability are essential.

Low-noise Microphone Type 4179 is suitable for monitoring very low background noise levels down to –5.5 dB(A) together with Preamplifier Type 2660.

Low-frequency Microphone Type 4193 is designed to measure infrasound, for example, in ship engine rooms, in helicopters and in wind-buffeted buildings.

Array Microphone Type 4935 is suitable for systems requiring a large number of microphones, e.g., for STSF measurements, especially those that require excellent phase-matching, e.g., Non-stationary STSF and beam-forming measurements. For a larger frequency range see Type 4944 A.

Outdoor Microphone Types 4184 and 4198 offer excellent protection against wind and rain when measuring outdoors.

Probe Microphone Type 4182 has a choice of probe tubes, stiff or flexible, making it perfect for measurements in awkward places.

High Sound Pressure Microphones are used for gunshots, fireworks and rocket testing. Some microphones can be exposed to maximum pressure of 201 dB peak.

High Static Pressure Microphone Type 4938-W-001 is specially designed for measuring in high static pressure from

1 – 10 Atm. The change in response at different static pressures has been minimised.

Airbag Microphone Type 4938-WB1418 is designed to fulfil "Microphone and Preamplifier System for measuring acoustic impulses within vehicles – SAE J247 FEB87", but only when combined with Preamplifier Type 2670-WB1419.

Piezoelectric microphones measure high intensity acoustic noise and very low pressure fluctuations. Rugged, hermetically-sealed construction and a wide temperature range –67°F to +500°F (–55°C to +260°C) make them extremely suitable for a wide range of environmental conditions.

Piezoresistive microphones' high sensitivity and high resonance make them ideal for measuring dynamic pressure. Model 8507C is designed for installations that don't require threaded mounting, and can be installed in difficult-to-reach locations. Its small size permits flush mounting on curved surfaces. Model 8510B is designed for a variety of aerospace, automotive and industrial measurements that require a combination of small size, high sensitivity, and wideband frequency response.

Type Number		4180	4160	4179	4193	4193/ UC 0211	4935
Diameter	inch	1/2	1	1	1/2	1/2	1/4
Optimised		Calibration	Calibration	Low-noise	Low-frequency	Low-frequency	Array
Standards		H	G	–	E, K, M	E, K, M	–
Nominal Open-circuit Sensitivity	mV/Pa	12.5	47	100	12.5	2	5.6
Polarization Voltage*	V	200	200	200	200	200	0
Optimised Frequency Response ±2 dB	Hz	4 to 20000	2.6 to 8000	10 to 10000	0.07** to 20000	0.13 to 20000	50 to 5000
Dynamic Range with Preamplifier Type	dB(A) to dB	21 to 160 (2669)	10 to 146 (2673)	–2.5 to 102 (2660)	20.7 to 161 (2669)	26 to 148 (2669)	32 to 140
Inherent Noise	dB (A)	18	9.5	–5.5	19	29	35
Capacitance	pF	17.5	55	40	18	118	N/A
Venting		Side	Side	Side	Side	Side	Front
Lower Limiting Frequency (–3 dB)	Hz	1 to 3	1 to 2	5 to 7	0.01 to 0.05	<0.1	<50
Operating Temperature Range	ºC	– 30 to 100	– 10 to 50	– 30 to 100	– 30 to 150	– 30 to 150	– 10 to 55
Temperature Coefficient	dB/ºC	– 0.002	+ 0.003	– 0.004	– 0.002	– 0.002	–
Pressure Coefficient	dB/kPa	– 0.007	– 0.0016	– 0.016	– 0.005	– 0.005	–
Preamplifier Included		No	No	No	No	No	DeltaTron
TEDS UTID		–	–	–	–	–	769

* 0 V = Prepolarized microphone ** Preamplifier-dependent (with 2669 ≈ 0.3 Hz)

Type Number		4944 A	4198	4184	4182	4941	4938-W-001
Diameter	inch	1/4	1/2	Probe	Probe	1/4	1/4
Optimised		Array	Outdoor	Outdoor Permanent	Probe	High-pressure	High static pressure
Standards		–	I, K	I, K	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1	50	12.5	3.16	0.09	1.6
Polarization Voltage*	V	0	0	200	200	200	200
Optimised Frequency Response ±2 dB	Hz	16 to 70000	6.3 to 16000	20 to 8000	1 to 20000	4 to 20000	4 to 70000
Dynamic Range with Preamplifier Type	dB(A) to dB	48 to 169	15.2 to 146	25 to140	42 to 164	73.5 to 184 (2670)	42 to 172 (2670)
Inherent Noise	dB (A)	48	15.2	25	42	59	30
Capacitance	pF	N/A	N/A	N/A	N/A	3.3	6.1
Venting		Side	Rear	Yes	Selected	Side	Side
Lower Limiting Frequency (–3 dB)	Hz	7 to 9	2 to 4	<20	< 0.7	0.3 to 3	0.3 to 3
Operating Temperature Range	ºC	–20 to 60	–25 to 60	–40 to 55	–10 to 700	– 40 to 150	– 40 to 150
Temperature Coefficient	dB/ºC	+0.008	–0.001	–0.005	–0.005	–	+0.003
Pressure Coefficient	dB/kPa	–0.003	–0.01	–0.006	–0.007	–	–0.003
Preamplifier Included		DeltaTron	Yes	Yes	Yes	No	No

* 0 V = Prepolarized microphone

Type Number		4938-WB 1418	2510, EE 0205	2510 M4E, EE 0206	8507 C-2 EE 0158	8510 B-1, EE 0161	8510 B-2, EE 0162
Diameter	inch	1/4	0.816	0.816	0.092	0.159	0.159
Optimised		Airbag	Piezoelectric	Piezoelectric	Piezoresistive	Piezoresistive	Piezoresistive
Standards		–	–	–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1.6	–	–	0.014	0.45	0.45
Polarization Voltage*	V	200	N/A	N/A	N/A	N/A	N/A
Optimised Frequency Response ±2 dB	Hz	0.5 to 70000	1 to 10000	1 to 10000	0 to 20000	0 to 16000	0 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	50 to 177 (2670 WB 1419)	100 to 180	100 to 180	80 to197	78 to 197	80 to 197
Inherent Noise	dB (A)	30	N/A	N/A	N/A	N/A	N/A
Capacitance	pF	6.1	N/A	N/A	N/A	N/A	N/A
Venting		Side	N/A	N/A	N/A	N/A	N/A
Lower Limiting Frequency (–3 dB)	Hz	0.05 to 0.2	<0.7 Hz	<0.7 Hz	0 Hz	0 Hz	0 Hz
Operating Temperature Range	ºC	–40 to 150	–54 to 260	–54 to 260	–54 to 107	–54 to 121	–54 to 121
Temperature Coefficient	dB/ºC	+0.003	–	–	–	–	–
Pressure Coefficient	dB/kPa	–0.003	–	–	–	–	–
Preamplifier Included		No	N/A	N/A	N/A	N/A	N/A

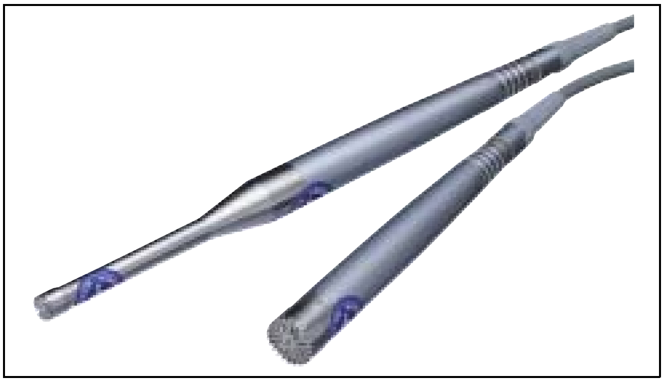
* 0 V = Prepolarized microphone

TEDS Microphone/Preamplifier Combinations

The new range of microphones with Transducer Electronic Data Sheets (TEDS) according to IEEE 1451.4, and enabling automatic detection and identification, covers free-field, pressure-field and diffuse-field microphones. They are available as 1/8-inch, 1/4-inch and 1/2-inch and cover almost any application. They can be connected to an ever-increasing range of instruments including Portable PULSE™ Front-end, NEXUS™ Conditioning Amplifier (Embedded Software Version 2.0 or later) and a PC, 16-ch. Conditioning Amplifier Type 2694, 4-ch. Power Supply Type 2829 or 8-ch. Signal Conditioning Card 482 for OASIS and provide:

- Plug and Play facilities
- Significantly reduced setup time
- Virtual elimination of cable connection errors
- Identification of transducer location that can be read into the microphone
- Automatic setting of transducer sensitivity in the conditioning unit
- Maximisation of the A/D converter's dynamic range

The TEDS microphone is sealed to the preamplifier with a calibration sticker. Recalibration is available and we can offer attractive prices on transducer/preamplifier combinations.



TEDS
Template Name: Microphone, integrated preamplifier (UTID, Universal Template Identification 769)
Data available:
Manufacturer, Type number, Serial number
Calibration date, Sensitivity, Polarization

Type Number		4939-A-011	4939-B/C/L-002	4188-A-021	4188-B/C/L-001	4189-A-021	4189-B/C/L-001
Diameter	inch	1/4	1/4	1/2	1/2	1/2	1/2
Optimised		Free-field	Free-field	Free-field	Free-field	Free-field	Free-field
Nominal Sensitivity (mV/Pa)	mV/Pa	4	3.6	31.6	31.6	50	50
Polarization Voltage	V	200	200	DeltaTron	0	DeltaTron	0
Optimised Frequency Response ±2 dB	Hz	4 to 100000	4 to 100000	20 to 12500	8 to 12500	20 to 20000	6.3 to 20000
Dynamic Range with Preamplifier	dB(A) to dB	35 to164	35 to164	19 to 141	15.8 to 146	16.5 to 138	15.2 to146
Preamplifier Included		2670	2669B/C/L	2671	2669B/C/L	2671	2669B/C/L
Adaptor Included		–	UA 0035	–	–	–	–
TEDS UTID		769	769	769	769	769	769

Type Number		4190-B/C/L-001	4191-B/C/L-001	4138-A-015	4138-B/C/L-006	4938-A-011	4938-B/C/L-002
Diameter	inch	1/2	1/2	1/8	1/8	1/4	1/4
Optimised		Free-field	Free-field	Pressure-field	Pressure-field	Pressure-field	Pressure-field
Nominal Sensitivity (mV/Pa)	mV/Pa	50	12.5	0.6	0.8	1.6	1.4
Polarization Voltage	V	200	200	200	200	200	200
Optimised Frequency Response ±2 dB	Hz	3.15 to 20000	3.15 to 40000	6.5 to 140000	6.5 to 140000	4 to 70000	4 to 70000
Dynamic Range with Preamplifier	dB(A) to dB	15 to 147	21.4 to 161	52.2 to 168	55 to168	42 to 172	42 to 172
Preamplifier Included		2669 B/C/L	2669 B/C/L	2670	2669 B/C/L	2670	2669 B/C/L
Adaptor Included		–	–	UA 0160	UA 0036	–	UA 0035
TEDS UTID		769	769	769	769	769	769

Type Number		4192-B/C/L-001	4942-A-021	4942-B/C/L-001	4943-B/C/L-001	4193-B/C/L-004	4941-A-011
Diameter	inch	1/2	1/2	1/2	1/2	1/2	1/4
Optimised		Pressure-field	Diffuse-field	Diffuse-field	Diffuse-field	Low-frequency	High-pressure
Nominal Sensitivity (mV/Pa)	mV/Pa	12.5	50	50	50	1.9	0.08
Polarization Voltage	V	200	DeltaTron	0	200	200	200
Optimised Frequency Response ±2 dB	Hz	3.15 to 20000	20 to 16000	6.3 to 16000	3.15 to 10000	0.16 to 20000	4 to 20000
Dynamic Range with Preamplifier	dB(A) to dB	20.7 to 161	16.5 to138	15.2 to 146	15 to 147	26 to 148	73.5 to184
Preamplifier Included		2669 B/C/L	2671	2669 B/C/L	2669 B/C/L	2669 B/C/L	2670
Adaptor Included		–	–	–	–	UC 0211	–
TEDS UTID		769	769	769	769	769	116289

Type Number		4941-B/C/L-002
Diameter	inch	1/4
Optimised		High-pressure
Nominal Sensitivity (mV/Pa)	mV/Pa	0.07
Polarization Voltage	V	200
Optimised Frequency Response ±2 dB	Hz	4 to 20000
Dynamic Range with Preamplifier	dB(A) to dB	75.8 to 184
Preamplifier Included		2669 B/C/L
Adaptor Included		UA 0035
TEDS UTID		116289

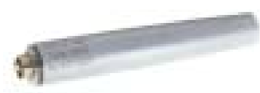
MICROPHONE PREAMPLIFIERS

The microphone preamplifiers share a robust and acoustically improved design, that allows them to operate in a wide range of environmental conditions. Their high output current capacity enables the use of extremely long extension cables, even with high sound pressure levels at high frequency.

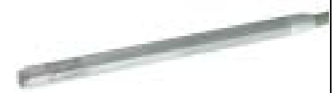
In principle, microphone preamplifiers have more or less identical electrical characteristics, i.e., a gain of unity and a frequency range of a few Hz to more than 200 kHz. The most obvious difference between preamplifiers is their diameter, the most common being 1/2-inch. For acoustical reasons, it is usual to select a preamplifier with the same diameter as the microphone used. Brüel & Kjær produce 1/2-inch and 1/4-inch preamplifiers. Adaptors are available to connect these to 1/8-inch or 1-inch microphones.

Apart from diameter, other important selection parameters include the transmission principle, (for example, current, voltage or digital signals) system verification facilities, phase characteristics, inherent noise and current supply requirements. Some preamplifiers are optimised for a specific application e.g., airbag measurements or very low noise measurements.

Most microphone preamplifiers are supplied with the TEDS Template Microphone Preamplifier UTID 1025 included. With a microphone attached to the preamplifier, the user can use a TEDS editor (e.g., WA 0876, WA 0877) to remap a new template, such as UTID 769, for the complete assembly into the preamplifier.



2669B/L



2670/2670-WB 1419

2669C

2670-W-001

Type Number		2669B	2669L	2669C	2670	2670-W-001	2670-WB 1419
Diameter	inch	1/2	1/2	1/2	1/4	1/4	1/4
Optimised		Acoustical	Acoustical	Cylindrical	Phase	Short, 48 mm	Airbag
Connector at Preamplifier		LEMO 0B, 7-pin	LEMO 0B, 7-pin	LEMO 1B, 7-pin	Fixed (2 m)	Fixed (0.6)	Fixed (2 m)
Connector at Instrument/Cable		B&K, 7-pin	LEMO 1B, 7-pin	None	LEMO 1B, 7-pin	LEMO 1B, 7-pin	LEMO 1B, 7-pin
Calibration Facility		CIC	CIC	CIC	CIC	CIC	None
Polarization Voltage Support		Yes	Yes	Yes	Yes	Yes	Yes
Supply Voltage	V	± 14 to ± 60 or 28 to 120	± 14 to ± 60 or 28 to 120	± 14 to ± 60 or 28 to 120	± 14 to ± 60 or 28 to 120	± 5 to ± 20 or 10 to 40 *	±14 to ± 60 or 28 to 120
Max. Output Voltage (Peak)	V	55 (10 below supply)	55 (10 below supply)	55 (10 below supply)	55 (10 below supply)	15	55 (10 below supply)
Max. Output Current (Peak)	mA	20	20	20	20	17	20
Frequency Range	Hz	3 to 200000 ± 0.5 dB (15 pF)	3 to 200000 ± 0.5 dB (15 pF)	3 to 200000 ± 0.5 dB (15 pF)	15 to 200000 ± 0.5 dB (6.2 pF)	15 to 200000 ± 0.5 dB (6.2 pF)	1 to 100000 ± 1 dB (6.2 pF)
Attenuation	dB	< 0.35	< 0.35	< 0.35	< 0.4	< 0.4	11
Noise A-weighted, typical	uV	1.9	1.9	1.9	4	4	4
Noise 22.4 Hz to 300 kHz, typical	uV	8.2	8.2	8.2	14	14	14
Input Impedance	GΩ‖pF	15 ‖0.3	15‖0.3	15‖0.3	15‖0.25	15‖0.25	15‖15
TEDS UTID		1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2248944	No	1025 from serial number 2248944

* **Note:** The warranty does not cover Preamplifier 2670-W-001 if used at a supply voltage >40 V

Earlier Preamplifiers	Compatible Brüel & Kjær Preamplifiers
2619	2669
2627	2673
2633	2670
2639	2669
2645	2673

Type Number		2671	2695	2673	2642	2660
Diameter	inch	1/2	1/2	1/4	1/2	1/2
Optimised		DeltaTron®	Short DeltaTron	Calibration	Battery	Low-noise
Connector at Preamplifier		BNC	10–32 UNF	LEMO 0B, 7-pin	Fixed	None
Connector at Instrument/Cable		None	None	LEMO 1B, 7-pin	LEMO 0B, 4-pin	B&K, 7-pin
Calibration Facility		None	None	IVC	None	None
Polarization Voltage Support		No	No	Yes	Yes up to 28 V	Yes
Supply Voltage	V	28	28	± 14 to 60 or 28 to 120	30 to 36	120 and 12
Max. Output Voltage (Peak)	V	7	7	55 (10 V below supply)	4.5	45
Max. Output Current (Peak)	mA	19	19	19	0.1	1.5
Frequency Range	Hz	20 to 50000 ± 2 dB (12 pF)	20 to 50000 ± 2 dB (15 pF)	3 to 200000 ± 0.5 dB (20 pF)	35 to 20000 ± 0.5 dB (14 pF)	20 to 200000 ± 1 dB (0 dB)(47 pF)
Attenuation	dB	< 0.35	< 0.2	< 0.05	< 3	< 0.06
Noise A-weighted, typical	uV	4	4	1.8	7.2	0.8
Noise 22.4 Hz to 300 kHz, typical	uV	15	12	11	20	5
Input Impedance	GΩ‖pF	1.5‖0.4	1.7‖0.4	1‖0.05	1‖3	36‖0.3
TEDS UTID		1025 from serial number 2264319	1025	No	No	No

DeltaTron Preamplifier Solutions Versus Standard Preamplifier Solutions

DeltaTron preamplifiers offer:

- Use of the vibration condition input
- Use of long, inexpensive, BNC co-axial cables
- Use of prepolarized microphones only
- TEDS

Standard microphone preamplifiers offer:

- Remote monitoring e.g., charge injection or insert voltage
- Very high output voltage that enables high sound pressures
- Use of external polarized microphones that enable use in high temperatures
- Use of prepolarized microphones
- Use of long cables
- TEDS

SOUND INTENSITY

The measurement of sound intensity provides information on the magnitude and the direction of the sound energy in the sound field. The measurement technique is used for a variety of applications such as the determination of sound power, sound absorption and sound transmission. Sound intensity is calculated from the quotient of the sound pressure and the particle velocity; sound pressure can easily be measured directly but the particle velocity is usually determined by a finite difference approximation. This requires two phase matched microphones in a face-to-face configuration. Brüel & Kjær provides a number of sound intensity probes that conform to Class 1 in the Sound Intensity Instrumentation Standard, IEC 61043, which describes the characteristics of microphone pairs, intensity probes and calibration techniques for intensity measurements.

Sound Intensity Probes

Two sound intensity probes are available – Type 3595 for use with the sound intensity analysis system based on sound level meter Type 2260, and Type 3599, suitable for use with sound intensity analyzers based on PULSE. The main difference is that Type 3595 is based on a 10-pin cabling system whereas Type 3599 is based on an 18-pin cabling system and includes a remote control unit. The acoustical specifications are the same as both use Sound Intensity 1/2-inch Microphone Pair Type 4197 and Dual Preamplifier Type 2683.

Type Number	3595	3599
Standards	IEC 61043 Class 1	IEC 61043 Class 1
Microphones	4197	4197
Dual Preamplifier	2683	2683
Remote Control Unit	–	ZH 0632
Spacer Length	6 to 200 mm	6 to 200 mm
Spacers Included	8.5 mm Spacer 250 Hz to 6.3 kHz; 12 mm Spacer 250 Hz to 5 kHz; 50 mm Spacer 20 Hz to 1.25 kHz	8.5 mm Spacer 250 Hz to 6.3 kHz; 12 mm Spacer 250 Hz to 5 kHz; 50 mm Spacer 20 Hz to 1.25 kHz

3595

3599

Sound Intensity Microphone Pairs

Type Number		4197	4178
Diameter	inch	1/2	1/4
Free-field Frequency Response ±1 dB	Hz	5 to 12500	6 to 14000
Free-field Frequency Response ±2 dB	Hz	0.3 to 20000	4 to 100000
Phase Response Difference (Absolute Value) 1/3-octave Centre Frequencies		< 0.05° : 20 Hz to 250 Hz < f(Hz)/5000 : 250 Hz to 6.3 kHz	< 0.2°: 20 Hz to 1 kHz Estimated f(kHz) × 0.2°: 1 kHz to 10 kHz
Amplitude Response Difference Normalized at 200 Hz		< 0.2 dB: 20 Hz to 1 kHz < 0.4 dB: 20 Hz to 7.1 kHz	< 0.2 dB: 20 Hz to 2 kHz < 0.3 dB: 2 Hz to 10 kHz
Accessories Included		8.5 mm Spacer UC 5349 12 mm Spacer UC 5269 50 mm Spacer UC 5270	6 mm Spacer UC 0196 12 mm Spacer UC 0195
Polarized Capacity Difference	pF	<1.0	<0.3

Dual Preamplifier

Type Number	2683
Phase Matching	< 0.015°at 50 Hz (20pF mic. capacitance) f(kHz) × 0.06°: 250 Hz to 10 kHz
Electrical Noise re Microphone Sensitivity: **1/4-inch 6.4 pF Dummy** **1/2-inch 19.5 pF Dummy**	 39.2 dB SPL(A) 19.4 dB SPL(A)
Attenuation for 1/2-inch Microphones	Ch.A Typ.: 0.6 dB, Ch.B Typ.: 0.3 dB
Attenuation for 1/4-inch Microphones	Ch.A Typ.: 1.7 dB, Ch.B Typ.: 0.7 dB

Sound Intensity Calibrators

Requirements for laboratory and field use are different. Brüel & Kjær, therefore, offers two instruments for sound intensity calibration; Type 3451 for laboratory use and Type 4297 for field use. Both calibrators fulfil IEC 61043, 1993 Class 1.

Comparison of Sound Intensity Calibrators

Type Number		**3541**	**4297**
Main Application		In the laboratory	In the field
Dismantling of Probe		Necessary	Unnecessary (up to 3 kHz)
Calibration of Sound Intensity Level	L_I	Yes	No
Calibration of Sound Pressure Level	L_p	Yes	Yes
Calibration of Particle Velocity Level	L_v	Yes	No
Pressure-Residual Intensity Index	$L_p - L_I$	20 to 50 kHz	20 to 3 kHz with spacer 20 to 6.3 kHz without spacer
Spacings Accommodated		Irrelevant as spacer must be removed from probe	Probe must be based on 12 mm spacer
Sound Pressure Source		Separate pistonphone	Integrated
Noise Generator		Separate pink and white noise generator	Integrated pink noise generator
Microphones Accomodated	inch	1/4 and 1/2	1/2
Number of Mechanical Parts		4	1


3541


4297

CABLES FOR MICROPHONES AND PREAMPLIFIERS

LEMO 0B to LEMO 1B Connector (7-pin) Flexible Silicone Cable, diameter 4 mm (–60 to 150°C)	AO 0419: 3.0 m, 90 pF/m EL 4006 and AC 0219-X: Variable length	
LEMO 0B to B&K connector (7-pin) Flexible Silicone Cable, diameter 4 mm (–60 to 150°C)	AO 0428: 3.0 m, 90 pF/m EL 4005 and AC 0219-X: Variable length	
Extension Cables LEMO 1B to 1B Connector Pur cable, robust, excellent shielding (–20 to 80°C), diameter 4 mm	AO 0414: 3.0 m, 95 pF/m AO 0415: 10 m, 95 pF/m AO 0416: 30 m, 95 pF/m EL 4004-V and AC 0289-X: Variable length	
Extension Cables B&K 7-pin to B&K 7-pin	AO 0027: 3.0 m, 95 pF/m, diameter 6 mm AO 0028: 10 m, 57 pF/m, diameter 9 mm AO 0029: 30 m, 57 pF/m, diameter 9 mm	
Cables B&K Female to LEMO 1B Connector	AO 0488: 3.0 m, 95 pF/m EL 4025: 0.2 m, 95 pF/m	
Flat Cable LEMO 1B to LEMO 1B Connector Shielded 7-core, thickness 0.2 mm	AR 0014: 0.5 m	
Single Screened BNC to BNC Co-axial Cables	AO 0087: 1.2 m AO 0142: 3 m AO 0430: 10 m	
Double Screened BNC to BNC Co-axial Cables	AO 0429: 1.2 m AO 0426: 3 m AO 0427: 10 m	

10 – 32 UNF to BNC Connector (2695)	AO 0531: 5 m	
Cable SMB – BNC (4944 A and 4935)	AO 0587: 3 m, straight WL 1320: X m, variable length, straight	
	AO 0564: 10 m, right angle	

Cable Length and Current Limitation in Preamplifiers

The current limitation in preamplifiers should be considered when high frequencies, long cables and relatively high signal levels are combined. The relation between the maximum sound pressure level, the frequency and cable load for a given current capability is given by the following formula:

$$SPL_{peak}(\max) = 94 + 20\log\left(\frac{i_{peak}}{2\pi \cdot f \cdot C_L \cdot S_c \cdot p_0}\right)[\text{dB}]$$

where:

i_{peak} = maximum current capacity of the preamplifier or (if lower) of the power supply in ampere

C_L = total capacitative load presented by the connection cable in farad. Typically 50 to 100 pF/m

S_c = loaded sensitivity of the microphone in V/Pa

p_0 = pressure level for stated microphone sensitivity = 1 Pa

f = applied maximum frequency

Example with 1000 meter of cable:

i_{peak} = 20 mA, S_c = 12.5 mV/Pa, f = 20 kHz, C_L = 95 nF (1000 m, 3000 feet (95 pF/m))

$SPL_{peak}(\max)$ = 136 dB

MICROPHONE ACCESSORIES

Adaptors

Adaptors for Mounting Preamplifiers and Extension Rods with Microphones of Different Diameters
UA 0786: 1/1-inch microphone to 1/2-inch preamplifier, Insert Voltage possibility
DB 0375: 1/1-inch microphone to 1/2-inch preamplifier
UA 0035: 1/4-inch microphone to 1/2-inch preamplifier (driven shield 0.33 pF)
WA 0371: 1/4-inch microphone to 1/2-inch preamplifier, short version (driven shield 0.08 pF)
UA 0036: 1/8-inch microphone to 1/2-inch preamplifier (driven shield 0.46 pF)
UA 0160: 1/8-inch microphone to 1/4-inch preamplifier (driven shield 2.44 pF)
Flexible Adaptors 1/4- to 1/2- inch and Flush Mountings for 1/4- and 1/2-inch Microphones
UA 0122: right angle (driven shield 1.25 pF)
UA 0123: straight (driven shield 1.25 pF)
Flexible Extension Rod
UA 0196: 1/2-inch to 1/2-inch 210 mm (driven shield 0.22 pF)
Right Angle Adaptor
EU 4000: 1/4-inch to 1/4-inch (driven shield 0.97 pF)
UA 1260: 1/2-inch to 1/2-inch

Windscreens

The windscreen is made of specially prepared, open-pored polyurethane foam attenuating wind noise 10 to 12 dB at lower wind velocities, and is suited for hand-held outdoor sound measurements. The windscreen is simply pushed as far as it will go over the microphone (fitted with its normal protection grid) and preamplifier.

Windscreen Order Numbers
UA 0207: For 1-inch microphones, spherical, diameter 90 mm, hole 20 mm
UA 0237: For 1/2-inch microphones, spherical, diameter 90 mm, hole 10 mm
UA 0459: For 1/2-inch microphones, spherical, diameter 65 mm, hole 10 mm
WQ 1099: For 1/4-inch microphones, spherical, diameter 65 mm, hole 5 mm
WQ 1133: For 1/4-inch microphones, ellipse 38 × 55 mm, hole 5 mm
UA 1070: Windscreen for 4184
UA 1071: Windscreen holder for 4184
UA 0253: 6 units of UA 0207
UA 0254: 6 units of UA 0237
UA 0469: 6 units of UA 0459
UA 0570: Windscreen for 1/2-inch microphone with holder and bird spike

Nose Cones

Nose cones are designed to reduce the aerodynamically induced noise present when the microphone is exposed to high wind speeds in a known direction, for example, during sound measurements in wind tunnels, ducts, etc. They replace the normal protection grid of the microphone, and have a streamlined shape with a highly polished surface giving the least possible resistance to air flow and thereby reducing the noise produced by the presence of the microphone itself. The fine wire mesh around the nose cone permits sound pressure transmission to the microphone diaphragm while a truncated cone behind the mesh reduces the air volume in front of the diaphragm.

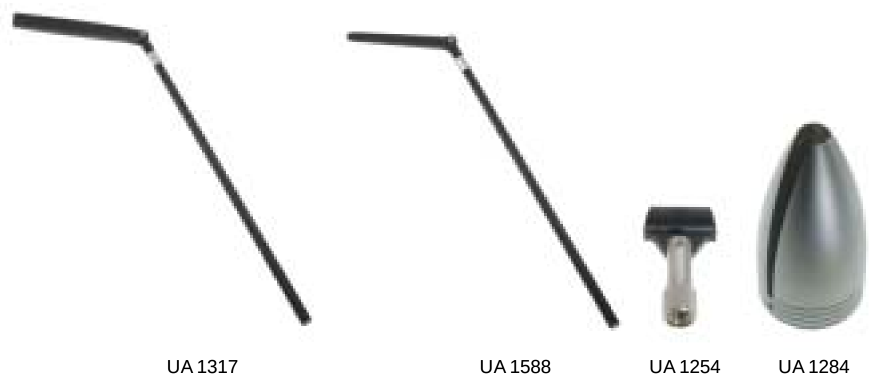
Nose Cone Order Numbers
UA 0387: 1/1-inch
UA 0386: 1/2-inch
UA 0385: 1/4-inch
UA 0355: 1/8-inch

Outdoor Protection

Outdoor Protection
UA 1404: Outdoor Microphone Kit for Preamplifiers 2669, 2671, 2673 and Sound Level Meters 2236, 2237, 2238, 2239 and 2260
DB 3611: Extension for UA 1404 – makes it possible to mount the preamplifier from Sound Level Meter Type 2231 inside Outdoor Kit UA 1404
UA 0308: Dehumidifier used with back-vented 1/2-inch microphones with nickel diaphragms
UA 0393: Rain cover with built in actuator

Preamplifier Holders

Preamplifier Holders
UA 1317 Preamplifier Holder to be used with 1/2-inch preamplifiers together with a camera tripod. The holder can be swivelled and locked at any angle between +90° and –90° from the vertical
UA 1588: Preamplifier Holder to be used with 1/4-inch preamplifiers together with a camera tripod (e.g., UA 1317)
UA 1254: Microphone Holder for Tripod (2671, 2669C SLM preamplifiers)
UA 1284: Microphone Stand for 2669B/L



Turbulence Screen

Turbulence Screen UA 0436 is designed to attenuate turbulence noise when measuring airborne noise in ducts, wind tunnels etc. The UA 0436 can be used with any 1/2-inch free-field condenser microphone mounted on a 1/2-inch microphone preamplifier.

UA 0436: For suppression of turbulence during noise measurements with 1/2-inch microphones inside air ducts	

Corrector

DZ 9566: Random Incidence Corrector gives Types 4130/76/88 a flat random response for measurements in diffuse sound fields	

Tripods

Tripods
UA 0587: Heavy Duty Tripod for Type 3923 Rotating Boom
UA 0801: Lightweight Tripod with tilt head, max.1332 mm
UA 0803: Tripod for photocells and microphones, max. 1250 mm
UA 0989: Tripod with pan and tilt head for Type 8329
UA 1251: Lightweight Tripod for Type 2236, compact
UA 1577: Tripod including CAM head (scanning laser)

Electrostatic Actuators

Electrostatic Actuators
UA 0023: For 1-inch microphones
UA 0033: For 1/2-inch microphones
Actuator Adaptors
DB 0264: For 1/4-inch microphones, use with UA 0033
DB 0900: For 1/8-inch microphones, use with UA 0033


UA 0023


UA 0033


DB 0264


DB 0900

Adaptors for Calibration

Adaptors for Calibration
DP 0776: Adaptor (for 1/2-inch microphones)
DP 0775: Adaptor (for 1/4-inch microphones)
DP 0774: Adaptor (for 1/8-inch microphones)


DP 0776


DP 0775


DP 0774

Miscellaneous

Miscellaneous
ZG 0350: LEMO to 7-pin Brüel & Kjær adaptor for connecting cables with LEMO 1B connector to instruments with B & K 7-pin connectors
UA 1405: CIC Adaptor, LEMO to B&K is an adaptor similar to ZG 0350 with a BNC to mini-jack cable of 1.5 m to inject CIC to the preamplifier
WB 0850: Insert Voltage or CIC Junction Unit
ZG 0328: BNC to B&K 7-pin, provides DeltaTron supply from microphone 7-pin supply
WB 1421: BNC to LEMO, provides DeltaTron supply from microphone LEMO supply
WB 1452: microdot to LEMO provides DeltaTron supply from microphone LEMO supply)


ZG 0350


UA 1405


WB 0850


ZG 0328


WB 1421


WB 1452

HYDROPHONES

The Brüel & Kjær range of hydrophones is a range of individually calibrated, waterborne-sound transducers that have a flat frequency response and are omnidirectional over a wide frequency range. Their construction is such that they are absolutely waterproof and have good corrosion resistance. There are four types.

Type 8103 is suitable for laboratory and industrial use and particularly for the acoustic study of marine animals or for cavitation measurements.

Type 8104 is ideal for calibration purposes.

Type 8105 is a robust, spherical hydrophone that can be used at an ocean depth of 1000 m. It has excellent directional characteristics, being omnidirectional over 270° in the axial plane and 360° in the radial plane.

Type 8106 has a built-in amplifier that gives a signal suitable for transmission over long underwater cables. It can be used down to an ocean depth of 1000 m.

Type	8103	8104	8105	8106
Voltage Sensitivity*: (with cable) at 20 °C	30 μV/Pa ±8 μV (−211 dB re 1 V/μPa ±2 dB)	56 μV/Pa ±15 μV (−205 dB re 1 V/μPa ±2 dB)	56 μV/Pa ±15 μV (−205 dB re 1 V/μPa ±2 dB)	2000 μV/Pa ±500 μV (−174 dB re 1 V/μPa ±2.5 dB)
Charge Sensitivity*:	0.12 pC/Pa	0.44 pC/Pa	0.42 pC/Pa	–
Capacitance*: **(with integral cable)**	3850 pF	7800 pF	7500 pF	–
Frequency Range* (re 250 Hz):	(+1.0 dB) 0.1 Hz to 100 kHz (−6.0 dB) (+2.5 dB) 0.1 Hz to 180 kHz (−12.5 dB)	(±4.0 dB) 0.1 Hz to 80 kHz (+4.0 dB) 0.1 Hz to 120 kHz (−12.0 dB)	(+1.0 dB) 0.1 Hz to 100 kHz (−6.5 dB) (+3.5 dB) 0.1 Hz to 160 kHz (−10.0 dB)	(+0.5 dB) 10 Hz to 10 kHz (−3.0 dB) (+0.5 dB) 7 Hz to 30 kHz (−8.0 dB)
Operating Temperature Range **Short-term:** **Continuous:**	−40°C to +120°C −40°C to +80°C	−40°C to +120°C −40°C to +80°C	−40°C to +120°C −40°C to +80°C	−10°C to +60°C
Max. Operating Static Pressure:	252 dB = 4×10^6 Pa = 40 atm. = 400 m ocean depth	252 dB = 4×10^6 Pa = 40 atm. = 400 m ocean depth	260 dB = 9.8×10^6 Pa = 100 atm. = 1000 m ocean depth	260 dB = 9.8×10^6 Pa = 100 atm. = 1000 m ocean depth
Dimensions: Length: **Body diameter:**	50 mm (1.97″) 9.5 mm (0.37″)	120 mm (4.73″) 21 mm (0.83″)	93 mm (3.66″) 22 mm (0.87″)	182 mm (7.17″) 32 mm (1.26″)
Weight: **(including integral cable)**	170 g (0.37 lb)	1.6 kg (3.5 lb)	1.6 kg (3.5 lb)	382 g (0.84 lb)
Integral Cable	6 m waterproof low-noise double-shielded teflon cable with standard miniature coaxial plug	10 m waterblocked low-noise shielded cable to MIL–C–915 with BNC plug	10 m waterblocked low-noise shielded cable to MIL–C–915 with BNC plug	None

* Nominal value, each hydrophone is supplied with its own calibration data
Note: All values are typical at 25°C (77°F), unless measurement uncertainty is specified. All uncertainty values are specified at 2σ (i.e., expanded uncertainty using a coverage factor of 2)

CONDITIONING AMPLIFIERS

Signal conditioning hardware is a very important component of most measurement systems. A typical system includes signal conditioning hardware that interfaces the raw signals and transducer output to the measurement or data recording device. Signal conditioning improves the performance and reliability of the measurement system with a variety of functions such as signal amplification, isolation, filtering, powering of transducers, overload detection, and TEDS support.

The main types of inputs for sound and vibration measurements are:

- Charge
- DeltaTron®
- Microphone
- Intensity
- Bridge
- Differential

Charge Input: For piezoelectric transducers such as charge accelerometers, force transducers, impact hammers, hydrophones etc.

DeltaTron Input: For piezoelectric accelerometers and preamplifiers with built-in electronics. DeltaTron identifies products that operate with a constant current power supply and give output signals in the form of a voltage modulation on the power line supply. The technology is also known by other manufacturers as ISOTRON®, ICP®* and Piezotron®.

Microphone Input: For microphone preamplifiers with seven pin sockets, usually a 7-pin LEMO socket although some units still have the B&K 7-pin socket.

Intensity Input: For intensity probes, either via two 7-pin LEMO sockets, or two 7-pin B&K sockets.

Bridge Input: Used for piezoresistive accelerometers, variable capacitance accelerometers and strain gauges. These accelerometers have the advantage of DC response making them suitable for measurement of long duration pulses found in transportation vibration, automotive crash studies and blast testing.

Differential Input: Differential accelerometers using a two wire cable surrounded by a screen. These accelerometers are usually used for heavy industrial application.

Microphone and DeltaTron tranducers can be conditioned directly from the PULSE™ Multi-analyzer System, whereas charge and bridge transducers require an adaptor.

* ICP is a registered trademark of PCB Piezotronics

In the following comparison tables, the following symbols are used:

✓	Standard feature
–	None
M	Manual control
C	Computer control
A	A weighting
Lin	Linear

Microphone Conditioning Amplifiers

2822

2804

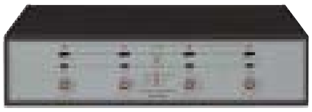
2810

2829

5935

5966

Acoustics	Microphone Multiplexer 2822	2-channel Microphone Power Supply 2804	2-channel Microphone Power Supply 2810	4-channel Microphone Power Supply 2829	Dual Micro-phone Supply with B&K Socket 5935	Dual Micro-phone Supply with LEMO Socket 5935L	8-channel Acoustic Front-end 5966
Polarization Voltage, V	0, 28, 200	0, 28, 201	28	0, 200	0, 28, 200	0, 28, 200	0, 28, 200
Microphone Input	7-pin B&K	7-pin B&K	5-pin LEMO	7-pin LEMO	7-pin B&K	7-pin LEMO	7-pin LEMO
AC Output	✓	✓	✓	✓	✓	✓	✓
Peak Meter	–	–	–	–	–	–	–
Display Type	–	–	–	–	–	–	–
TEDS Support, IEEE P1451.4	–	–	–	✓	–	–	–
Filters	–	–	–	Option	A, Lin	A, Lin	A, Lin
A, B, C, D Filters	–	–	–	–	–	–	–
Type of Control	M&C	M	M	–	M	M	M
19-inch Rack Mountable	✓	✓	✓	✓	✓	✓	✓
Channels Min./Max./19-inch	12	2	2	4	2	2	8
AC Input Power	✓	–	✓	–	–	–	✓
DC Input Power	–	✓	✓	✓	✓	✓	✓
Battery/Charge Adaptor	–	–	–	✓	–	–	–
Battery	–	✓	✓	–	✓	✓	✓
Gain	–	–	0 to 40 dB	–	0 to 55dB	0 to 55 dB	0 to 40 dB

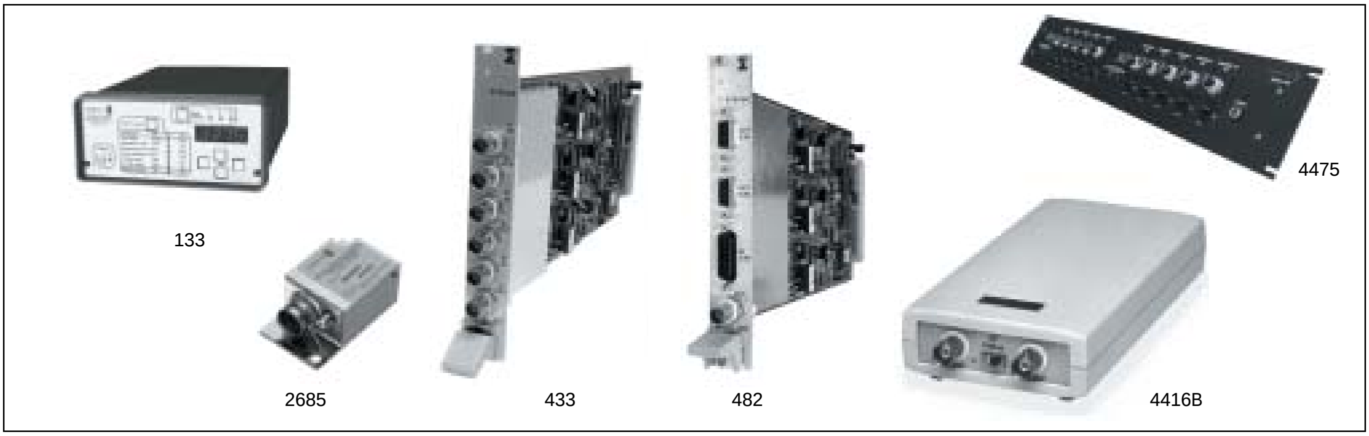


5968

2690/2691

Acoustics	4-channel Acoustic Front-end 5968	2-channel Microphone Conditioning Amplifier NEXUS™ 2690 A 0S2	4-channel Microphone Conditioning Amplifier NEXUS 2690 A 0S4	2-channel Intensity Conditioning Amplifier NEXUS 2691 A 0S4	2-channel Microphone Conditioning Amplifier with Filters NEXUS 2690 A 0F2	4-channel Microphone Conditioning Amplifier with Filters NEXUS 2690 A 0F4
Polarization Voltage, V	0, 28, 200	0, 200	0, 200	0, 200	0, 200	0, 200
Microphone Input	7-pin LEMO	7-pin LEMO	7-pin LEMO	7-pin LEMO	7-pin LEMO	7-pin LEMO
AC Output	✓	✓	✓	✓	✓	✓
Peak Meter	–	✓	✓	✓	✓	✓
Display Type	–	LCD	LCD	LCD	LCD	LCD
TEDS Support, IEEE P1451.4	–	✓	✓	✓	✓	✓
Filters	Option	Option	Option	Option	✓	✓
A, B, C, D Filters	–	Option	Option	Option	✓	✓
Type of Control	M	M&C	M&C	M&C	M&C	M&C
19-inch Rack Mountable	✓	✓	✓	✓	✓	✓
Channels Min./Max./19-inch	4	2	4	2	2	4
AC Input Power	–	✓	✓	✓	✓	✓
DC Input Power	✓	✓	✓	✓	✓	✓
Battery/Charge Adaptor	–	✓	✓	✓	✓	✓
Battery	✓	Option	Option	Option	Option	Option
Gain	0 to 40 dB	–20 to 80 dB	–20 to 80 dB	–20 to 80 dB	–20 to 80 dB	–20 to 80 dB

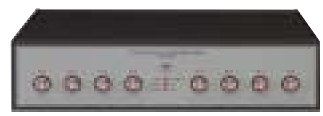
DeltaTron Conditioning Amplifiers



Acoustics	PE/ISOTRON Signal Condi-tioner 133	ISOTRON Air-borne Charge Amplifier 2685MX	3-channel PE/ ISOTRON Con-ditioner OASIS 433	8-channel SMART Trans-ducer Condi-tioner OASIS 482	Battery-pow-ered ISOTRON Conditioner 4416B	10-channel ISOTRON Power Supply 4475	DeltaTron Power Supply WB 1372
Charge Input (Piezoelectric)	BNC	–	BNC	–	–	–	–
DeltaTron/ISOTRON input	BNC	BNC	BNC	BNC	BNC	BNC	BNC
AC Output	✓	✓	✓	✓	✓	✓	✓
RMS	✓	–	–	–	–	–	–
Peak	–	–	–	–	–	–	–
Display Type	LED	–	–	–	–	–	Meter
TEDS support IEEE P1451.4	–	–	–	✓	–	–	–
Filter	✓	Option	✓	✓	–	–	–
A, B, C, D Filters	–	–	–	–	–	–	–
Type of Control	M&C	M	C	C	M	M	M
19-inch Rack Mountable	✓	–	✓	✓	–	✓	–
Channels Min./Max./19-inch	3/9	1	3/48	8/128	1	10	1
AC Input Power	✓	✓	✓	✓	–	–	–
DC Input Power	Option	–	–	–	✓	✓	✓
BatteryAdaptor/Charge Adaptor	Option	–	–	–	Option	Option	–
Battery	–	–	–	–	–	–	✓

2525

2694

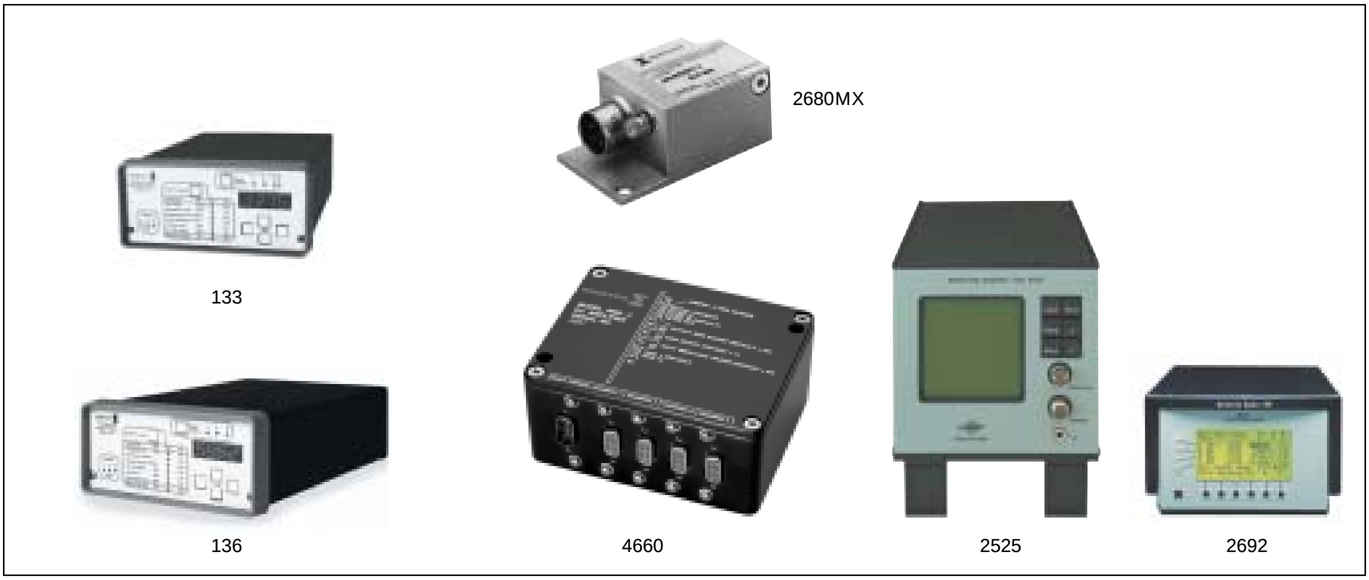


5963

2690

Acoustics	DeltaTron Power Supply Adaptor ZG 0328	Measuring Amplifier 2525	16-channel DeltaTron Conditioning Amplifier 2694	8-channel DeltaTron Supply 5963	4-channel DeltaTron Conditioning Amplifier with Filters NEXUS 2693 A 0S4	4-channel DeltaTron Conditioning Amplifier with Filters NEXUS 2693 A 0F4	4-channel DeltaTron Conditioning Amplifier with Single and Double Integration NEXUS 2693 A 0I4
Charge Input (Piezoelectric)	–	TNC	–	–	–	–	–
DeltaTron/ISOTRON Input	7-pin LEMO	BNC	BNC	BNC	BNC	BNC	BNC
AC Output	✓	✓	✓	✓	✓	✓	✓
RMS	–	✓	–	–	–	–	–
Peak	–	✓	–	–	✓	✓	✓
Display Type	–	LCD	–	–	LCD	LCD	LCD
TEDS support IEEE P1451.4	–	–	✓	–	✓	✓	✓
Filter	–	Option	Option	–	✓	✓	✓
A, B, C, D Filters	–	Option	Option	–	Option	✓	Option
Type of Control	M	M&C	M&C	M	M&C	M&C	M&C
19″ Rack Mountable	–	Option	✓	Option	Option	Option	Option
Channels Min./Max./19-inch	1	1	16	8	4	4	4
AC Input Power	–	✓	✓	✓	✓	✓	✓
DC Input Power	–	–	✓	✓	✓	✓	✓
BatteryAdaptor/Charge Adaptor	–	–	✓	–	✓	✓	✓
Battery	–	–	–	✓	Option	Option	Option

Charge Conditioning Amplifiers



Acoustics	PE/ISOTRON Signal Condi-tioner 133	DC Amplifier 136	DC Amplifier 2680MX	4-channel Air-borne PR and VC Signal Conditioner 4660	Measuring Amplifier 2525	1-channel Charge Condi-tioning Ampli-fier NEXUS 2692 A 0S1	4-channel Charge Condi-tioning Ampli-fier NEXUS 2692 A 0S4
Charge Input (Piezoelectric)	✓	–	✓	–	✓	✓	✓
Bridge Input (Piezoresistive)	–	✓	–	✓	–	–	–
AC Output	✓	✓	✓	✓	✓	✓	✓
DC Output	–	✓	–	–	–	–	–
RMS	✓	✓	–	–	✓	–	–
Peak	–	–	–	–	✓	✓	✓
Display Type	LED	LED	–	–	LCD	LCD	LCD
TEDS support IEEE1451.4	–	–	–	–	–	✓	✓
Filter	✓	✓	Option	–	✓	Option	Option
A, B, C, D Filters	–	–	–	–	–	✓	✓
Type of Control	M&C	M&C	M	M	M&C	M&C	M&C
19″ Rack Mountable	✓	✓	–	–	✓	✓	✓
Channels Min./Max./19-inch	3/9	3	1	4	1	1	4
AC Input Power	✓	✓	–	–	✓	✓	✓
DC Input Power	Option	Option	✓	✓	–	✓	✓
BatteryAdaptor/Charge Adaptor	Option	Option	–	–	–	✓	✓
Battery	–	–	–	–	–	Option	Option

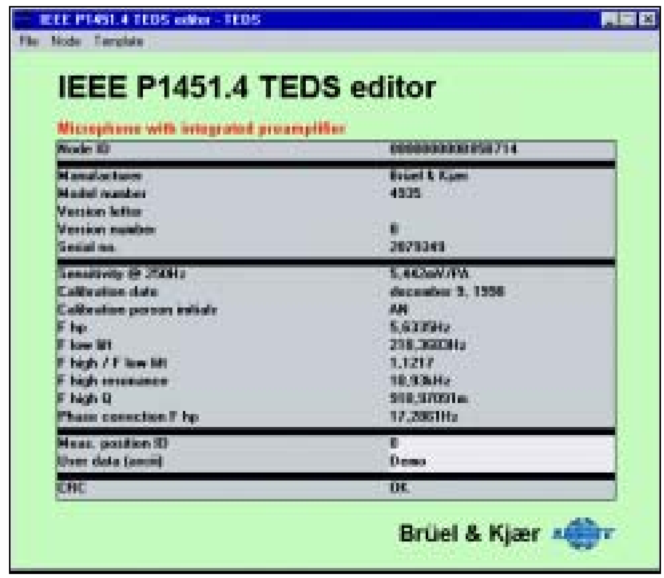
TEDS and IEEE1451.4 Support

The IEEE 1451 Smart Transducer Interface Standards describe an open, common, network-independent communication standard for Smart transducers. The IEEE 1451.4 defines a Mixed Mode Interface for analogue transducers with analogue and digital operating modes. A Transducer Electronic Data Sheet (TEDS) is added to a traditional two-wire, constant current excited transducer containing a FET amplifier. The TEDS contains a minimum of pertinent data stored in a physically small memory device, as required by tiny sensors.

The advantages of a system containing TEDS include:

- Elimination of cabling and connection errors
- Identification and specification using digitial communication
- "Plug and play" technology for acoustic and vibration testing
- Reduction of setup time
- Simplification of calibration databases

Access to the data in the TEDS template is available via a TEDS Editor Kit or by Control Software Packages for conditioning amplifiers that support IEEE 1451.4 (i.e., NEXUS, Oasis and 16-channel Conditioning Amplifier Type 2694) or by analysis systems such as PULSE.



TEDS Editor Kits	WA 0876	WA 0877	WA 0887
Principle Use	Calibration	Development	Viewer
Reads All Fields in Template	Yes	Yes	Yes
Writes in Calibration/Transducer Specific Field	Yes	Yes	No
Writes in Manufacturer's Field	No	Yes	No
Writes in User Field	Yes	Yes	Yes

CALIBRATION

The most important parameter for any measurement device is sensitivity. The sensitivity can be defined as the ratio of the output parameter to the input parameter. To determine the sensitivity is to calibrate the measurement device.

A calibration is performed:

- To ensure that your measurements are correct
- To prove that measurement methods and the equipment used are accurate, for example, to prove that a measurement complies with the requirements of national legislation, standard bodies and customers
- To verify the stability of the measurement equipment, including equipment used to perform calibration
- To account for local measurement conditions, for example, variations in ambient pressure and temperature
- To ensure product quality
- To build confidence in measurement results

Calibrators

4231 4226 4228 4229

Type Number		4231	4226	4228	4229
Description		Sound Level Calibrator	Pistonphone	Multifunction Acoustic Calibrator	Hydrophone Calibrator
Standards		IEC 942 (1998) Class 1 ANSIS1.4–1984	IEC 942 (1998) Class 1 Ansi S1.4–1984	IEC 942 (1998) Class 1	–
Calibration Pressure	dB SPL	94 and 114	94, 104 and 114	124	From 151 to 166 dB re 1uPa, depending on hydrophone
Calibration Frequencies	Hz	1000	31.5 Hz to 16 kHz in octave steps. 12.5 kHz	251.2	251.2
Calibration Accuracy	dB	±0.2	±0.2 at 94 dB	±0.2	±0.7
Transducer		1-inch and 1/2-inch (1/4-inch and 1/8-inch with adaptor)	1/2-inch and 1/4-inch	1-inch, 1/2-inch,1/4-inch and 1/8-inch	Fits Types 8100, 8101, 8103, 8104, 8105 and 8106

GLOSSARY OF ACOUSTICAL TERMS

Absorption
The conversion of sound energy into another form of energy, usually heat when passing through an acoustical medium.

Absorption coefficient
Ratio of sound absorbing effectiveness at a specific frequency, of a unit area of acoustical absorbent to a unit area of perfectly absorptive material.

Acoustics
The science of the production, control, transmission, reception and effects of sound and of the phenomenon of hearing.

Active sound field
A sound field in which the particle velocity is in phase with the sound pressure. All acoustic energy is transmitted, none is stored. A plane wave propagating in a free field is an example of a purely active sound field and constitutes the real part of complex sound field.

Ambient noise
All-pervasive noise associated with a given environment.

Amplitude distribution
A method of representing time-varying noise by indicating the percentage of time that the noise level is present n a series of amplitude intervals.

Anechoic room
A room whose boundaries effectively absorb all incident sound over the frequency range of interest, thereby creating essentially free field conditions.

Audibility threshold
The sound pressure level, for a specified frequency at which persons with normal hearing begin to respond.

Background noise
The ambient noise level above which signals must be presented or noise sources measured.

Complex intensity
Complex intensity is the combined intensity and imaginary intensity.

Cumulative distribution
A method of representing time-varying noise by indicating the percentage of time that the noise level is present above (or below) a series of amplitude levels.

Damping (1)
The action of frictional or dissipative forces on a dynamic system causing the system to lose energy and reduce the amplitude of movement.

Damping (2)
Removal of echoes and reverberation by the use of sound absorbing materials. *Also:* Sound proofing

Decibel scale
A linear numbering scale used to define a logarithmic amplitude scale, thereby compressing a wide range of amplitude values to a small set of numbers.

Diffraction
The scattering of radiation at an object smaller than one wavelength and the subsequent interference of the scattered wavefronts.

Diffuse field
A sound field in which the sound pressure level is the same everywhere and the flow of energy is equally probable in all directions.

Diffuse sound
Sound that is completely random in phase; sound which appears to have no single source.

Directivity factor
The ration of the mean-square pressure (or intensity) on the axis of a transducer at a certain distance to the mean-square pressure (or intensity) which a spherical source radiating the same power would produce at that point.

Dynamic capability
The dynamic capability of an intensity measurement system is determined by adding normally 5 dB (for a measuring error less than 2 dB) to the Residual Intensity Index.

Far field
Distribution of acoustic energy at a very much greater distance from a source than the linear dimensions of the source itself; the region of acoustic radiation used to the source and in which the sound waves can be considered planar.

Free field
An environment in which there are no reflective surfaces within the frequency region of interest.

Hearing loss
An increase in the threshold of audibility due to disease, injury, age or exposure to intense noise.

Hertz
The unit of frequency measurement, representing cycles per second.

Imaginary intensity
Imaginary intensity is the non-propagating part of the sound field (sometimes called the reactive part).

Impedance, specific acoustic
The complex ration of dynamic pressure to particle velocity at a point in an acoustic medium, measured in rayls (1 rayl = 1 N · S/m³).

Infrasound
Sound at frequencies below the audible range, i.e., below about 16 Hz.

Intensity
Intensity is the real part of the complex intensity and is the propagating part of the sound field (sometimes called the active part).

Isolation
Resistance to the transmission of sound by materials and structures.

Loudness
Subjective impression of the intensity of a sound.

Masking
The process by which threshold of audibility of one sound is raised by the presence of another (masking) sound.

Near field
That part of a sound field, usually within about two wavelengths from a noise source, where there is no simple relationship between sound level and distance.

Newton
The force required to accelerate a kg mass at 1 m/s². Approximately equal to the gravitational force on a 100 g mass.

Noise emission level
The dB(A) level measured at a specified distance and direction from a noise source, in an open environment, above a specified type of surface. Generally follows the recommendation of a national or industry standard.

Noise reduction coefficient, NRC
The arithmetic average of the sound absorption coefficients of a material at 250, 500, 1000 and 2000 Hz.

Noy
A linear unit of noisiness or annoyance.

Particle velocity
The velocity of air molecules about their rest position due to a sound wave.

Pascal, Pa
A unit of pressure corresponding to a force of 1 newton acting uniformly upon an area of 1 square metre. Hence 1 Pa = 1 N/m².

Phase mismatch
The relative phase mismatch between the two channels in an Intensity Measuring System.

Phon
The loudness level of a sound. It is numerically equal to the sound pressure level of a 1 kHz free progressive wave, which is judged by reliable listeners to be as loud as the unknown sound.

Pink noise
Broadband noise whose energy content is inversely proportional to frequency (–3 dB per octave or –10 dB per decade).

Power spectrum level
The level of the power is a band one hertz wide referred to a given reference power.

Pressure Residual Intensity Index, $L_{K,0}$
The pressure residual intensity index for a given measurement system is defined as the difference between the measured pressure level and the indicated sound intensity level when exactly the same signal is fed into the two channels of an intensity analysing system.

Random noise
Noise, whose instantaneous amplitude is not specified at any instant of time. Instantaneous amplitude can only be defined statistically by an amplitude distribution function.

Residual Intensity Index
Residual Intensity Index in a given direction at a point is defined as the difference between the sound level and the sound pressure level measured in the given direction at that point. In practice L_K is normally negative.

Residual Intensity, $L_{I,R}$
The sound intensity level measured when the same signal

is fed to both channels of a sound intensity measuring system, or it is exposed to a pure reactive field.

Reverberation
The persistance of sound in an enclosure after a sound source has been stopped. Reverberation time is the time, in seconds required for sound pressure at a specific frequency to decay 60 dB after a sound source is stopped.

Root mean square (RMS)
The square root of the arithmetic average of a set of squared instantaneous values.

Sabine
A measure of sound absorption of a surface. One metric sabine is equivalent to 1 square metre of perfectly absorptive surface

Semianechoic field
A free field above a reflective plane.

Sone
A linear unit of loudness. The ration of loudness of a sound to that of a 1 kHz tone 40 dB above the threshold of hearing.

Sound
Energy that is transmitted by pressure waves in air or other materials and is the objective cause of the sensation of hearing. Commonly called noise if it is unwanted.

Sound intensity
The rate of sound energy transmission per unit area in a specified direction.

Sound level
The level of sound measured with a sound level meter and one of its weighting networks. When A-weighting is used, the sound level is given in dB(A).

Sound level meter
An electronic instrument for measuring the RMS level of sound in accordance with an accepted national or international standard.

Sound power
The total sound energy radiated by a source per unit time.

Sound power level
The fundamental measure of sound power. Defined as:

$$L_W = 10 \log \frac{P}{P_0} \text{dB}$$

Where P is the RMS value of sound power in watts, and P_0 is 1 pW.

Sound pressure
A dynamic variation in atmospheric pressure. The pressure at a point in space minus the static pressure at that point.

Sound pressure level
The fundamental measure of sound pressure. Defined as:

$$L_p = 20 \log \frac{p}{p_0} \text{dB}$$

Where p is the RMS value (unless otherwise stated) of sound pressure in pascals, and p_0 is 20 μPa for measurements in air.

Sound transmission class, STC
A single-number rating for describing sound transmission loss of a wall or partition.

Sound transmission loss
Ratio of the sound energy emitted by an acoustical material or structure to the energy incident upon the opposite side.

Standing wave
A periodic wave having a fixed distribution in space which is the result of interference of progressive waves of the same frequency and kind. Characterised by the existence of maxima and minima amplitudes that are fixed in space.

Ultrasound
Sound at frequencies above the audible range, i.e., above about 20 kHz.

Wavelength
The distance measured perpendicular to the wavefront in the direction of propagation between two successive points in the wave, which are separated by one period. Equals the ratio of the speed of sound in the medium to the fundamental frequency.

Weighting network
An electronic filter in a sound level meter which approximates under defined conditions the frequency response of the human ear. The A-weighting network is most commonly used.

White noise
Broadband noise having constant energy per unit of frequency.

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TYPE NUMBER INDEX

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