Microphones & Conditioning

Product *Catalogue, Version 15*

Brüel & Kjær

WELCOME

Welcome to Brüel & Kjær's Microphones & Conditioning Catalogue covering our full range of Microphones, Preamplifiers, Accessories, Hydrophones, Pressure Transducers 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.

Microphone Type 4160

A Heritage in Excellence

Although originally invented by Edward Christopher Wente back in 1916, condenser measuring microphones were not really produced in volume quantities until 1956 when Brüel & Kjær introduced Type 4131 and Type 4132 cartridges. At the end of the fifties Brüel & Kjær already had a complete range of measuring microphones covering sizes from ¼- to 1-inch. Ever since, Brüel & Kjær has kept its commitment to maintaining market leadership in measuring microphones. A number of important milestones and numerous patents are proof of this.

Our dedication to total customer satisfaction means that selecting a transducer from Brüel & Kjær gives you not only peak performance but also optimal product support. And choosing the total measurement chain from Brüel & Kjær brings you additional benefits such as CIC (Charge Injection Calibration), Dyn-X Technology, the recent REq-X technology for real-time transducer correction and, of course, full application support.

Highly skilled specialists assemble all our microphones in a clean room environment. Most of our microphones use stainless steel and laser welding technology. Lately though, the use of titanium has pushed microphone performance one step further, bringing with it benefits such as the surface microphone technology and the all-titanium Low-noise TEDS Microphone Type 4955.

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. 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 controlling 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.

Top Quality

In all aspects of sound and vibration there are challenges to be met. For example, making sure that the car that one takes to work each day can withstand the mechanical shocks imposed on it, demands measurements of 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. Legislation also sets exacting standards. This often means documented results that are traceable to known sources, such as a national calibration laboratory. And naturally, the support customers receive must always be the most reliable.

CONTENTS

A HERITAGE OF EXCELLENCE

Brüel & Kjær has more than 50 years of proven commitment to continuous product improvement and groundbreaking new innovations in measuring microphones.

First Generation

1956 

Type 4131 — World's first volume-produced measurement microphones, Types 4131 (free-field) and 4132 (pressure-field), developed, amongst others, by Dr. Per V. Brüel

1967 

Type 4138 — World's first 1/8" measuring microphone. Due to on-going product improvements, this type is still available

1975 

Type 4160 — Brüel & Kjær is requested to produce a replacement for the Western Electric WE 640 AA Reference Microphone. As a result, Type 4160 and later the ½" Type 4180 were introduced. These are still the world de facto acoustical standards

1980 

Type 4155 — Brüel & Kjær launches the world's first high-stability, measurement grade, electret microphones

1984 

Type 4179 — Using advanced modelling and clever design, this microphone has a noise floor of –2.5 dB(A), still unbeaten after nearly 30 years!

Falcon Range

1987 

Type 4182 — Brüel & Kjær introduces probe microphone for measurement in extremely confined spaces and up to more than 600°C

1993 

Type 4188 * — The Falcon series is introduced. Featuring stainless steel, press-fitted diaphragms, these microphones result in a step change in microphone technology

1994 

Type 4189 — Falcon series at peak performance. Type 4189 is probably the world's most popular ½" free-field microphone

2000 

Type 4297 — The world's only one-unit Sound Intensity Calibrator enables calibration without dismantling the probe

Titanium Generation

2003 

Type 4948 * — Surface Microphone – another Brüel & Kjær first. "All Titanium" and originally developed for Aerospace applications

2004 

Type 4949 * — Surface Microphones now also find their way into automotive, where they break new frontiers in wind-tunnel testing

2005 

Type 4952 * — Another "world's first" from Brüel & Kjær is this outdoor microphone where all parts exposed to the weather are made from polymer materials

2006 

Type 4955 * — Continuing the "All Titanium" concept, this TEDS microphone has 1.1 V/Pa sensitivity and a typical noise floor of 5.5 dB

Pictures are not to scale

** Utilising one or more Brüel & Kjær patented priciples*

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SELECTING THE RIGHT MICROPHONE

Selecting the best microphone for a given application can seem to be an overwhelming task due to the many different types to choose from. The interactive transducer selection guide on www.bksv.com can be a big help. In this catalogue we take a slightly different approach by introducing the microphone matrix.

Condenser microphones are either externally polarized or prepolarized. They come in different sizes – 1-inch, ½-inch, ¼-inch, or 1/8-inch – and are optimised for either free-, pressure-, or diffuse-field. Microphones that do not directly match one of these classes are denoted as "Special Microphones".

Not all positions in the matrix correspond to a type number, for example, 1-inch microphones are normally externally polarized, since they were introduced before prepolarized microphones could be produced with sufficient stability.

1/8-inch microphones are pressure types. Due to their small size, the free field and pressure response are approximately the same up to quite high frequencies (for example, the free-field correction is less than 1 dB at 15 kHz).

Mapping the Brüel & Kjær measurement microphones in the microphone matrix is now a simple task.

For selection consider the following:

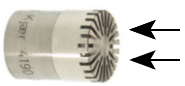
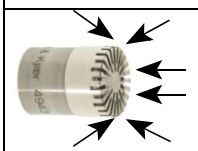
Which kind of input module – classical or DeltaTron®?
DeltaTron can only work with prepolarized types, and classical input with both prepolarized and externally polarized cartridges. For more information about DeltaTron and classical input see the preamplifier section. For portable instruments and where high humidity is present, prepolarized microphones are preferred. For more general use in the laboratory or where high temperature is present, the use of external polarised microphones is recommended.

Does the microphone have to fulfill any specific standard?
If this is the case the "Standards" table might be helpful.

Frequency range and maximum sound pressure level (SPL) will often determine which microphone size to use.

Generally a smaller microphone has a broader frequency range and a lower sensitivity. For more details see the "Maximum Limits and Dynamic Range" section.

For which sound field should the microphone be optimised?
For measurements made away from reflecting surfaces, for example, when making outdoor measurements, or in acoustically well-damped indoor environments, a free-field microphone is best. But for measurements made in small closed couplers, or close to hard surfaces, a pressure-field microphone is best. For measurements in enclosed areas where reverberation is likely, microphones optimised for diffuse-field (random-incidence) response are best.

Microphone Type		1/8-inch	1/4-inch	1/2-inch	1-inch	Polarization
	Free-field		4954	4137 4176 4188 4189 4950		Prepolarized
			4939	4190 4191	4145	Externally polarized
	Pressure-field		4944	4947 4948 4949		Prepolarized
		4138	4938 4941	4192	4144	Externally polarized
	Diffuse-field			4942		Prepolarized
				4943		Externally polarized
	Special		4957 4958	4948 4949		Prepolarized
			4187 4938-WH-1418 4938-W-001	4180 4193 4955	4160 4179	Externally polarized

In some cases, pressure type microphones can also be found to have sufficiently flat random incidence response. This is because the random incidence response of a pressure-field microphone is much flatter across the frequency range than that of a microphone optimised for flat free-field response. A special case is the measurement of surface pressure where surface microphones would be the obvious choice.

Special applications
For special applications, a special microphone can be selected, for example, laboratory reference microphones, outdoor microphones, array microphones, infra- sound microphones, etc.

Microphone Standards

Laboratory reference microphones are specified in the international standard IEC 61094–1:2000.

Measurement microphones are specified in the international standard IEC 61094-4:1995.

These standards use the abbreviation WS for working standards, for example, measurement microphones used in daily routine measurements, while the abbreviation LS denotes laboratory standards.

The digits following "WS" indicate as follows:
- 1 = 1-inch microphone
- 2 = ½-inch microphone
- 3 = ¼-inch microphone

The letter "F" denotes a free-field type and "P" a pressure- field type

Electroacoustic Standards

The most relevant electroacoustic standard is the IEC 61672:2002 "Electroacoustics – Sound Level Meters".

Although the microphone is an important component in any system that has to comply with IEC 61672 there are many other factors to consider. Despite this, the following tables also show which microphones are suitable for system solutions that have to fulfill the requirements of IEC 61672.

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

Abbreviations used for Standards in the Tables

	IEC 61094		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				

Maximum Limits and Dynamic Range

Microphone Cartridges

Inherent Noise: Even if a microphone is placed in a "totally quiet" room there will be some Brownian movement of the microphone back-plate and diaphragm. These movements correspond to very small pressure fluctuations and will cause changes in the cartridge capacity which – if a polarisation voltage is present – cause an output voltage from the microphone. The SPL corresponding to this output voltage is defined as the inherent noise of the cartridge.

3% Distortion Limit: Even though the condenser microphone is highly linear, at a certain pressure there will be some distortion of the output signal. At Brüel & Kjær we specify the 3% distortion limit as a recommended maximum limit for accurate measurements.

10% Distortion Limit: Increasing the sound pressure behind the 3% distortion limit will result in a further increase in distortion. In some cases, a 10% distortion limit is specified. In many practical cases, the 10% distortion limit is determined by the preamplifier.

Maximum SPL: Due to mechanical forces acting on the cartridge there is a maximum pressure level which should never be exceeded or the long-term stability can be influenced and/or mechanical damage can happen. The corresponding sound pressure level is called the maximum SPL.

Dynamic Range of Microphone/Preamplifier Combinations: In a practical application, the lower limit of dynamic range is determined by the combined noise from the cartridge and the preamplifier. The upper SPL limit will often be determined by the output voltage swing from the preamplifier. This is especially important when using DeltaTron (IEPE) preamplifiers, since here the maximum voltage is limited by the input stage compliance (open-circuit) voltage.

A compliance voltage of, say, 28 V as used in many front-ends will limit the maximum voltage swing to around 20 V_{pp} and this may determine the real maximum limit of a cartridge preamplifier combination.

Brüel & Kjær defines the dynamic range as the range from the noise floor to the SPL resulting in a 3% distortion limit with a given cartridge/preamplifier combination, and nominal compliance voltage where relevant.

SPL limitations for different microphone cartridge sensitivity and a DeltaTron preamplifier with 14 V pp output voltage swing

Max. SPL dB	50 mV/Pa	12.5 mV/Pa	3.16 mV/Pa	1 mV/Pa
138	OK	OK	OK	OK
150		OK	OK	OK
162			OK	OK
172				OK

Note: With classical input and 120 V supply the maximum SPL is approximately 12 dB higher

Replacing Discontinued Brüel & Kjær Microphones

Most present Brüel & Kjær microphones are Falcon Range® microphones. The Falcon Range line offers a number of advantages, for example, the diaphragm mounting method (press fit mounted or laser welded) that provides a higher mechanical robustness. Furthermore, the use of a stainless steel diaphragm results in an improved resistance to environmental conditions. The table can be helpful if you need to replace an older Brüel & Kjær type.

Older Types of Microphone	Recommended Replacement Microphone Types
4133	4191
4134	4192
4135	4939
4136	4938
4147	4193
4155	4189
4165	4190
4166	4943
4196/4935	4957
4951	4958
4181	4197

MICROPHONES

Free-field Microphones

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

Type Number		4939	4954	4137*	4176	4188	4189
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
Standards		C	C	J, L	I, K	I, K	B, I, L
Nominal Open-circuit Sensitivity	mV/Pa	4	3.16	31.6	50	31.6	50
Polarization Voltage**	V	200	0	0	0	0	0
Optimised Frequency Response ±2 dB	Hz	4 to 100000	4 to 80000	8 to 12500	7 to 12500	8 to 12500	6.3 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	35 to 164 (2670)	40 to 164 (2670)	15.8 to 146 (2669)	14 to 142 (2669)	15.8 to 146 (2669)	15.2 to 146 (2669)
Inherent Noise	dB (A)	28	<35	14.2	13.5	14.2	14.6
Capacitance	pF	6.1	5.1	12	12.5	12	13
Venting		Side	Side	Rear	Rear	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	0.3 to 3	1 to 5	0.5 to 5	1 to 5	2 to 4
Operating Temperature Range	°C	–40 to 150	–40 to 150	–30 to 125	–30 to 100	–30 to 125	–30 to 150
Temperature Coefficient	dB/°C	+0.003	+0.009	+0.005	–0.004	+0.005	–0.001
Pressure Coefficient	dB/kPa	–0.007	–0.007	–0.021	–0.02	–0.021	–0.01

* Class 2 microphone for Type 2237 ** 0 V = Prepolarized microphone

Type Number		4190	4191	4950	4145
Diameter	inch	1/2	1/2	1/2	1
Optimised		Free-field	Free-field	Free-field	Free-field
Standards		B, I, L	B, I, L, M	I, K	A, I
Nominal Open-circuit Sensitivity	mV/Pa	50	12.5	50	50
Polarization Voltage*	V	200	200	0	200
Optimised Frequency Response ±2 dB	Hz	3.15 to 20000	3.15 to 40000	4 to 16 kHz	2.6 to 18000
Dynamic Range with Preamplifier Type	dB(A) to dB	15 to 147 (2669)	21.4 to 161 (2669)	14 to 142 (2669)	10.2 to 146 (2669)
Inherent Noise	dB (A)	14.5	20	13.5	10
Capacitance	pF	16	18	12.5	66
Venting		Rear	Side	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	1 to 2	1 to 2	0.5 to 5	1 to 2
Operating Temperature Range	°C	–30 to 150	–30 to 300	–30 to 100	–30 to 100
Temperature Coefficient	dB/°C	–0.007	–0.002	+0.006	–0.002
Pressure Coefficient	dB/kPa	–0.01	–0.007	–0.02	–0.015

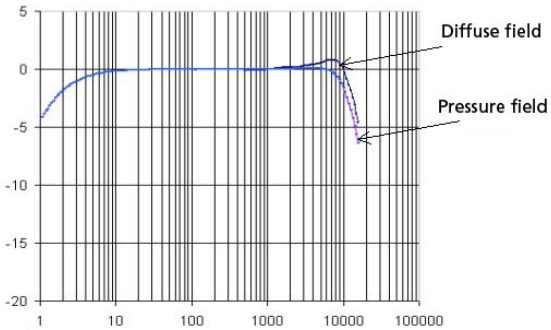
* 0 V = Prepolarized microphone

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.

In many cases the pressure and diffuse field response will both be within ±2dB up to a certain frequency. In the example for Type 4943 (shown below), both responses are within ±2 dB up til 10 kHz.

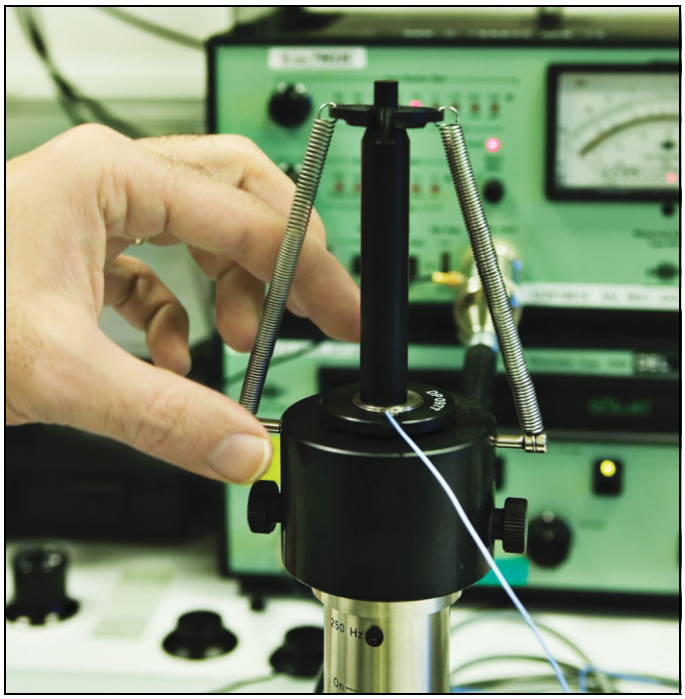
Type Number		4942	4943
Diameter	inch	1/2	1/2
Optimised		Diffuse-field	Diffuse-field
Standards		K	K
Nominal Open-circuit Sensitivity	mV/Pa	50	50
Polarization Voltage*	V	0	200
Optimised Frequency Response ±2 dB	Hz	6.3 to 16000	3.15 to 10000
Dynamic Range with Preamplifier Type	dB(A) to dB	15.2 to 146 (2669)	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	°C	–40 to 150	–40 to 150
Temperature Coefficient	dB/°C	–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 best suited for measurement of the sound pressure in a small closed couplers or close to hard reflective surfaces (see picture). A special class of pressure microphone is the so-called surface microphone, which due to its unique geometrical dimensions, can be mounted directly on surfaces such as the skin of an airplane or the surface of a car, for easy measurement of the true pressure fluctuations. Brüel & Kjær Surface Microphones Types 4948 and 4949 even have a built-in DeltaTron preamplifier with TEDS, that make them true plug and play transducers.



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)	11 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	°C	–30 to 100	–40 to 150	–40 to 150	–30 to 125	–30 to 150	–30 to 100
Temperature Coefficient	dB/°C	–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

* 4938-W-001 is optimised for high static pressure ** 0 V = Prepolarized microphone

Type Number		4948	4948-A	4948-B	4949	4949-B
Diaphragm	inch	0.41	0.41	0.41	0.41	0.41
Optimised		Surface Pressure	Surface Pressure	Surface Pressure	Surface Pressure	Surface Pressure
Standards		–	–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1.4	1.4	1.4	11.2	11.2
Polarization Voltage*	V	0	0	0	0	0
Optimised Frequency Response ±3 dB	Hz	5 to 20000	5 to 20000	5 to 20000	5 to 20000	5 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	55 to 160	55 to 160	55 to 160	30 to 140	30 to 140
Inherent Noise	dB (A)	55 (typical)	55 (typical)	55 (typical)	27.8 (typical)	27.8 (typical)
Capacitance	pF	N/A	N/A	N/A	N/A	N/A
Venting		Front	Front	Front	Front	Front
Lower Limiting Frequency (–3 dB)	Hz	1 to 5	1 to 5	1 to 5	0.5 to 5	0.5 to 5
Operating Temperature Range	°C	–55 to 100	–55 to 100	–55 to 100	–55 to 100	–55 to 100
Temperature Coefficient	dB/°C	0.013	0.013	0.013	0.013	0.013
Pressure Coefficient	dB/kPa	–0.007	–0.007	–0.007	–0.007	–0.007
Preamplifier Included		DeltaTron	DeltaTron	DeltaTron	DeltaTron	DeltaTron
TEDS UTID		769	769	769	769	769
CIC		No	Yes	Yes	No	Yes

* 0 V = Prepolarized microphone

Type 4948 used for measurement of sound pressure directly on the skin of an airplane

Type 4949 used for measurement of pressure fluctuations on the side window of a car

Low-noise Microphones

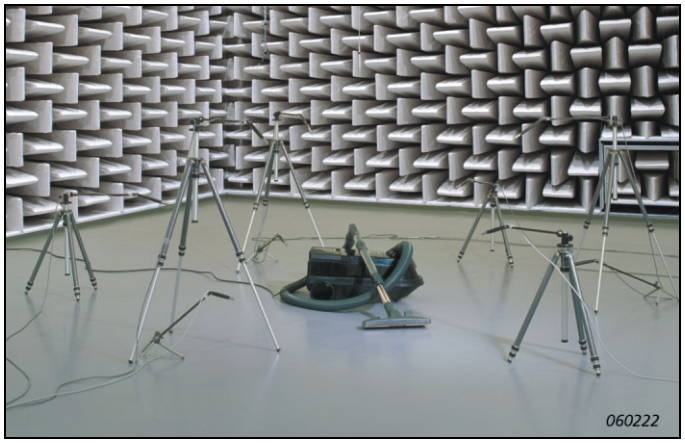
Low-noise microphones are required for qualification of anechoic chambers for Sound Power Measurements and test of components with low Sound Power rating. Type 4179 must be used with dedicated preamplifier Type 2660 or 2660-W-001. This combination has an unbeatable noise floor of –2.5 dBA while Type 4955 has the size of a normal ½″ TEDS microphone and an excellent noise floor of typically 5.5 dnBA. Additionally, Type 4955 features a titanium microphone cartridge and titanium preamplifier house.

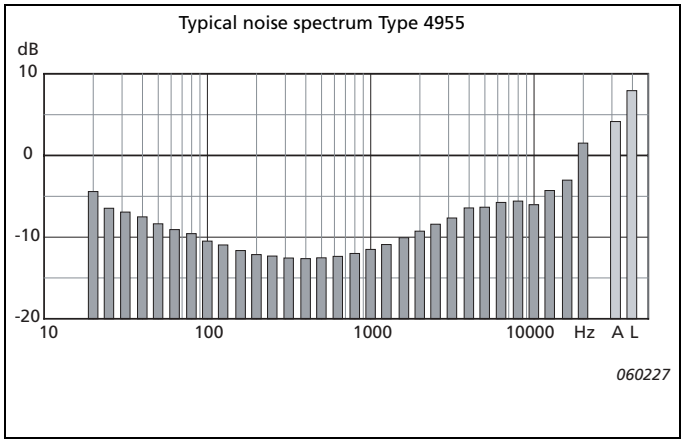
Type Number		4179	4955
Diameter	inch	1	1/2
Optimised		Low-noise	Low-noise
Standards		–	–
Nominal Open-circuit Sensitivity	mV/Pa	100	1100
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	10 to 10000	10 to 16000
Dynamic Range with Preamplifier Type	dB(A) to dB	–2.5 to 102 (2660)	6.5 to 110 (Built-in)
Inherent Noise	dB (A)	–5.5*	<6.5†
Capacitance	pF	40	N/A
Venting		Side	Front
Lower Limiting Frequency (–3 dB)	Hz	5 to 7	5
Operating Temperature Range	°C	– 30 to 100	–20 to 100
Temperature Coefficient	dB/°C	– 0.004	<±0.01
Pressure Coefficient	dB/kPa	– 0.016	–0.03
Preamplifier Included		No	Yes
TEDS UTID			116289
Connector		N/A	LEMO 1B

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.

Type 4955 is a ½-inch "all titanium" TEDS microphone with a guaranteed noise floor less than 6.5 dB(A).

* Cartridge alone, must be used with Type 2660 preamplifier
† With integral preamplifier





Array Microphones

Array applications are gaining in popularity. The picture on the right shows a typical application where a "picture" is taken of all noise sources in the engine compartment of a car.

NEW NEW NEW

Type Number		4944-A	4954-A	4957	4958
Diameter	inch	1/4	1/4	1/4	1/4
Optimised		Array	Free-field	Array	Array
Standards		–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1	2.8	17	17
Polarization Voltage*	V	0	0	0	0
Optimised Frequency Response ±2 dB	Hz	16 to 70000	16 to 80000	50 to 10 k	20 to 20 k
Dynamic Range with Preamplifier Type	dB(A) to dB	48 to 169	40 to 164	30 to 140	30 to 140
Inherent Noise	dB (A)	48	<40	<30	<30
Capacitance	pF	N/A	N/A	N/A	N/A
Venting		Side	Side	Front	Front
Lower Limiting Frequency (–3 dB)	Hz	7 to 9	<9	<50	<50
Operating Temperature Range	°C	–20 to 60	–20 to 100	–10 to 55	–10 to 55
Temperature Coefficient	dB/°C	+0.008	+0.009	–	–
Pressure Coefficient	dB/kPa	–0.003	–0.007	–	–
Preamplifier Included		DeltaTron	DeltaTron	DeltaTron	DeltaTron
TEDS UTID/UDID		769	769	I27-0-0-0U	I27-0-0-1U
Connector†	Type	SMB	SMB	SMB	SMB

Types 4944-A and **4954-A** are robust cartridges useable at higher frequencies and temperatures.

Types 4957 and **4958** feature a higher sensitivity.

Type 4957 is an economy type with only basic TEDS and limited frequency range, while Type 4958 is a high-precision type with "Intelligent TEDS", that is, a TEDS which contains polynomial coefficients describing the complex transfer function of the microphone. This information can be used in the array application in order to increase sharpness and precision.

* 0 V = Prepolarized microphone
† Standard type array microphones use SMB connectors but as customised products they can be delivered with 10–32 UNF (Microdot) connectors

High-intensity Testing

Most noise measurements are limited to around 140 to 150 dB maximum SPL, but applications such as measurement of gunshots, airbag deployment noise, etc., require measurements of dynamic pressures fluctuations corresponding to a SPL far beyond 160 dB.*

For measurements below 110 dB the condenser microphone will normally be the preferred transducer, while above 200 dB pressure sensors have to be used. In the intermediate range there is a choice between pressure sensor (piezoelectric microphone) or condenser microphone. Piezomicrophones are basically Gauge-PSIG types and are either charge or piezoresistive type.

Charge types have the benefit of being hermetically sealed and self contained (that is, they don't need supply or polarization voltage). Charge transducers will work with voltage input amplifiers, but for best performance and ease of use they should be connected to a charge input.

Optimally, piezoresistive transducers need a full bridge setup and bridge input conditioning for best performance, they can basically work down to DC.

In cases where there isn't a "stiff" pressure field, the higher and not so well specified free-field correction of the piezo microphones can be a problem.

Condenser microphones benefit from a higher degree of standardisation, wider frequency range, lower noise floor, and standardised calibration methods. They are readily available as TEDS microphones for direct connection to industry standard DeltaTron (IEPE) inputs. Condenser microphones are normally fully specified with respect to frequency response, free-field corrections, influence of accessories, etc.

* Note: Above 160 dB air behaves highly non-linearly

Type Number		4941	4938-WB-1418
Diameter	inch	1/4	1/4
Optimised		High-pressure	Airbag
Standards		–	–
Nominal Open-circuit Sensitivity	mV/Pa	0.09	0.4
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	4 to 20000	0.5 to 70000
Dynamic Range with Preamplifier Type	dB(A) to dB	73.5 to 184 (2670)	50 to 177 (2670 WB 1419)
Inherent Noise	dB (A)	59	30
Capacitance	pF	3.3	6.1
Venting		Side	Side
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	0.05 to 0.2
Operating Temperature Range	°C	– 40 to 150	– 40 to 150
Temperature Coefficient	dB/°C	–	+0.003
Pressure Coefficient	dB/kPa	–	–0.003
Preamplifier Included		No	No

High Sound Pressure Microphone Type 4941 is used for gunshots, fireworks and rocket testing.

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-WB-1418 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-WB-1419.

Piezoelectric Microphones

Type Number		2510	2510-M4A	8507-C-2	8510-B-1	8510-B-2
Order Number		EE-0205	EE-0206	EE-0158	EE-0161	EE-0162
Diameter	inch	0.816	0.816	0.092	0.159	0.159
Optimised		Piezoelectric	Piezoelectric	Piezoresistive	Piezoresistive	Piezoresistive
Standards		–	–	–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	0.155*	0.155*	0.025**	0.045**	0.022**
Polarization Voltage	V	N/A	N/A	N/A	N/A	N/A
Specified Frequency Response	Hz	1 to 10000	1 to 10000	0 to 20000	0 to 16000	0 to 20000
Dynamic Range	dB SPL	100 to 180	100 to 180	80 to 181	95 to 177	100 to 181
Inherent Noise	dB SPL	N/A	N/A	N/A	<78	<80
Capacitance	pF	5200	5200	N/A	N/A	N/A
Venting		N/A	N/A	N/A	N/A	N/A
Lower Limiting Frequency (–3 dB)	Hz	<0.7 Hz	<0.7 Hz	0 Hz	0 Hz	0 Hz
Operating Temperature Range	°C	–54 to 260	–54 to 260	–54 to 107	–54 to 121	–54 to 121

* pC/Pa
** At 10 V excitation

ENDEVCO Types 2510 and **2510-M4A** are both charge type transducers useable up to 180 dB SPL and 260°C. Type 2510-M4A provides special mounting for flush diaphragm applications.

ENDEVCO Type 8507-C-2 is a miniature piezo microphone (diameter less than 2.5 mm) capable of measuring up to at least 181 dB SPL and 15 kHz.

ENDEVCO Types 8510-B-1 and 2 are piezoresistive sensors with a maximum temperature limit around 93°C, and maximum SPL of 180 dB for the 8510-B-2. These types feature 10–32 UNF thread mounting.

Hydrophones

Although originally intended for underwater measurements these hermetically sealed devices are also very suitable for high intensity pressure measurements in air, this is because of the low sensitivity of the hydrophone. The useable frequency range is from a few fractions of a Hz to around 20 kHz.

PSI or dB?

Traditionally acoustical engineers work in dB SPL defined $20 \times \log (p_a/20\,\mu Pa)$ where p_a is the actual (dynamic) pressure in pascals.

Pressure sensors often refer to PSI (Pounds Per Square Inch).

It may be good to know that dB SPL can easily be converted to pascal and after that to PSI.

1 Pa = 0.0001450 pascal and hence:

dB SPL	Pressure Pascal	Pressure PSI
94	1	0.000145
154	10^3	0.145
174	10^4	1.45
194	10^5	14.5
200	2×10^5	29

Outdoor Microphones

Outdoor Microphone Type 4952 in a typical noise monitoring situation

Our outdoor microphones are intended for permanent or semi permanent outdoor use. Aside from the obvious weather protection required, one should also consider factors such as calibration facilities, on-site remote verification (CIC is the obvious method here), and conformance with standards of special importance, for example, the requirements specified in IEC 61672 Electroacoustics – Sound Level Meters. This standard defines the requirements to the directivity response of the microphone and is often an overlooked or misinterpreted requirement.

All Outdoor Microphones are supported by a broad range of accessories. Please refer to the accessories section for an overview.

Type Number		4184	4198	4952
Diameter	inch	Probe	1/2	1/2
Optimised		Outdoor	Outdoor	Outdoor
Standards		I, K	I, K	I, K
Nominal Open-circuit Sensitivity	mV/Pa	12.5	50	31.6
Polarization Voltage*	V	200	0	0
Optimised Frequency Response ±2 dB	Hz	20 to 8000	6.3 to 16000	8 to 12.5 kHz
Dynamic Range with Preamplifier Type	dB(A) to dB	25 to 140	15.2 to 146	15.8 to 146
Inherent Noise	dB (A)	25	15.2	<16
Venting		Yes	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	<20	2 to 4	1 to 5
Operating Temperature Range	°C	–40 to 55	–25 to 60	–30 to 60
Temperature Coefficient	dB/°C	–0.005	–0.001	0.005
Pressure Coefficient	dB/kPa	–0.006	–0.01	–0.021
Preamplifier Included		Yes	Yes	Yes
Connector		B&K 7-pin	LEMO 1B	LEMO 1B

* 0 V = Prepolarized microphone

Type 4184 Weatherproof Microphone Unit – For permanent, semi-permanent and portable noise monitoring. It features a probe type microphone for optimal protection and directivity response plus both CIC facility and a built-in acoustic sound source for verification.

Type 4198 Outdoor Microphone Unit – For semi-permanent noise monitoring. Depending on circumstances, this well protected microphone can sustain several months of unattended use. Features CIC and Falcon Range data disc.

Type 4952 Outdoor Microphone – The latest member of the Brüel & Kjær Outdoor Microphone family. The outer parts of this microphone consist of carefully selected polymer materials making it suitable even for longer periods of unattended outdoor use (at least one year service interval). This microphone also features CIC. The use of separate equalization filters enables Type 4952 to fulfill the requirements of IEC 61672 both for 0° and 90° of incidence.

UA-1404 Outdoor Microphone Kit – For protection of your existing Type 4188, 4189, or 4190 microphones. Same performance as Type 4198.

Laboratory Standard Microphones

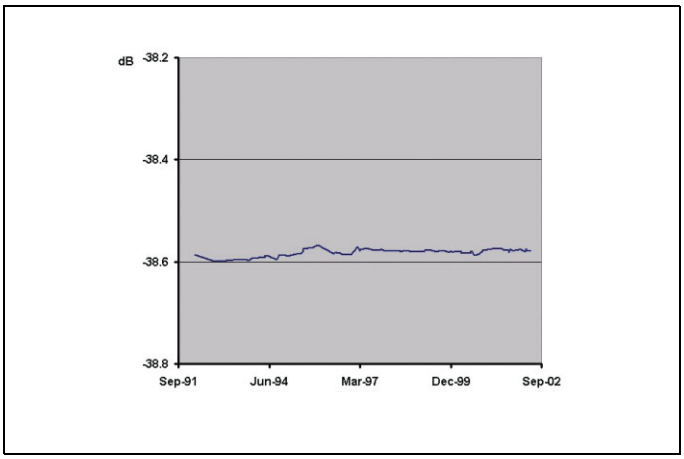
The most used laboratory standard microphones are **Types 4160 (1″) and 4180 (1/2″)**. These microphones have a well-defined cavity in front of the diaphragm and are optimised for use in couplers and for maximum long term stability under reference conditions. The proven long term stability is in the area of a few mdB's per year (see figure below).

Type Number		4160	4180
Diameter	inch	1	1/2
Optimised		Calibration	Calibration
Standards		G	H
Nominal Open-circuit Sensitivity	mV/Pa	47	12.5
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	2.6 to 8000	4 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	10 to 146 (2673)	21 to 160 (2669)
Inherent Noise	dB (A)	9.5	18
Capacitance	pF	55	17.5
Venting		Side	Side
Lower Limiting Frequency (–3 dB)	Hz	1 to 2	1 to 3
Operating Temperature Range	°C	–10 to 50	–30 to 100
Temperature Coefficient	dB/°C	+0.003	–0.002
Pressure Coefficient	dB/kPa	–0.0016	–0.007
Preamplifier Included		No	No
Connector			

The most common way of performing primary calibration of laboratory standard microphones is to use the reciprocity calibration principle. Brüel & Kjær offers the world's most used reciprocity calibration apparatus, that is, **Type 5998** (see picture below) which is used as part of Reciprocity Calibration System **Type 9699**.

Reciprocity Calibration Apparatus Type 5998

Measured stability of a Brüel & Kjær Type 4180 Laboratory Reference Microphone over a period of 10 years. Note: 0.2 dB/division



Customised Products

Despite the large number of transducers available in our standard programme, special measurement situations can occur requiring transducers that are not part of Brüel & Kjær's standard product range. In order to effectively meet our customer's needs we offer customised products.

We already have a broad portfolio of non-standard products developed for special applications. Maybe one of these products can also solve your problem? Please contact your local Brüel & Kjær representative for further information.

Some examples of customised products:

- Short version of Preamplifier Type 2670 with supply voltage regulation
- Surface Microphones with 30 m cable
- Classical preamplifier with both IVC and CIC
- 1/8-inch microphones with open-end flush grids
- Customer specific TEDS templates
- Sandwich version of the Surface Microphone for special applications
- Cable reinforcement solutions
- Array microphones with 10–32 UNF connector instead of SMB
- Wideband phase matching of TEDS microphones
- Hydrophone phase calibration
- Pressure sensing microphone with special mounting adaptor

Miscellaneous

Type Number		4193	4193 with UC-0211	4189 with UC-5265
Diameter	inch	1/2	1/2	1/2
Optimised		Low-frequency	Low-frequency	Low-frequency
Standards		E, K, M	E, K, M	B, I, L
Nominal Open-circuit Sensitivity	mV/Pa	12.5	2	50
Polarization Voltage	V	200	200	0
Optimised Frequency Response ±2 dB	Hz	0.07 to 20000	0.13 to 20000	–3 dB to 1 Hz
Dynamic Range with Preamplifier Type	dB(A) to dB	20.7 to 161 (2669)	29 to 148 (2669)	
Inherent Noise	dB (A)	19	29	
Capacitance	pF	18	118	13
Venting		Side	Side	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.01 to 0.05	<0.1	1
Operating Temperature Range	°C	–30 to 150	–30 to 150	–30 to 150
Temperature Coefficient	dB/°C	–0.002	–0.002	–
Pressure Coefficient	dB/kPa	–0.005	–0.005	–
Preamplifier Included		No	No	No
Connector				Fits 4189

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

Type 4189 with UC-5265 brings the –3 dB limit of Type 2260 Sound Level Meter down to 1 Hz.

Type Number		4938-W-001	4101	4101-A
Diameter	inch	1/4	1/5	1/5
Optimised		High static pressure	Binaural Recording	Binaural Recording with TEDS
Standards		–	–	–
Nominal Open-circuit Sensitivity	mV/Pa	1.6	20	20
Polarization Voltage*	V	200	0	0
Optimised Frequency Response ±2 dB	Hz	4 to 70000	20 to 20000	20 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	42 to 172 (2670)	23 to 134	23 to 134
Inherent Noise	dB (A)	30	23	23
Capacitance	pF	6.1	N/A	N/A
Venting		Side	Rear	Rear
Lower Limiting Frequency (–3 dB)	Hz	0.3 to 3	< 20	< 20
Operating Temperature Range	°C	– 40 to 150	– 30 to 70	– 30 to 70
Temperature Coefficient	dB/°C	+0.003	–	–
Pressure Coefficient	dB/kPa	– 0.003	–	–
Preamplifier Included		No	DeltaTron	DeltaTron
Connector				

High-static Pressure Microphone Type 4938-W-001 is specially designed for measuring in high-static pressure 1 – 10 Atm. The change in response at different static pressure has been minimised.

Binaural Microphone Type 4101 is designed especially for binaural recording where testing on a human object is preferred and/or the use of the traditional Head and Torso Simulator (HATS) method is precluded.

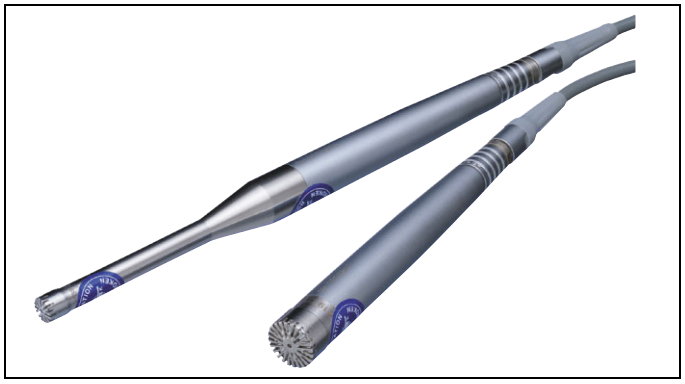
* 0 V = Prepolarized microphone

Type Number		4182	4187
Diameter	inch	Probe	1/4
Optimised		Probe	Pressure
Standards		–	–
Nominal Open-circuit Sensitivity	mV/Pa	3.16	4
Polarization Voltage	V	200	200
Optimised Frequency Response ±2 dB	Hz	1 to 20000	1 to 6400
Dynamic Range with Preamplifier Type	dB(A) to dB	42 to 164	–
Inherent Noise	dB (A)	42	–
Capacitance	pF	N/A	6.4
Venting		Selected	Rear
Lower Limiting Frequency (–3 dB)	Hz	< 0.7	<1
Operating Temperature Range	°C	– 10 to 700	–
Temperature Coefficient	dB/°C	– 0.005	–
Pressure Coefficient	dB/kPa	– 0.007	–
Preamplifier Included		Yes	No
Connector			

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

Impedance Tube Microphone Type 4187 is a 1/4-inch microphone specially designed for use in Impedance Tube Kit Type 4206. The microphone features a non-detachable protection grid which forms an airtight front cavity.

TEDS Microphones



A wide range of TEDS (Transducer Electronic Data Sheet) microphones are available from Brüel & Kjær. A TEDS microphone consists of a microphone cartridge and its pre-amplifer, sealed to form one unit called the TEDS microphone.

TEDS is standardised by IEEE and is supported by many front-ends and conditioning amplifiers including Brüel & Kjær's PULSE front-ends, the NEXUS line of Conditioning Amplifiers, the 16-channel Conditioning Amplifier Type 2694 and many more.

TEDS offers a number of benefits:

- Plug and play facilities
- Type, S/N, sensitivity and more read in directly from the transducer
- Significantly reduced setup time
- Practical elimination of cable routing errors
- Transducer location can be read into the transducer
- The TEDS microphone is assembled under controlled conditions

How does TEDS work?
Basically the chip containing the TEDS data and TEDS interface is build into the microphone preamplifier. TEDS data is updated during the boot sequence or whenever "update TEDS" is activated.

TEDS data can be transmitted to the front-end in two different ways:

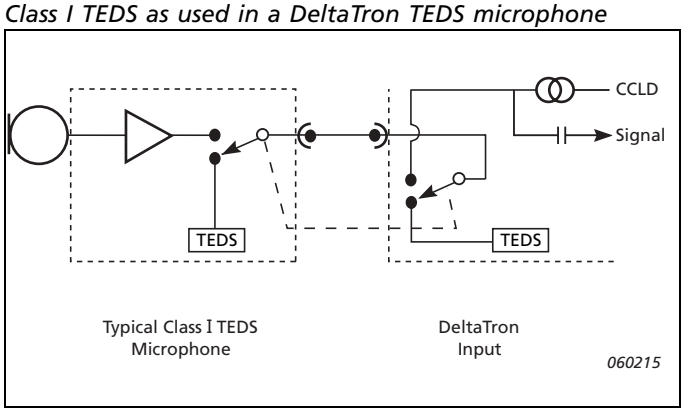
- Class I TEDS – on the same wire as the analog signal
- Class II TEDS – via a separate wire

Class I is always used with DeltaTron transducers since TEDS can be implemented using the traditional coaxial cable.

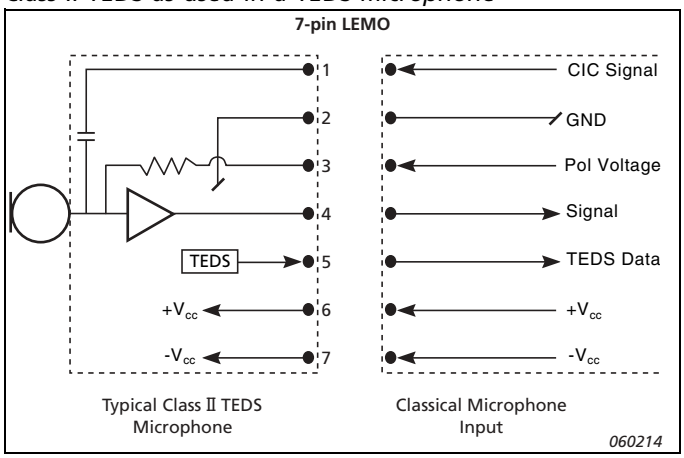
For measuring microphones, Class II is the most commonly used and pin 5 (often denoted as "No connection" in PDs) is used to transmit the TEDS data. This is important when using extension cables as some older cables might really not have pin 5 connected, which will break the TEDS chain.

Since the TEDS microphone has been assembled under controlled conditions, special precautions can be taken to avoid dust and contamination entering the boundary between microphone cartridge and the preamplifier. This is important in order to maintain low noise even at high temperatures and high relative humidity.

Class I TEDS as used in a DeltaTron TEDS microphone



Class II TEDS as used in a TEDS microphone



The IEEE 1451.4 Standard
Most sound and vibration transducers (Brüel & Kjær as well as other manufacturers) conform with IEEE P1451.4 V.0.9 which is actually a standard proposal and differs slightly from the final standard IEEE 1451 V.1.0.

Re-mapping to IEEE 1451 V.1.0 is available for all Brüel & Kjær transducers as part of after sales support. Relevant Brüel & Kjær hardware (PULSE, NEXUS, etc.) support both the proposed and final version of the standard, and in many applications the user will not notice a difference between the two standards. The major difference between the proposed and final version concerns the memory map. In the proposed version, all data is in a R/W area of the memory, while in V.1.0 some permanent data (manufacturer, etc.) has been moved to a write once area of the memory. This leaves more space in the so-called user area of the memory.

Currently, only Array Microphones Types 4957 and 4958 are supplied with TEDS according to the final revision – IEEE 1451.4 V.1.0. This is because precision Array Microphone Type 4958 requires more space for definition of the polynominal which describes the complex transfer function.

TEDS Templates
The TEDS template defines the memory mapping of the TEDS chip and hence the "understanding" between transducer and front-end.

A number of TEDS templates have been standardised by the IEEE and in addition to this a number of non-standard vendor specific templates exist. The different TEDS templates are differentiated by different ID numbers. At the moment Brüel & Kjær uses the following templates for TEDS microphones and pre-amplifiers:

IEEE P1451.4 Beta – TEDS Templates

UTID No.	Name	Remarks
34013408	Microphone with integrated preamplifier	Used for Array Microphones Types 4935 and 4951. This template is with transfer function

IEEE P1451.4 V.0.9 – TEDS Templates

UTID No.	Name	Remarks
769	Microphone, integrated preamplifier	Used for most TEDS microphones
1025	Microphone Preamplifier	Used for most TEDS microphone preamplifiers
116289	Microphone, integrated preamplifier, extended sensitivity	Used in special cases like low-sensitivity microphones or reference frequency not 250 Hz

IEEE 1451.4 V.1.0 – TEDS Templates

UDID No.	Name	Remarks
I27-0-0-0U	Microphone with integrated preamplifier, V.1.0	This template is without transfer function Replaces UTID 769 and 116289
I27-0-0-1U	Microphone with integrated preamplifier, transfer function, V.1.0	Same as UDID 127-0-0-0U but with transfer function Replaces UTID 34013408

		1/2-inch Microphones					
Type Number		**4188-A-021**	**4188-A-031**	**4188-B/C/L-001**	**4189-A-021**	**4189-A-031**	**4189-B/C/L-001**
Optimised		Free-field	Free-field	Free-field	Free-field	Free-field	Free-field
Nominal Sensitivity	mV/Pa	31.6	31.6	31.6	50	50	50
Polarization Voltage*	V	DeltaTron	DeltaTron	0	DeltaTron	DeltaTron	0
Optimised Frequency Response ±2 dB	Hz	20 to 12500	20 to 12500	8 to 12500	20 to 20000	20 to 20000	6.3 to 20000
Dynamic Range of TEDS Microphone	dB(A) to dB	19 to 141	21 to 138	15.8 to 146	16.5 to 138	18 to 134	15.2 to 146
Preamplifier Included		2671	2699	2669B/C/L	2671	2699	2669B/C/L
Adaptor Included		–	–	–	–	–	–
TEDS UTID		769	116289	769	769	116289	769
Connector		BNC	BNC	LEMO	BNC	BNC	LEMO

* 0 V = Prepolarized Microphone

		1/2-inch Microphones					
Type Number		**4189-A-022**	**4190-B/C/L-001**	**4190-L-002**	**4191-B/C/L-001**	**4192-B/C/L-001**	**4193-B/C/L-004**
Optimised		Free-field	Free-field	Free-field	Free-field	Pressure-field	Low-frequency
Nominal Sensitivity	mV/Pa	50	50	50	12.5	12.5	1.9
Polarization Voltage*	V	0	200	200	200	200	200
Optimised Frequency Response ±2 dB	Hz	20 to 20000	3.15 to 20000	3.15 to 20000	3.15 to 40000	3.15 to 20000	0.16 to 20000
Dynamic Range of TEDS Microphone	dB(A) to dB	18 to 134	15 to 147	15 to 147	21.4 to 161	20.7 to 161	26 to 148
Preamplifier Included		2671	2669 B/C/L	2669-L	2669 B/C/L	2669 B/C/L	2669 B/C/L
Adaptor Included		UA-1260	–	UA-1260	–	–	UC 0211
TEDS UTID		769	769	769	769	769	769
Connector		BNC	LEMO	LEMO	LEMO	LEMO	LEMO

* 0 V = Prepolarized Microphone

		1/2-inch Microphones				
Type Number		**4955**	**4942-A-021**	**4942-A-031**	**4942-B/C/L-001**	**4943-B/C/L-001**
Optimised		Free-field	Diffuse-field	Diffuse-field	Diffuse-field	Diffuse-field
Nominal Sensitivity	mV/Pa	1100	50	50	50	50
Polarization Voltage*	V	200	DeltaTron	DeltaTron	0	200
Optimised Frequency Response ±2 dB	Hz	5 to 20000 (±3 dB)	20 to 16000	20 to 16000	6.3 to 16000	3.15 to 10000
Dynamic Range of TEDS Microphone	dB(A) to dB	6.5 to 110	16.5 to 138	18 to 134	15.2 to 146	15 to 147
Preamplifier Included		Yes	2671	2699	2669 B/C/L	2669 B/C/L
Adaptor Included		–	–	–	–	–
TEDS UTID		116289	769	116289	769	769
Connector		LEMO	BNC	BNC	LEMO	LEMO

* 0 V = Prepolarized Microphone

		1/4-inch Microphones					
Type Number		**4938-A-011**	**4938-B/C/L-002**	**4939-A-011**	**4941-A-011**	**4941-B/C/L-002**	**4944-A**
Optimised		Pressure-field	Pressure-field	Free-field	High-pressure	High-pressure	Pressure
Nominal Sensitivity	mV/Pa	1.6	1.4	4	0.08	0.07	0.9
Polarization Voltage*	V	200	200	200	200	200	0
Optimised Frequency Response ±2 dB	Hz	4 to 70000	4 to 70000	4 to 100000	4 to 20000	4 to 20000	16 to 170000
Dynamic Range of TEDS Microphone	dB(A) to dB	42 to 172	42 to 172	35 to 164	73.5 to 184	75.8 to 184	48 to 169
Preamplifier Included		2670	2669 B/C/L	2670	2670	2669 B/C/L	DeltaTron
Adaptor Included		–	UA 0035	–	–	UA 0035	–
TEDS UTID		769	769	769	116289	116289	769
Connector		LEMO	LEMO	LEMO	LEMO	LEMO	SMB**

* 0 V = Prepolarized Microphone
** Optionally available with 10–32 UNF socket

		1/4-inch Microphones		
Type Number		**4954-A**	**4957**	**4958**
Optimised		Free-field	Array	Array
Nominal Sensitivity	mV/Pa	2.8	17	17
Polarization Voltage*	V	0	0	0
Optimised Frequency Response ±2 dB	Hz	16 to 80000	50 to 10000	20 to 20000
Dynamic Range with Preamplifier Type	dB(A) to dB	40 to 164	30 to 140	30 to 140
Preamplifier Included		DeltaTron	DeltaTron	DeltaTron
Adaptor Included		–	–	–
TEDS UTID		769	I27-0-0-0U	I27-0-0-1U
Connector		SMB**	SMB**	SMB**

* 0 V = Prepolarized Microphone
** Optionally available with 10–32 UNF socket

		1/8-inch Microphones	
Type Number		**4138-A-015**	**4138-B/C/L-001**
Optimised		Pressure-field	Pressure-field
Nominal Sensitivity	mV/Pa	0.6	0.8
Polarization Voltage*	V	200	200
Optimised Frequency Response ±2 dB	Hz	6.5 to 140000	6.5 to 140000
Dynamic Range of TEDS Microphone	dB(A) to dB	52.2 to 168	55 to 168
Preamplifier Included		2670	2669 B/C/L
Adaptor Included		UA 0160	UA 0036
TEDS UTID		769	769
Connector		LEMO	LEMO

* 0 V = Prepolarized Microphone

MICROPHONE PREAMPLIFIERS

A condenser microphone must be combined with a preamplifier to provide impedance conversion, some filtering, and the capability to drive relatively long cables without significant signal degradation.

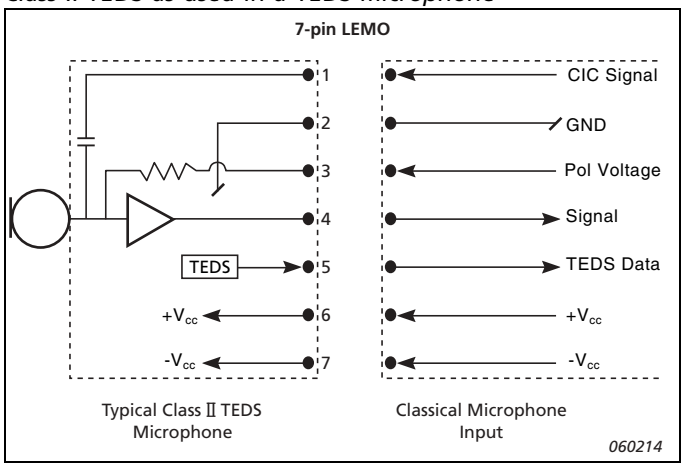
Preamplifiers are designed in accordance with two different principles here denoted as:

- The classical preamplifier
- The DeltaTron preamplifier

Each has its own special features.

The Classical Preamplifier

Class II TEDS as used in a TEDS microphone



The classical preamplifier has an easy to understand concept. It is basically a unity gain amplifier with extremely high input impedance and very low input capacitance.

The supply voltage can be either ±15 V DC or a single 120 V DC.

The output signal has its own separate wire, as do the polarization and CIC voltage.

Pin 5 is often used for transmission of TEDS data (so called Class II TEDS)

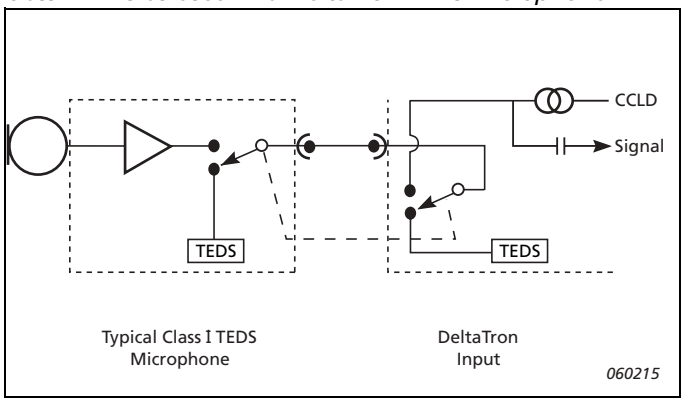
CIC (Charge Injection Calibration) is possible by injecting a signal (on pin 1 of the LEMO connector).

The DeltaTron Preamplifier

Despite its origin in the vibration transducer world, the Constant Current Line Drive (CCLD) principle is gaining increasing popularity also in a wide area of sound and measurement applications.

Different manufacturers market transducers using the CCLD principle under different names, the Brüel & Kjær name being DeltaTron. The benefit of the DeltaTron principle is that one and the same wire is used for both the signal and the supply current! Using TEDS Class I even the TEDS data can be transmitted over that same wire (using a level controlled electronic switch as shown in the figure below).

Class I TEDS as used in a DeltaTron TEDS microphone



This opens for the use of cost-effectivecoaxial cables and BNC connectors as known from general T&M applications.

A DeltaTron input can be connected to microphones as well as vibration sensors (and many other sensors with CCLD output).

Due to the working principle the signal is superimposed on a DC voltage. This DC bias voltage is typically around 12 V. Bias drift (over temperature or time) will reduce the dynamic range.

Due to the lower DC supply voltage (typically 20 – 28 V DC compliance voltage out of the front-end), there is some limitation in the upper limit for a DeltaTron solution. Another limitation of DeltaTron solution is that only pre-polarized microphones can be used and that CIC is not available.

However in many practical applications this is happily accepted in order to get the benefits DeltaTron solutions, that is, ease of use and cheap cables!

The size of the DC bias voltage is often used by the front-end to provide some simple means of cable monitoring. A bias voltage below a certain value is interpreted as short circuit while a DC value above a certain value is interpreted as open circuit.

Classical Versus DeltaTron Preamplifiers		
	Classical	**DeltaTron**
Output Voltage	55 V_p	7 V_p
Output Current	2 – 20 mA	3 – 20 mA
Noise	<2 µV	4 µV
Distortion	<–80 dB	<–70 dB
Verification	CIC/IVC	No
IEEE 1451.4	Yes	Yes
Cable Price	Higher	Lower
Connector	LEMO	BNC
Microphone Type	Both	Prepolarized only
Accelerometer Conditioning	No	Yes

Brüel & Kjær Range of Microphone Preamplifiers

We offer a large selection of robust and acoustically optimised preamplifiers that allow operation in a wide range of environmental conditions. The high output current capability of Brüel & Kjær preamplifiers allows the use of extremely long cables, even with high sound pressure levels present at high frequencies.

Preamplifiers are available in both ½″ and ¼″ dimensions for direct fit with the most used microphone cartridge sizes. For 1″ and 1/8″ cartridge adaptors are available.

The most popular classical ½″ preamplifier is Type 2669 which is available in several different versions. When insert voltage calibration is required, Type 2673 is the obvious choice.

Type 2695, maybe due to its small size (half the length of the extremely popular DeltaTron preamplifier Type 2671), is an often overlooked unit.

Type 2699 combines a DeltaTron preamplifier and an A-weighting filter in one unit. This type can be easily distinguished from other preamplifiers due to the two engraved rings.

Type 2670 ¼″ preamplifiers are available in different versions each with their own special features.

When sold alone most preamplifiers are supplied with the TEDS Template UTID 1025. When sold as part of a TEDS microphone the template UTID 769 or 116289 is used.

For tables please see overleaf.

Replacing Discontinued Brüel & Kjær Preamplifiers

Modern (Falcon Range) preamplifiers have several advantages over the older types, for example, with respect to parameters, such as settling time, noise immunity, physical size and connectors.

The table below can be helpful if you need a replacement for an older Brüel & Kjær type.

Older Preamplifier Type	Recommended Replacement Preamplifier Type
2619	2669
2627	2673
2633	2670
2639	2669
2645	2673

2669B/L

2670/2670 WB-1419

2669C

2670-W-001

Type Number		2669-B	2669-L	2669 -	2669-001	2670	2670-W-001
Diameter	inch	1/2	1/2	1/2	1/2	1/4	1/4
Optimised		Acoustical	Acoustical	Cylindrical	For 4232 only	Phase	Short, 48 mm
Connector at Preamplifier		LEMO 0B, 7-pin	LEMO 0B, 7-pin	LEMO 1B, 7-pin	LEMO 1B, 7-pin	Fixed (2 m)	Fixed (0.6 m)
Connector at Instrument/Cable		B&K, 7-pin	LEMO 1B, 7-pin	None	None	LEMO 1B, 7-pin	0.6 m cable with LEMO 1B, 7-pin
Calibration Facility		CIC	CIC	CIC	CIC	CIC	CIC
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	± 14 to ± 60 or 28 to 120	± 5 to ± 20 or 10 to 40 *
Max. Output Voltage (Peak)	V	55 (10 below supply)	55 (10 below supply)	55 (10 below supply)	55 (10 below supply)	55 (10 below supply)	15
Max. Output Current (Peak)	mA	20	20	20	20	20	17
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)	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)
Attenuation	dB	< 0.35	< 0.35	< 0.35	< 0.35	< 0.4	< 0.4
Noise A-weighted, typical	µV	1.9	1.9	1.9	1.9	4	4
Noise 22.4 Hz to 300 kHz, typical	µV	8.2	8.2	8.2	8.2	14	14
Input Impedance	GΩ‖pF	15 ‖0.3	15‖0.3	15‖0.3	15‖0.3	15‖0.25	15‖0.25
TEDS UTID		1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2221155	1025 from serial number 2248944	No

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

2671

2670/2670 WB-1419

2695

2673

2699

Type Number		2670-WB-1419	2671	2671-W-001	2673	2695	2699
Diameter	inch	1/4	1/2	1/2	1/2	1/2	1/2
Optimised		Airbag	DeltaTron	DeltaTron	Calibration	Short DeltaTron	DeltaTron
Connector at Preamplifier		Fixed (2 m) cable	BNC	BNC	LEMO 0B, 7-pin	10–32 UNF	BNC
Connector at Instrument Cable		LEMO 1B, 7-pin	N/A	None	LEMO 1B, 7-pin	N/A	N/A
Calibration Facility		None	None	None	LEMO 0B, 7-pin	10–32 UNF	BNC
Polarization Voltage Support		Yes	No	No	Yes	No	No
Supply Voltage	V	± 14 to ± 60 or 28 to 120	28	28	± 14 to 60 or 28 to 120	28	28
Max. Output Voltage (Peak)	V	55 (10 below supply)	7	7	55 (10 V below supply)	7	7
Max. Output Current (Peak)	mA	20	19	19	19	19	18
Frequency Range	Hz	1 to 100000 ± 1 dB (6.2 pF)	20 to 50000 ± 2 dB (12 pF)	3 to 50000 2 dB (12 pF)	3 to 200000 ± 0.5 dB (20 pF)	20 to 50000 ± 2 dB (15 pF)	A-weighted to IEC61672 Class 1
Attenuation	dB	11	< 0.35	<0.35	< 0.05	< 0.2	0 ±0.3 dB at 1 kHz
Noise A-weighted, Typical	µV	4	4	2	1.8	4	8 Max., LIN
Noise 22.4 Hz to 300 kHz, Typical	µV	14	15	4	11	12	N/A
Input Impedance	GΩ‖pF	15‖15	1.5‖0.4	10‖0.4	1‖0.05	1.7‖0.4	10 +20–40%‖0.5
TEDS UTID		1025 from serial number 2264319	1025 from serial number 2264319	1025 from serial number 2221155	No	1025	102 ref. freq. 1000 Hz

2660

Type Number		2660	2660-W-001
Diameter	inch	1/2 and 1/1	1/2
Optimised		Low-noise	Low-noise
Connector at Preamplifier		None	None
Connector at Instrument/Cable		B&K, 7-pin	B&K, 7-pin
Calibration Facility		None	None
Polarization Voltage Support		Yes	Yes
Supply Voltage	V	120 and 12	±14 to ±16 V
Max. Output Voltage (Peak)	V	45	4
Max. Output Current (Peak)	mA	1.5	1.5
Frequency Range	Hz	20 to 200000 ± 1 dB (0 dB)(47 pF)	20 to 200000 ± 1 dB (0 dB)(47 pF)
Attenuation	dB	< 0.06	< 0.06
Noise A-weighted, typical	µV	0.8	0.8
Noise 22.4 Hz to 300 kHz, typical	µV	5	5
Input Impedance	GΩ‖pF	36‖0.3	36‖0.3
TEDS UTID		No	No

Microphone Verification and Calibration

Charge Injection Calibration (CIC)

This is a Brüel & Kjær patented method for in-situ verification of the integrity of the entire measurement chain, for example, microphone, preamplifier and cabling. Even microphones remote from the input stage/conditioning amplifier can be verified. The basic philosophy behind CIC is that if we have a known condition (for example, a properly calibrated microphone) and establish a reference measurement, then as long as the reference value does not change, nothing has changed and the microphone calibration will still be valid. Additionally CIC verifies the cable and preamplifier. Furthermore, if an error occurs, then the change in the CIC signal will very often clearly indicate which kind of problem causes the error.

The CIC technique is a great improvement over the traditional insert voltage calibration method which virtually ignores the state of the microphone. The CIC technique is very sensitive to any change in the microphone's capacitance, which is a reliable indicator of the microphone's condition.

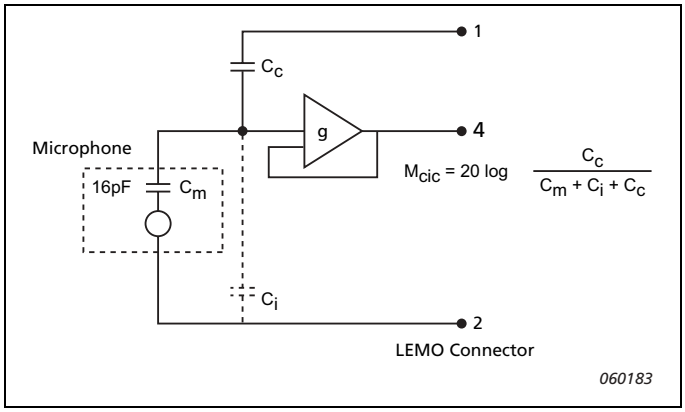
The technique works by introducing a small but accurately defined capacitance C_c (typically 0.2 pF) with a very high leakage resistance (greater than 50000 GΩ) into the circuit of the preamplifier, see figure. C_i and R_i represent the preamplifier's high input impedance and g its gain (= 1).

For a given calibration signal e_i, the output e_o of this arrangement will change considerably, even for small changes in the microphone's capacitance C_m. The CIC technique is about 100 times more sensitive than the insert voltage calibration. In the extreme case where there is a significant leakage between the microphone's diaphragm and its back plate (C_m becomes very large), the output signal will change by tens of decibels compared with only tenths of a decibel using the insert voltage method.

Another important CIC feature is that, unlike the insert voltage technique, it is far less sensitive to external electrical fields.

Insert Voltage Calibration (IVC)

This method was originally developed for calibration of the open-circuit voltage sensitivity of microphones and, for this purpose, it is still the best method. IVC requires a special preamplifier and will not detect microphone changes as easily as the CIC method.



How to Perform CIC

The CIC method can be used to monitor the measurement system at all frequencies covered by the system.

Use low frequencies to observe changes in the preamplifier input resistance or additional leakage.

Use the mid-frequency range, for example, around 1 kHz to check for changes to the microphone capacitance. The CIC output is essentially inversely proportional to the microphone capacitance.

Check the high-frequency attenuation (above 10 kHz) to monitor for changes in the microphone resonance.

When can CIC be used?

CIC requires use of a preamplifier and a cable which supports CIC plus a front-end input which allows CIC measurement. If the power supply does not support CIC, Brüel & Kjær can supply adaptors to inject the CIC signal; use WB-0850 for a Brüel & Kjær connector and UA-1405 for a LEMO connector. Presently CIC is not possible when using preamplifiers with DeltaTron output.

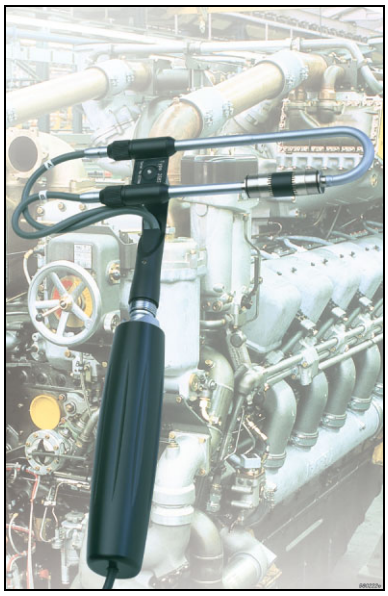
The Brüel & Kjær PULSE Multi-analyzer and the NEXUS range of conditioning amplifiers support CIC for the microphone inputs.

Calibration

The microphone and the entire measurement chain must be calibrated at regular intervals. The calibration provides traceability and proven accuracy to your system. The intention behind CIC is not to replace the calibration but to enable you to extend the calibration interval.

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	1 kHz – 20 kHz: ±0.1° × f [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	< 0.3 dB: 100 Hz to 10 kHz < 0.5 dB: 100 Hz to 20 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 5 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

MICROPHONE & PREAMPLIFIER EXTENSION CABLES

The best connection between A and B is a cable from Brüel & Kjær. A quality cable is so much more than just an electrical connection between two points. Cables from Brüel & Kjær are carefully selected and designed in order to offer excellent electrical properties such as high screening and low capacitance combined with maximum strength and flexibility for easy handling.

The preferred length for many extension cables is 3, 10 or 30 m, but nearly all Brüel & Kjær cables are available in customer specific lengths. The ordering system follows a simple yet flexible structure. Up to 99.9 m, the cable length can be specified in tenths of a meter (decimetre) and from 100 m in steps of 1 m.

Generally the order number is:

AO-XXXX-Y-ZZZ

where:

- AO-XXXX is the basic cable type
- Y defines the length unit: Y = D (decimetre), Y = M (metres)
- Z is the length value

For example, a 3 m long AO-0414 cable has order number:

AO-0414-D-030

corresponding to a length of 30 decimetres.

A 100 m long AO-0414 cable has order number:

AO-0414-M-100

Part No.	Connector A	Connector B	Raw Cable	Description	
AO-0414	LEMO 1B, Female	LEMO 1B, Male	AC-0289	Most popular extension able for classical preamplifier and microphone input. Also fits directly in preamplifiers with cylindrical houses. PUR cable –20 to +80°C	
AO-0419	LEMO 0B, Female	LEMO 1B, Male	AC-0219	Preamplifier Cable Silicone Cable –60 to +150°C Suits only 2669 and 2673 with conical house	
AO-0428	LEMO 0B, Female	7-pin B&K, Male	AC-0219	From present classical preamplifier with conical house to B&K input Silicone cable –60 to +150°C	
AO-0027	7-pin B&K, Female	7-pin B&K, Male	AC-0289	From old Brüel & Kjær preamplifier to B&K input. Single-screened PUR cable –20 to +80°C	

Part No.	Connector A	Connector B	Raw Cable	Description	
AO-0028	7-pin B&K, Female	7-pin B&K, Male	Double-screened AC-3028	As AO-0027 but with double-screened cable	
AO-0488	7-pin B&K, Female	LEMO 1B, Male	AC-0289	Connects older Brüel & Kjær systems to modern input PUR cable –20 to +80°C	
AO-0645	LEMO 1B, Female	LEMO 1B, 10-pin, Male	AC-0289	Connects classical microphone preamplifiers to SLM and other input (2250/60 and 3639) PUR cable –20 to +80°C	
AO-0479	LEMO 1B, Male	BNC	AC-0289	Microphone front-end input cable Only LEMO pin 2 and 4 are connected to BNC, LEMO pin 2 is GND PUR cable –20 to +80°C	
AO-0537	7-pin B&K, Female	LEMO 1B, Male	AC-0289	Adaptor cable – use only with 2633 and 2639 PUR cable –20 to +80°C	

Part No.	Connector A	Connector B	Raw Cable	Description	
AO-0463	10–32 UNF	10–32 UNF	AC-0208	Economy cable PVC –20 to +70°C	
AO-0563	SMB (right angle)	SMB (right angle)	RG-174	When you need SMB in both ends –10 to +80°C	
AO-0564	SMB (right angle	BNC	RG-174	Where space is limited SMB and BNC –10 to +80°C	
AO-0587	SMB	BNC	AC-0208	For use with array microphones PVC cable –20 to +70°C	
AO-0687	10–32 UNF	10–32 UNF	AC-0005	Super Cable with extensive connector relief PFA cable –40 to +120°C	
AO-0087	BNC	BNC	RG-58/U	General purpose coaxial cable with BNC 50 Ω	
AO-0426	BNC	BNC	RG-223/U (Double-screened)	General purpose coaxial cable with BNC, double-screened 50 Ω	
AO-0531	10–32 UNF	BNC	AC-0208	For surface microphones or 1/4-inch TEDS microphones with 10–32 UNF PVC cable –20 to +70°C	

Part No.	Connector A	Connector B	Raw Cable	Description	
AR-0014	LEMO 1B, F	LEMO 1B, M	Shielded flat cable	Signal routing through closed doors and windows 0.2 mm thick	
WL-1287	LEMO 1B, Female	LEMO 1B,10-pin, M	AC-0289	Connects 4182 to 2250/60, etc., SLM input PUR cable –20 to +80°C	
WL-1302	7-pin B&K	LEMO 1B, Male	AC-0289	Adaptor cable, 2660-W-001 to PULSE/NEXUS Maximum ±16 V DC supply PUR cable –20 to +80°	
EL-4025	LEMO 1B, Female	B&K 7-pin, Female		Connection cable for 5935-L	

Raw Cables

This table provides information about the raw cables used for a number of Brüel & Kjær extension cables. Note that the temperature range for a cable with connectors can be limited compared with the specifications for the raw cable.

Raw Cable	Cable, ∅ mm	Jacket	Colour	Temperature Range, °C	Centre Conductor	Impedance Ohms	pF/m	Description
AC-0005	2	PFA	Black	–75 to +250	Silver-plated Steel	50	105	Special cable with low tri-boelectric noise
AC-0079	4	PUR	Grey	–30 to +90	7∗0.10 mm^2		95...115	Special braided shield micro-phone cable
RG-58/U	4.95	PVC	Black	–25 to +170	19∗0.1 cm	50	101	Single screen type RG-58/U coaxial cable
AC-0208	2	PVC	Grey	–20 to +70				Single screen highly flexible, low-cost, thin, coaxial cable
AC-0219	4	Silicone	Grey	–50 to +150	7∗0.06 mm^2		90	Special braided shield micro-phone cable
AC-0289	4.2	PUR	Black, dull	–30 to +70	10∗0.04mm^2		95	Special braided shield micro-phone cable
RG-223/U	5.38	PVC	Black	–35 to +70	0.9 cm	50	101	Double braided shield type RG-233/U coaxial cable

Cable Length and Current Limitation in Preamplifiers

Brüel & Kjær preamplifiers can drive very long cables. The cable length is limited though by the available output current of the preamplifier, especially in situations where high frequency signals must be measured at high levels.

The maximum sound pressure level ($L_{p,peak}$) which can be measured with the combination of available current, cable load, frequency content of signal and microphone sensitivity can be calculated with the following expression:

$$L_{p,\,peak} = 94 + 20\log\left(\frac{i_{peak}}{2\cdot\pi\cdot f_{max}\cdot C_L\cdot 1\,Pa\cdot S_c}\right)[dB]$$

where:

i_{peak} = maximum available peak current, either the preamplifiers maximum output current or the supply current minus the preamplifier's current consumption, whichever is the smallest

f_{max} = maximum frequency in the signal

C_L = total capacitative load presented by the connection cable in farad (F). The load is calculated by multiplying the cable length in metres with the cable capacitance in F per metre

S_c = loaded sensitivity of the microphone in V/Pa (Nominal Sensitivity)

The following examples illustrate the use of the above equation.

Example 1
Using a PULSE Dyn-X module with DeltaTron® Microphone Preamplifier Type 2671, a Prepolarized Free-field, ½-inch Microphone Type 4188 and 100 m of 95 pF/m cable:

i_{peak} = 4 mA – 1 mA = 3 mA

C_L = 95 pF/m × 100 m = 9.5 nF

S_c = 31.6 mV/Pa

f_{max} = 10000 Hz

$$L_{p,\,peak} = 94 + 20\log\left(\frac{0.003}{2\cdot\pi\cdot 10000\cdot 9.5\cdot 10^{-9}\cdot 1\,Pa\cdot 0.0316}\right) = 138\,dB$$

Example 2
Using a PULSE Dyn-X module with ½-inch Microphone Preamplifier Type 2669, a ½-inch Free-field Microphone Type 4191 and 1000 m of 95 pF/m cable:

i_{peak} = 20 mA – 3 mA = 17 mA

C_L = 95 pF/m × 1000 m = 95 nF

S_c = 12.5 mV/Pa

f_{max} = 20000 Hz

$$L_{p,\,peak} = 94 + 20\log\left(\frac{0.017}{2\cdot\pi\cdot 20000\cdot 95\cdot 10^{-9}\cdot 1\,Pa\cdot 0.0125}\right) = 135\,dB$$

Note: The maximum peak sound pressure level for shorter cables may be limited by the available voltage and the preamplifiers maximum slew rate. Further details about the limitations due to voltage, current, and slew rate of the preamplifiers can be found in Brüel & Kjær's Microphone Handbook.

Popular Connectors Used in Acoustic Measurements

Older Brüel & Kjær equipment traditionally used proprietary so-called B&K coaxial connectors (JP-0101) and the famous B&K 7-pin microphone plugs for the preamplifier input.

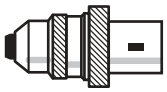
Due to the long lifetime and high stability of Brüel & Kjær instruments, thousands of instruments using these traditional connectors are still on the market, and we still supply extension cables and adaptors that connect these instruments to newer types of transducers.

Eventually, these older connectors were replaced by the LEMO 7-pin connector (for classical microphone input), and the industry standard BNC connector for signal input/output. BNC connectors are also a popular choice for DeltaTron preamplifiers.

Another popular coaxial connector (originating from the vibration world) is the 10 – 32 UNF, also called the "Microdot" connector. The 10 – 32 UNF is especially popular where vibrations can be expected, while the SMB type connectors are often encountered in multi-hannel systems, where space around the connector is limited, for example, in array-solutions.

For an overview of the range of different adaptors please see the "Accessories" section.

JP-0101



7-pin microphone preamplifier plug (male)

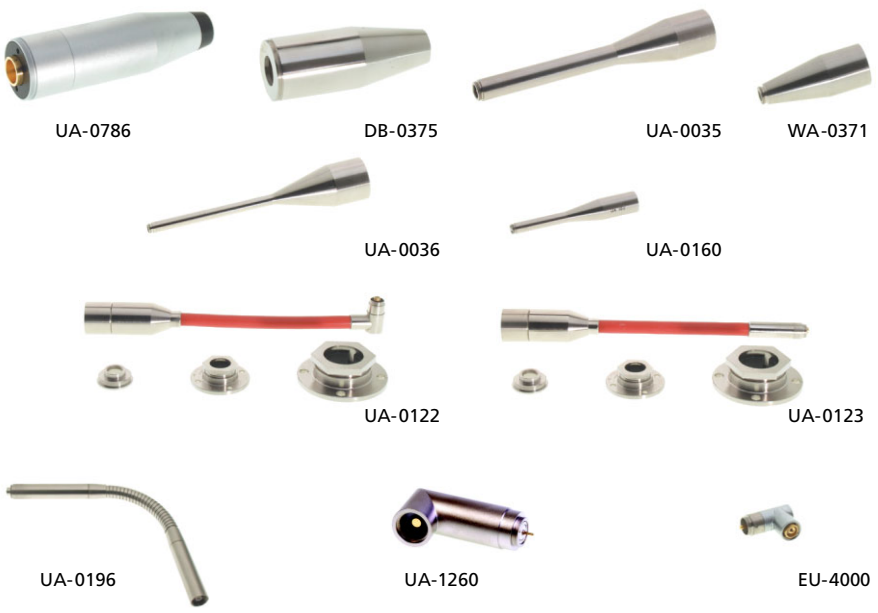
JP-0035

LEMO 7-pin

MICROPHONE ACCESSORIES

Adaptors

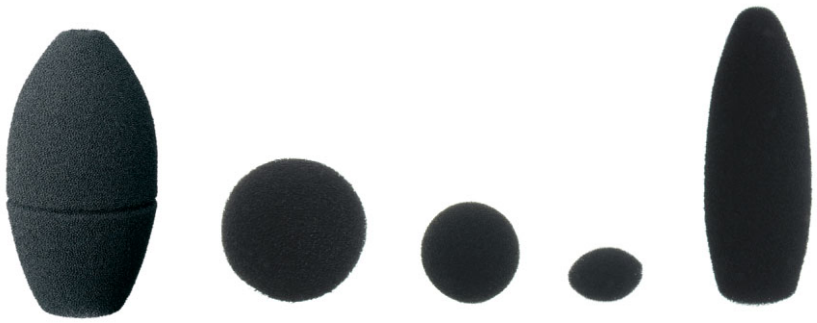
Adaptors for Mounting Preamplifiers and Extension Rods with Microphones of Different Diameters	
UA-0786	1/1-inch microphone to 1/2-inch preamplifier, Insert Voltage possibility
DB-0375	1/1-inch microphone to 1/2-inch preamplifier
UA-0035	1/4-inch microphone to 1/2-inch preamplifier (driven shield 0.33 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)
Angle Adaptors	
EU-4000	1/4-inch to 1/4-inch (driven shield 0.97 pF) 90°
UA-1260	1/2-inch to 1/2-inch (80° approxi-mately)



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.

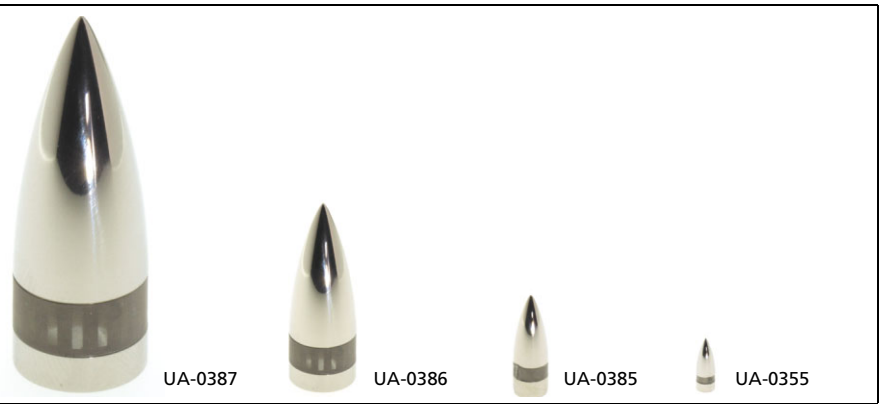
Windscreen Order Numbers	
UA-1070	Windscreen for 4184
UA-1071	Windscreen holder for 4184
UA-0207	For 1-inch microphones, spherical, diameter 90 mm, hole 20 mm
UA-0237	For 1/2-inch microphones, spherical, diameter 90 mm, hole 10 mm
UA-0253	6 units of UA-0207
UA-0254	6 units of UA-0237
UA-0459	For 1/2-inch microphones, spherical, diameter 65 mm, hole 10 mm
UA-0469	6 units of UA-0459
UA-1679	Type 4952. Upper part with windscreen
UA-1700	Windscreen for Type 4952
UA-1701	6 units of UA-1700 units
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
DS-0394	Windscreen for Type 4198/ UA-1404



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



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	

Outdoor Protection

UA-1404	Outdoor Microphone Kit for Preamplifiers 2669, 2671, 2673 and Sound Level Meters 2236, 2237, 2238, 2239
DB-3611	Extension for UA-1404 – makes it possible to mount the preamplifier from Sound Level Meter Type 2231
UA-0308	Dehumidifier used with back-vented 1/2-inch microphones with nickel diaphragms
UA-0393	Rain cover with built in actuator
UA-1679	Upper Part with Integral Windscreen
UC-5360	Windscreen Holder with bird spike for 4198/UA-1404

Preamplifier Holders

Preamplifier Holders Order Numbers	
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 (for example, UA-1317)
UA-0588	Microphone Holder for Tripod (2671, 2669-C SLM preamplifiers)
UA-1284	Microphone Stand for 2669-B/L

Corrector

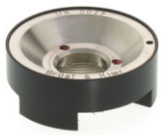
DZ-9566	Random Incidence Corrector gives Types 4176/4188 a flat random response for measurements in diffuse sound fields	

Tripods

UA-0587	Heavy Duty Tripod for Type 3923 Rotating Boom, max. height 1.46 m
UA-0801	Lightweight Tripod with tilt head, max.1332 mm
UA-0803	Tripod for photocells and micro-phones, max. 1250 mm
UA-0989	Tripod with pan and tilt head for Type 8329
UA-1251	Lightweight Tripod for Type 2236, compact, max. height 1.22 m
UA-1577	Tripod including CAM head
UA-1707	Tripod Adaptor for Type 4952

Electrostatic Actuators

UA-0023	For 1-inch microphones
UA-0033	For 1/2-inch microphones
UA-1639	For calibration of Surface 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

UA-1639

DB-0264

DB-0900

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-0977	Adaptor (for un-flanged surface microphone)
DP-0978	Adaptor (for Type 4101)
DP-0979	Adaptor (for flush-mounted surface microphone)

DP-0776

DP-0775

DP-0774

DP-0978

DP-0977

DP-0979

Miscellaneous

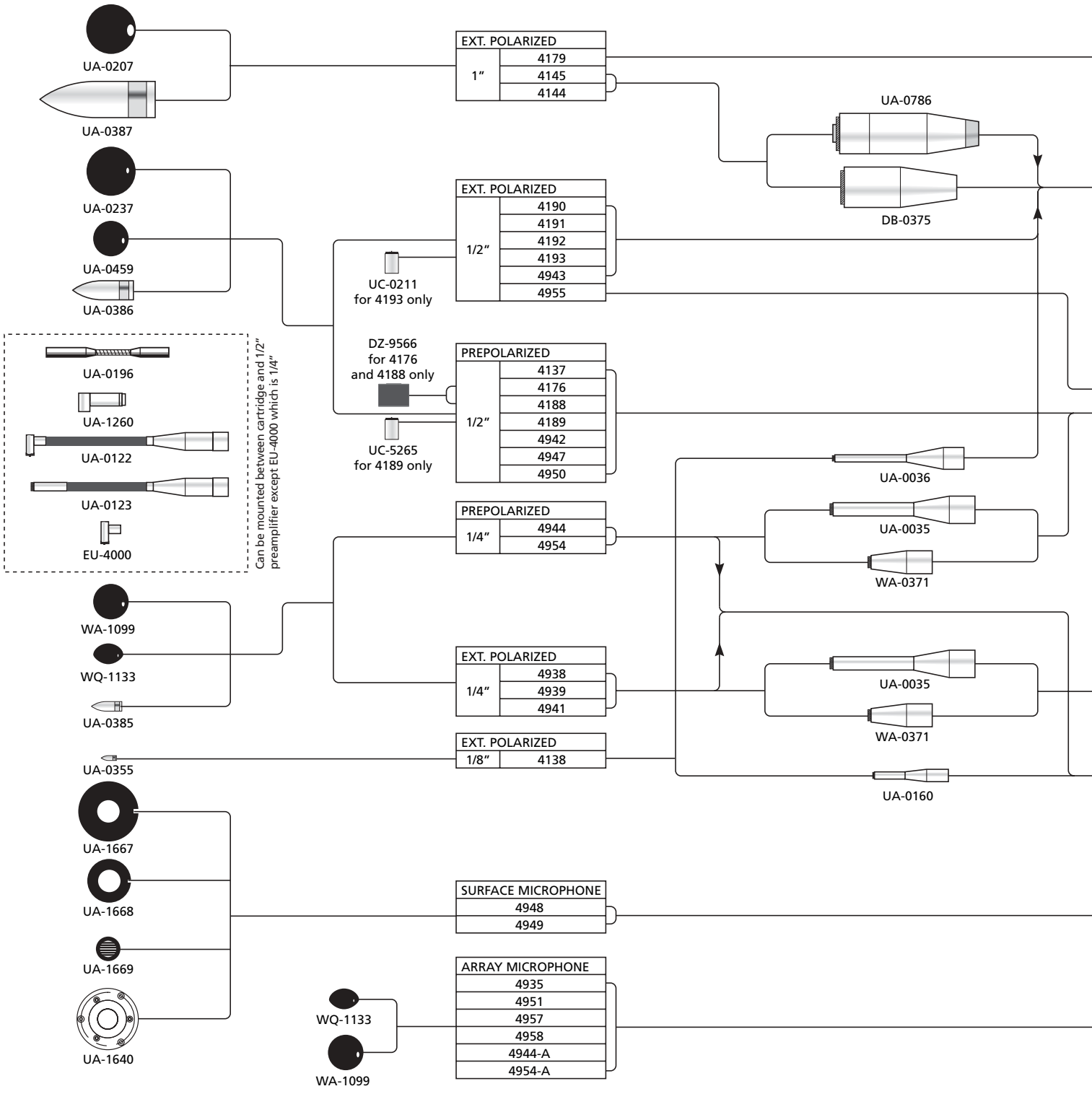
ZG-0350	LEMO to 7-pin B&K adaptor for connecting cables with LEMO 1B male connector to instruments with B&K 7-pin connectors
UA-1405	CIC Adaptor, LEMO to B&K is an adaptor similar to ZG-0350 with a BNC to mini-jack cable of 1.5 m to inject CIC to the preamplifier
WB-0850	Insert Voltage or CIC Junction Unit
ZG-0328	BNC to B&K 7-pin, provides Delta-Tron supply from microphone 7-pin supply*
WB-1421	BNC to LEMO, provides DeltaTron supply from microphone LEMO supply*
WB-1452	Microdot to LEMO provides Delta-Tron supply from microphone LEMO supply*
WA-0160	General Purpose Transmitter Adaptor for ½″ microphones Generates approx. 77 dB SPL in a 1 ccm coupler @ 1 V Generates approx. –18 dB SPL in the free-field @ 1 V and 1 kHz at 1 m distance Free-field SPL increases +12 dB/oct. Values for typical 50 mV/Pa cartridge
UA-0920	Transmitter Adaptor for Type 4182 Basically same performance as WA-0160

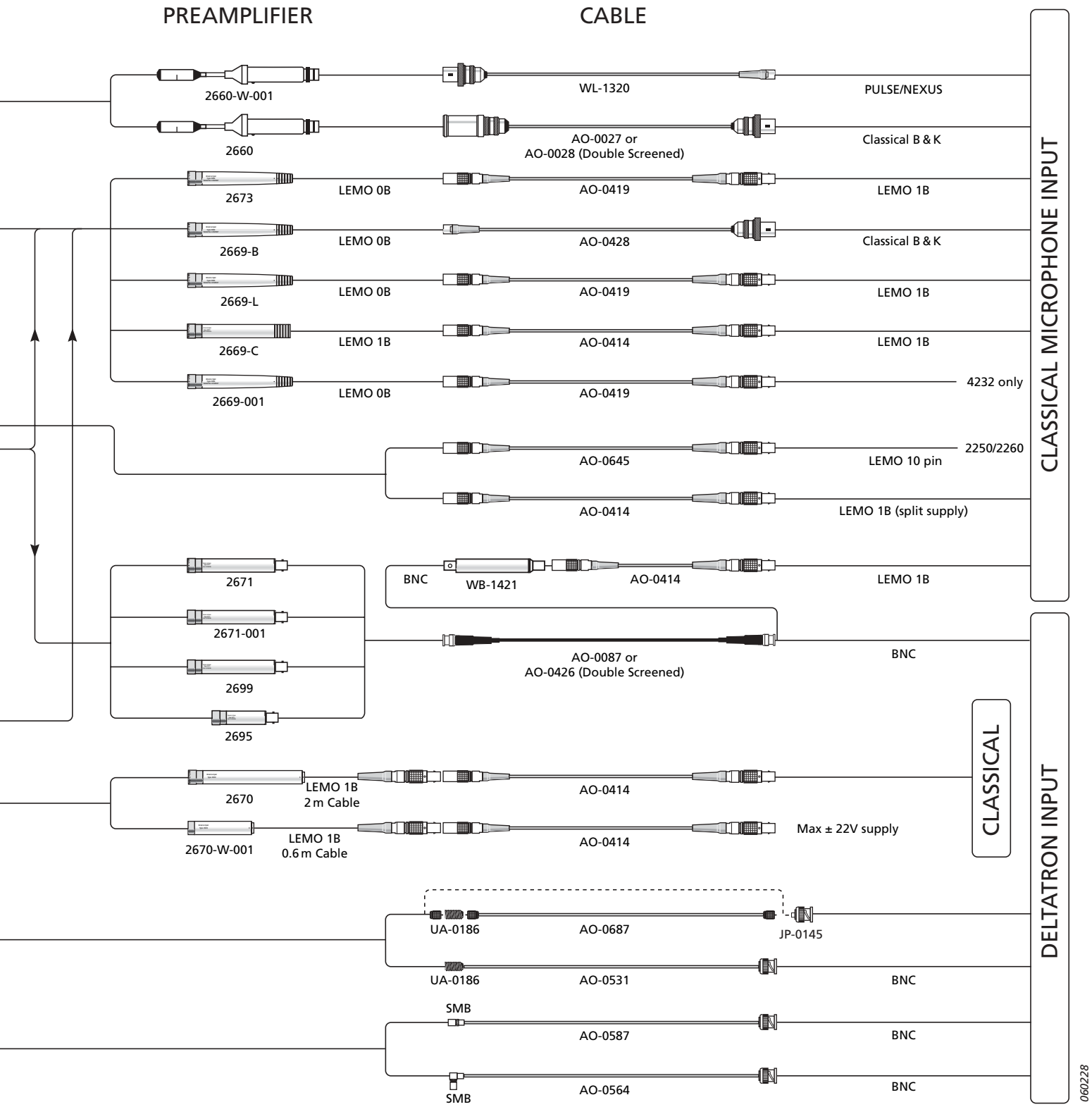
* These units require minimum 28 V DC supply from the front-end – cannot be used with PULSE

MICROPHONE ACCESSORIES

CARTRIDGES

ADAPTOR




PREAMPLIFIER
CABLE
2660-W-001
WL-1320
PULSE/NEXUS
2660
AO-0027 or
AO-0028 (Double Screened)
Classical B & K
2673
LEMO 0B
AO-0419
LEMO 1B
2669-B
LEMO 0B
AO-0428
Classical B & K
2669-L
LEMO 0B
AO-0419
LEMO 1B
2669-C
LEMO 1B
AO-0414
LEMO 1B
2669-001
LEMO 0B
AO-0419
4232 only
AO-0645
LEMO 10 pin
2250/2260
AO-0414
LEMO 1B (split supply)
CLASSICAL MICROPHONE INPUT
2671
BNC
WB-1421
AO-0414
LEMO 1B
2671-001
AO-0087 or
AO-0426 (Double Screened)
BNC
2699
2695
CLASSICAL
2670
LEMO 1B
2 m Cable
AO-0414
2670-W-001
LEMO 1B
0.6 m Cable
AO-0414
Max ± 22V supply
UA-0186
AO-0687
JP-0145
UA-0186
AO-0531
BNC
SMB
AO-0587
BNC
SMB
AO-0564
BNC
DELTATRON INPUT
060228

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.

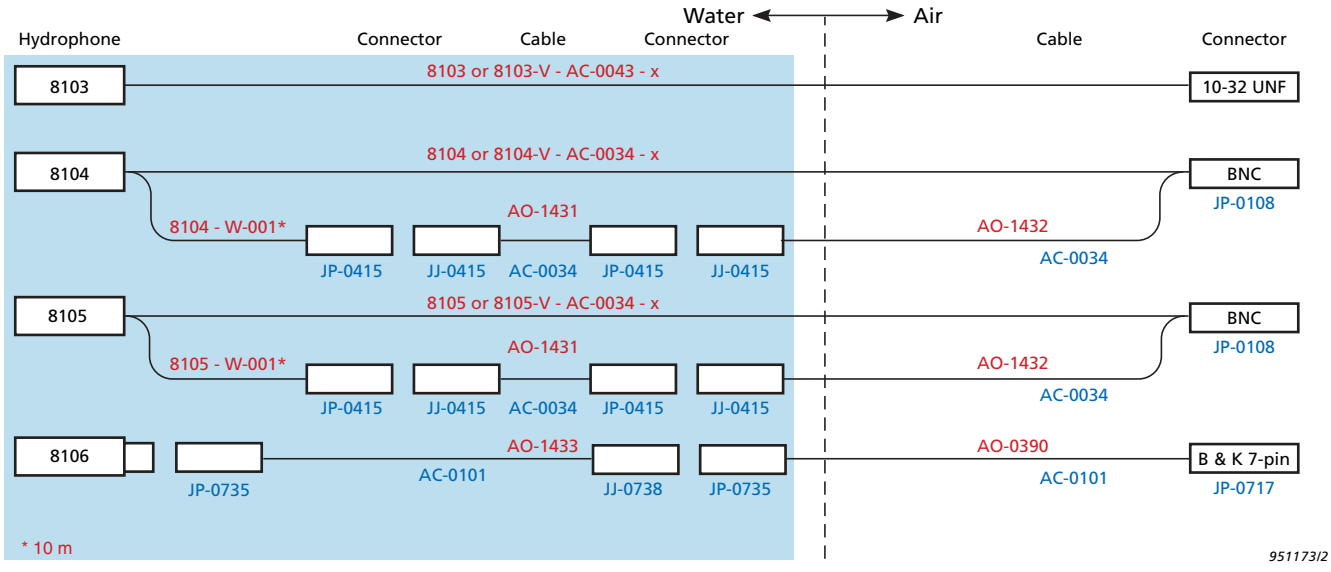
Type 8106 has a built-in amplifier that gives a signal suitable for transmission over long underwater cables. It can be used down to an ocean depth of 1000 m.

Type Number	8103	8104	8105	8106
Sensitivity*	−211 dB re 1 V/μPa ±2 dB	−205 dB re 1 V/μPa ±2 dB		−173 dB re 1 V/μPa ±3 dB
Nominal Voltage Sensitivity	29 μV/Pa	56 μV/Pa		2.24 mV/Pa
Nominal Charge Sensitivity*	0.1 pC/Pa	0.44 pC/Pa	0.41 pC/Pa	N/A
Capacitance* (incl. standard cable)	3700 pF	7800 pF	7250 pF	N/A
Frequency Response* (re 250 Hz)	0.1 Hz to 20 kHz +1/−1.5 dB 0.1 Hz to 100 kHz +1.5/−6.0 dB 0.1 Hz to 180 kHz +3.5/−12.5 dB	0.1 Hz to 10 kHz ±1.5 dB 0.1 Hz to 80 kHz ±4.0 dB 0.1 Hz to 120 kHz +4/−12.0 dB	0.1 Hz to 100 kHz +1/−6.5 dB 0.1 Hz to 160 kHz +3.5/−10.0 dB	10 Hz to 10 kHz +0.5/−3.0 dB 7 Hz to 30 kHz +0.5/−6.0 dB 3 Hz to 80 kHz +6/−10.0 dB
Horizontal Directivity (radial xy plane)	±2 dB at 100 kHz			±2 dB at 20 kHz
Vertical Directivity (axial xz plane)	±4 dB at 100 kHz	±2 dB at 50 kHz	±2 dB over 270° at 80 kHz ±2.5 dB at 100 kHz	±3 dB at 20 kHz
Leakage Resistance* (at 20 ×C)	>2500 MΩ			
Operating Temperature Range: Short-term Continuous	−30°C to +120°C −30°C to +80°C			−10°C to +60°C
Sensitivity Change with Temp.: Charge Voltage	0 to +0.03 dB/°C 0 to −0.03 dB/°C	0 to +0.03 dB/°C 0 to −0.04 dB/°C	0 to +0.03 dB/°C 0 to −0.03 dB/°C	– 0 to +0.01 dB/°C
Max. Operating Static Pressure	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	
Sensitivity Change with Static Pressure	0 to -3×10^{-7} dB/Pa (0 to −0.03 dB/atm.)			0 to 1×10^{-7} dB/Pa 0 to 0.01 dB/atm.
Allowable Total Radiation Dose	5×10^7 Rad.			

Type Number	8103	8104	8105	8106
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.)		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		

* Nominal value, each hydrophone is supplied with its own calibration data
Note: Unless otherwise stated, all values are valid at 23°C (73°F)

Hydrophone Cables and Connectors



PRESSURE TRANSDUCERS

Pressure transducers produce an electrical output proportional to the pressure applied. The frequency of pressure fluctuation should be lower than the resonant frequency of the transducer, and the electrical output is essentially independent of frequency below one-fifth the resonant frequency (flat frequency response).

When pressure is applied, the force on the sensing element due to the pressure results in a deformation of the sensing element. This deformation changes the resistance of the element and the electrical output of the transducer. In a well-designed transducer, the deformation and electrical output are directly proportional to pressure over a wide range of frequencies.

The sensing elements and constraining parts in silicon diaphragm pressure transducers possess such a small amount of damping due to internal friction that it may be disregarded. Significant amounts of damping may be introduced by the medium being measured.

The ENDEVCO pressure transducers listed in this catalogue employ a fully active Wheatstone Bridge, consisting of four piezoresistive gauges atomically diffused into a sculptured silicon diaphragm. The silicon integrated chip is itself the diaphragm. Applied pressure presents a distributed load to the diaphragm, which in turn provides bending stresses and resultant strains to which the strain gauges react. This stress creates a strain proportional to the applied pressure, which results in a bridge unbalance. With an applied voltage, this unbalance produces a millivolt deviation at the bridge output, which is proportional to the net difference in pressure acting upon the diaphragm.

Pressure transducers are available with three reference pressure options: Gauge, psig; Absolute, psia; and Differential, psid.

Gauge-PSIG: Pressure is referenced to ambient pressure through an open reference tube.

Absolute-PSIA: Pressure is referenced to absolute zero pressure by sealing a vacuum within the transducer cavity (true absolute).

Differential-PSID: Pressure is referenced to a second pressure source through the reference tube. For the reference port source, differential units must use a non-conductive non-corrosive medium, which will not affect epoxy. Water and media containing water are not permissible. The reference port is the *low pressure* side in all differential measurements. Differential transducers are designed for specified maximum line pressure. Maximum reference pressure, and maximum case pressure are specified on the data sheets.

The piezoresistive strain-gauge element is a solid-state, silicon resistor, which changes electrical resistance in proportion to applied mechanical stress. Since it is a single crystal, it is not only strong but virtually free of mechanical hysteresis with inherently good linearity. The significant characteristic of this element is that its change of resistance is largely relative to its change in length. It has a gauge factor many times greater than the typical wire strain gauge. Piezoresistive element gauge factors range typically from 50 to 200.

The diffused piezoresistive transducer uses a silicon element for the mechanical structure, and the strain gauge is an integral part of the silicon element. The gauge is diffused into the structure. To accomplish this, IC manufacturing techniques are employed, and the technique lends itself to miniaturisation and volume manufacture.

ENDEVCO uses a sculptured diaphragm that is considerably thicker at the outer edge, and has two islands in the middle section. This concentrates the stress to ensure maximum accuracy.

The major disadvantages of silicon diaphragms are their difficulties of providing water and chemical media protection and their tendency to shatter under particle impingement. Silicon is a brittle material, crystalline in structure, and can crack or shatter on impact. Protective screens are provided or optional on all ENDEVCO models.

Pressure Transducer Options: See Table "Pressure Transducer Options (page 49) for options available for common pressure transducers.

Piezoelectric microphones are suitable for measurement of high intensity acoustic noise. Rugged, hermetically sealed construction and a temperature range –67°F to +500°F (–55°C to +260°C) make them extremely suitable for a wide range of environmental conditions. These microphones require no external power.

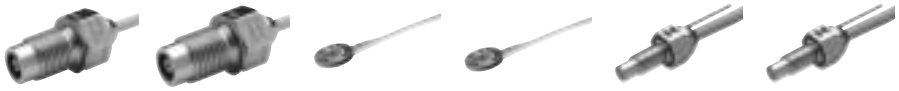
Piezoresistive microphones' are suitable for measurement of high intensity sound. These microphones employ a four-active arm strain gauge bride. Typically these microphones require 10 V DC bridge voltage. Temperature range from 0° to 20°F (–18° to 93°C).

Model/Type Number		8507-C-2	8507-C-5	8507-C-15	8510-B-1	8510-B-2	8510-B-5
Order Number		EE-0158	EE-0159	EE-0157	EE-0161	EE-0162	EE-0165
Description		Top Connector	Top Connector	Top Connector	Top Connector	Top Connector	Top Connector
Approximate Positive Sensitivity*	mV/psi	150	60	20	200	150	60
Measuring Principle		Gauge	Gauge	Gauge	Gauge	Gauge	Gauge
Full Scale Pressure*	psi	2	5	15	1	2	5
Resonant Frequency	kHz	70	85	130	55	70	85
Linearity (% Full Scale Output)		1.5	0.75	0.5	1.5	1.5	0.75
Operating Temperature Range	°C	–54 to +107	–54 to +107	–54 to +107	–54 to +121	–54 to +121	–54 to +121
	°F	–65 to +225	–65 to +255	–65 to +225	–65 to +250	–65 to +250	–65 to +250
Burst Pressure Diaphragm/Ref psi	psi Min	40/40	100/50	150/50	25/25	40/40	100/100
Weight	gram	0.3	0.3	0.3	2.3	2.3	2.3
Connector, Electrical		4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor
Mounting		Adhesive	Adhesive	Adhesive	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread
Cable and Accessory Types Included		22409**	22409**	22409**	24328**	24328**	24328**
Clip, Stud, Screw Types Included		None	None	None	None	None	None

* 1 psi = 6.895 kPa = 0.069 bar ** Optional

Model/Type Number		8510-B-200	8510-B-500	8510-B-2000	8510-C-15	8510-C-50	8510-C-100
Order Number		EE-0163	EE-0166	EE-0164	EE-0168	EE-0169	EE-0167
Description		Top Connector	Top Connector	Top Connector	Top Connector	Top Connector	Top Connector
Approximate Positive Sensitivity*	mV/psi	1.5	0.6	0.5	15	4.5	2.25
Measuring Principle		Gauge	Gauge	Gauge	Gauge	Gauge	Gauge
Full Scale Pressure*	psi	200	500	2000	15	50	100
Resonant Frequency	kHz	320	500	900	180	320	500
Linearity (% Full Scale Output)		0.5	0.5	1	0.5	0.4	0.4
Operating Temperature Range	°C	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +121
	°F	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250
Burst Pressure Diaphragm/Ref psi	psi Min	1000/300	2500/300	10000/300	75/75	250/250	400/300
Weight	gram	2.3	2.3	2.3	2.3	2.3	2.3
Connector, Electrical		4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor
Mounting		10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread
Cable and Accessory Types Included		24328**	24328**	24328**	24328**	24328**	24328**
Clip, Stud, Screw Types Included		None	None	None	None	None	None

* 1 psi = 6.895 kPa = 0.069 bar ** Optional



Model/Type Number		8511-A-5 K	8511-A-20 K	8515-C–15	8515-C-50	8530-B-200	8530-B-500
Order Number		EE-0172	EE-0171	EE-0176	EE-0178	EE-0185	EE-0187
Description		Top Connector	Top Connector	Side Connector	Side Connector	Top Connector	Top Connector
Approximate Positive Sensitivity*	mV/psi	0.1	0.025	13.3	4	3	0.6
Measuring Principle		Gauge	Gauge	Absolute	Absolute	Absolute	Absolute
Full Scale Pressure*	psi	5000	20000	15	50	200	500
Resonant Frequency	kHz	1000	1000	180	320	750	1000
Linearity (% Full Scale Output)		1.5	1.5	0.5	0.5	0.5	0.5
Operating Temperature Range	°C	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +121
	°F	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250
Burst Pressure Diaphragm/Ref psi	psi Min	20000	40000	90	250	800	2000
Weight	gram	11	11	0.08	0.08	2.3	2.3
Connector, Electrical		4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor	4 Conductor
Mounting		3/8–24 UNF 2 A Thread	3/8–24 UNF 2 A Thread	Adhesive	Adhesive	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread
Cable and Accessory Types Included		24328**	24328**	EW 862**	EW 862**	24328**	24328**
Clip, Stud, Screw Types Included		None	None	None	None	None	None

* 1 psi = 6.895 kPa = 0.069 bar ** Optional

Model/Type Number		8530-B-1000	8530-B-2 KM 37	8530-C-5	8530-C-50	8530-C-00	8540-15
Order number		EE-0184	EE-0186	EE-0189	EE-0190	EE-0188	EE-0196
Description		Top Connector	Top Connector	Top Connector	Top Connector	Top Connector	Top Connector
Approximate Positive Sensitivity*	mV/psi	0.3	0.3	15	4.5	2.25	20
Measuring Principle		Absolute	Absolute	Absolute	Absolute	Absolute	Absolute
Full Scale Pressure*	psi	1000	2000	15	50	100	15
Resonant Frequency	kHz	1000	1000	180	320	500	140
Linearity (% Full Scale Output)		0.5	1	0.5	0.4	0.4	0.5
Operating Temperature Range	°C	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +121	–54 to +260
	°F	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +250	–65 to +500
Burst Pressure Diaphragm/Ref psi	psi Min	4000	4000	75	250	400	30
Weight	gram	2.3	2.3	2.3	2.3	2.3	8.5
Connector, Electrical		4 Conductor	4-pin	4 Conductor	4 Conductor	4 Conductor	4 Conductor
Mounting		10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread	10–32 UNF 2 A Thread
Cable and Accessory Types Included		24328**	3028–120***	24328**	24328**	24328**	25045**
Clip, Stud, Screw Types Included		None	None	None	None	None	None

* 1 psi = 6.895 kPa = 0.069 bar ** Optional *** Detachable

Model/Type Number		8540–50	8540–200	8540–500
Order Number		EE-0198	EE-0197	EE-0199
Description		Top Connector	Top Connector	Top Connector
Approximate Positive Sensitivity*	mV/psi	6	0.1	0.6
Measuring Principle		Absolute	Absolute	Absolute
Full Scale Pressure*	psi	50	200	500
Resonant Frequency	kHz	240	450	900
Linearity (% Full Scale Output)		0.5	0.75	0.75
Operating Temperature Range	°C	–54 to +260	–54 to +260	–54 to +260
	°F	–65 to +500	–65 to +500	–65 to +500
Burst Pressure Diaphragm/Ref psi	psi Min	100	400	1000
Weight	gram	8.5	8.5	8.5
Connector, Electrical		4 Conductor	4 Conductor	4 Conductor
Mounting		10 –32 UNF 2 A Thread	10 –32 UNF 2 A Thread	10 –32 UNF 2 A Thread
Cable and Accessory Types Included		25045**	25045**	25045**
Clip, Stud, Screw Types Included		None	None	None

* 1 psi = 6.895 kPa = 0.069 bar ** Optional

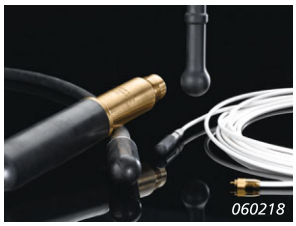
Pressure Transducer Options			
Type Number	Standard	With 4-pin connector without cable	Metric Thread
8510-B-1	EE-0161	EE-0161-001	
8510-B-2	EE-0162	EE-0162-001	
8510-B-5	EE-0165	EE-0165-001	EE-0165-003
8510-B-200	EE-0163	EE-0163-001	
8510-B-500	EE-0166	EE-0166-001	
8510-B-2000	EE-0164	EE-0164-001	
8510-C-15	EE0168	EE0168-001	EE-0168-004
8510-C-50	EE-0169	EE-0169-001	
8510-C-100	EE-0167	EE-0167-001	
8511-A-5K	EE-0172	EE-0172-002	
8511-A-20K	EE-0171	EE-0171-002	
8530-B-200	EE-0185	EE-0185-001	
8530-B-500	EE-0187	EE-0187-001	
8530-B-1000	EE-0184	EE-0184-001	
8530-B-2K M37		EE-0186*	
8530-C-15	EE-0189	EE-0189-001	EE-0385
8530-C-50	EE-0190	EE-0190-001	
8530-C-100	EE-0188	EE-0188-001	

* With cable

SIGNAL CONDITIONING

Signal conditioning improves the performance and reliability of the measurement system. A typical system includes the signal conditioning hardware, which works as an interface between the raw signals and transducer outputs to the measurement device. The conditioning amplifier will supply the system with signal amplification, electrical isolation, filtering, powering of transducers, overload detection, and Transducer Electronic Datasheet (TEDS) support.

The main types of conditioning inputs are microphone, DeltaTron® (or IEPE), charge, intensity, bridge and differential.

Different Input Types			Products	Usage
Acoustics	Microphone		• NEXUS Microphone Conditioning Amplifier • Microphone Power Supply Type 2829 • Dual Microphone Supply Type 5935, with B&K socket • 8-channel Acoustic Front-end Type 5966	For microphone preamplifiers with seven pin sockets, usually a 7-pin LEMO socket and sometimes the B&K 7-pin socket.
Vibration	DeltaTron		• NEXUS DeltaTron Conditioning Amplifiers • Measuring Amplifier, Type 2525 • 16-channel DetaTron Conditioning Amplifier Type 2694 • PE/DeltaTron Signal Conditioner Type EE-0212 (133) • Battery Powered DeltaTron Conditioner Type EE-0247 (4416-B) • WB-1372 DeltaTron power Supply	For piezoelectric accelerometers and preamplifiers with built-in electronics.
Acoustics/Vibration	Charge		• NEXUS Charge Conditioning Amplifiers • Measuring Amplifier Type 2525 • PE/DeltaTron Signal Conditioner Type EE- 0212 (133)	For piezoelectric transducers such as charge accelerometers, force transducers, impact hammers, or hydrophones.
Acoustics	Intensity		• NEXUS Microphone Conditioning Amplifier	For intensity probes, either via two 7-pin LEMO sockets, or two 7-pin B&K sockets.

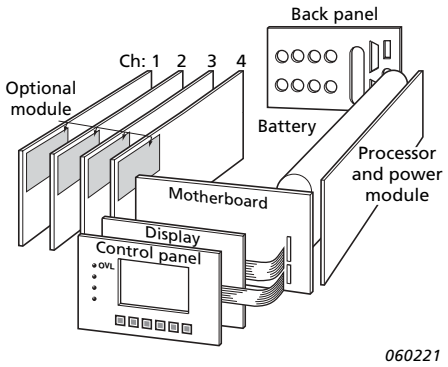
Different Input Types			Products	Usage
Vibration	Bridge		• 3-channel DC/Bridge Amplifier Type EE-0215 (136)	For piezoresistive accelerometers, variable capacitance accelerometers and strain gauges.
	Differential		• Charge Amplifiers Types 2634, 2663, and 2663-B (see Accelerometer & Conditioning Catalogue, BF 0212)	For differential/balanced piezoelectric accelerometers.

NEXUS Conditioning Amplifiers

The most flexible and advanced conditioning amplifier from Brüel & Kjær is NEXUS™. NEXUS is flexible in the way it can be configured. It is advanced as it can have both acoustic and vibration inputs in the same mainframe. One NEXUS mainframe can contain up to four independent channels and different filters such as bandpass filters and auxiliary filters. It is possible to choose between different standard conditioning amplifiers such as microphone, DeltaTron®, charge, and intensity inputs. NEXUS can be configured according to your needs. We have preconfigured the most commonly used NEXUS versions for your use.

NEXUS Physical Dimensions
Height: 90 mm (3.5″)
Width: 144 mm (5.7″)
Depth: 230 mm (9.1″)
Weight: 3 kg (6.6 lb.), including battery

- Digital Control Interface. Conforms to EIA/TIA-574 (RS–232)
- One mainframe holds up to four input channels
- External DC power input, complies with ISO 7637–1 (12 V) and 7637–2 (24 V)
- Operating temperature: –10 to 55°C



NEXUS Optional
- Holds an internal battery (not included)
- Any combination of the four input channels is possible
- Optional filters such as low-pass filters, 20 Hz high-pass filters, single/double integration and A-, B-, C-, and D-weighting filters
- Additional options are also constant power and upper limiting frequency to 140 kHz

NEXUS Microphone Conditioning Amplifier

You can have up to 4 microphone channels in a single conditioning amplifier.

Preconfigured NEXUS for Acoustical Measurements						
Channels	1	2	4	2	2	4
Type Number	**2690-A-0S1**	**2690-A-0S2**	**2690-A-0S4**	**2691-A-0S2**	**2690-A-0F2**	**2690-A-0F4**
Description	1-channel Microphone Conditioning Amplifier	2-channel Microphone Conditioning Amplifier	4-channel Microphone Conditioning Amplifier	2-channel (single probe) Intensity Conditioning Amplifier	2-channel Microphone Conditioning Amplifier with A, B, C, and D filters	4-channel Microphone Conditioning Amplifier with A, B, C, and D filters

Common Features of all NEXUS with Microphone Input

- Up to 4 microphone channels in one mainframe
- Microphone connector is 7-pin LEMO
- AC input
- DC input
- AC output
- Battery/Charge Adaptor
- Frequency range (–1dB): 0.1 Hz to 100 kHz
- Floating input for maximum EMI* protection
- Supply voltage can be ±14 or ±40 V
- Maximum input: 31.6 V (peak)
- Input protection: ≤50 V (peak)·
- Input impedance 1 MΩ || 300 pF (AC coupled)
- Input range10 to 33 V DC
- Polarization voltage V is 0 V or 200 V
- Peak meter
- LCD display
- TEDS support, IEEE 1451.4
- Manual or computer controlled
- Mountable in a 19-inch rack
- –20 to 60 dB amplifier gain (80 dB with reduced specifications)
- Implemented CIC†
- Current overload detection
- A-weighting filter type "O" is standard

* EMI – Eletromagnetic Interference

† CIC – Charge Injection Calibration

NEXUS DeltaTron Conditioning Amplifiers

Up to four DeltaTron input modules can be fitted for conditioning of input signals from Constant Current Line Drive based accelerometers, microphone preamplifiers or "direct voltage" input.

Preconfigured NEXUS for Vibration Measurements								
Channels	1	2	4	1	4	4	4	4
Type Number	**2693-A-0S1**	**2693-A-0S2**	**2693-A-0S4**	**2693-A-0I1**	**2693-A-0I4**	**2693-A-0M4**	**2693-A-0P4**	**2693-A-0F4**
Description	1-channel DeltaTron Conditioning Amplifier	2-channel DeltaTron Conditioning Amplifier	4-channel DeltaTron Conditioning Amplifier	DeltaTron Conditioning Amplifier with Integration Filter	DeltaTron Conditioning Amplifier with Single and Double Integrations	2-channel Charge and 2-channel DeltaTron Conditioning Amplifier	DeltaTron Conditioning with Constant Power On	DeltaTron Conditioning Amplifier with A, B, C, and D Filters

Common Features of all NEXUS with DeltaTron Input

- Up to 4 DeltraTron input channels in one mainframe
- BNT connector, floating or single-ended
- AC input
- DC input
- AC output
- Battery/Charge Adaptor
- Constant current: 4 to 10 mA with a +28 V voltage source
- Current overload detection
- Tacho probe connection via TNC socket supplied with 8 V DC voltage
- –20 to 60 dB gain (80 dB with reduced specifications)
- Peak meter
- LCD display
- TEDS support, IEEE 1451.4
- Manual or computer controlled
- Mountable in a 19-inch rack
- Input impedance 1 MΩ || 100 pF (AC coupled)
- Frequency range (10%): 0.1 Hz to 100 kHz (gain <60 dB)

NEXUS Charge Conditioning Amplifiers

A conditioning charge amplifier can contain up to 4 separate charge input channels. Each channel has comprehensive high- and low-pass filtering facilities. Single and double integration modes are available.

	Preconfigured NEXUS for Vibration Measurements								
Channels	1	2	4	1	2	4	1	4	4
Type Number	**2692-A-0S1**	**2692-A-0S2**	**2692-A-0S4**	**2692-A-0I1**	**2692-A-0I2**	**2692-A-0I4**	**2692-A-0P1**	**2692-C**	**2692-D**
Description	1-channel Charge Conditioning Amplifier	2-channel Charge Conditioning Amplifier	4-channel Charge Conditioning Amplifier	1-channel Charge Conditioning Amplifier with Single and Double Integration	2-channel Charge Conditioning Amplifier with Single and Double Integration	4-channel Charge Conditioning Amplifier with Single and Double Integration	1-channel Charge Conditioning with Constant Power On	4-channel Conditioning Amplifier for very high levels (100 nC)	4-channel Conditioning Amplifier for very high levels (100 nC) with Single and Double Integration Filters

Common Features of all NEXUS with Charge Input

- Up to four separate charge input channels
- TNC connector
- TNC to 10–32 UNF adaptor
- Differential charge: 10 nC (peak)
- Differential charge for 2692-C/D: 100 nC (peak)
- AC output
- AC input
- DC input
- Single ended or floating input
- Both manual and computer control
- Mountable in a 19-inch rack
- Peak meter
- LCD display
- TEDS support, IEEE 1451.4
- Battery/Charge Adaptor
- Calibration functions
- MRT‡ facilities
- –20 to 60 dB gain (80 dB with reduced specifications)

‡ MRT – Mounted Resonance Testing

Microphone Power Supply Type 2829

This 4-channel Microphone Power Amplifier has a very robust design. Suitable for production, testing and quality control of loudspeakers and telephones. This unit is especially designed for acoustical systems.

	**2829 Physical Dimensions** • Height: 232 mm (9.13″) • Width: 46 mm (1.81″) • Depth: 106 mm (4.17″) • Weight: 430 gram (15.25 oz.)
Channels	Input: 4 LEMO 1B female, Output: 4 BNC
Type Number	2829
Description	4-channel Microphone Power Supply

Features of Type 2829

- 4-pin inputs, LEMO sockets
- 4 outputs via BNC outlets
- AC output
- DC input power, 12 V
- Stackable units
- Operating temperature is –10 to +55°C (14 to 131°F)
- TEDS support, IEEE 1451.4
- Implemented CIC**
- CIC, maximum input 10 V RMS
- CIC input impedance is 100 kΩ
- Polarization Voltage, 0 V or 200 V
- Provides ± 50 V DC for preamplifiers
- Mountable in a 19-inch rack
- Battery/Charge Adaptor

** CIC – Charge InjectionCalibration

Dual Microphone Supply Type 5935/5935-L

These two dual microphone suppliers work as power supplies and conditioning for microphone preamplifiers and Delta-Tron conditioning. They are mainly used as microphone preamplifier power supplies with the feature that they also make it possible to amplify the output of the preamplifiers or accelerometers. They are specially designed for work in-the-field due to their portability. Both types can also be rack-mounted which makes them perfect for laboratory installations.

5935 Physical Dimensions
- Height: 132.6 mm (5.2″)
- Width: 69.5 mm (2.6″)
- Depth: 200 mm (7.9″)
- Weight: 1.1 kg (2 lb. 7 oz)

	5935	5935-L
Channels	Input: 2 channels, 7-pin B&K sockets Output: 2 BNC sockets	Input: 2 channels, 7-pin LEMO sockets Output: 2 BNC sockets
Type Number	5935	5935-L
Description	Dual-channel Microphone Power Supply, B&K sockets	Dual-channel Microphone Power Supply, LEMO sockets
Application	Use with DeltaTron accelerometers and Microphone Preamplifier Type 2671	Use with Falcon Range microphone preamplifiers (Type 5935-L)
Special Features	Supplies heater current for dehumidification in cases where an external power source is used	Implemented CIC

Common Features of Types 5935 and 5935-L

- Input impedance: 200 kΩ||500 pF
- Maximum input level: 5 V RMS
- DC input power
- AC output
- Channel gain range: –5 dB to +55 dB
- Selectable linear or A-weighted frequency response for each channel
- Amplitude and phase-match channels
- Polarization Voltage, 0 V, 28 V or 200 V
- Internal batteries or external power source
- Rack mounting possibilities
- Low output impedance (15 Ω)
- Operating temperature: –10 to +50°C (14 to 122°F)

8-channel Acoustic Front-end Type 5966

Type 5966 front-end is a multichannel microphone preamplifier power supply, and a high-quality audio frequency field-measurement instrument. It is suitable for applications where many inputs are gathered simultaneously. Suitable for use with a DAT recorder.

	**5966 Physical Dimensions** • Height: 70 mm (2.8″) • Width: 297 mm (11.7″) • Depth: 220 mm (8.7″) • Weight (not including battery): 3 kg (6 lb. 10 oz)
Channels	8
Type Number	5966
Description	8-channel microphone preamplifier power supply input for Sony PC 208Ax

Features for Type 5966

- AC input
- DC input
- Input impedance: 200 kΩ
- Maximum input level: 5 V RMS
- Maximum and minimum gain: 40 dB, 0 dB
- AC output
- Output impedance is very low: 30 Ω
- A-weighting and Linear filters
- Input: 7-pin LEMO socket
- Output: BNC
- Polarization Voltage: 0 V, 28 V, or 200 V
- Frequency response: 0.5 kHz to 20 kHz
- Rack-mounting possibility
- External supply:12 V to 20 V DC
- Tacho input: BNT
- Tacho data output: 9-pin D-type socket
- 2-pin external input supply
- Operating Temperature: 0 to 50°C (32 to 122°F)
- Channel gain, selectable: 0 dB, 20 dB, or 40 dB

Measuring Amplifier Type 2525

This low-noise amplifier has both Charge and DeltaTron inputs. The product is mainly designed for product and prototype testing. It includes automatic gain adjustment, level monitoring with alarm output, and signal overload indication.

	**2525 Physical Dimensions** • Height: 132.5 mm (5.22″) • Width: 139.5 mm (5.49″) • Depth: 320 mm (12.6″) • Weight: 3.6 kg (5.8 lb.)
Channels	1
Type Number	2525
Description	Measuring Amplifier

Features of Type 2525

- Charge Input: TNC Socket on front-end
- Maximum input: 0 to100 kHz: 50 nC peak
- DeltaTron Input: BNC socket on front-end
- AC output
- AC input power
- RMS
- Peak
- Menu based user-interface
- Both manual and remote control option
- Storage of up to 8 amplifier setups
- Gain adjustment ensures rapid and accurate setup and ease of interpretation
- Conversion of acceleration signals to velocity and displacement
- Includes a mounted resonance measuring function for the best mounting of accelerometers
- Built-in filters: high-pass and low-pass
- External filters can be attached via a 15-pin auxiliary connector
- Operating temperature: 5 to 40°C (41 to 104°F)
- Mountable in rack
- LCD display

16-channel DeltaTron Conditioning Amplifier Type 2694

This multichannel conditioning amplifier has an analogue input for accelerometers, microphone preamplifiers, and tachometers. The amplifier can be stacked and is specially designed for larger multichannel applications such as modal analysis or array measurements.

2694 Physical Dimensions
- Height: 46.3 mm (1.7″)
- Width: 449 mm (17.7″)
- Depth: 254mm (10″)
- Weight:2.5 kg (5.5 lb.)

Type Number	Description	
2694-A	Standard version • No filters	16-channel standard DeltaTron Conditioning Amplifier
2694-B	Basic version • No optional filters available	16-channel standard DeltaTron Conditioning Amplifier
2694-C	Customised version • Optional filters, A-, B-, C- and D-filters, single and double integration filters in 1 to 16 channels, or single and double integration filters in all 16 channels	
2694-D	16-channel standard DeltaTron Conditioning Amplifier with single and double Integration filters	

Features of Type 2694

- DeltaTron input, channel 1 to 15: BNC
- Voltage input connector, channel 16; BNT (CCLD, voltage or tacho)
- AC output
- AC Input Power
- DC Input Power
- DC supply
- Transducer supply: DeltaTron Current: 6 mA ±15%, DeltaTron Voltage: 25 V ±10%
- Battery/Charge adaptor
- Controlled by Windows®-based software
- Operating temperature: –10 to 55°C (14 to 131°F)
- Optional filters, high-pass, A-, B-, C-, D-filter, low-pass filter
- TEDS support, IEEE 1451.4
- Stackable and rack mountable
- Serial Interface: RS–232

PE/DeltaTron Signal Conditioner EE-0212

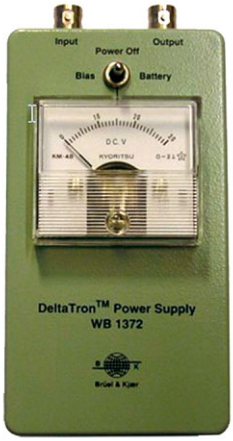
EE-0212 is portable and can be stacked 3 at a time. This makes the unit suitable for automotive test applications and other in-the-field measurement setups.

	**EE-0212 Physical Dimensions** • Height:141 mm (5.57″) • Width: 64 mm (2.52″) • Depth: 304.8 mm (12″) • Weight: 1.81 kg (4 lb.)
Channels	3
Type Number	133
Order Number	EE-0212
Description	PE/DeltaTron Signal Conditioner

Features of EE-0212

- Charge input (Piezoelectric): BNC
- DeltaTron Input: BNC
- AC output
- AC input power
- DC input power is an option
- Optional battery/charge adaptor
- Maximum charge input: ≤30000 pC
- 100 kHz bandwidth
- Rack mountable
- Filter options, high-pass
- LED display
- RMS
- Power option: 12 V DC
- Both manual and computer control options
- Computer control via RSR-232
- High-pass filter

DeltaTron Power Supply Type WB-1372



WB-1372 Physical Dimensions
- Height: 39 mm (1.5″)
- Width: 65 mm (2.5″)
- Depth: 120 mm (4.7″)
- Weight: gram (oz.)

Channels	1
Type Number	WB-1372
Description	DeltaTron Power Supply

Features of WB-1372

- Powers one DeltaTron transducer
- Input/output BNC sockets
- Transducer current: 3 mA (±20%)
- Displays bias voltage on the meter
- Dynamic Impedance: >100 kΩ
- Battery powered. 3 pcs. 9V standard batteries for powering
- Battery check
- AC output

Battery-powered DeltaTron Conditioner EE-0247

This unit is very handy and lightweight. It is battery-operated and can be used for transducers with DeltaTron or others with IEPE. The unit has been designed to supply the transducer with current and provides it with a selectable gain of 1 or 10.

	**EE-0247 Physical Dimensions** • Height: 79.4 mm (3.125″) • Width: 31.8 mm (1.25″) • Depth: 149.2 mm (5.875″) • Weight: 0.51 kg (18 oz)
Channels	1
Type Number	4416-B
Order Number	EE-0247
Description	Battery-powered DeltaTron Conditioner

Features of EE-0247

- DeltaTron input: BNC
- AC output
- DC input power
- Input Impedance: >20 kΩ
- External power supply: 12 V DC at 25 mA minimum
- Selectable gain: 1 or 10
- Battery operation time: 8 hours
- LED indicators
- Manual Control
- Battery/charge adaptor
- Operating Temperature: 0 to +50°C (+32 to +122°F)

3-channel DC/Bridge Amplifier Type EE-0215

This unit can easily be used within the automotive industry, for example, for crash testing.

	**EE-0215 Physical Dimensions** • Height: 141 mm (5.57″) • Width: 64 mm (2.52″) • Depth: 304.8 mm (12″) • Weight: 1.81 kg (4 lb.)
Channels	3
Type Number	136
Order Number	EE-0215
Description	3-channel DC Bridge Voltage Amplifier

Features of EE-0215

- Bridge input (Piezoresistive)
- AC/DC voltage output
- BNC output connector
- RMS reading
- AC input power
- DC input power is optional
- It is powered with 90 – 264 V AC, 50/60 Hz
- 200 kHz bandwidth
- Optional application software
- 4 different excitation voltage levels
- Gain range is 0 to 1000
- Battery/Charge adaptor is optional
- Rack mountable, three can be stacked and configured together
- LED display
- Optional filters
- Both manual and computer control
- RS–232 Serial Interface
- 12 V DC power option
- Low-pass filter

Brüel & Kjær offers a 3-channel DC-powered Differential Voltage Amplifier. This option, EE-0216 (136-1), makes it possible to transport the amplifier in an easy and comfortable way.

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 or 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 Calibrator	Multifunction Acoustic Calibrator	Pistonphone	Hydrophone Calibrator
Standards		EN/IEC 60942 (2003) Class LS* and Class 1 ANSIS1.40–1984	EN/IEC 60942 (2003) Class LS and Class 1 ANSIS1.40–1984	IEC 60942 (1998) Class 1	–
Calibration Pressure	dB SPL	94 and 114	94, 104 and 114	124	From 151 to 166 dB re 1µPa, depending on hydrophone
Calibration Frequencies	Hz	1000	31.5 Hz to 16 kHz in octave steps plus 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

* Type 4231 conforms with Class LS tolerances over the full temperature range from –10 to +50°C

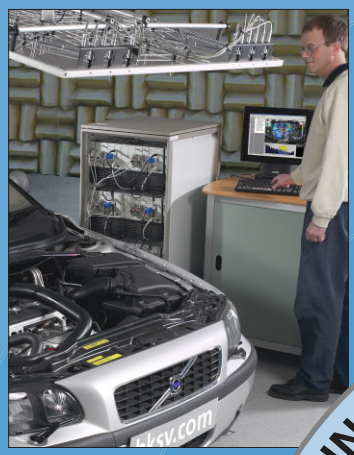
BRÜEL & KJÆR SERVICE

Maximise the Return on your Investment

When you buy software, instruments or transducers from Brüel & Kjær, you buy products that meet the highest standards in quality and performance. In addition, Brüel & Kjær offers a range of services to help you maintain your equipment and the integrity of your measurements through the entire lifetime of the products. A Brüel & Kjær service agreement is the best way to ensure that you get the full benefit of your investment for many years to come.

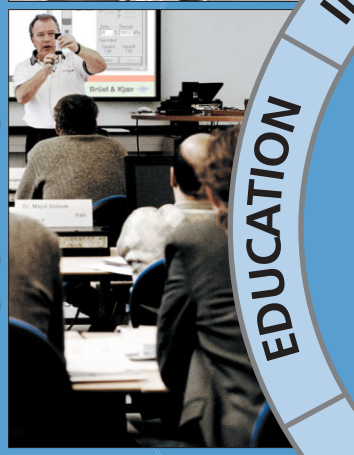
Installation

It is very important to Brüel & Kjær that our customers get up and running successfully with their new equipment. To achieve this we supply all products with detailed product documentation and we strive to make our products easy and intuitive to use. However, in some cases, especially with our more comprehensive systems, it may be beneficial to get the assistance of Brüel & Kjær project engineers and application specialists. Therefore, we offer on-site installation and site acceptance test if required.



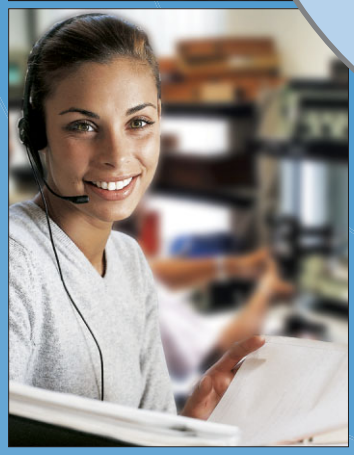
Education

We have made 60 years of knowledge and experience available to our customers through our knowledge centre, Brüel & Kjær University, from which we can build and spread sound and vibration related knowledge worldwide by means of seminars, advanced courses and product training covering a broad range of applications, theories and products. Through this knowledge-sharing program, we believe that we can truly help our customers and their employees maximise the benefits gained from using Brüel & Kjær equipment.

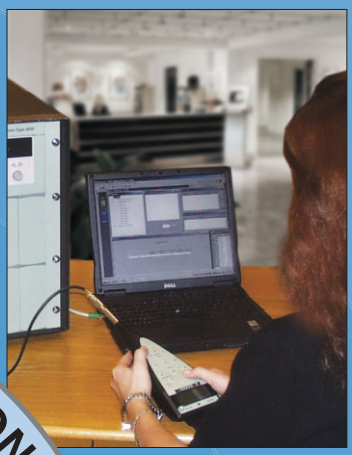


Support

In addition, Brüel & Kjær offers a variety of technical literature ranging from Product Data to reference books that help you to understand the applications, the products and the theory behind sound and vibration measurements. Most of this literature is available not only as printed matter but also in electronic form and can be found on our website www.bksv.com. Customers with a Help Line agreement also get access to technical support through Brüel & Kjær's worldwide service network, where a team of technical specialists is ready to answer, by telephone, mail or fax, any questions that you have about our products.



Global Service
Brüel &Kjær can provide these services wherever our customers are found. We employ approximately 100 people in 21 service centres throughout America, Europe and Asia. We're never further away than your local sales representative or service centre, so help is always at hand in your local language.

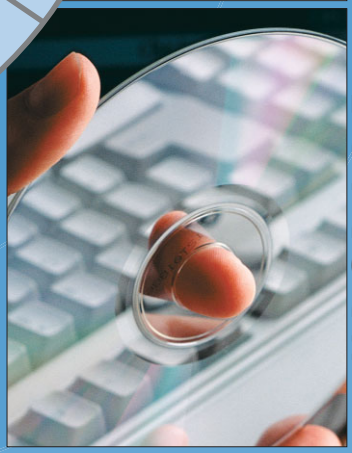


CALIBRATION

Calibration
Measuring with properly calibrated equipment is the only way of knowing that your readings or results are correct. Regular calibration of your measuring equipment is not just an investment in quality. It can also be a source of real cost savings by minimising the cost of errors due to faulty or inaccurate measurements.
We offer a comprehensive range of calibration services, and all Brüel & Kjær calibrations are documented traceable as well as being performed in accordance with the relevant national and international standards. Our calibration laboratories are accredited in many regions, fulfilling the requirements of ISO and other standards. We are also able to offer primary calibrations for transducers through the Danish Primary Laboratory of Acoustics (DPLA), operated by Brüel & Kjær in association with the Technical University of Denmark.

MAINTENANCE

Maintenance
Reliable measurements can only be made with properly calibrated instruments in good working order. We know our products better than anyone else, and if an instrument requires repair or adjustment, our skilled engineers are on hand to do the necessary work. By signing an extended warranty agreement, you can eliminate the risk of unexpected repair costs and extend the factory warranty period up to five years after purchase.



UPGRADE

Upgrade
As manufacturers of PC-based measurement systems, we know that software is of prime importance. As a result, we are continuously improving our software with new features, enhancements and updates and including these improvements in new releases. Subscribing to a Software Maintenance and Upgrade Agreement gives you access to the latest news and software releases from the Brüel & Kjær family of software applications, with new features, improved functionality, bug fixes and error corrections. This will help you keep your equipment at the highest level of performance for many years to come.

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 in 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, that is, 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.

Sabin
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 meaterial 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, that is, 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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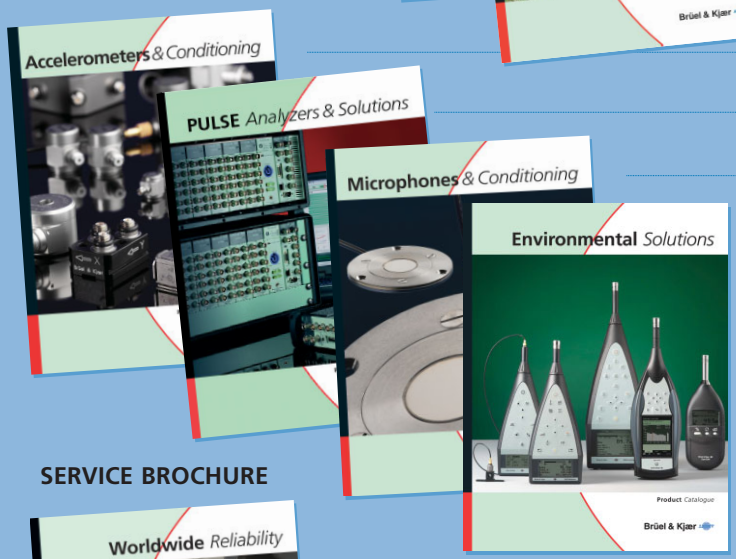

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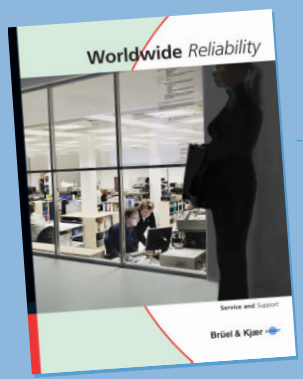

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