



# Product Catalogue

Measurement Microphones

Q1-2020

**GRAS** Sound  
& Vibration



# We Make Microphones

GRAS is a worldwide leader in the sound and vibration industry. We develop and manufacture state-of-the-art measurement microphones and related equipment to industries where acoustic measuring accuracy and repeatability is of utmost importance. This includes applications and solutions for customers within the fields of aerospace, automotive, audiology, consumer electronics, and other high-demanding industries.

## Innovation

As a family-owned company, we safeguard our heritage by constantly striving to push the boundaries of what is possible and help our customers improve their products. This is why we have the industry's most advanced microphones – a broad range of high-quality microphones for general acoustic applications complemented by an even broader range of highly specialized microphones and test solutions developed and fine-tuned to match specific challenges.

This is a reflection of our unique willingness to help solve our customers' measurement needs and provide solutions for tomorrow. Listening to our customers is at the core of who we are.

## Quality

Our measurement microphones are designed to support critical areas in our customers' R&D, QA and Production Line testing. Using Highly Accelerated Lifetime Tests (HALT) we ensure that our microphones perform optimally in real-life situations and retain the long-term stability that is crucial for trustworthy measurement results. All our microphones are made in Denmark from stainless steel and in a quality that allows for a 5 year warranty.

## Unique Repair Service

Should you by mistake damage the diaphragm on a GRAS microphone, our special technique enables repair at a very reasonable price, ensuring a very low cost of ownership.

## Calibration Services

Depending on the use, measurement environment and internal quality control programs, we recommend that microphones are calibrated at a dedicated calibration laboratory at least every second year. We endorse our Accredited Calibration Laboratory in Denmark or the GRAS Microphone Calibration Centers located in Asia, Europe and North America.

## Partners

GRAS is located in Denmark and represented worldwide in more than 40 countries. Also, we are the preferred supplier of acoustic sensors to a long list of measurement solution providers. Whether you are searching for a multi-channel solution, a replacement microphone or a customized design, your local GRAS partner will in close cooperation with us be able to help solve your measurement needs.

Please visit [gras.dk](http://gras.dk) to find your local GRAS partner.

## Tradition

We were founded in 1994 by Danish acoustics pioneer Gunnar Rasmussen who for more than 60 years has contributed to the world of sound and vibration with his unique ideas and designs. In 1956 Mr. Rasmussen designed the first reproducible 1" condenser measurement microphone. Mr. Rasmussen's ingenuity soon led to the world's most popular and probably most copied acoustic sensor: The 1/2" measurement microphone. Then the 1/4" and 1/8" microphones followed with outstanding dynamic and high-frequency capabilities that made high-definition diagnostics of impulse noise possible. Many variants have been made available over the years, all based on Gunnar Rasmussen's original 1" pressure microphone design.



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## Choosing a Microphone

Measurement microphones are available in many types covering various frequency ranges, dynamic ranges and application situations. The following guide is provided to help select the right microphone for a given application.

Selecting a microphone involves a number of choices, which can be summarized as:

- ✓ Externally polarized vs. prepolarized
- ✓ Free-field, Pressure or Random incidence
- ✓ Dynamic range
- ✓ Frequency range

### Externally Polarized vs. Prepolarized

All GRAS measurement microphones are of the condenser type. This requires a polarization voltage which can either be supplied from an external power supply or the microphone itself can be polarized by injecting a permanent electrical charge into a thin PTFE layer on the microphone backplate.

#### Externally Polarized Microphones

These microphones are used with standard preamplifiers such as the GRAS 26AK, which has a 7-pin LEMO connector. The preamplifier must be connected to a power module (for example GRAS 12AK) or an analyzer input that can supply the preamplifier with power as well as 200 V polarization for the microphone capsule.

Externally polarized microphones are the most accurate and stable and are to be preferred for very critical measurements.

#### Prepolarized Microphones

These microphones are used typically with CCP (Constant Current Power\*) preamplifiers such as GRAS 26CA. Prepolarized microphones must be connected to an input stage for CCP transducers or be powered by a CCP supply, for example the GRAS 12AL.

CCP preamplifiers use standard coaxial cables, thus reducing costs. On the other hand, the long term stability and high-temperature stability of prepolarized microphones are not as good as for externally polarized microphones.

\*) CCP (Constant Current Power) is the same as IEPE (Integrated Electronic Piezo-Electric) and CCLD (Constant Current Line Drive) and is compatible with many other constant current driven products such as Deltatron® (Brüel & Kjaer), Isotron® (Endevco Corp.), ICP® (PCB Group, Inc.).

## Free-field, Pressure or Random Incidence

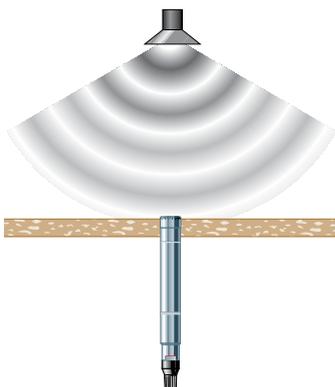
Measurement microphones can be divided into three groups: Free-field, Pressure, and Random incidence. The differences between microphones from group to group are at the higher frequencies, where the size of a microphone becomes comparable with the wavelengths of the sound being measured.



### Free-field Microphones

A free-field microphone is designed essentially to measure the sound pressure as it was before the microphone was introduced into the sound field. At higher frequencies, the presence of the microphone itself in the sound field will disturb the sound pressure locally. The frequency response of a free-field microphone has been carefully adjusted to compensate for the disturbances to the local sound field. (See also random incidence microphones).

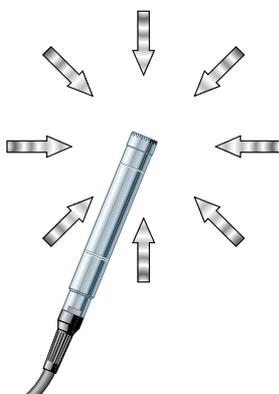
Free-field microphones are recommended for most sound pressure level measurements for example with sound level meters, sound power measurements, and sound radiation studies.



### Pressure Microphones

A pressure microphone is for measuring the actual sound pressure on the surface of the microphone's diaphragm. A typical application is in the measurement of sound pressure in a closed coupler or, as shown to the left, the measurement of sound pressure at a boundary or wall; in which case the microphone forms part of the wall and measures the sound pressure on the wall itself.

Pressure microphones are recommended for use with couplers like GRAS RA0045 IEC 60318-4 and GRAS RA0038 IEC 60318-5, 2cc coupler and studies of sound pressures inside closed cavities.



### Random Incidence Microphones

A random incidence microphone is for measuring in sound fields, where the sound comes from many directions e.g. when measuring in a reverberation chamber or other highly reflecting surroundings.

The combined influence of sound waves coming from all directions depends on how these sound waves are distributed over the various directions. For measurement microphones, a standard distribution has been defined based on statistical considerations; resulting in a standardized random incidence microphone.

Random incidence is used typically for sound pressure level measurements according to ANSI standards.

## Dynamic Range of a Microphone

The dynamic range of a microphone can be defined as the range between the lowest level and the highest level that the microphone can handle. This is not only a function of the microphone alone but also of the preamplifier used with the microphone. The dynamic range of a microphone is, to a large extent, directly linked to its sensitivity.

In general, a microphone with high sensitivity will be able to measure very low levels, but not very high levels, and a microphone with low sensitivity will be able to measure very high levels, but not very low levels.

The sensitivity of a microphone is determined chiefly by the size of the microphone and the tension of its diaphragm. Generally speaking, a large microphone, with a loose diaphragm, will have high sensitivity and a small microphone, with a stiff diaphragm, will have low sensitivity.

### Upper Limit of Dynamic Range

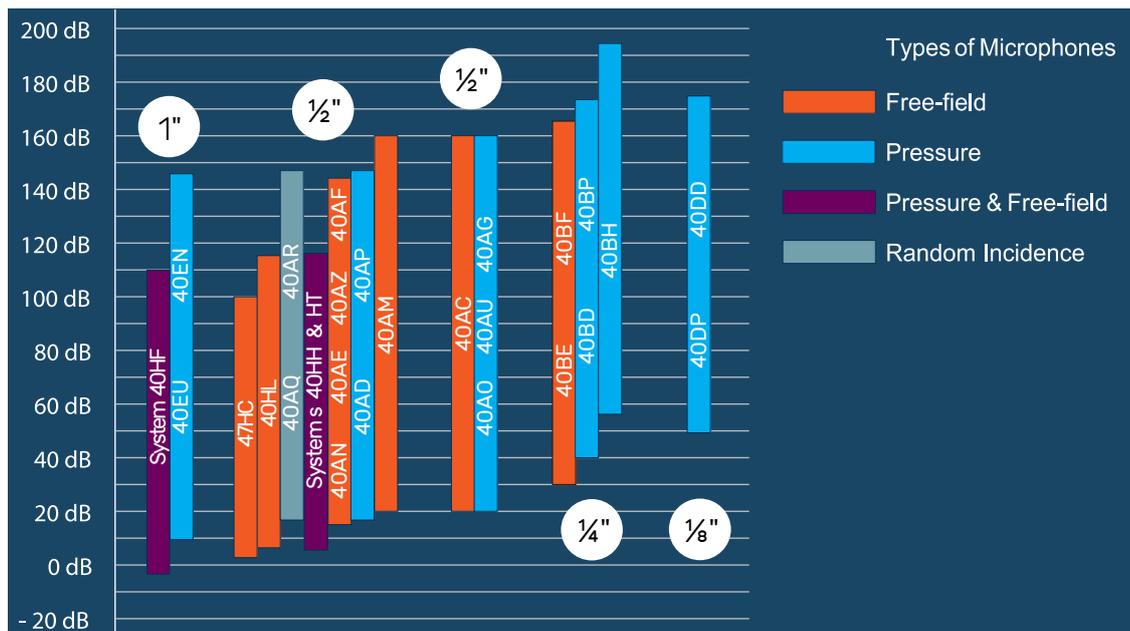
The highest levels that can be measured are limited by the amount of movement allowed for the diaphragm before it comes into contact with the microphone's backplate.

As the level of the sound pressure on a microphone increases, the deflection of the diaphragm will accordingly be greater and greater until, at some point, the diaphragm strikes the backplate inside the body of the microphone. This is ultimately the highest level the microphone can measure.

### Lower Limit of Dynamic Range

The thermal agitation of air molecules is sufficient for a microphone to generate a very small output signal, even in absolutely quiet conditions. This "thermal noise" lies normally at around 5  $\mu\text{V}$  and will be superimposed on any acoustically excited signal detected by the microphone. Because of this, no acoustically excited signal below the level of the thermal noise can be measured.

The dynamic ranges of various GRAS microphones are shown in the chart below. Different colors are used to distinguish between pressure (blue), free-field (orange) and random incidence (light grey) microphones.



The microphones are grouped according to size of external diameter, i.e. 1", 1/2", 1/4" and 1/8". The Part or Model number of each microphone is also shown.

## Frequency Range of a Microphone

The frequency range of a microphone is defined as the interval between its upper limiting frequency and its lower limiting frequency. With today's microphones, it is possible to cover a frequency range starting from around 1 Hz and reaching up to 140 kHz.

Low-frequency measurements require a microphone with a well-controlled static pressure equalization with a very slow venting. Special versions are available for infra-sound measurements.

High-frequency measurements are very sensitive to diaphragm stiffness, damping and mass as well as diffraction.

### Upper Limiting Frequency

The upper limiting frequency is linked to the size of the microphone, or more precisely, the size of the microphone compared with the wavelength of sound. Since wavelength is inversely proportional to frequency, it gets progressively shorter at higher frequencies. Hence, the smaller the diameter of the microphone, the higher are the frequencies it can measure. On the other hand, the sensitivity of a microphone is also related to its size which also affects its dynamic range.

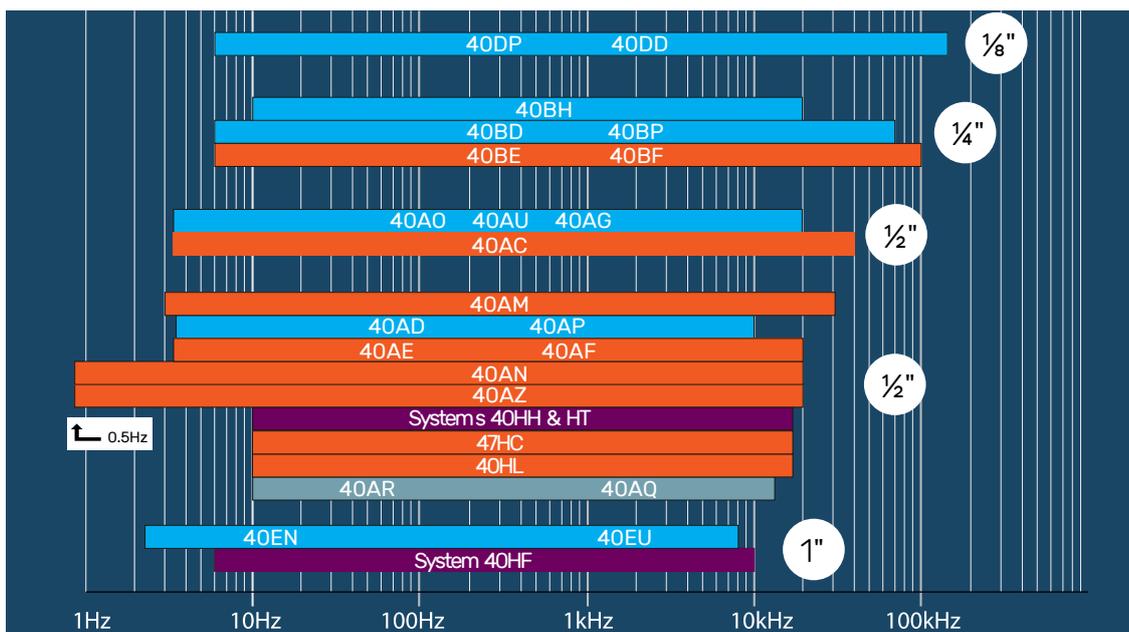
The frequency ranges of various GRAS microphones are shown in the chart below. Different colors are used to distinguish between pressure (blue), free-field (orange) and random incidence (light grey) microphones.

### Lower Limiting Frequency

The lower limiting frequency of a microphone is determined by its static pressure equalization system. Basically, a microphone measures the difference between its internal pressure and the ambient pressure.

If the microphone was completely airtight, changes in barometric pressure and altitude would result in a static deflection of its diaphragm and, consequently, in a change of frequency response and sensitivity.

To avoid this, the microphone is manufactured with a static pressure equalization channel for equalizing the internal pressure with ambient pressure. On the other hand, equalization must be slow enough to avoid affecting the measurement of dynamic signals.



The microphones are grouped according to size of external diameter, i.e. 1", 1/2", 1/4" and 1/8". The Part or Model number of each microphone is also shown.

# Microphone Sets

## Microphone Sets – a Safe and Easy Solution

Daily situations where you mix up externally polarized and prepolarized microphones and preamplifiers or use wrong calibration data in your system setup are time-consuming and often not discovered until a whole set of measurement data is analyzed and consequently discarded.

To help you avoid this we offer most of our measurement microphones as microphone sets: Pre-assembled and ready-to-use combinations of microphones and preamplifiers.

### Pre-assembled Sets

The GRAS 46XX-series of pre-assembled microphones and preamplifiers offers carefully selected combinations to obtain the best possible properties and reliability, thus optimizing the work-flow for the user and minimizing typical handling errors.

The sets are assembled in a dust-free environment to avoid contamination of the interface between the microphone and preamplifier. They are calibrated together and sealed with a label. The label can be removed and the set dismantled if desired by the user.

### Easy Selection

The measurement microphone sets have been combined so they fulfill our users' typical measurement needs. Whatever your measurement system and application, you should be able to find a set that suits your needs.

### Plug & Play

The microphone sets can be connected directly to all professional measurement systems, and as indicated they are available for both CCP and 7-pin LEMO inputs. If your measurement platform supports intelligent transducers according to IEEE 1451.4 Transducer Electronic Data Sheet (TEDS) you can simply plug in the microphones and they will identify themselves with their specific properties, types and calibration data. This feature is especially appreciated by multi-channel users.

### Cables

The CCP sets use high-quality coaxial cables whereas the LEMO sets use a special, soft type of multi-core shielded cable. It should be noted that longer cables will influence the upper frequency and dynamic ranges.

### Calibration Data

All microphone sets are delivered as a unit and are calibrated accordingly. The sets are delivered with calibration charts including sensitivity values and frequency response curves for the complete set. The sensitivity value can therefore be used directly in your system setup.

### Verification and Annual Calibration

For frequent verification of the measurement chain, a sound source will be required. GRAS supplies a number of pistonphones and a multifunction sound calibrator for this purpose. Depending on the use and your internal quality control requirements we recommend that the sets are recalibrated at least every second year.

### Warranty

GRAS offers a 5-year warranty on microphone sets.

### Service

Should you by mistake damage the diaphragm on a GRAS microphone, our special technique enables repair at a very reasonable price, ensuring a very low cost of ownership. Cable and connector can usually be replaced, which is also the case for the microphone cartridge and preamplifier unit.

Typically a GRAS microphone set is named for the microphone capsule. A 40AE microphone thus becomes a 46AE microphone set when paired with the preamplifier.



# LEMO MICROPHONE SETS

## FREE-FIELD AND RANDOM INCIDENCE

### GRAS 46AC

#### 1/2" LEMO Free-field Standard Microphone Set, Wide Frequency



46AC is a high-performance 1/2" free-field standard microphone set for measuring medium sound pressure levels at high frequencies; with built-in TEDS and 7-pin LEMO connector.

### GRAS 46BF-1

#### 1/4" LEMO Free-field Standard Microphone Set



46BF-1 is a 1/4" high frequency free-field microphone set for high level measurements with built-in TEDS and a 5-pin LEMO connector.  
To be used with AA0091 or AA0092-CL 5-pin to 7-pin LEMO cable.

### GRAS 46AF

#### 1/2" LEMO Free-field Standard Microphone Set



46AF is a 1/2" general purpose high sensitivity free-field microphone set with built-in TEDS and 7-pin LEMO connector.

### GRAS 46AR

#### 1/2" LEMO Random incidence Standard Microphone Set



46AR is a 1/2" high sensitivity random incidence microphone set optimized to measure sound correctly in random, diffuse and reverberant sound fields; with built-in TEDS and 7-pin LEMO connector.

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
46AC	12.5	3.15 - 40 k	28 - 120	20 dB(A) to 164 dB	-30 to +70	97	12.7	13.2	42
46AF	50	3.15 - 20 k	28 - 120	17 dB(A) to 149 dB	-30 to +70	101	12.7	13.2	42
46AR	50	3.15 - 16 k*	28 - 120	19 dB(A) to 149 dB	-30 to +70	101	12.7	13.2	42
46BF-1	3.6	4 - 100 k	28 - 120	35 dB(A) to 172 dB	-30 to +70	69	6.35	6.9	10
Units	mV/Pa	Hz	V DC	re. 20 µPa	°C	mm	mm	mm	g

\* ±3 dB. All other ±2 dB.

**GRAS 46AG**

**1/2" LEMO Pressure Standard Microphone Set**



46AG is a 1/2" high precision pressure microphone set for laboratory work and coupler measurements with built-in TEDS and 5-pin LEMO connector.

*To be used with AA0091 or AA0092-CL 5-pin to 7-pin LEMO cable. A front-vented version is available, 46AG-FV.*

**GRAS 46BP-1**

**1/4" LEMO Pressure Standard Microphone Set**



46BP-1 is a 1/4" LEMO microphone set for pressure measurements for measuring high sound pressure levels at high frequencies, with a 5-pin LEMO connector.

*To be used with AA0091 or AA0092-CL 5-pin to 7-pin LEMO cable.*

**GRAS 46AP**

**1/2" LEMO Pressure Standard Microphone Set, High Sensitivity**



46AP is a 1/2" general purpose pressure microphone set with built-in TEDS and 7-pin LEMO connector.

**GRAS 46DP-1**

**1/8" LEMO Pressure Standard Microphone Set**



46DP-1 is a 1/8" pressure microphone set with built-in TEDS and a 5-pin LEMO connector.

*To be used with AA0091 or AA0092-CL 5-pin to 7-pin LEMO cable.*

**GRAS 46BH-1**

**1/4" LEMO Pressure Standard Microphone Set, High Pressure**



46BH-1 is a 1/4" high pressure microphone set with built-in TEDS and a 5-pin LEMO connector. With a dynamic range topping at 193 dB it is ideal for measuring at very high sound pressure levels.

*To be used with AA0091 or AA0092-CL 5-pin to 7-pin LEMO cable.*

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
46AG	12	3.15 - 20 k	28 - 120	25 dB(A) to 164 dB	-30 to +70	101	12.7	13.2	42
46AP	50	3.15 - 10 k	28 - 120	18 dB(A) to 149 dB	-30 to +70	101	12.7	13.2	42
46BH-1	0.4	10 - 20 k	28 - 120	54 dB(A) to 193 dB	-30 to +70	69	6.35	6.9	10
46BP-1	1.5	4 - 70 k	28 - 120	39 dB(A) to 172 dB	-30 to +70	69	6.35	6.9	10
46DP-1	0.9	6.5 - 140 k	28 - 120	52 dB(A) to 178 dB	-30 to +70	90	3.2	3.5	8
Units	mV/Pa	Hz	V DC	re. 20 µPa	°C	mm	mm	mm	g

# CCP MICROPHONE SETS

FREE-FIELD, RANDOM INCIDENCE AND PRESSURE

## GRAS 146AE

### 1/2" CCP Free-field Microphone Set



146AE is a versatile 1/2" free-field measurement microphone set for the broadest range of noise measurements in challenging environments. It is well protected against vibrations, humidity, dust, oil mists, and temperatures from -40 to 125°C. *A comprehensive range of accessories is available, visit [www.gras.dk](http://www.gras.dk).*

## GRAS 147AX

### CCP Rugged Pressure Microphone



147AX is a surface mounted pressure microphone. It comes with a novel magnetic mounting system which provides precise, repeatable and easy mounting. It is well protected against vibrations, humidity, dust, oil mists, and temperatures from -40 to 125°C. *A comprehensive range of accessories is available, visit [www.gras.dk](http://www.gras.dk).*

## GRAS 46AE

### 1/2" CCP Free-field Standard Microphone Set



46AE is a 1/2" free-field general purpose high sensitivity microphone set with built-in TEDS and BNC connector.

## GRAS 46AM

### 1/2" CCP Free-field Standard Microphone Set, Wide Frequency



46AM is a 1/2" CCP microphone set for measuring medium sound pressure levels at a wide range of frequencies; with built-in TEDS and a BNC connector.

## GRAS 46BE

### 1/4" CCP Free-field Standard Microphone Set, Wide Frequency



46BE is a 1/4" Constant Current Power CCP free-field microphone set for measuring high sound pressure levels at high frequencies. It is terminated with a 10/32 UNC Microdot female connector and has TEDS. *A high-temperature version is available, 46BE-HT.*

## GRAS 46AQ

### 1/2" CCP Random Incidence Standard Microphone Set



46AQ is a 1/2" CCP high sensitivity random incidence microphone set, optimized to measure sound correctly in random, diffuse and reverberant sound fields; with built-in TEDS and BNC connector.

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Max. Output Peak Voltage	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
146AE	50	3.15 - 20 k	2-20	18 dB(A) to 133 dB	8	-40 to +125	86.5	12.7	14.5	35
46AE	50	3.15 - 20 k	2 - 20	17 dB(A) to 138 dB	8	-30 to +85	84	12.7	13.2	40
46BE	3.6	4 - 80 k	2 - 20	35 dB(A) to 160 dB	8	-30 to +85	53	6.35	6.9	10
147AX	45	3.15 - 20 k	2 - 20	19 dB(A) to 133 dB	8	-40 to +125	-	12.5	14.5	27
46AM	14.5	3.15 - 31.5 k	2 - 20	25 dB(A) to 149 dB	8	-30 to +85	90	12.7	13.2	40
46AQ	50	3.15 - 12.5 k	2 - 20	17 dB(A) to 138 dB	8	-30 to +85	101	12.7	13.2	40
Units	mV/Pa	Hz	mA	re. 20 µPa	V	°C	mm	mm	mm	g

\* with 5 m integrated cable.

**GRAS 46AO**

**1/2" CCP Pressure Standard Microphone Set**



46AO is a 1/2" pressure high precision microphone set for laboratory work. Including built-in TEDS and BNC connector.

*A front-vented version is available, 46AO-FV.*

**GRAS 46BG**

**1/4" CCP Pressure Standard Microphone Set, High Pressure**



46BG is a 1/4" microphone set for high level measurement with built-in TEDS and a Microdot connector. Its low sensitivity and special-designed diaphragm make it ideal for handling high levels.

*A front-vented version is available, 46BG-FV.*

**GRAS 46AD**

**1/2" CCP Pressure Standard Microphone Set, High Sensitivity**



46AD is a 1/2" pressure high sensitivity microphone set with built-in TEDS and BNC connector.

**GRAS 46BL**

**1/4" CCP Pressure Microphone Set, High Sensitivity**



46BL is a 1/4" microphone set for high sensitivity and low-noise measurement with built-in TEDS and a Microdot connector.

*A high-temperature version is available, 46BL-HT.*

**GRAS 46BD**

**1/4" CCP Pressure Standard Microphone Set**



46BD is a 1/4" pressure microphone set with low sensitivity for high-level and high-frequency measurements, with built-in TEDS and Microdot connector.

*A front-vented version is available, 46BD-FV.*

*A version with SMB connector is available, 46BD-S1.*

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Max. Output Peak Voltage	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
46AO	12	3.15 - 20 k	2 - 20	25 dB(A) to 150 dB	8	-30 to +85	80	12.7	13.2	39
46AD	50	3.15 - 10 k	2 - 20	18 dB(A) to 138 dB	8	-30 to +85	94	12.7	13.2	40
46BD	1.45	4 - 70 k	2 - 20	44 dB(A) to 166 dB	8	-30 to +85	53	6.35	6.9	10
46BG	0.25	3.15 - 70 k	2 - 20	60 dB(A) to 184 dB	8	-30 to +85	53	6.35	6.9	8
46BL	18	4 - 20 k	2 - 20	25 dB(A) to 147 dB	8	-30 to +85	53	6.35	6.9	8
Units	mV/Pa	Hz	mA	re. 20 µPa	V	°C	mm	mm	mm	g

# CCP MICROPHONE SETS

## PRESSURE

### GRAS 46DD

#### 1/8" CCP Pressure Standard Microphone Set



46DD is a low sensitivity microphone set for sound measurements at high frequencies. With built-in TEDS and Microdot connector.

*A front-vented version is available, 46DD-FV.*

### GRAS 46DE

#### 1/8" CCP Pressure Standard Microphone Set



46DE is a 1/8" CCP Pressure Microphone Set with Microdot connector. The preamplifier is 1/8", making it the world's smallest microphone set.

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Max. Output Peak Voltage	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
46DD	0.8	6.5 - 140 k*	2 - 20	52 dB(A) to 174 dB	8	-30 to +85	64	3.2	3.5	8
46DE	0.8	6.5 - 140 k*	2 - 20	52 dB(A) to 174 dB	8	-30 to +85	38.2	3.2	3.5	7
Units	mV/Pa	Hz	mA	re. 20 µPa	V	°C	mm	mm	mm	g

\* ±3 dB.

# EXTERNALLY POLARIZED MEASUREMENT MICROPHONES

## FREE-FIELD

### GRAS 40AF

#### 1/2" Free-field Microphone



General purpose high sensitivity microphone with a frequency range from 3.15 Hz to 20 kHz. Can measure sound pressure levels down to 14 dB(A). For Type 0 and Type 1 measurements.

### GRAS 40AC

#### 1/2" Free-field Microphone, Wide Frequency



High precision microphone for laboratory work and as a working standard microphone in calibration laboratories. Wide frequency range from 3.15 Hz to 40 kHz. Its size and low sensitivity make it extremely robust and stable and can measure sound levels up to 164 dB.

	Size	Application	Sensitivity	Dynamic Range	Frequency Range	Polarization Voltage	IEC 61094 Designation
40AF	12.7 (1/2")	Free-field	50	14 - 149	3.15 - 20 k	200	WS2F
40AC	12.7 (1/2")	Free-field	12.5	20 - 164	3.15 - 40 k	200	WS2F
Units	mm (housing)		mV/Pa	dB re. 20 µPa	Hz	V	

# EXTERNALLY POLARIZED MEASUREMENT MICROPHONES

FREE-FIELD, RANDOM INCIDENCE AND PRESSURE

## GRAS 40AN

1/2" Free-field Microphone, Low Frequency



High sensitivity microphone ideal for measuring sound at frequencies down to 0.5 Hz. This microphone is the obvious choice for infra-sound measurement. Use the dedicated 26HG 1/4" preamplifier in order to obtain the low frequency response.

## GRAS 40AR

1/2" Random Incidence Microphone



High sensitivity microphone with a frequency response optimized to measure sound correctly in random, diffuse and reverberant sound fields. It fulfills the requirements of ANSI standard S1.4.

## GRAS 40BF

1/4" Free-field Microphone



Low sensitivity microphone for high level and high frequency measurements. Its low sensitivity makes it ideal for measuring high sound pressure levels of up to 172 dB. Its small size reduces the effects of diffraction and reflections around the microphone, resulting in a frequency range reaching up to 100 kHz.

## GRAS 40EN

1" Pressure Microphone



High precision microphone for laboratory work. Ideal for measurements in couplers, e.g. the RA0075 NBS 9-A 6cc Coupler for testing earphones according to ANSI S3.7 - 1995 and RA0113 which is a 2cc IEC 60318-5 (60126) Coupler. Can also be flush mounted to measure sound pressures on walls and boundaries.

## GRAS 40AU-1

1/2" Reference Pressure Microphone



High precision, laboratory-standard microphone with a front cavity as specified in IEC 61094-2. It is supplied with a protective dust cap.

	Size	Application	Sensitivity	Dynamic Range	Frequency Range	Polarization Voltage	IEC 61094 Designation
40AN	12.7 (1/2")	Free-field	50	14 - 149	0.5 - 20 k	200	WS2F
40BF	6.35 (1/4")	Free-field	4	30 - 172	4 - 100 k	200	WS3F
40AU-1	12.7 (1/2")	Pressure	12.5	20 - 160	3.15 - 20 k	200	LS2P
40AR	12.7 (1/2")	Random	50	14 - 149	3.15 - 12.5 k	200	WS2P/D
40EN	23.77 (1")	Pressure	50	9.6 - 146	2.6 - 8 k	200	WS1P
Units	mm (housing)		mV/Pa	dB re. 20 µPa	Hz	V	

## PRESSURE

### GRAS 40AG

#### 1/2" Pressure Microphone



High precision microphone for laboratory work and coupler measurements (e.g. in the RA0039 IEC 60318-1 (60318) Ear Simulator). Has a frequency range from 3.15 Hz to 20 kHz. Its size and low sensitivity makes it extremely robust and stable and it can measure sound pressure levels up to 164 dB.

### GRAS 40AP

#### 1/2" Pressure Microphone, High Sensitivity



High sensitivity microphone with a frequency range from 3.15 Hz to 10 kHz. Can measure sound pressure levels down to 16 dB(A). May also be used as a random incidence microphone.  
*A front-vented version is available, 40AP-FV.*

### GRAS 40BP

#### 1/4" Pressure Microphone



Low sensitivity microphone for sound measurements at high levels and high frequencies. Its low sensitivity makes it ideal for measuring high sound pressure levels of up to 169 dB. Its small size reduces the effects of diffraction and reflections around the microphone, resulting in a frequency range extending up to 70 kHz.  
*A front-vented version is available, 40BP-FV.*

### GRAS 40BH

#### 1/4" Pressure Microphone, High Pressure



Low sensitivity microphone for sound measurements at very high levels. Its very low sensitivity makes it ideal for measuring very high sound pressure levels up to 193 dB. Its small size reduces the effects of diffraction and reflections around the microphone, making it ideal for pulse measurements in frequencies up to 20 kHz.

### GRAS 40DP

#### 1/8" Pressure Microphone



Low sensitivity microphone for sound measurements at high frequencies and high levels. Its low sensitivity makes it ideal for measuring high sound pressure levels up to 178 dB. Its very small size reduces the effects of diffraction and reflections around the microphone, resulting in a frequency range extending up to 140 kHz.

	Size	Application	Sensitivity	Dynamic Range	Frequency Range	Polarization Voltage	IEC 61094 Designation
40AG	12.7 (1/2")	Pressure	12.5	25 - 160	3.15 - 20 k	200	WS2P
40BP	6.35 (1/4")	Pressure	1.6	34 - 169	4 - 70 k	200	WS3P
40AP	12.7 (1/2")	Pressure	50	16 - 149	3.15 - 10 k	200	WS2P
40BH	6.35 (1/4")	Pressure	0.4	54 - 193	10 - 20 k	200	WS3P
40DP	3.16 (1/8")	Pressure	1	49 - 178	6.5 - 140 k	200	-
Units	mm (housing)		mV/Pa	dB re. 20 µPa	Hz	V	

### GRAS 40AE

#### 1/2" Free-field Microphone



General purpose high sensitivity microphone with a frequency range from 3.15 Hz to 20 kHz. Requires no external polarization voltage. Ideal with CCP preamplifiers, Type 1 sound level meters and other similar measurement setups.

### GRAS 40AZ

#### 1/2" Free-field Microphone, Low Frequency



Low frequency microphone especially designed for infra-sound measurements. Frequency range from 0.5 Hz to 20 kHz. Use the dedicated 26CG 1/4" CCP preamplifier in order to obtain the low frequency response.

### GRAS 40AM

#### 1/2" Free-field Microphone, Wide Frequency



High precision microphone for laboratory work. Wide frequency range from 3.15 Hz to 31.5 kHz. Its size and low sensitivity make it extremely robust and stable and it can measure sound levels up to 163 dB.

### GRAS 40BE

#### 1/4" Free-field Microphone



Low sensitivity microphone for high level and high frequency measurements. Requires no polarization voltage. Its low sensitivity makes it ideal for measuring high sound-pressure levels up to 168 dB. Ideal with CCP preamplifiers and for sound measurements at very high frequencies and levels.

*A front-vented version is available, 40BE-FV.*

### GRAS 40AQ

#### 1/2" Random Incidence Microphone



High sensitivity microphone with a frequency response optimized to measure sound correctly in random, diffuse and reverberant sound fields. Requires no external polarization voltage. It fulfills the requirements of ANSI standard S1.4.

	Size	Application	Sensitivity	Dynamic Range	Frequency Range	Polarization Voltage	IEC 61094 Designation
40AE	12.7 (1/2")	Free-field	50	15 - 148	3.15 - 20 k	0	WS2F
40AM	12.7 (1/2")	Free-field	14.5	20 - 163	3.15 - 31.5 k	0	WS2F
40AQ	12.7 (1/2")	Random	50	16 - 148	3.15 - 12.5 k	0	WS2P/D
40AZ	12.7 (1/2")	Free-field	50	14 - 148	0.5 - 20 k	0	WS2F
40BE	6.35 (1/4")	Free-field	4	30 - 168	4 - 80 k	0	WS3F
Units	mm (housing)		mV/Pa	dB re. 20 µPa	Hz	V	

## GRAS 40AD

1/2" Pressure Microphone, High Sensitivity



A high sensitivity microphone with a frequency range from 3.15 Hz to 10 kHz. Requires no external polarization voltage. Can measure sound pressure levels down to 16 dB(A). May also be used as a random-incidence microphone. *A front-vented version is available, 40AD-FV.*

## GRAS 40BD

1/4" Pressure Microphone



Its low sensitivity makes it ideal for measuring high sound pressure levels up to 166 dB. Its small size reduces the effects of diffraction around the microphone, resulting in a frequency range extending up to 70 kHz. *A front-vented version is available, 40BD-FV.*

## GRAS 40AO

1/2" Pressure Microphone, Wide Frequency



A high precision microphone for laboratory work. Has a frequency range from 3.15 Hz to 20 kHz. Requires no external polarization voltage. Its size and lower sensitivity make it extremely robust and stable and it can measure sound pressure levels up to 163 dB. *A front-vented version is available, 40AO-FV.*

## GRAS 40DD

1/8" Pressure Microphone



Low sensitivity microphone for sound measurements at high frequencies and high levels. Its low sensitivity makes it ideal for measuring high sound pressure levels of up to 175 dB. Its very small size reduces the effects of diffraction and reflections around the microphone, resulting in a frequency range extending up to 70 kHz.

	Size	Application	Sensitivity	Dynamic Range	Frequency Range	Polarization Voltage	IEC 61094 Designation
40AD	12.7 (1/2")	Pressure	50	16 - 148	3.15 - 10 k	0	WS2P/D
40AO	12.7 (1/2")	Pressure	12.5	25 - 163	3.15 - 20 k	0	WS2P
40BD	6.35 (1/4")	Pressure	1.6	40 - 174	4 - 70 k	0	WS3P
40DD	3.16 (1/8")	Pressure	0.9	49 - 175	6.5 - 70 k	0	-
Units	mm (housing)		mV/Pa	dB re. 20 µPa	Hz	V	

## GRAS 40AK

### 1/2" Ext. Polarized Intensity Microphone Kit



Complete kit of the 40AI phase-matched 1/2" Intensity Microphone pair, solid spacers and adapters for a pair of 26AA 1/4" Preamplifiers.

The microphones have a free-field response optimized for use in face-to-face configuration and a high sensitivity to enable low level measurements. As a pair, they fulfill the phase requirements for Class 1 intensity microphones in accordance with IEC International Standard 61043.

The solid spacers are for intensity probe configurations using microphone separations of 12 mm, 25 mm, 50 mm and 100 mm to cover a full frequency range from 50 Hz to 10 kHz, and improve microphone protection even under the most adverse of measurement conditions.

Included are two right-angled adapters and one straight adapter for use with the 26AA 1/4" Preamplifier pair.

## GRAS 40BI

### 1/4" Ext. Polarized Intensity Microphone Kit



Complete kit of two phase-matched 1/4" intensity microphones, solid spacers and adapters for a pair of 26AA 1/4" Preamplifiers. Used for measuring very high intensity levels which exceed the dynamic range of 1/2" intensity microphones (i.e. 40AI) or in situations where space is limited. The microphones have a free-field response optimized for use in face-to-face configuration. As a pair, they fulfill the phase requirements for Class 2 intensity microphones in accordance with IEC 61043.

The solid spacers are for configurations using microphone separations of 6 mm, 12 mm and 25 mm. The 6 mm spacer alone will cover a frequency range from 500 Hz to 20 kHz, and improves microphone protection even under the most adverse conditions. Included are two right-angled adapters and one straight adapter for use with the 26AA 1/4" Preamplifier Set.

*A prepolarized version is available, 40BI-S1.*

## GRAS 40AI

### 1/2" Ext. Polarized Intensity Microphone Pair



A pair of 1/2" phase-matched Intensity Microphones as used in 40AK, but without spacers and adapters.



## GRAS 40GI

### 1/2" Pre-polarized Intensity Microphone Pair



A pair of 1/2" prepolarized intensity microphones as used in 40GK, but without spacers and adapters.



## GRAS 40GK

### 1/2" Pre-polarized Intensity Microphone Kit



Complete kit of two phase-matched 1/2" prepolarized intensity microphones, solid spacers and adapters for a pair of 26CB 1/4" CCP preamplifiers.

These prepolarized microphones have a free-field response optimized for use in face-to-face optimized intensity probes. As a pair, they fulfill the phase requirements for Class 1 intensity microphones in accordance with IEC 61043.

The solid spacers are for intensity probe configurations covering a full frequency range from 50 Hz to 10 kHz using microphone separations of 12 mm, 25 mm, 50 mm and 100 mm. Two right-angled adapters and one straight adapter for use with the 26CB 1/4" CCP preamplifiers are included.

Specifications	40AI/40AK	40BI/40BI-S1	40GI/GK	Units
Sensitivity	25	4	12.5	mV/Pa
Dynamic Range	20 - 157	35 - 172	27 - 163	dB re. 20 µPa
Frequency Response	IEC 60651 Type 0	IEC 60651 Type 0	IEC 60651 Type 0	
Phase Response	IEC 61043 Class 1	IEC 61043 Class 2	IEC 61043 Class 1	
Polarization Voltage	200	200/0	0	V
Diameter	13.2	6.9	13.2	mm

# | Special Microphones

Special microphones are often required for applications where there are particular requirements surrounding the methods of measurements and configurations.

**Surface microphones** are for general purpose measurements on planar and curved surfaces, with a wide useful frequency range reaching up to 70 kHz and a large dynamic range topping at around 178 dB.

**Array microphones** are for situations where concurrent measurements are required at several points in an array.

For example in the analyses of:

- ✓ Sound fields
- ✓ Sound power
- ✓ Transients

Close manufacturing tolerances together with the advantages of TEDS provide GRAS array microphones with a high degree of interchangeability. This is a major advantage when they are used in multiples forming arrays and matrices. All have a coaxial SMB output connector.

**Flush-mount microphones** have very low installation height to fit the sensors into very confined spaces and narrow structures, e.g. in acoustic antennas and beams. With an installation height of less than 10 mm and thin coax wiring, the GRAS flush-mount series can be integrated into literally any design without sacrificing aerodynamic properties.

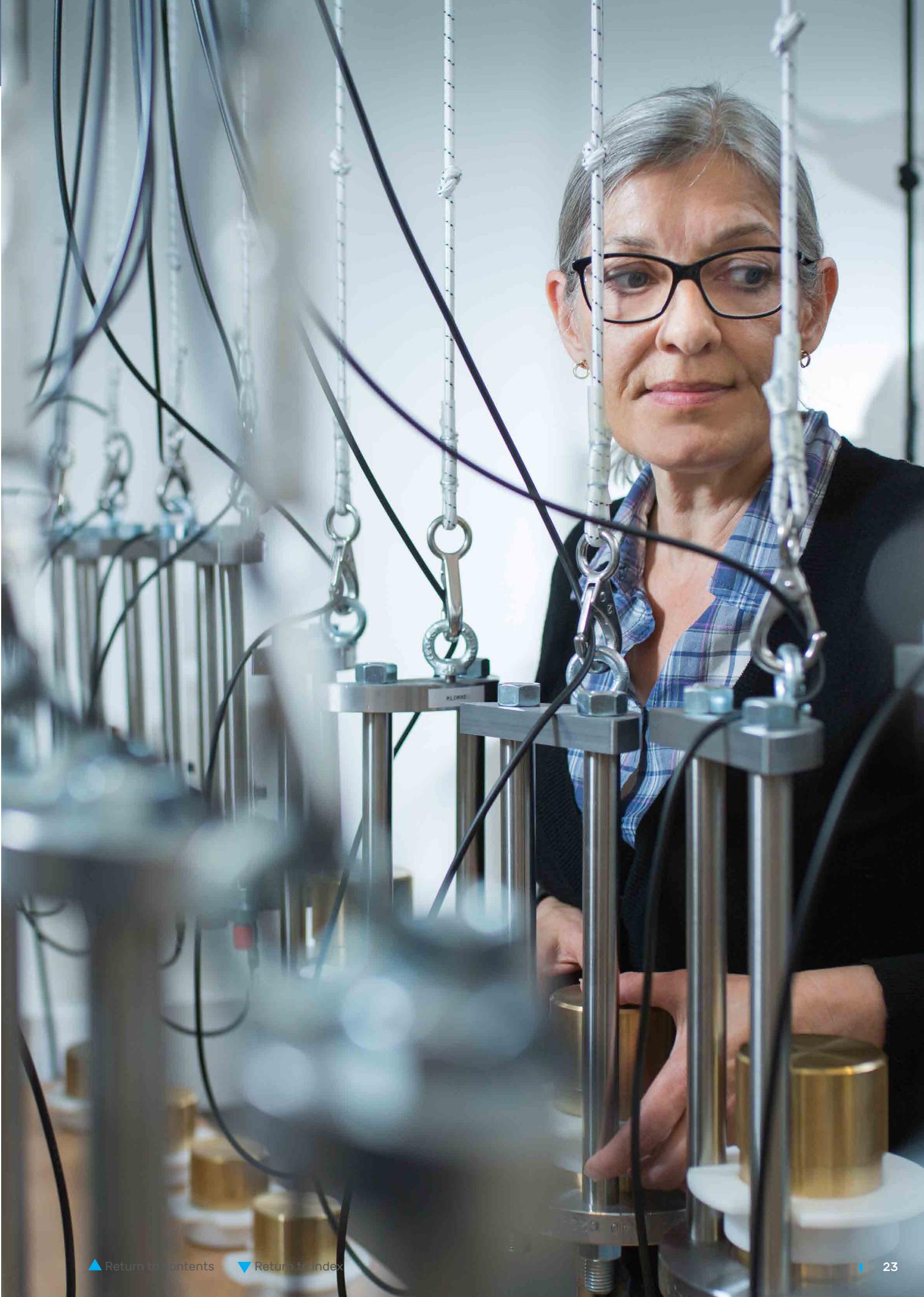
**Probe microphones** are for measurements in difficult or inaccessible situations, for example at high temperatures or in conditions of airflow. Their right-angled design makes them particularly well suited for measurements in exhaust systems and machinery in general, as well as for scanning surfaces such as loudspeakers and cabinets. The small size, low weight and all stainless steel design of the probe's tip make it robust, durable, easy to handle and simple to mount.

**Turbulence Screens** are for aeroacoustic testing in solid-walled wind tunnels. The hydrodynamic component of turbulence is attenuated up to 25 dB. Thereby the acoustic signals of interest can be identified and diagnosed with a reliable resolution.

**Ground array** microphone kits are developed for fixed-wing aircraft and rotorcraft flyover measurements in phased arrays, where the noise is mapped for research or approval purposes. They offer a practical alternative to the conventional upside-down microphone setup.

**Infra-sound microphones** have a very low low-frequency cut-off down to 0.09 Hz. They consist of a special microphone combined with a special pre-amplifier and a low-frequency adapter. To account for pressure variations close to 0 Hz, a special ambient pressure equalization system is used.

**GRAS hemisphere kits** are compliant with the ISO 3744, 3745 and 3746 (ANSI S12.54, S12.55, S12.56) standards for sound power measurements and accommodate for 4, 10 and 20 microphone positions.



## Surface Microphones



### GRAS 40LS

#### CCP Precision Surface Microphone

40LS is a high precision microphone for measurements on airplane surfaces, vehicle surfaces, critical measurements in wind-tunnel as well as general measurements on planar and curved surfaces. It has a wide frequency range reaching up to 70 kHz and a large dynamic range topping at around 167 dB.

40LS is based on high performance measuring microphone technique, which makes the microphone very precise, robust and reliable. The microphone is an integrated unit consisting of the microphone capsule itself and a CCP preamplifier including TEDS for easy access of identification data and calibration data.

### GRAS 40LA

#### CCP Precision Surface Microphone, High Pressure

40LA is a high precision surface microphone with a very low sensitivity 0.5 mV/Pa (178 dB).

### GRAS 40PS-1

#### CCP Surface Microphone

40PS-1 Surface Microphone is a low-profile, light surface microphone for general purpose measurements on planar and curved surfaces exposed to slipstreams.

Specifications	40LA	40LS	40PS-1
Nominal Sensitivity	0.5 mV/Pa	1.8 mV/Pa at 250 Hz	15 mV/Pa at 250 Hz
Frequency Range	10 Hz - 20 kHz ( $\pm 1$ dB) 5 Hz - 70 kHz ( $\pm 3$ dB)	10 Hz - 20 kHz ( $\pm 1$ dB) 5 Hz - 70 kHz ( $\pm 3$ dB)	10 Hz - 12 kHz (+1, -2 dB) 10 Hz - 20 kHz (+1, -6 dB)
Upper Limit of Dynamic Range	178 dB re. 20 $\mu$ Pa	167 dB re. 20 $\mu$ Pa	145 dB re. 20 $\mu$ Pa
Output connector	Microdot 10/32	Microdot 10/32	Microdot 10/32
Lower Limit of Dynamic Range	< 56 dB(A) re. 20 $\mu$ Pa (thermal noise)	< 46 dB(A) re. 20 $\mu$ Pa (thermal noise)	< 27 dB(A) re. 20 $\mu$ Pa (thermal noise)
Temperature Range	-55 °C to +100 °C	-50 °C to +100 °C	-0 °C to +50 °C
Output Impedance	< 50 $\Omega$	< 50 $\Omega$	< 50 $\Omega$
Diameter (with fairing) (without fairing)	42 mm 16.2 mm	42 mm 16.2 mm	40 mm 12.5 mm
Thickness	2.5 mm	2.5 mm	2.8 mm
Weight	3 g	3 g	1.5 g
Cable Length	1.5 m	1.5 m	2 m
Cable Diameter	1.1 mm	1.1 mm	1.1 mm

## GRAS 147EB

### CCP X-Rugged Microphone Set



147EB is a rugged microphone set optimized for wheelhouse brake-noise measurements. It comes with a three-layer protection system that enables it to withstand the conditions in the wheelhouse during prolonged testing on public roads in all types of climate and weather. It is well

protected against vibrations, humidity, dust, oil mists, and temperatures from -40 to 125°C.

*Easily replaceable windscreens provide added protection. See page 105. Visit [www.gras.dk](http://www.gras.dk) for further accessories.*

	Nominal Sensitivity	Frequency Response	Power Supply	Dynamic Range	Max. Output Peak Voltage	Temperature Range	Length	Diameter without Protection Grid	Diameter with Protection Grid	Weight
147EB	50	3.15 - 20 k*	2 - 20	18 dB(A) to 133 dB	8	-40 to +125	87.2	12.7	23.77	61.5
Units	mV/Pa	Hz	mA	re. 20 µPa	V	°C	mm	mm	mm	g

\* After correction for the influence of the 1" grid

# PROBE MICROPHONES

## GRAS 40SA

### LEMO Probe Microphone



Small, compact unit for sound pressure measurements in small enclosures, harsh environments and very close to sound sources. The high acoustic input impedance of the probe tip has minimal influence on the acoustic field, and can withstand temperatures of up to 800 °C.

It is constructed with a detachable stainless steel probe tip that guides the acoustic signal to a microphone inside the probe housing. For closed-coupler measurements, the probe microphone uses internal pressure equalization to balance out static pressure differences.

## GRAS 40SC

### CCP Probe Microphone



Similar to the 40SA in both size and performance but differs in the way it is powered. The GRAS 40SC is built around a prepolarized microphone and CCP preamplifier and requires a constant-current power supply. It has a BNC output socket for making a connection to a constant-current power supply or a data-acquisition system that can supply constant current between 2 and 20 mA.

Both probe types are delivered with a selection of probe tips of various lengths that can be customized with the supplied set of pliers.

	Sensitivity at 250 Hz	Dynamic Range	Frequency Range (±3 dB)	Electrical Output Impedance	Noise Floor (typical)	
					A-weighted	Lin (20 Hz - 20 kHz)
40SA	3	40 to > 166	2 - 8 k	55	6	2
40SC	3	40 to > 160	2 - 8 k	< 50	6	3
Units	mV/Pa (nom.)	dB re. 20 µPa	Hz	Ω	µV	µV

## GRAS 47AX

### 1/2" CCP Flush-Mount Microphone Set



47AX is a low profile 1/2" precision pressure microphone set with built-in CCP preamplifier. With a height (to the diaphragm) of only 8 mm, 47AX is suitably designed for flush mounting in plates in ground array applications and other applications with size constraints.

## GRAS 47BX

### 1/4" CCP Flush-Mount Microphone Set



47BX is a low profile 1/4" precision pressure microphone set with built-in CCP preamplifier. With a height (to the diaphragm) of only 8 mm, 47BX is suitably designed for flush mounting in plates in ground array applications and other applications with size constraints.

## GRAS 47AD

### 1/2" CCP Flush-mount Microphone Set High Sensitivity



Identical to 47AX, but with higher sensitivity  
- see specifications below.

## GRAS 47DX

### 1/8" CCP Flush-mount Microphone Set



47DX is a low profile 1/8" precision pressure microphone set with built-in CCP preamplifier. With a height (to the diaphragm) of only 9 mm, 47DX is suitably designed for flush mounting in plates in ground array applications and other applications with size constraints.

Specifications	47AX	47BX
Nominal Sensitivity	12.5 mV/Pa at 250 Hz	1.6 mV/Pa at 250 Hz
Frequency Response	3.15 Hz - 20 kHz ( $\pm 2.0$ dB) 5 Hz - 12.5 kHz ( $\pm 1.0$ dB)	4 Hz - 70 kHz ( $\pm 2.0$ dB) 10 Hz - 25 kHz ( $\pm 1.0$ dB)
Dynamic Range	Upper limit; 150 dB re. 20 $\mu$ Pa (3% distortion) Thermal noise; 22 dB(A) re. 20 $\mu$ Pa	Upper limit; 166 dB re. 20 $\mu$ Pa (3% distortion) Thermal noise; 44 dB(A) re. 20 $\mu$ Pa
Temperature	- 30 °C to + 70 °C (operation) - 40 °C to + 85 °C (storage)	- 30 °C to + 70 °C (operation) - 40 °C to + 85 °C (storage)
Static Pressure Coefficient	-0.008 dB/kPa (250 Hz / 25 °C)	-0.008 dB/kPa (250 Hz / 25 °C)
Dimensions	Diameter; Microphone: 12 mm - Preamplifier: 18 mm	
Height of Microphone Set	With grid: 9.2 mm / Without grid: 8 mm	With grid: 9.2 mm / Without grid: 8 mm
Weight	9 g	7.5 g

Specifications	47AD	47DX
Nominal Sensitivity	50 mV/Pa at 250 Hz	0.9 mV/Pa at 250 Hz
Frequency Response	3.15 Hz - 10 kHz ( $\pm 2.0$ dB) 12.5 Hz - 7 kHz ( $\pm 1.0$ dB)	10 Hz - 100 kHz ( $\pm 3.0$ dB)
Dynamic Range	Upper limit; 138 dB re. 20 $\mu$ Pa (3% distortion) Thermal noise; 18 dB(A) re. 20 $\mu$ Pa	Upper limit; 174 dB re. 20 $\mu$ Pa (3% distortion) Thermal noise; 52 dB(A) re. 20 $\mu$ Pa
Temperature	- 30 °C to + 70 °C (operation) - 40 °C to + 85 °C (storage)	- 30 °C to + 70 °C (operation) - 40 °C to + 85 °C (storage)
Static Pressure Coefficient	-0.008 dB/kPa (250 Hz / 25 °C)	-0.008 dB/kPa (250 Hz / 25 °C)
Dimensions	Diameter; Microphone: 12 mm - Preamplifier: 18 mm	Diameter; Microphone: 3 mm - Preamplifier: 12 mm
Height of Microphone Set	With grid: 9.2 mm / Without grid: 8 mm	With grid: 9.4 mm / Without grid: 9 mm
Weight	9 g	4 g

### GRAS 67TS-1-CL

#### 67TS-1-CL Turbulence Screen Kit with Flush-mount Microphone



67TS-1-CL Turbulence Screen Kit is designed for aero-acoustic testing in solid-walled wind tunnels. The hydrodynamic component of turbulence is attenuated up to 25 dB. Thereby the acoustic signals of interest can be identified and diagnosed with a reliable resolution. The 47BX-CL 1/4" CCP Flush-mount Microphone Set is included.

### GRAS 67TS

#### 67TS-1-CL Turbulence Screen Kit



67TS Turbulence Screen Kit is identical to the 67TS-1-CL, but without microphone.

## GROUND ARRAY KITS



The GRAS ground array kits are developed for fixed-wing aircraft and rotorcraft flyover measurements in phased arrays, where the noise is mapped for research or approval purposes.

The design offers a practical alternative to the conventional up-side-down microphone setup. They are based on customized versions of the 47AX or 47AD flush-mount pressure microphone set, integrated into a  $\varnothing 40$  cm POM plate, which is easy to position and calibrate in the field.



### GRAS 67AX

#### $\varnothing 40$ cm CCP Ground Array Microphone Kit



Includes the GRAS 47AX-S1 1/2" CCP Flush-mount Microphone Set, which is a rear-vented version of 47AX.

*See specifications for 47AX on page 26.*

### GRAS 67AD

#### $\varnothing 40$ cm CCP Ground Array Microphone Kit



Includes the GRAS 47AD-S1 1/2" Flush-mount Microphone Set, which is a rear-vented version of 47AD.

*See specifications for 47AD on page 26.*

## GRAS 40PH

### CCP Free-field Array Microphone



Cost-effective free-field microphone for general purpose measurements in arrays and matrices with a nominal sensitivity of 50 mV/Pa. It has a wide frequency range up to 20 kHz and a dynamic range from 32 dB(A) to 135 dB. Its integrated CCP preamplifier and built-in TEDS enables it to be used with TEDS compatible input modules.

## GRAS 40PP

### CCP Free-field QC Microphone



40PP is designed for on-line test of products, where the focus is on acoustically correct setup with as little as possible disturbance of the acoustic field and DUT.

## GRAS 40PL

### CCP Free-field Array Microphone, High Pressure



Cost-effective microphone for general purpose measurements in arrays and matrices with a nominal sensitivity of 10 mV/Pa.

It has a wide frequency range up to 20 kHz and a large dynamic range from 32 dB(A) to 150 dB. Its integrated CCP preamplifier and built-in TEDS enables it to be used with TEDS compatible input modules.

## GRAS 40PK

### CCP Free-field QC Microphone, Short



40PK is designed for on-line test, but in confined spaces, where the focus is not so much on the correct acoustical performance as on the available test space.

40PP and 40PK microphones are CCP supplied and specified for measurements with relatively wide tolerances. They are smart-transducers and thereby allow for fast and easy exchange, provided the test equipment is TEDS compatible.

For tighter tolerances, higher transducer linearity and data resolution, we recommend to use our standard high quality measurement microphones.

The QC microphones can be sensitivity calibrated and fully repaired.

Specifications	40PH	40PL	40PP	40PK
Sensitivity at 250 Hz	50 mV/Pa (nominal)	10 mV/Pa (nominal)	50 mV/Pa (nominal)	18 mV/Pa (nominal)
Dynamic Range				
Lower limit	< 32 dB(A) re. 20 µPa	< 32 dB(A) re. 20 µPa	< 32 dB(A) re. 20 µPa	< 26 dB(A) re. 20 µPa
Upper limit	135 dB re. 20 µPa	150 dB re. 20 µPa	128dB re. 20 µPa	145 dB re. 20 µPa
Frequency Range				
± 1 dB	50 Hz - 5 kHz	50 Hz - 5 kHz	20 Hz - 10 kHz	-
± 2 dB	5 kHz - 20 kHz	5 kHz - 20 kHz	10 Hz - 20 Hz, 10 kHz - 20 kHz	10 Hz - 10 kHz
± 3 dB	10 Hz - 50 Hz	10 Hz - 50 Hz		10 kHz - 20 kHz
Output Impedance	< 50 Ω	< 50 Ω	< 50 Ω	< 50 Ω

## GRAS 46AN

### 1/2" LEMO Free-field Standard Microphone Set, Low Frequency



High sensitivity microphone ideal for measuring sound at frequencies down to 0.5 Hz. This microphone is the obvious choice for infra-sound measurement. It has built-in TEDS and a 7-pin LEMO connector.

## GRAS 47AC

### 1/2" CCP Infra-Sound Microphone Set



47AC is a 1/2" CCP free-field microphone set optimized for infra-sound measurements down to 0.09 Hz.

## GRAS 46AZ

### 1/2" CCP Free-field Standard Microphone Set, Low Frequency



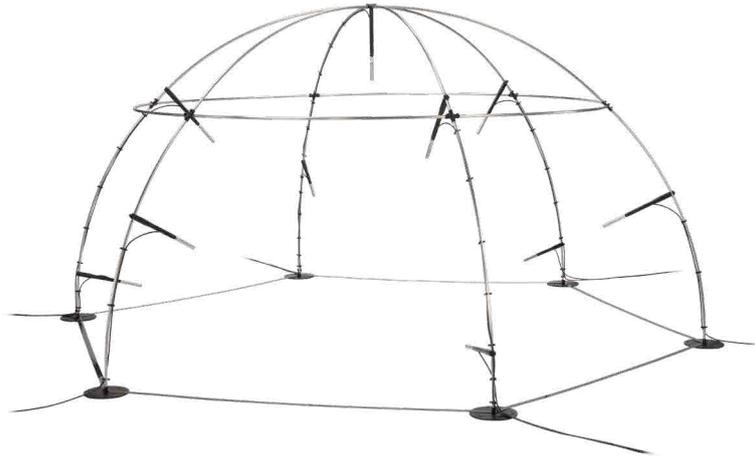
Low frequency microphone especially designed for infra-sound measurements. Frequency range from 0.5 Hz to 20 kHz. Use the dedicated GRAS 26CG 1/4" CCP preamplifier in order to obtain the low frequency response.

Specifications	46AN	46AZ	47AC
Size	12.7 (1/2") mm (housing)	12.7 (1/2") mm (housing)	12.7 (1/2") mm (housing)
Application	Free-field	Free-field	Free-field
Sensitivity	50 mV/pa	50 mV/pa	8 mV/pa
Dynamic Range	17 dB(A) - 149 dB re 20 µPa	17 dB(A) - 138 dB re 20 µPa	20 dB(A) - 148 dB re 20 µPa
Frequency Range	0.5 Hz - 20 kHz	0.5 Hz - 20 kHz	0.09 Hz - 20 kHz
Polarization voltage	200 V	0 V	0 V
IEC 61094 designation	WS2F	WS2F	WS2F

## Hemisphere Kits



The GRAS hemisphere kits are optimized for easy sound power testing ensuring acoustically correct and repeatable measurement data. The hemisphere kits are straightforward to assemble and it is simple to position the microphones and access the DUT. The GRAS hemispheres are compliant with the ISO 3744, 3745 and 3746 (ANSI S12.54, S12.55, S12.56) standards and accommodate for 4, 10 and 20 positions. The hemisphere kits contain the mechanical structure, microphone sets and cables.



### GRAS 67HA

#### Hemisphere Kits, 1 m Radius



##### For LEMO Input

67HA-01 1 m LEMO Hemisphere Kit, 4-Channel  
 67HA-02 1 m LEMO Hemisphere Kit, 10-Channel  
 67HA-03 1 m LEMO Hemisphere Kit, 20-Channel

##### For CCP Input

67HA-04 1 m CCP Hemisphere Kit, 4-Channel  
 67HA-05 1 m CCP Hemisphere Kit, 10-Channel  
 67HA-06 1 m CCP Hemisphere Kit, 10-Channel

##### For Low-noise Applications

67HA-07 1 m LEMO Low-noise Hemisphere Kit, 4-Channel  
 67HA-08 1 m LEMO Low-noise Hemisphere Kit, 10-Channel  
 67HA-09 1 m LEMO Low-noise Hemisphere Kit, 20-Channel

*A pair of flight cases for 1 m hemisphere & accessories is available, RA0276.*

### GRAS 67HB

#### Hemisphere Kits, 2 m Radius



##### For LEMO Input

67HB-01 2 m LEMO Hemisphere Kit, 4-Channel  
 67HB-02 2 m LEMO Hemisphere Kit, 10-Channel  
 67HB-03 2 m LEMO Hemisphere Kit, 20-Channel

##### For CCP Input

67HB-04 2 m CCP Hemisphere Kit, 4-Channel  
 67HB-05 2 m CCP Hemisphere Kit, 10-Channel  
 67HB-06 2 m CCP Hemisphere Kit, 10-Channel

##### For Low-noise Applications

67HB-07 2 m LEMO Low-noise Hemisphere Kit, 4-Channel  
 67HB-08 2 m LEMO Low-noise Hemisphere Kit, 10-Channel  
 67HB-09 2 m LEMO Low-noise Hemisphere Kit, 20-Channel

*A pair of flight cases for 2 m hemisphere & accessories is available, RA0277.*

# Preamplifiers

The output from a condenser microphone is a very high impedance signal and is therefore very sensitive to the capacitive loads of cables. This makes it necessary to introduce a driver with a high input impedance and a low output impedance. Such a driver is called a preamplifier.

The frequency range of a preamplifier is determined by its electronic circuit and is typically more than 200 kHz at the high end and 1 - 10 Hz at the lower end. The lower end is determined by the input impedance of the preamplifier and the capacitance of the microphone. High microphone capacitance gives a low cut-off frequency.

The dynamic range of a preamplifier is defined as the range between the highest level the preamplifier can handle without distortion, and the lowest level it can measure. The highest level is related to the preamplifiers supply voltage, whereas the lowest level is related to the electrical noise generated by the preamplifier itself.

Today there are two different preamplifier principles in the world of acoustics.

One is the traditional type for externally polarized microphones often referred to as the "LEMO" type because of its 7-pin connector which has become an industry standard. It is voltage driven and can handle high voltage signals up to 50 V<sub>peak</sub>.

The other principle uses a Constant Current Power (CCP) supply and was introduced around 1996 to the world of high-precision acoustics. Before that, the quality of CCP preamplifiers was not as good as the voltage driven LEMO types, but that is not the case today. A CCP preamplifier uses a Constant Current Power supply, which must lie between 2 mA and 20 mA (nominally 4 mA), to produce a constant nominal voltage level of 12 V DC (referred to as the bias voltage).

The output signal from the microphone superimposes fluctuations around this DC level. The great advantage of CCP preamplifiers is that they use a two wire system where the signal is superimposed on the wire through which the current is kept constant. This means that simple coaxial cables can be used instead of the more complex 7-core cables used with the voltage-driven LEMO types. This is traded off by accepting a lower upper limit in dynamic range (due to the lower driving voltage of a constant-current source) which limits the maximum output signal to approximately 8 V<sub>peak</sub>, and the necessity of having to use prepolarized microphones. The range of available prepolarized microphones is still not as wide as for externally polarized microphones, although GRAS was the first in the world to introduce 1/4" and 1/8" prepolarized microphones.

GRAS microphone preamplifiers are all small robust units optimized for acoustical measurements with condenser microphones. They are all compatible with measurement microphones as defined in the international standard IEC 61094 "Measurement Microphones, Part 4: Specifications for working standard microphones".

All GRAS preamplifiers are built around a small, thick-film precision amplifier with very high input impedance. The casings are made of stainless steel for maximum strength and durability with minimal sensitivity to vibration and microphonics.

They will work within their specifications up to a temperature of 70 °C. Special versions for use at temperatures up to 120 °C are available on request. The effect of elevated temperature is a slight increase in the inherent noise level. This will change the lower limit of the dynamic range of the microphone/preamplifier combination, thus limiting the ability to measure very low sound pressure levels.

CCP (Constant Current Power) is the same as IEPE (Integrated Electronic Piezo-Electric) and CCLD (Constant Current Line Drive) and is compatible with many other constant current driven products such as Deltatron® (Brüel & Kjaer), Isotron® (Endevco Corp.), ICP® (PCB Group, Inc.).

## GRAS 26AG

### 1/2" LEMO Insert Voltage Preamplifier



▼ Preamplifier with an integrated 7-pin LEMO connector. Configured to permit use of the insert voltage technique for determining the open-circuit sensitivity of a microphone. Cable (not included) is available in various lengths (see under Accessories).

## GRAS 26AK

### 1/2" LEMO Preamplifier



▼ General purpose preamplifier with an integrated 7-pin LEMO connector. Cable (not included) is available in various lengths (see under accessories).

## GRAS 26AJ

### 1/2" LEMO Preamplifier with SysCheck



▼ General purpose preamplifier with an integrated 7-pin LEMO connector. Includes built-in SysCheck facility for enabling easy system checks to be made. Cable (not included) is available in various lengths (see under accessories).

## GRAS 26AH

### 1/2" LEMO Preamplifier with SysCheck



▼ General purpose preamplifier with an integrated 3 meter cable terminating in a 7-pin LEMO connector. Includes built-in SysCheck facility for enabling easy system checks to be made. *Also available in a 1/4" version, 26AL. It looks like 26AN on page 33. Data are listed below.*

## GRAS 26AM

### 1/2" LEMO Preamplifier



▼ General purpose preamplifier with an integrated 3 m cable terminating in a 7-pin LEMO connector.

Specifications	26AH, AM	26AG, AJ, AK	26AL
Frequency Range	2.5 Hz - 200 kHz ( $\pm 0.2$ dB)	2.5 Hz - 200 kHz ( $\pm 0.2$ dB)	2.5 Hz - 200 kHz ( $\pm 0.2$ dB)
Input Impedance	20 G $\Omega$ , 0.4 pF	20 G $\Omega$ , 0.4 pF	20 G $\Omega$ , 0.4 pF
Output impedance (typical)	75 $\Omega$	75 $\Omega$	75 $\Omega$
Output Connector	7-pin LEMO male	7-pin LEMO male	7-pin LEMO male
Power Supply, Single	28 V, 0.7 mA to 120 V, 2.5 mA	28 V, 0.7 mA to 120 V, 2.5 mA	28 V, 0.7 mA to 120 V, 2.5 mA
Power Supply, Dual	$\pm 14$ V, 0.7 mA to $\pm 60$ V, 2.5 mA	$\pm 14$ V, 0.7 mA to $\pm 60$ V, 2.5 mA	$\pm 14$ V, 0.7 mA to $\pm 60$ V, 2.5 mA
Noise: A-weighted	$\leq 2.5$ $\mu$ Vrms (typically 1.8 $\mu$ V)	$\leq 2.5$ $\mu$ Vrms (typically 1.8 $\mu$ V)	$\leq 2.5$ $\mu$ Vrms (typically 1.8 $\mu$ V)
Noise: linear (20 Hz - 20 kHz)	$\leq 6$ $\mu$ Vrms (typically 3.5 $\mu$ V)	$\leq 6$ $\mu$ Vrms (typically 3.5 $\mu$ V)	$\leq 6$ $\mu$ Vrms (typically 3.5 $\mu$ V)
Gain	-0.25 dB (typical)	-0.35 (typical)	-0.29 dB (typical)
Operating Temperature	-30 $^{\circ}$ C to +70 $^{\circ}$ C	-30 $^{\circ}$ C to +70 $^{\circ}$ C	-30 $^{\circ}$ C to +70 $^{\circ}$ C
Storage Temperature	-40 $^{\circ}$ C to +85 $^{\circ}$ C	-40 $^{\circ}$ C to +85 $^{\circ}$ C	-40 $^{\circ}$ C to +85 $^{\circ}$ C

## GRAS 26AB

### 1/4" LEMO Preamplifier



General purpose preamplifier with an integrated 7-pin LEMO connector. A 1/4" to 1/2" adapter, AF0008, is included, so that it can also be used with GRAS 1/2" microphones. Cable is not included.

## GRAS 26AN

### 1/4" LEMO Insert Voltage Preamplifier



Preamplifier with an integrated 7-pin LEMO connector. Configured to permit use of the insert voltage technique for determining the open-circuit sensitivity of a microphone. A 1/4" to 1/2" adapter, GR0010, is included, so that it can also be used with GRAS 1/2" microphones. Cable is not included.

## GRAS 26AR

### 1/4" LEMO Preamplifier, 4-pin mini-LEMO



Preamplifier with integrated 4-pin LEMO mini connector. It is a robust unit, short enough for use in confined spaces and with option for socket mounting in arrays and similar structures, enabling easy calibration and exchange.  
*To be used with Cable AA0057.*

## GRAS 26AC-1

### 1/4" LEMO Preamplifier with Integrated 5-pin Miniconnector



General purpose preamplifier with integrated 5-pin mini-connector. A 1/4" to 1/2" adapter, GR0010, is included, so that it can also be used with GRAS 1/2" microphones.  
*To be used with Cable AA0091 or AA0092-CL.*

## GRAS 26HG

### 1/4" LEMO Preamplifier, Low Frequency



Similar to 26AC but with 40 G $\Omega$  input impedance to enable low level and low frequency measurements. It has a 3 m integrated cable.

## GRAS 26AS

### 1/4" LEMO Preamplifier, Very Short



Preamplifier with an integrated 3 m lightweight cable terminating in a 7-pin LEMO connector. It is a very small unit, short enough for use in e.g. anechoic test boxes and with the KEMAR Manikin and Hearing-protector Test Fixture.

Specifications	26AR	26AB, 26AN // 26AC-1	26HG	26AS
Frequency Range	2.5 Hz - 200 kHz ( $\pm$ 0.2 dB)	2 Hz - 200 kHz ( $\pm$ 0.2 dB)	1 Hz - 200 kHz ( $\pm$ 0.2 dB)	2.5 Hz - 200 kHz ( $\pm$ 0.2 dB)
Input Impedance	20 G $\Omega$ , 0.4 pF	20 G $\Omega$ , 0.4 pF	40 G $\Omega$ , 0.4 pF	20 G $\Omega$ , 0.4 pF
Output impedance (typical)	75 $\Omega$	55 $\Omega$	75 $\Omega$	75 $\Omega$
Output Connector	4-pin LEMO male mini	7-pin LEMO male // 5-pin LEMO male	7-pin LEMO male	7-pin LEMO male
Power Supply, Single	28 V, 0.7 mA to 120 V, 2.5 mA	28 V, 0.7 mA to 120 V, 2.5 mA	28 V, 0.7 mA to 120 V, 2.5 mA	28 V, 0.7 mA to 120 V, 2.5 mA
Power Supply, Dual	$\pm$ 14 V, 0.7 mA to $\pm$ 60 V, 2.5 mA	$\pm$ 14 V, 0.7 mA to $\pm$ 60 V, 2.5 mA	$\pm$ 14 V, 0.7 mA to $\pm$ 60 V, 2.5 mA	$\pm$ 14 V, 0.7 mA to $\pm$ 60 V, 2.5 mA
Noise: A-weighted	6 (typically 4)	$\leq$ 2.5 $\mu$ Vrms (typically 1.8 $\mu$ V)	$\leq$ 2.5 $\mu$ Vrms (typically 1.5 $\mu$ V)	6 (typically 4)
Noise: lin. (20 Hz - 20 kHz)	10 (typically 8)	$\leq$ 6 $\mu$ Vrms (typically 3.5 $\mu$ V)	$\leq$ 6 $\mu$ Vrms (typically 3.2 $\mu$ V)	10 (typically 8)
Gain	-0.35 dB (typical)	-0.29 dB (typical)	-0.25 dB (typical)	-0.29 dB (typical)
Operating Temperature	-30 $^{\circ}$ C to +70 $^{\circ}$ C	-30 $^{\circ}$ C to +70 $^{\circ}$ C	-30 $^{\circ}$ C to +70 $^{\circ}$ C	-30 $^{\circ}$ C to +70 $^{\circ}$ C
Storage Temperature	-40 $^{\circ}$ C to +85 $^{\circ}$ C	-40 $^{\circ}$ C to +85 $^{\circ}$ C	-40 $^{\circ}$ C to +85 $^{\circ}$ C	-40 $^{\circ}$ C to +85 $^{\circ}$ C

## GRAS 26CA

### 1/2" CCP Preamp with BNC Connector



26CA is a CCP preamplifier with integrated BNC connector. For use with 1/2" prepolarized microphones and standard constant-current input devices. Includes built-in TEDS which enables it to be programmed as a complete unit together with a microphone.

*A high-temperature version is available, 26CA-HT.*

## GRAS 26CK

### 1/2" CCP Preamp, Very Short



26CK 1/2" Preamplifier is a very small preamplifier with Microdot connector. The 26CK has a very low inherent noise level, a large dynamic range, and a frequency response from 2.5 Hz to above 200 kHz.

## GRAS 26CF

### 1/2" CCP Preamp with Gain and Filters



26CF is a CCP preamplifier with integrated BNC connector for use with 1/2" prepolarized microphones and standard constant-current input devices. It has two flush-mounted switches for selecting various combinations of gain and filtering, i.e.:

#### Gain switch settings:

0 dB - for normal microphone signals.

+20 dB - for boosting weak microphone signals.

#### Filter switch settings:

A-Weighting - as required in standard measurements.

Linear - to let the microphone signal pass unfiltered.

High-pass - to cut off unwanted low frequencies.

## GRAS 26CI

### 1/2" CCP Preamp with BNC Connector, Low Frequency



26CI is optimized for low frequency use with prepolarized condenser microphones. It uses a CCP power supply (ICP ©), e.g. 12AL. It has a very low inherent noise level, a large dynamic range and a frequency response from 1 Hz to above 200 kHz.

Specifications	26CA	26CA-HT	26CF	26CK	26CI
Frequency Range	2.5 Hz - 200 kHz (± 0.2 dB)	2.5 Hz - 200 kHz (± 0.2 dB)	2.5 Hz - 200 kHz (± 0.2 dB)	2.5 Hz - 200 kHz (± 0.2 dB)	1 Hz - 200 kHz (± 0.2 dB)
Input Impedance	20 GΩ, 0.4 pF	20 GΩ, 0.4 pF	20 GΩ, 0.4 pF	20 GΩ, 0.4 pF	40 GΩ, 0.4 pF
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω
Output Connector	BNC	BNC	BNC	Microdot	BNC
Power Supply	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)	4 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)
Noise A-weighted	≤ 2.5 μVrms (typ. 2.0 μV)	≤ 2.5 μVrms	Typ. 10 μVrms (built-in A-weighting)	≤ 2.5 μVrms	≤ 2.5 μVrms
Noise Linear	≤ 6 μVrms (typ. 3.5 μV)	≤ 6 μVrms	Typically 8 μVrms	≤ 6 μVrms	≤ 6 μVrms
Gain (Typically)	-0.3 dB	-0.3 dB	-0.35 dB	-0.35 dB	-0.35 dB
Operating Temp.	-30 °C to +85 °C	-30 °C to +120 °C	-30 °C to +85 °C	-30 °C to +85 °C	-30 °C to +85 °C
Storage Temp.	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C

## GRAS 26CB

### 1/4" CCP Preamplifier



26CB is a CCP preamplifier with integrated Microdot connector for use with 1/4" prepolarized microphones. It includes built-in TEDS which enables it to be programmed as a complete unit together with a microphone.  
*A high-temperature version is available, 26CB-HT*

## GRAS 26CG

### 1/4" CCP Preamplifier



26CG is a CCP preamplifier with integrated Microdot connector for use with 1/4" prepolarized microphones. It includes built-in TEDS which enables it to be programmed as a complete unit together with a microphone.

## GRAS 26CC

### 1/4" CCP Preamplifier



26CC is a CCP preamplifier with integrated SMB connector. For use with 1/4" prepolarized microphones. For direct use on GRAS Array Modules PR0001 and PR0002 connected to constant-current input devices. Includes built-in TEDS which enables it to be programmed as a complete unit together with a microphone.

## GRAS 26CS

### 1/4" CCP Preamplifier, Very Short



26CS has a Microdot connector for constant-current input devices. It is a very small unit, short enough for use in e.g. anechoic test boxes and with the KEMAR Manikin and 45CA Hearing-protector Test Fixture.

Specifications	26CB	26CB-HT	26CC	26CG	26CS
Frequency Range	2.5 Hz - 200 kHz (± 0.2 dB)	2.5 Hz - 200 kHz (± 0.2 dB)	2.5 Hz - 200 kHz (± 0.2 dB)	1 Hz - 200 kHz	2 Hz - 200 kHz
Input Impedance	20 GΩ, 0.4 pF	20 GΩ, 0.4 pF	20 GΩ, 0.4 pF	40 GΩ, 0.4 pF	20 GΩ, 0.4 pF
Output Impedance	< 50 Ω	< 50 Ω	< 50 Ω	< 55 Ω	< 50 Ω
Output Connector	Microdot	Microdot	SMB	Microdot	Microdot
Power Supply	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)	2 mA to 20 mA (typ. 4 mA)
Noise A-weighted	≤ 2.5 μVrms (typ. 1.8 μV)	≤ 2.5 μVrms (typ. 1.8 μV)	≤ 2.5 μVrms (typ. 2.0 μV)	≤ 2.5 μVrms (typ. 1.5 μV)	≤ 2.5 μVrms
Noise linear	≤ 6 μVrms (typ. 3.5 μV)	≤ 6 μVrms (typ. 3.5 μV)	≤ 6 μVrms (typ. 3.5 μV)	≤ 6 μVrms (typ. 3.5 μV)	≤ 6 μV
Gain (Typically)	-0.35 dB	-0.25 dB	-0.35 dB	-0.35 dB	-0.45 dB
Operating Temp.	-30 °C to +85 °C	-30 °C to +120 °C	-30 °C to +85 °C	-30 °C to +85 °C	-30 °C to +85 °C
Storage Temp.	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C

# Microphones for Outdoor Use

Unprotected measurement microphones are sensitive to environmental factors such as wind, rain and snow. This shortcoming has been eliminated by specially-designed units that protect the microphone and its diaphragm from the effects of outdoor use. Each has a windscreen surmounted by four-pronged anti-bird spikes to prevent birds using it as a perch.

Perching birds and their excreta can seriously distort measurements or even overload the measurement equipment. Smaller birds have actually been known to nest on top of the earlier three-pronged anti-bird spikes. Hence, the introduction of the fourth, center prong.

GRAS outdoor microphones are available in the following two versions:

- For airport noise monitoring, where the measurement direction points upwards ( $0^\circ$  incidence).
- For community noise- or traffic noise measurements, where the measurement direction is in the horizontal plane ( $90^\circ$  incidence).

GRAS Sound & Vibration has more than 1500 of these units deployed all over the world, from the Arctic cold in Norway to the humid jungles of Malaysia.



## GRAS 41AM

### Outdoor Microphone, 0° incidence



For permanent outdoor installation, for example in airport noise monitoring systems. Has built-in A-weighting,  $\pm 20$  dB amplifier (for shifting the dynamic range up or down by 20 dB) and electrostatic actuator for complete check of system functionality.

GRAS 41AM is fitted with a GRAS 41AS 1/2" microphone for measurements at 0° incidence and is optimized for use with its windscreen and rain protection.



## GRAS 41CN

### Outdoor Microphone, 90° incidence



For permanent outdoor installation, for example in community noise- or traffic noise monitoring systems. Has built-in A-weighting,  $\pm 20$  dB amplifier (for shifting the dynamic range up or down by 20 dB) and electrostatic actuator for complete check of system functionality.

GRAS 41CN is fitted with a special GRAS 1/2" microphone for measurements at 90° incidence and is optimized for use with its windscreen and rain protection.

#### Included:

- AM0052 Windscreen incl. birdspike
- AM0052 Transport protection cap
- AM0038 Spanner
- AM0029 Pole adapter
- AM0033 Tripod adapter
- AE0001 LEMO plug

#### Accessories available:

- AC0001 Adapter box
- RA0009 Pistonphone adapter 41AM
- RA0041 Pistonphone adapter 41CN
- AM0009 Set of 5 foam windscreens

#### Cables:

- AA0003 3 m
- AA0002 10 m
- AA0015 100 m on cable drum
- AA0016 200 m on cable drum

Specifications	41AM and 41CN
Sensitivity	50 mV/Pa (unified)
Dynamic Range	20 - 136 dB re. 20 $\mu$ Pa / 38 - 156 dB re. 20 $\mu$ Pa (-20 dB gain)
Frequency Response	IEC 60651 type 0 / ANSI S1.4 - 1983 type 0 / IEC 61672 Class 1
Power supply	12 - 18 VDC
Cal. level of electrostatic actuator	90 dB at 1000 Hz
Output connector	6-pin LEMO
Pole adapter	50 mm (1.97") G 1 1/2" (ISO 228/1)
Reference direction 41AM	0° (vertical for airport noise)
Reference direction 41CN	90° (horizontal for community noise)

## GRAS 41AC

### Outdoor Microphone Kit



The 41AC is a small and handy precision outdoor microphone kit according to IEC 61672-1 and designed for unattended use in prolonged periods.

41AC can easily be configured for measurement of noise with 90 degrees of incidence, typically community noise, or – with the included correction data – for measurement of noise with 0 degrees of incidence, typically overhead aircraft.

Depending on input type, 41AC is available in three versions.

### 41AC Configurations

**GRAS 41AC-2** LEMO Outdoor Microphone with RemoteCheck for Community & Airport Noise. With the features 7-pin LEMO connection and built-in RemoteCheck technology that makes it possible to remotely check the measurement chain for changes.

**GRAS 41AC-3** CCP Outdoor Microphone for Community & Airport Noise. With CCP connection and built-in TEDS for easy identification and system setup.

**GRAS 41AC-4** LEMO Outdoor Microphone for Community and Airport Noise (0 V pol.) 41AC-4 uses a prepolarized microphone with a LEMO type preamplifier.

All three kits include tripod and pole-mount options and are delivered with individual calibration and correction data.

*Additional windscreen, AM0378, is available as a separate item.*



Specifications	41AC-2, 41AC-3 & 41AC-4
Sensitivity	50 mV/Pa (nominal)
Dynamic Range	17 - 144 dB re. 20 µPa
Frequency Range	5 Hz - 10 kHz
Compliance	IEC 61672 Class 1
Polarization Voltage	200 V (41AC-2); 0 V (41AC-3 & 4)
Connector Type	7-pin LEMO (41AC-2 & 4); BNC (41AC-3)
Microphone Type and Reference Direction	See text above

# Low-noise Measuring Systems

Normal measurement microphones have a very wide dynamic range and cover most practical applications. There are however special situations where special microphones are required e.g. the measurements of very low sound pressure levels. Normal measurement microphones have a noise floor around 10 dB(A) re. 20  $\mu$ Pa in 1/3 octave bands, while the human ear is able to detect levels down to around 0 dB. In fact, the 0 dB level was originally defined as the threshold of the human hearing ability at 1 kHz.

In some applications, it is required to measure down to and below the threshold of the human ear. This is possible by using special high sensitive microphones combined with special low-noise preamplifiers.

One of the applications of such microphones may be the measurement of the sound power of high-end personal computers. These are not only used in noisy office environments but tend to move into living rooms, meeting rooms and hotel rooms. In some hotel rooms the traditional TV set has been replaced by a computer, delivering not only all TV channels but also pay channels, account status, wake up calls and other services. This requires the computer to be turned on all the time and to avoid disturbances during sleep the noise level has to be below the threshold of hearing. In turn, this requires that component manufacturers of hard drives, fans, etc. also deliver very low-noise devices.

In order to achieve the very low noise floor of the microphone and preamplifier, these have been specially matched and adjusted together. This further enables the microphone/preamplifier combination to be switched to be used for free-field measurements or for pressure measurements.

The special preamplifier and matching circuit require a higher supply current than can be obtained from traditional microphone preamplifier supplies, and therefore the GRAS 40HH and GRAS 40HF must be used together with the GRAS 12HF low-noise system power supply. To avoid damaging traditional microphone preamplifier supplies, the 7-pin LEMO on the low-noise preamplifier is different from the 7-pin LEMO normally used for microphone preamplifiers.

The very high sensitivity of low-noise microphones means that the sound pressure level used for calibration should be limited to 94 dB to avoid overloading. A special coupler, RA0090 for the pistonphones GRAS 42AA or GRAS 42AP is available to reduce the level from 114 dB to 94 dB.



## GRAS 40HF

### 1" LEMO Low-noise Microphone System



40HF has a wide dynamic range that enables measurements from below -2 dB(A) to 110 dB re. 20  $\mu$ Pa from 10 Hz to 10 kHz.

It comprises the following two specially-designed and matched components:

- High sensitive 1" microphone
- Low-noise 1" microphone preamplifier

Can be switched to operate either for pressure measurements or free-field measurements.

*Accessory: RA0095 Dehumidifier for 1" microphone.*

*A dedicated power module is required (12HF or 12HM). The specifications given on page 43 are for such a complete system.*

## GRAS 40HH

### 1/2" LEMO Low-noise Microphone System



40HH has a wide dynamic range that enables measurements from below 6.5 dB(A) to 113 dB re. 20  $\mu$ Pa from 10 Hz to 20 kHz.

It comprises the following two specially-designed and matched components:

- High sensitive 1/2" microphone
- Low-noise 1/2" microphone preamplifier

Can be switched to operate either for pressure measurements or free-field measurements.

*A dedicated power module is required (12HF or 12HM). The specifications given on page 43 are for such a complete system.*

## GRAS 40HT

### 1/2" LEMO Low-noise Microphone System



For use in confined spaces. Otherwise, specifications similar to 40HH.

It comprises the following specially designed and matched components:

- High sensitive 1/2" microphone
- Gain and filter unit
- Low-noise 1/4" microphone preamplifier with an adapter (GR0010) for the 1/2" microphone.

It can be switched to operate either for pressure measurements or free-field measurements.

*A dedicated power module is required (12HF or 12HM). The specifications given on page 43 are for such a complete system.*



## GRAS 47HC

### 1/2" CCP Low-noise Microphone System



47HC 1/2" Low-noise Microphone System measures sound pressure levels down to close to the threshold of human hearing. It is thus generally suitable for sound-power measurements on even very quiet products. Its very wide dynamic range permits measurements down to below 6.5 dB re. 20  $\mu$ Pa (in 1/3-octave bands). 47HC has TEDS.

## GRAS 40HL

### 1/2" LEMO Low-noise Microphone System



Stand-alone low-noise Microphone system for connecting directly to any analyzer input module with 7-pin LEMO. The system is calibrated as a complete unit and has a wide dynamic range that enables measurements from below 6.5 dB(A) to 110 dB re. 20  $\mu$ Pa within 10 Hz to 20 kHz.

- High sensitivity 1/2" microphone
- Low-noise 1/2" preamplifier with built-in TEDS

*40HL is used in the 67HA and 67HB Hemisphere Kits for 4-, 10- and 20 channel low-noise measurements.*

Specifications	40HF	40HH	40HL	40HT	47HC	Units
Nominal System Sensitivity	1.1	0.8	0.85	0.8	0.45	V/Pa
Frequency Range	12.5 - 4 k	12.5 - 10 k	Hz $\pm$ 1 dB			
	10 - 10 k	10 - 16 k	10 - 16 k	10 - 16 k	10 - 16 k	Hz $\pm$ 2 dB
	6 - 12.5 k	6 - 20 k	6 - 20 k	6 - 20 k	6 - 20 k	Hz + 2 dB, -3 dB
Dynamic Range Lower Limit	-2	6.5	6.5	6.5	6.5	dB(A) re. 20 $\mu$ Pa
Dynamic Range Upper Limit	110	113	110	113	100	dB peak

# Intensity Probes

The technique of intensity measurements is a powerful tool used for locating sound sources, order ranking them and determining the sound power emitted. The method is based on the simultaneous determination of sound pressure and particle velocity using two closely spaced, face-to-face microphones. A sound-intensity probe must maintain a well-defined acoustical spacing between the microphones with a minimum of disturbance to the sound field.

Generally speaking, the technique of intensity measurements involves determining the direction of a sound wave by detecting differences in arrival time at two closely-spaced microphones.

If the sound wave arrives first at microphone A then, a little later, at microphone B, the sound wave must be traveling in the direction from A to B. On the other hand, if it arrives first at microphone B, then it must be traveling in the opposite direction. In the case where it arrives at the two microphones at the same time, then it must be traveling in a direction perpendicular to the pair of microphones.

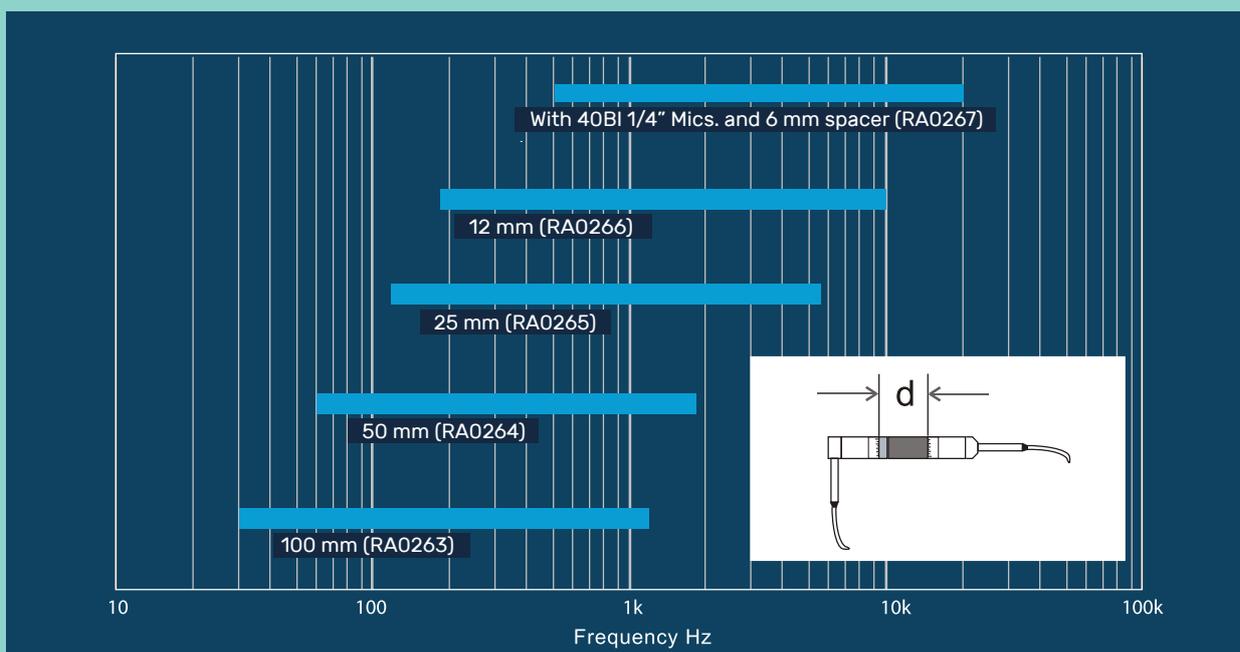
The ability of a pair of microphones to determine accurately small differences in arrival times depends on how small the difference is between the phase responses of the two microphones. Therefore, phase-matching is an all-important factor for a pair of intensity microphones.

The GRAS 40AI and GRAS 40BI intensity microphone pairs have been carefully manufactured and selected to have a minimum phase difference.

To ensure maximum measurement accuracy, the spacing between the microphones should be optimized for the particular measurement conditions. At low frequencies and in highly reverberant conditions, spacing should be large, whereas at high frequencies, it should be small.

The GRAS 50AI and GRAS 50GI Intensity Probes come with a selection of solid spacers for microphone separations ranging from 12 mm to 100 mm. The design of the probe enables spacers to be swapped without dismantling the probe.

The useful frequency range of a sound intensity probe depends on the phase response of the microphones and the distance between the microphones. The GRAS sound intensity probes have been designed to switch easily between different microphone spacers to cover different frequency ranges. The useful frequency ranges for different microphone spacers are shown below.





## GRAS 50AI-Series Intensity Probes



50AI Intensity Probes comprise:

- GRAS 40AK 1/2" Intensity Microphone Set
- GRAS 26AA 1/4" Preampfier Set and a remote-control handle

The remote-control functions make it possible to control the process of data acquisition entirely from the handle of the probe. Various versions of the 50AI are available with different remote-control handles for direct use with a wide range of general purpose frequency analyzers as well as specialised sound intensity analyzers.

### GRAS 50AI-B LEMO Intensity Probe



50AI-B has remote-control functions for direct connection to, and control of, sound-intensity measuring systems from a wide range of suppliers such as 01dB and Neutrix-Cortex. Can be used directly with the 12AB Intensity Power Module, which provides all necessary voltages for the remote-control functions and powering the preamplifiers; also enables direct use with 01dB Sound Intensity systems.

### GRAS 50AI-D LEMO Intensity Probe



50AI-D is similar to version B, but uses an internal 9V battery (already fitted on delivery) for enabling its remote-control functions, i.e. Müller-BBM.

### GRAS 50AI-C LEMO Intensity Probe



50AI-C can be connected directly to any analyzer with two standard 7-pin LEMO microphone-preampfier inputs. Can be used with the following GRAS Power Modules:

- 12AB Intensity Power Module
- 12AA Power Modules (via the included adapter cable AC0003, which splits the output from a 12-pin LEMO socket into two 7-pin LEMO plugs)

*Different adapter cables are available, see page 103.*

Specifications	50AI
Microphone pair	40AK
Preamplifiers	2 x 26AA (with 4-pin LEMO FGG 0B)
Frequency response & phase matching	IEC 61043 Class 1

## GRAS 50GI

### CCP Intensity Probe



50GI CCP Intensity Probe comprises:

- A 40 GK 1/2" Prepolarized Intensity Microphone Set
- Two 26CB 1/4" CCP Preamplifiers and a dedicated handle.

This intensity probe can be connected directly to any CCP-compatible input-module with two BNC or Microdot connectors. The prepolarized intensity microphones are phase-matched and fulfill the phase requirements for Class 1 intensity microphones in accordance with IEC 61043.

The intensity probe is designed to have as little acoustic influence as possible and allows for very near-field diagnostics of noise sources. The microphone spacers are easily interchanged without any need for extra tools and enables measurements in the area from 50 Hz to 10 kHz.

## GRAS 50GI-R

### CCP Intensity Probe with Remote Control



50GI-R CCP Intensity Probe comprises:

- A 40GK sound Intensity Microphone Pair
- Two 26CB CCP Microphone Preamplifiers
- Four solid spacers of various lengths
- Windscreen
- Probe handle with remote control.

50GI-R is delivered in a carrying case as a ready-to-use kit, complete with all the above accessories. The microphones are 1/2" free-field prepolarized microphones with a uniquely-designed pressure equalization system, which ensures extremely well defined phase characteristics.

The microphones and preamplifiers are mounted on a swivel head on the telescopic arm of the Remote control handle. To cover the full frequency range from 50 Hz to 10 kHz, the 50GI-R probe is delivered with four solid spacers for spacing the microphones at 12 mm, 25 mm, 50 mm and 100 mm. These spacers can be easily interchanged without dismantling the probe.

Specifications	50GI
Microphone pair	40GK
Preamplifiers	2 x 26CB (with BNC/Microdot)
Frequency response & phase matching	IEC 61043 Class 1

## GRAS 50GI-P

### CCP Rugged Intensity Probe



The 50GI-P CCP Intensity Probe comprises a 40GK Sound Intensity Microphone Pair, two 26CB CCP Microphone Preamplifiers, three solid spacers of various lengths, windscreen and a probe handle.

The probe head is symmetrical which enables reliable calibrations as described in the proposed standard (ISO/DIS 9614-2) for sound power measurements.

50GI-P is delivered in a carrying case as a ready-to-use kit, complete with all the above accessories.

The microphones are 1/2" intensity prepolarized microphones with a uniquely-designed pressure equalization system, which ensures extremely well defined phase characteristics.

Specifications	50GI-P
Microphone pairs	40GK-S1
Preamplifiers	26CC set
Spacers	12, 25 and 50 mm
Frequency response & phase matching	IEC 61043 Class 1

## GRAS 50GI-RP

### CCP Rugged Intensity Probe with Remote Control



50GI-RP is identical to 50GI-P but with remote control buttons for start/stop of the intensity analyzer.

Specifications	50GI-RP
Microphone pairs	40GK-S1
Preamplifiers	26CC set
Spacers	12, 25 and 50 mm
Frequency response & phase matching	IEC 61043 Class 1

## GRAS 50VI-1

### LEMO Vector-intensity Probe 3-D



50VI-1 is a three-dimensional flexible and adjustable sound-intensity probe. It includes the necessary pairs of phase-matched 40AI intensity microphones, 26AA Pre-amplifier Sets, 25 mm and 50 mm spacers, 6-channel probe handle and a 10 m cable with LEMO connectors.

The probe handle has inputs for 6 preamplifiers and a pair of LEDs for indicating two states as well as a push button for interactive use with a remote-control system. For example, the output socket for remote control can be connected to the RS-232 interface of a computer which controls the process of data acquisition.

The 12AC 6-Channel Power Module is recommended.

Specifications	50VI-1
Microphone pairs	3 x 40AI
Preamplifiers	6 x 26AA (with 4-pole LEMO FGG OB)
Spacers	3-D 25 mm and 50 mm
Frequency response & phase matching	IEC 61043 Class 1

## GRAS 60LK

### 3-D Vector Probe Head Development Kit



60LK is a 3-D Vector Probe Head with four 1/4" phase-matched measurement microphones arranged in a Ø30mm spherical shell.

The microphones are placed at the vertices of a tetrahedron. They span a three-dimensional space, and therefore appropriate mathematical operations allow the determination of the full sound intensity vector.

The microphones in each particular probe are computer selected from a large population of microphones to have the smallest possible phase and magnitude differences between all possible pairs of combinations.

*To be used with AC0025 3 m LEMO 4-pin to 4 x BNC Adapter Cable for 60LK.*

Specifications	60LK
Microphones	4 phase matched 1/4" microphones
Polarization	0 V
Connector	4-pin LEMO
Frequency response & phase matching	IEC 61043 Class 2

# Pistonphones and Calibration Equipment

Calibration is an essential step in every precision sound measurement. It establishes the relationship between the sound pressure acting on a microphone and the resulting electrical output of the microphone. There are basically two properties of a measurement microphone requiring calibration, these are level calibration and frequency-response calibration.

Level calibration determines the absolute sensitivity of the measurement microphone. Various methods can be used, e.g. reciprocity, comparison, pistonphone or calibrator.

- a) Reciprocity is normally considered the most accurate method but is elaborate and expensive.
- b) Comparison is where the sensitivity of the microphone under test is compared with the known sensitivity of a reference microphone. It is simple and can be done with commonly-available equipment and requires minor investment.
- c) A pistonphone, with a precision barometer for applying static pressure corrections, is a robust and highly reliable method of level calibration at 250 Hz.
  - At 250 Hz, the frequency response of most microphones is flat and will give a more accurate result.
- d) A calibrator is a convenient way of calibrating a microphone at 1000 Hz but does not have the same precision as a pistonphone. Neither does it require static-pressure corrections.
  - At 1000 Hz, weighting filters have 0 dB attenuation and will therefore not affect the calibration. In these cases, it might be an advantage to use a 1000 Hz calibration tone.

A frequency-response calibration describes the response of the microphone over a range of frequencies. Frequency-response measurements can be presented in various ways, i.e. pressure response, free-field response, and diffuse-field response.

Generally, pressure response is determined by using an electrostatic actuator which simulates purely an oscillating pressure exerted on the microphone's diaphragm. Free-field and diffuse-field responses can then be arrived at by adding predetermined correction values to the measured actuator (pressure) response of the microphone.

Electrostatic actuators require no special acoustic laboratory facilities since background noise is not too critical a factor.

An electrostatic actuator consists of an electrically conductive rigid plate mounted close to, and parallel with, the microphone's diaphragm. When an oscillating voltage is applied between the microphone's housing and the electrostatic actuator, an oscillating force will be exerted on the diaphragm. This oscillating force simulates an oscillating sound pressure, thus making it possible to determine the response of the microphone to pressure alone. This means that the frequency response of microphones can be measured under normal circumstances, not requiring special sound-insulated test chambers, as long as the background noise levels are reasonably low.

The pistonphone works on the principle of a pair of similar opposing, reciprocating pistons actuated by a precision-machined cam disc with a sinusoidal profile. The profile of the cam disc is such that the pistons follow a sinusoidal movement at a frequency equal to four times the speed of rotation. This results in a corresponding sinusoidal variation in the effective volume of the closed coupler and, consequently, an acoustic signal within it.

The mechanical structure of the pistonphone makes this generated acoustic pressure signal very reliable and stable. By careful control of the atmospheric pressure conditions and the calibration temperature, the calibration far exceeds the requirements for class LS calibrators. Absolute calibration accuracy has been determined to be within  $\pm 0.05$  dB at reference conditions for the pistonphone.



## GRAS 42AA

### Pistonphone



42AA is a precision sound source for calibrating microphones, sound level meters and other sound measuring equipment.

It is battery-operated and produces a constant nominal sound pressure level of 114 dB re. 20  $\mu$ Pa (equivalent to 10 Pa) at 250 Hz, or 105.4 dB(A) re. 20  $\mu$ Pa. Each 42AA is within 0.1dB of the nominal value and is delivered with an individual calibration chart and a barometer for Class 1 static pressure corrections. For Class 0 static pressure corrections, a precision barometer is required.

42AA can be used both for field checks of complete measurement systems as well as for laboratory calibrations of measurement microphones. It complies with the requirements of IEC 60942 (1988) Class 1 and is PTB approved.

## GRAS 42AC

### High Pressure Pistonphone



42AC is a precision sound source for calibrating microphones, sound level meters and other sound measuring equipment at high levels. It is battery-operated and produces a constant nominal sound pressure level of 134 dB re. 20  $\mu$ Pa (equivalent to 100 Pa) at 250 Hz, or 125.4 dB(A) re. 20  $\mu$ Pa. Each 42AC is within 0.1 dB of the nominal value and is delivered with an individual calibration chart and a barometer for Class 1 static pressure corrections. For Class 0 static pressure corrections, a precision barometer is required.

42AC can be used both for field checks of complete measurement systems as well as for laboratory calibrations of measurement microphones. It complies with the requirements of IEC 60942 (1988) Class 1. An adapter (GR0398) is included for use with hydrophone couplers.

Specifications	42AA	42AC	42AP
Sound pressure level	114 dB (re. 20 $\mu$ Pa) $\pm$ 0.08 dB	134 dB (re. 20 $\mu$ Pa) $\pm$ 0.08 dB	114 dB (re. 20 $\mu$ Pa) $\pm$ 0.05 dB
Frequency	250 Hz	250 Hz	250 Hz or 251.2 Hz
Accuracy	IEC 60942 (1988) Class 1	IEC 60942 (1988) Class 1	IEC 60942 (1988) Class 0, LS
Temperature range	-10 °C to +55 °C	-10 °C to +55 °C	-10 °C to +55 °C
Batteries	4 x AA alkaline (IEC LR 6)	4 x AA alkaline (IEC LR 6)	4 x AA alkaline (IEC LR 6)
External power	-	-	6V DC 125mA
Weight	325 g	325 g	437 g

## GRAS 42AP

### Intelligent Pistonphone



42AP is a battery-operated precision sound source for calibrating microphones, sound level meters and other sound measuring equipment. It has built-in precision barometer and thermometer. Via its display and RS-232 interface, the user can read the actual corrected sound pressure level, as well as the calibration temperature and ambient static pressure.

It produces a constant nominal sound pressure level of 114 dB re. 20  $\mu$ Pa (equivalent to 10 Pa) at either 250 Hz or 251.2 Hz (true centre frequency of a 250 Hz, 1/3-octave band filter).

The actual sound pressure level, corrected for static ambient pressure, is shown on its display, which can also show the A-weighted sound pressure level after correcting it for using an A-weighting filter.

#### The display can be switched to show any of the following:

- Actual corrected sound pressure level in decibels
- Actual corrected sound pressure level in decibels, if measured with an A-weighting filter
- Static air pressure in hPa
- Calibration temperature in °C
- Calibration temperature in °F
- The pistonphone frequency can be programmed, via its RS-232 interface, to be either 250 Hz or 251.2 Hz
- 42AP is an extremely stable laboratory standard sound source, which can also be used for field calibrations - it retains its high accuracy even under hostile environmental conditions. It complies with all the requirements of IEC Standard 60942 (2003) LS
- An individual calibration chart is part of the delivery.

## GRAS 42AG

### Multifunction Sound Calibrator



The 42AG Multifunction Sound Calibrator is a portable, battery-operated precision microphone calibrator. The calibrator can be used directly on 1" microphones. Adapters for calibrating 1/2" (factory mounted), 1/4" and 1/8" microphones are included. It can produce a sinusoidal signal of 250 Hz or 1 kHz at 94 dB or 114 dB.

The calibration level is virtually independent of ambient conditions like temperature, atmospheric pressure and humidity within the specified range of operation. For documentation purposes, 42AG provides display of the environmental conditions: ambient air pressure, and temperature.

42AG comes with adapters for all standard microphone sizes from 1" down to 1/8".

Specifications	42AG
Sound pressure level	94 dB ( $\pm 0.2$ dB) or 114 dB ( $\pm 0.2$ dB)
Frequency	250 (251.19 $\pm$ 0.30 Hz) or 1 kHz (1000 $\pm$ 1 Hz)
Accuracy	IEC 60942 (1988) Class 1
Temperature range	-10 °C to +50 °C
Batteries	LR03 (AAA)
Weight	125 g

## GRAS 42AE

### Low Frequency Calibrator



42AE permits microphone calibration at frequencies down to 0.01 Hz for both front- and rear-vented microphones.

The two-port configuration allows the actual sound pressure in the coupler to be monitored by a reference microphone simultaneously with the microphone under test. The sound pressure can alternatively be monitored using the voltage output proportional to the pressure in the coupler. The built-in, DC-coupled power amplifier enables the calibrator to be used for swept-sine, broadband and step function investigations.

42AE is delivered with various types of adapters for calibrating 1/8" to 1" microphones and preamplifiers. A power supply is included.

Specifications	42AE
Sound Pressure Level	140 dB (re. 20 $\mu$ Pa)
Frequency	< 0.1 - 150 Hz
Signal Input (max)	0.7 Vrms
Calibration Signal	1 mV/Pa (140 dB max)
Weight	1.6 kg

## GRAS 14AA

### Electrostatic Actuator Amplifier



High voltage, high gain amplifier and voltage supply for driving electrostatic actuators. The high voltage output can also be used to drive standard microphones as sound sources. The 14AA can drive an electrostatic actuator with a 300 V peak-to-peak signal superimposed on 800 V DC.

Its wide frequency range makes it possible to determine the pressure frequency response of condenser microphones from 1 Hz to 200 kHz (note: care should be taken below 200 Hz because of the influence of pressure equalization in the rear volume of the microphone).

14AA can be connected directly to an external signal generator or the generator output of any standard signal analyzer.

Specifications	14AA
Input Signal (max)	3 V peak-to-peak
Gain	+ 40 dB
Output Signal (max)	300 V peak-to-peak
Actuator Polarization Voltage	800 V
Frequency Response	1 Hz - 200 kHz
Output Impedance	1 k $\Omega$
Power Supply	110/130 V AC or 220/240 V AC
Weight	1.4 kg

## Calibration Stands



The GRAS Calibration Stands provide convenient platforms for holding the microphones and accessories used for calibration. They ensure that microphones and accessories are mounted in exactly the same way every time you calibrate.

**AL0010** provides a platform for testing condenser microphones. It has a fixture for holding a 1/2" preamplifier securely in place as well as recesses and a column for safely parking electrostatic actuators and microphone protection grids when not in use. It can be set up for both 1/2" and 1" microphones.

**AL0011** provides a convenient platform for calibrating IEC 60318-1 Ear Simulators, e.g. RA0039. The stand and the adapters are designed for standardized frequency calibration using a transmitter setup with a microphone as sound source (not included) and the 14AA Electrostatic Actuator Amplifier for driving the setup.

- AL0010** Calibration Stand
- AL0011** Calibration Stand for IEC 60318-1 Ear Simulator
- AL0017** Pistonphone Calibration Stand (not shown)
- AL0021** Microphone Set Calibration Stand (not shown)



### GRAS RA0014

#### 1/2" Electrostatic Actuator



An electrostatic actuator for testing the frequency response of standard 1/2", 1/4" and 1/8" microphones. Adapters are included for testing 1/4" and 1/8" microphones. The RA0014 can be connected directly to the 14AA Electrostatic Actuator Amplifier.

### GRAS RA0014-S1

#### 1/2" Electrostatic Actuator for 40AU-1



As RA0014, but with dimensions fitting 40AU-1.

### GRAS RA0015

#### 1" Electrostatic Actuator



An electrostatic actuator for testing the frequency response of standard 1" microphones. The RA0015 can be connected directly to the 14AA Electrostatic Actuator Amplifier.

### GRAS 51AB

#### Intensity Calibrator



For calibrating the phase response of a pair of microphones used for measuring sound intensity, e.g. GRAS 40AI and GRAS 40BI. It includes a calibrated acoustic resistance to enable the computation of particle velocity and intensity levels.

Complies with IEC International Standard 61043.

#### Accessories included:

2 x 1/4" microphone adapters

Specifications	51AB
Input Connector	BNC socket
Maximum input signal	1 V RMS
Frequency Range	50 Hz - 6.3 kHz
Frequency-intensity index	>27 dB (nomin. mic. spacing 25 mm)
SPL difference between channels	<0.1 dB
Operating temperature range	+ 5 °C to + 40 °C
Dimensions	Height: 42.2 mm Width: 50.3 mm Depth: 60.0 mm
Weight	515 g



## GRAS 90CA -S2

### Microphone Calibration System based on NI-PXI



*Computer for system control and monitor are part of the delivery (not shown in the photo)*



The GRAS 90CA-S2 Microphone Calibration System is a complete computer-controlled system for calibration of microphones and microphone sets. It provides you with a computer-controlled level and frequency-response calibration of measurement microphones and microphone sets. This highly automated process is convenient with its ready-to-use software and hardware, and auto-generated customizable documentation.

90CA-S2 provides accurate calibration hardware, easily changeable test conditions and a highly reproducible calibration method.

Calibration with the 90CA-S2 is in compliance with

- ANSI S1.10 – 1966 (R1976)
- IEC 61094-1
- IEC 61094-6

Additional software can be purchased for the calibration of preamplifiers.

Specifications	90CA-S2
Level Calibration:	250 Hz, 114 dB
Frequency Calibration:	200 Hz to 92 kHz*

\*Up to 200 kHz with additional hardware option

# Artificial Ears, Ear and Mouth Simulators, and KEMAR

The human ear is acoustically a complicated structure with volumes, channels and damping, resulting in a complex acoustical impedance. Also, at higher frequencies, the diffraction around the outer ear will change the acoustic field and result in a unique response at the inner ear.

In order to be able to compare and quantify measurements related to the human ear, a number of international standards and recommendations have defined some “ideal” or average ears. These can be simulated by more or less complicated mechanical and acoustical systems.

The IEC 60318-1 & 2 (60318) coupler is an example of a standardized human ear, having the same acoustic input impedance as an average human ear.

Another example is IEC 60318-4 (former 60711) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts.

Mouth simulators are sound sources for simulating the sound field around the human mouth at close quarters and are used for testing telephone mouthpieces as well as other microphones similarly used in vocal-communication networks. They are built around a loudspeaker and deliver sound signals at a “Mouth Reference Point” in accordance with International Standards IEEE 269, 661 and ITU-T Rec. P51.

The ear and mouth simulators can be incorporated into a wide range of measuring setups for testing telephones, hearing aids, headphones, headsets, etc.

The ear simulators can also be incorporated into a Head and Torso Simulator (HATS) like KEMAR, which lends more realism to in-situ anthropomorphic testing. KEMAR is a model of a human head and torso and has been extensively used for the last 45 years for studying the interaction between the human head and torso and sound fields.

KEMAR was developed by KNOWLES Inc. in 1972 and is thoroughly documented in numerous studies, some of which have been collected in the book *Manikin Measurement* by Mahlon D. Burkhard.



## GRAS 43AA

Ear Simulator Kit According to IEC 60318-1



43AA is a complete test jig for acoustical measurements on telephone handsets and earphones in accordance with:

- IEC 60318-1 (60318) Electroacoustics – Simulators of human head and ear - Part 1: Ear simulator for the calibration of supra-aural and circumaural earphones,
- ITU-T Recommendation P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

43AA also complies with IEC 60318-2 (1999) (withdrawn and now incorporated into 60318-1).

### Included:

- RA0039 IEC 60318-1 (60318) Ear Simulator
- 40AG 1/2" Pressure Microphone
- 26AC 1/4" Pre-amplifier
- Mounting plate for circum-aural headphones
- The RA0052 Test Jig has an adjustable spring-loaded arm to exert a variable force on the test object.

## GRAS 43AB

1/2" 2cc Coupler Kit According to IEC 60318-5



43AB is a complete test jig for acoustical measurements on hearing aids in accordance with IEC 60318-5 (60126) and ANSI S3.7-1995 on insert type hearing aids in accordance with:

- IEC 60318-5 (60126) IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts.
- ANSI S3.7-1995 American National Standard for Coupler Calibration of Earphones.

### Included:

- RA0038 IEC 60318-5 (60126) 2cc Coupler
- 40AG 1/2" Pressure Microphone
- 26AC 1/4" Pre-amplifier
- The RA0052 Test Jig has an adjustable spring-loaded arm to exert a variable force on the test object
- Studs and moulds for BTE and ITE instruments.

## 43AA Variants

**43AA-S2** Ear Simulator Kit According to IEC 60318-1, CCP. 40AO Pre-polarized Pressure Microphone included.

**43AA-S3** Ear Simulator Kit According to IEC 60318-1, LEMO, as 43AA, but with 26AB Pre-amplifier.

Specifications	43AA	43AB
Standards	IEC 60318-1 ITU-T Rec. P.57	IEC 60318-5 ANSI S3.7
Dynamic Range (ext. pol. mic.) (prepol. mic.)	25 dB(A) - 164 dB 25 dB(A) - 153 dB	25 dB(A) - 164 dB
Effective Volume	-	2 cc
Weight	1650 g	1550 g

## GRAS 43AC

### Ear Simulator Kit According to IEC 60318-4



43AC is a complete test jig for acoustical measurements on earphones coupled to the ear by inserts such as tubes and ear moulds in accordance with:

- IEC 60318-4 (former 60711) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts.
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

#### Included:

- RA0045 IEC 60318-4 (former 60711) Ear Simulator
- 40AG 1/2" Pressure Microphone
- 26AC 1/4" Preamp
- The RA0052 Test Jig has an adjustable spring-loaded arm to exert a variable force on the test object.

## GRAS 43AF

### 1" 6cc Coupler Kit According to IEC 60318-3



43AF is a complete test jig for acoustically testing telephone handsets and earphones in accordance with ANSI S3.7 – 1995 and IEC 60318-3.

#### Included:

- RA0075 NBS 9-A 6cc Coupler
- RA0076 Thread Adapter
- 40EN 1" Pressure Microphone (in WE 640AA configuration)
- 26AC 1/4" Preamp
- The RA0052 Test Jig has an adjustable spring-loaded arm to exert a variable force on the test object.

## 43AC Variants

**43AC-S1** Ear Simulator Kit According to IEC 60318-4, CCP. For more info about the included RA0045-S1, see page 67.

**43AC-S4** High-Frequency Ear Simulator Kit LEMO. For more info about the included RA0401, see page 67.

**43AC-S5** High-Frequency Ear Simulator Kit CCP. For more info about the included RA0402, see page 67.

**43AC-S6** Hi-Res Ear Simulator Kit, LEMO. For more info about the included RA0403, see page 68.

**43AC-S7** Hi-Res Ear Simulator Kit, CCP. For more info about the included RA0404, see page 68.

Specifications	43AC	43AF
Standards	IEC 60318-4, ITU-T Rec. P.57	IEC 60318-3, ANSI S3.7
Performance data	RA0045, RA0045-S1 } specs on RA0401, RA0402 } page 67 RA0403, RA0404 }	25 dB(A) - 160 dB
Effective Volume	1260 mm <sup>3</sup>	6 cc
Weight	1650 g	1550 g

## GRAS 43AD

Ear Simulator Kit according to ITU-T Rec. P57 Type 1



43AD is a complete assembly for acoustical measurements on acoustical transmitters and loudspeakers in accordance with:

- IEC 60318-1 (60318) Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the calibration of supra-aural earphones. 43AA also complies with IEC 60318-2 (1999) (withdrawn and now incorporated into 60318-1).
- ITU-T Recommendation P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

It can be integrated with a telephone test head or permanently installed on a production test line.

### Included:

- RA0039 IEC 60318-1 (60318) Ear Simulator
- 40AG 1/2" Pressure Microphone
- 26AK 1/2" Pre-amplifier
- GR0332 and GR0336 Snap Coupling
- Mounting plate for circum-aural headphones.

## GRAS 43AE

Ear Simulator Kit according to ITU-T Rec. P57 Type 3.2



43AE is an IEC 60318-4 (former 60711) Ear Simulator for acoustically testing supra-aural earphones, telephone handsets and loudspeakers in accordance with:

- IEC 60318-4 (former 60711) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts (1/2" Pressure Microphone 40AG included)
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

### Included:

- RA0045 IEC 60318-4 (former 60711) Ear Simulator (40AG 1/2" Microphone built-in)
- 26AC 1/4" Pre-amplifier
- RA0056 Low-leak simplified Pinna Simulator
- RA0057 High-leak simplified Pinna Simulator.

## 43AD Variant

**43AD-S1** CCP Ear Simulator Kit According to ITU-T Rec. P57 Type 1.

## 43AE Variants

**43AE-S1** CCP Ear Simulator Kit According to ITU-T Rec. P57 Type 3.2.

**43AE-S2** LEMO Ear Simulator Kit According to ITU-T Rec. P57 Type 3.2. As 43AE, but with 26AB Pre-amplifier.

Specifications	43AD	43AE
Standards	IEC 60318-1 ITU-T Rec. P.57	IEC 60318-4 ITU-T Rec. P.57
Dynamic Range	25 dB(A) - 164 dB	25 dB(A) - 164 dB
Effective Volume	-	1260 mm <sup>3</sup>
Weight	1650 g	1550 g

## GRAS 43AG

### Ear & Cheek Simulator Kit IEC 60318-4 & 7



43AG is a table top test device for measurements on earphones of various types. It simulates the ear and cheek of a human head as well as approximates the acoustic impedance of an average human ear. It can be used to verify frequency response, distortion, isolation and leakage. Its versatility means that it can be used for testing of both concha and insert types earphones. It can also be used for headphone and headset testing, both circum-aural and supra-aural types. Also, all common types of hearing-aids and telephone handset can be tested with 43AG.

The following configurations are available:

#### 43AG Configurations

- 43AG-1** Ear and Cheek Simulator LEMO is configured with an RA0045 Externally Polarized Ear Simulator According to IEC 60318-4 and a large KEMAR Right Pinna 55 Shore 00.
- 43AG-2** Ear and Cheek Simulator CCP is configured with a RA0045-S1 Prepolarized Ear Simulator According to IEC 60318-4 and a large KEMAR Right Pinna 55 Shore 00.
- 43AG-3** Ear and Cheek Simulator w Anthropometric Pinna LEMO is configured with an RA0045 Externally Polarized Ear Simulator According to IEC 60318-4 and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-4** Ear and Cheek Simulator w Anthropometric Pinna CCP is configured with a RA0045-S1 Prepolarized Ear Simulator According to IEC 60318-4 and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-5** Ear and Cheek Simulator, Low-noise is configured with a 43BB low-noise ear simulator system and a large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-6** Ear and Cheek Simulator, High-Frequency, LEMO is configured with an RA0401 Externally Polarized High-Frequency Ear Simulator and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-7** Ear and Cheek Simulator, High-Frequency CCP is configured with an RA0402 Prepolarized High-Frequency Ear Simulator and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-8** Ear and Cheek Simulator, Hi-Res, LEMO is configured with an RA0403 Externally Polarized Hi-Res Ear Simulator and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.
- 43AG-9** Ear and Cheek Simulator, Hi-Res, CCP is configured with an RA0404 Prepolarized Hi-Res Ear Simulator and a KB5000 Large KEMAR Right Anthropometric Pinna 35 Shore 00.

#### Specifications

For specifications for the Ear Simulators, see page 67.

For specifications for 43BB, see page 64.

For more information about the Pinnae, see page 96.

## GRAS 43BA

### 1/4" 0.4cc High-frequency Coupler Kit



43BA is a high frequency 1/4" 0.4cc coupler for test of hearing aids at frequencies up to 16 kHz. It is a complete kit with a 1/4" pressure microphone, a 1/4" preamplifier and the same adapters known from the reference 2cc coupler. It is designed for repetitive use and is equally suited for research, quality assurance and production test applications.

The 43BA coupler kit is designed to facilitate the measurement needs described in the IEC TS 62886:2016 "Method for measuring electroacoustic performance up to 16 kHz" and meets the need for an accurate and repeatable measurement method that can be used by designers of hearing aids and hearing aids receivers, and by fitters of hearing aids.

Three versions of the 0.4cc coupler kit are available:



## 43BA Coupler Kits

- 43BA-1** 1/4" 0.4cc High Frequency Coupler Kit Includes 40BP 1/4" Ext. Polarized Pressure Microphone, 26AS 1/4" Standard Preamplifier with 3 m Integrated Cable, Very Short and RA0252 1/4" 0.4cc High frequency Coupler as well as cable and adapters.
- 43BA-2** 1/4" 0.4cc CCP High Frequency Coupler Kit Includes 40BD 1/4" prepolarized Pressure Microphone, 26CS 1/4" CCP Standard Preamplifier with Microdot Connector, Very Short and RA0252 1/4" 0.4cc High frequency Coupler as well as cable and adapters.
- 43BA-3** 1/4" 0.4cc CCP High Frequency Coupler Kit, High Sensitivity Includes a special 1/4" prepolarized high sensitivity microphone, 26CS 1/4" CCP Standard Preamplifier with Microdot Connector, Very Short and RA0252 1/4" 0.4cc High frequency Coupler as well as cable and adapters.

## GRAS 43BB



### Low-noise Ear Simulator System



43BB is a low-noise, high-sensitive ear simulator system for measurements of sound pressure levels close to or below the threshold of human hearing.

It has a very low noise floor – below 10.5 dB(A) – and can measure sound levels below or close to the threshold of human hearing. For comparison, a standard IEC 60318-4 (711) ear simulator with a 40AG 1/2" microphone has its noise floor at 24.2 dB(A).

It consists of the well known standardized IEC 60318-4 ear simulator and the 40HT Low-noise Microphone System.

*43BB-1 is a variant designed for mounting in KEMAR. It is also part of the KEMAR configurations for low-noise testing, 45BB-11 and -12 and 45BC-11 and -12, see page 70.*

Specifications	43BB
Connector	7-pin LEMO with 3-m cable
Dynamic range	10.5 dB(A) - 113 dB
Coupler volume	1260 mm <sup>3</sup>

## GRAS 43AH

### CCP Ear Simulator for Production Testing ITU-T P57 3.2 LL



▼ This ear simulator consists of the ITU-T Rec. P.57 Type 2 Ear Simulator and Type 3.2 Simplified Low-leak Pinna Simulator and is designed for making ITU-T standardized tests of telephone handsets, receivers and receiver/loudspeaker-modules on the production line. Besides the RA0045-S1 Prepolarized Ear Simulator, the 26CB 1/4" Preamplifier and the RA0056 Low-leak Pinna Simulator 43AH includes a detachable front-plate that can be machined to make well-defined testing on various receiver related items. A calibration adapter to be used with 42AA/42AP Pistonphone is included.



▼ 43AH can also be delivered with customized front plates that will enable leakage-controlled testing according to your specific needs.

## GRAS 43AI

### CCP Ear Simulator for Production Testing ITU-T P57 3.2 HL



▼ This ear simulator is similar to 43AH but comprises a Type 3.2 Simplified High-leak Pinna Simulator for testing leak tolerant receivers.

## GRAS RA0038

### 1/2" 2cc Coupler IEC 60318-5



▼ An IEC 60318-5 (60126) 2cc coupler which complies with the requirements of:

- IEC 60318-5 (60126) IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts.
- ANSI S3.7-1995 American National Standard for Coupler Calibration of Earphones.

It is used with a 40AG 1/2" microphone and a 26AS preamplifier, which is a 1/4" very short preamplifier with 3 m integrated cable supplied with an adapter for 1/2" microphones. RA0038 is also part of the 43AB 2cc Coupler Kit.

## GRAS RA0075

### NBS 9-A 6cc Coupler



▼ RA0075 is for testing earphones according to ANSI 3.7 - 1995 and IEC 60318-3. It can be used with a 1" pressure microphone like 40EN, a 1/2" preamplifier like 26AK and various adapters, e.g. RA0073.

## GRAS RA0252

### 1/4" 0.4cc High-frequency Coupler



▼ The coupler used in the 43BA kits is available separately i.e. without microphone, ear mould and tube adapters.

Specifications	RA0038	RA0075
Standards	IEC 60318-5 (60126) ANSI S3.7-1995	ANSI S3.7-1995, Coupler calibration of earphones

## GRAS RA0113

### 1" 2cc Coupler IEC 60318-5



RA0113 is a 2cc IEC 60318-5 (60126) coupler which uses a 1" microphone, like 40EN and a 1/2" preamplifier like 26AK supplied with e.g. RA0073 Adapter.

The microphone, without its grid, screws into the base of RA0113. In all other respects, this coupler is equivalent to RA0038.

It complies with the following international and national requirements for testing insert type hearing aids:

- IEC 60318-5 (60126) IEC reference Coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts.
- ANSI S3.7-1995 American National Standard for Coupler Calibration of Earphones.

## GRAS RA0039

### Ear Simulator IEC 60318-1



RA0039 is an IEC 60318-1 (60318) Ear Simulator with an input impedance closely resembling that of an average human ear. When coupled to a sound source, its impedance will load the sound source similar to the loading caused by the human ear. It complies with the requirements of:

- IEC 60318-1 (60318) Electroacoustics – Simulators of human head and ear – Part 1: Ear simulator for the calibration of supra-aural earphones, 1998-07.
- ITU-T Recommendation P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

RA0039 is also part of the 43AA and 43AD Ear Simulator kits.

Specifications	RA0113	RA0039
Standards	IEC 60318-5 ANSI S3.7 (1995)	IEC 60318-1 (60318) / ITU-T Rec. P.57 (08/96)
Frequency Range	-	100 Hz - 8 kHz
Effective Volume	2 cc	-
Height	35 mm	19.8 mm
Diameter	22.4 mm	60 mm
Weight	50 g	137 g

## IEC 60318-4 Ear Simulators

**RA0045** Externally Polarized Ear Simulator IEC 60318-4

**RA0045-S1** Prepolarized Ear Simulator IEC 60318-4



**RA0045** is an IEC 60318-4 (former 60711) Ear Simulator for making acoustic measurements on earphones coupled to the human ear by ear inserts such as tubes, ear moulds or ear tips in accordance with:

- IEC 60318-4 (former 60711) Occluded-ear simulator for the measurement of earphones coupled to the ear by ear inserts.
- ITU-T Recommendations P.57 (08/96) Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears.

It is delivered with a built-in 40AG 1/2" microphone and an individual calibration chart for the coupler-microphone combination. Can be used with either of the RA0056 and RA0057 Pinna Simulators to simulate a complete ear for testing telephones and loudspeakers.



**RA0045-S1** is similar to RA0045 but is delivered with a built-in prepolarized microphone GRAS 40A0 for use with CCP preamplifiers.

### More RA0045 Variants

**RA0045-S4** High Sensitivity, 40AP Ext. Pol. Microphone

**RA0045-S5** High Pressure, 40BP Ext. Pol. Microphone

**RA0045-S6** High Sensitivity, 40AD Prepol. Microphone

Specifications for these RA0045 variants can be found at [www.gras.dk](http://www.gras.dk)

## IEC 60318-4 Ear Simulators, High-Frequency

**RA0401** Externally Polarized High-Frequency Ear Simulator IEC 60318-4

**RA0402** Prepolarized High-Frequency Ear Simulator IEC 60318-4



**RA0401** is a high-frequency version of the standardized 60318-4 ear simulator (RA0045), which has gained wide acceptance as the preferred tool for measurements with simulation of the acoustic load presented by the human ear. Below 10 kHz, the standardized ear simulator does a good job. However, above 10 kHz, the steep resonance at 13.5 kHz dominates. In RA0401 this resonance is damped and the useful frequency range is extended to 20 kHz.

RA0401 complies with IEC60318-4 and is fully backward compatible as its acoustic transfer impedance is within the tolerance band specified by IEC60318-4. From 10 to 20 kHz the transfer impedance is within  $\pm 2.2$  dB, resulting in improved repeatability. Also, realistic THD measurements are now possible.



It is measured and calibrated according to the ITU-T Recommendation P.57 and delivered with a calibration chart specifying its sensitivity and frequency response.



**RA0402** is similar to RA0401 but has a built-in prepolarized microphone for use with CCP preamplifiers.

Specifications	RA0045/RA0045-S1	RA0401/RA0402	RA0403/RA0404
Standards	IEC 60318-4 (former 60711) ITU-T Rec. P.57 (08/96)	IEC 60318-4 (former 60711) ITU-T Rec. P.57 (08/96)	IEC 60318-4 (former 60711) compatible ITU-T Rec. P.57 (08/96)
Dynamic Range	25 dB(A) - 164 dB/25 dB(A) - 150 dB	25 dB(A) - 164 dB/25 dB(A) - 150 dB	44 dB(A) - 169 dB/44dB(A) - 166 dB
Effective Volume	1260 @ 500 Hz	1260 @ 500 Hz	1260 @ 500 Hz
Resonant Frequency	13.5 kHz $\pm$ 1 kHz	13.5 kHz $\pm$ 1 kHz	13.5 kHz $\pm$ 1 kHz
Height	36.5 mm	36.5 mm	36.5 mm
Diameter	23.8 mm	23.8 mm	23.8 mm
Weight	71 g	74 g	74 g

## IEC 60318-4 Ear Simulators, Hi-Res

**RA0403** Externally Polarized Hi-Res Ear Simulator

**RA0404** Prepolarized Hi-Res Ear Simulator



**RA0403** is a Hi-Res version of the well-known standardized 60318-4 ear simulator (RA0045), which has gained wide acceptance as the preferred tool for measurements with simulation of the acoustic load presented by the human ear. Below 10 kHz, the standardized ear simulator does a good job. However, above 10 kHz, the steep resonance at 13.5 kHz dominates. In RA0403 this resonance is damped. This, in combination with the use of a 1/4" microphone, extends the useful frequency range to 50 kHz.

RA0403 is compatible with IEC60318-4 and is fully backward compatible as its acoustic transfer impedance is within the tolerance band specified by IEC60318-4. From 10 to 20 kHz the transfer impedance is within  $\pm 2.2$  dB, from 20 kHz to 50 kHz it is within  $\pm 3.2$  dB, resulting in improved repeatability. Also, realistic THD measurements are now possible in the full audible frequency range.



It is measured and calibrated according to the ITU-T Recommendation P.57 and delivered with a calibration chart specifying its sensitivity and frequency response.



**RA0404** is similar to RA0403 but is delivered with a built-in prepolarized microphone for use with CCP preamplifiers.

*Specifications on the previous page.*

# ITU-T PINNA SIMULATORS

## GRAS RA0056

Low-leak Pinna Simulator



A low-leak pinna (outer ear) simulator for use with the RA0045 Ear Simulator to simulate a complete ear for testing telephones and loudspeakers. The RA0056 meets the specifications in the ITU-T Recommendation P.57 (08/96) "Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears".

## GRAS RA0057

High-leak Pinna Simulator



A high-leak pinna (outer ear) simulator for use with the RA0045 Ear Simulator to simulate a complete ear for testing telephones and loudspeakers. The RA0057 meets the specifications in the ITU-T Recommendation P.57 (08/96) "Series P: Telephone transmission quality, Objective measuring apparatus: Artificial ears".

## GRAS 44AA & 44AB

### Mouth Simulators



GRAS 44AA



RA0104 / RA0105



GRAS 44AB



A sound source, which simulates the acoustic field close to the human mouth and complies with the standards IEEE 269, 661 and ITU-T Rec. P51.

For testing telephone mouthpieces as well as other microphones. At the mouth reference point (MRP), which is 25 mm from the detachable lip ring, the minimum-continuous signal it can produce in 1/3-octave bands is 100 dB re. 20  $\mu$ Pa in the frequency range 100 Hz to 10 kHz.

44AA's loudspeaker accepts an external signal either directly or via its own built-in power amplifier.

44AB's loudspeaker accepts a signal from an external power amplifier directly via the BNC input.

The jigs RA0104 and RA0105 are included for calibration according to ITU-T Rec. P51 and IEEE 269. These are for use with 1/4" or 1/2" microphones on 1/4" preamplifiers.

RA0104 holds the microphone at 0° incidence (1/4" only) to the sound source, RA0105 at 90° incidence (1/4" or 1/2").

Specifications	44AA	44AB
Min. continuous output level at MRP	110 dB re. 20 $\mu$ Pa (200 Hz – 6 kHz) 100 dB re. 20 $\mu$ Pa (100 Hz – 16 kHz)	110 dB re. 20 $\mu$ Pa (200 Hz – 6 kHz) 100 dB re. 20 $\mu$ Pa (100 Hz – 16 kHz)
Loudspeaker	8 $\Omega$ / 10 W (max. continuous)	8 $\Omega$ / 10 W (max. continuous)
Amplifier	Gain: 10 dB / Input impedance: 20 k $\Omega$	- / -
Mouth opening	20 mm diameter	20 mm diameter
Lip ring: External diameter / Distance from mouth	48 mm / 10 mm	48 mm / 10 mm
Dimensions: Diameter / Height (with lip ring)	104 mm / 104 mm	104 mm / 104 mm

**KEMAR Head and Torso Simulators**



KEMAR is a head and torso simulator which is factory configured for hearing aid tests, ear- and headphone tests or sound quality recordings. Introduced in 1972 by Knowles Electronics and acquired by GRAS in 2005, it is the origin of all other head and torso simulators and thus the industry standard for in-situ anthropomorphic testing of all kinds of hearing instruments and head- and earphones.

KEMAR is available with and without mouth simulator. It meets the requirements of ANSI S3.36 and IEC 60318-7 and

can be configured with more sizes of standardized pinna simulators, the IEC 60318-4 Ear Simulators or various 1/2" and 1/4" pressure microphones for binaural recordings. KEMAR accommodates for LEMO as well as CCP preamplifiers which are all electrically accessible from the connector panel on the back.

The preconfigured KEMAR models include ear simulators, microphones, preamplifiers and pinnae for specific applications. They are delivered fully assembled and tested in one box.



**GRAS 45BB**

**45BB KEMAR Head & Torso**

*A number of rubber pinnae (small and large, soft and hard, anthropometric and wide aperture) are available. 3D-simulation models (step files) of KEMAR with pinnae are also available. See page 96.*



**GRAS 45BC**

**45BC KEMAR Head & Torso with Mouth Simulator**

**KEMAR Configurations**

- 45BB 45BB-1** KEMAR Head & Torso for Hearing Aid Test, 1-Ch LEMO
- 45BB-2** KEMAR Head & Torso for Hearing Aid Test, 1-Ch CCP
- 45BB-3** KEMAR Head & Torso for Sound Quality Recording, 2-Ch LEMO
- 45BB-4** KEMAR Head & Torso for Sound Quality Recording, 2-Ch CCP
- 45BB-5** KEMAR Head & Torso for Ear- and Headphone Test, 2-Ch LEMO
- 45BB-6** KEMAR Head & Torso for Ear- and Headphone Test, 2-Ch CCP
- 45BB-7** KEMAR Head & Torso for Test of Binaural Hearing Aid, 2-Ch LEMO
- 45BB-8** KEMAR Head & Torso for Test of Binaural Hearing Aid, 2-Ch CCP
- 45BB-9** KEMAR with Anthropometric Pinnae for Ear- and Headphone Test, 2-Ch LEMO
- 45BB-10** KEMAR with Anthropometric Pinnae for Ear- and Headphone Test, 2-Ch CCP
- 45BB-11** KEMAR with Anthropometric Pinnae for Low-noise Ear- and Headphone Test, 1-Ch LEMO
- 45BB-12** KEMAR with Anthropometric Pinnae for Low-noise Ear- and Headphone Test, 2-Ch LEMO
- 45BB-13** KEMAR for High-Frequency Test of Ear- and Headphones, 2-Ch LEMO
- 45BB-14** KEMAR for High-Frequency Test of Ear- and Headphones, 2-Ch CCP
- 45BB-15** KEMAR for Hi-Res Test of Ear- and Headphones, 2-Ch LEMO
- 45BB-16** KEMAR for Hi-Res Test of Ear- and Headphones, 2-Ch CCP
  
- 45BC 45BC-1** KEMAR Head & Torso with Mouth Simulator for Headset Test, 2-Ch LEMO
- 45BC-2** KEMAR Head & Torso with Mouth Simulator for Headset Test, 2-Ch CCP
- 45BC-3** KEMAR Head & Torso with Mouth Simulator for Telephone Test, 1-Ch LEMO
- 45BC-4** KEMAR Head & Torso with Mouth Simulator for Telephone Test, 1-Ch CCP
- 45BC-9** KEMAR with Mouth Simulator and Anthropometric Pinnae for Headset Test, 2-Ch LEMO
- 45BC-10** KEMAR with Mouth Simulator and Anthropometric Pinnae for Headset Test, 2-Ch CCP
- 45BC-11** KEMAR with Mouth Simulator and Anthropometric Pinnae for Low-noise Headset Test, 1-Ch LEMO
- 45BC-12** KEMAR with Mouth Simulator and Anthropometric Pinnae for Low-noise Headset Test, 2-Ch LEMO
- 45BC-13** KEMAR with Mouth Simulator for High-Frequency Headset Test, 2-Ch LEMO
- 45BC-14** KEMAR with Mouth Simulator for High-Frequency Headset Test, 2-Ch CCP
- 45BC-15** KEMAR with Mouth Simulator for Hi-Res Test of Headsets, 2-Ch LEMO
- 45BC-16** KEMAR with Mouth Simulator for Hi-Res Test of Headsets, 2-Ch CCP

## GRAS 45EA

### Handset Positioning System for KEMAR



45EA Handset Positioning System is made for the 45BC KEMAR Manikin with Mouth Simulator configured for telephone testing. The system is designed with maximum flexibility and acoustic performance in mind for laboratories & development environments that focus on the acoustic quality of their telephone handsets.

The finger grip is provided with adjustable positioning and scales which may be noted down for reproducible mounting and positioning.

The system is mounted on the KEMAR with no use of additional tools and can switch from right to left side setup with minimum alterations.

The Ear Reference Point of the preferred pinna type is determined by the supplied ERP-gauge and the applied handset pressure-force measured by use of the included force gauge RA0184.

## GRAS 45EB

### Ear-bud Positioning System for KEMAR



45EB Ear-bud Positioning System is made for the 45BB KEMAR Manikin and the 45BC KEMAR Manikin with mouth simulator.

This system is designed for positioning and holding ear-buds or ear-borne devices in the concha of the pinna simulator. The pressure force and position is adjustable and will with the preferred pinna secure proper mounting and repeatable measurements.

The applied pressure-force is measured by use of the included force gauge RA0184.

45EB can be retrofitted on all KEMAR versions.

## GRAS 45CA

### Headphone/Hearing-protector Test Fixture



45CA's robust design makes it ideally suited for binaural testing of active and passive earplugs, as well as circumaural hearing protectors. It is primarily intended for testing the performance of hearing-protection devices but can also be used for testing earphones and headphones. It is fitted with either microphones or ear simulators, depending on the device to test and the standard to comply with. Compliance with ISO 4869-3, IEC 60318-1 and IEC 60318-4 assures technicians, decision makers, and authorities of repeatability and transparent data when developing and verifying hearing protectors.

The pinnae for 45CA are basically the same as the standard KEMAR pinnae, but rounded to fit the large 45CA base plate. This large base plate reduces or eliminates the risk of leakage. 45CA includes two plugs for measuring the acoustic isolation in a closed ear.

The most common configurations can be ordered fully assembled, calibrated. They are listed below.



### 45CA Configurations

- 45CA-1** Headphone/Hearing-Protector Test Fixture, ISO 4869-3 1" Mic. LEMO - for test of ear muffs
- 45CA-2** Headphone/Hearing-Protector Test Fixture, ISO 4869-3 1/2" Mic. CCP - for test of ear muffs
- 45CA-3** Headphone/Hearing-Protector Test Fixture, IEC 60318-1 LEMO - for test of ear muffs and headphones
- 45CA-4** Headphone/Hearing-Protector Test Fixture, IEC 60318-1 CCP - for test of ear muffs and headphones
- 45CA-5** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 LEMO - test of ear muffs, ear plugs, headphones, ear phones
- 45CA-6** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 CCP - test of ear muffs, ear plugs, headphones, ear phones
- 45CA-7** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 LEMO, with Anthropometric Pinnae - for test of ear muffs, ear plugs, headphones and ear phones
- 45CA-8** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 CCP, with Anthropometric Pinnae - for test of ear muffs, ear plugs, headphones and ear phones
- 45CA-9** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 LEMO, High-Frequency with Anthropometric Pinnae - for test of headphones and ear phones up to 20 kHz
- 45CA-10** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 CCP, High-Frequency with Anthropometric Pinnae - for test of headphones and ear phones up to 20 kHz
- 45CA-11** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 LEMO, Hi-Res, with Anthropometric Pinnae - for test of headphones and ear phones up to 50 kHz
- 45CA-12** Headphone/Hearing-Protector Test Fixture, IEC 60318-4 CCP, Hi-Res, with Anthropometric Pinnae - for test of headphones and ear phones up to 50 kHz

Specifications	4CA
ISO standard	ISO 4869-3 (45CA-1 & 2)
ITU-T Recommendations	P.380
IEC standard	60318-1 (45CA-3 & 4) 60318-4 (45CA-5 to 45CA-10) 60318-4 compatible (45CA-11 to 45CA-12)
Self Insertion Loss, measured with closed ear simulators (45CA-1 and 45CA-2)	
80-250 Hz	>50 dB
350 - 4000 Hz	>65 dB
5000 - 20.000 Hz	>55 dB
Weight	11.6 kg
<i>For more specifications, visit GRAS.dk</i>	

## GRAS 45CB

### Acoustic Test Fixture According to ANSI S12.42



45CB is designed for standardized, binaural testing of passive and active earmuffs and earplugs. Besides a robust design made for field testing and high sound pressure levels (blasts), it has a very high self-insertion loss, body temperature regulated ear-canals with silicone lining and a huge pinna surround – all to provide the most realistic and repeatable fit.

45CB directly handles sound pressure levels up to 169 dB and, indirectly (using comparison methods), levels up to 190 dB. It has a self insertion-loss better than 65 dB.

The modified IEC 60318-4 ear simulator with 1/4" microphone extends the frequency range as required by the standard. The 14-mm long ear canal extension is designed to let you also test all types of ear plugs.

The silicone-rubber lining of the extension enables leakage-free mounting of both foam plugs and customized molded types. The silicone-rubber lining of the plates ensures leakage-free mounting, as well as high repeatability and reliability.

## GRAS 67SB

### Blast Probe Microphone



The 67SB Blast Probe is designed as a reference microphone for impulse measurements according to the ANSI S12.42 standard.

The 1/8" reference microphone inside it is ideally suited for capturing impulsive signals with a very fine time resolution. This microphone has an upper limit of 174 dB in the dynamic range.

An adapter is included with the 67SB, so you can perform a verification of the microphone before each use.

67SB is provided with a 1/4" threaded hole for mounting directly on a tripod, e.g. AL0006.

Specifications	45CB	67SB
Sensitivity	1.6 mV	1 mV
Dynamic range	50 dB(A) - 169 dB	10 - 20 kHz
Self insertion Loss	100 Hz - 8 kHz: > 74 dB 80 Hz -12.5 kHz: > 65 dB	52 dB(A) - 174 dB
Standard	ANSI S12.42	ANSI S12.42
Connector	7-pin LEMO	7-pin LEMO
Weight	14.75 kg	650 g

## GRAS 45CC

### Headphone Test Fixture



45CC is a flexible platform for dual-channel testing of headphones and headsets. It can be configured with microphones, IEC 60318-1 ear simulators and ITU-T P.51 mouth simulator. It can be adjusted very precisely to support different headphone/headset designs and sizes for high accuracy and repeatability. It is well suited for research and development, quality control and production line testing.



### 45CC Configuration

- 45CC-1** Headphone Test Fixture with Externally Polarized 1/2" Microphones
- 45CC-2** Headphone Test Fixture with Prepolarized 1/2" Microphones
- 45CC-3** Headphone Test Fixture with IEC 60318-1 Ear Simulators and Ext. Polarized 1/2" Microphones
- 45CC-4** Headphone Test Fixture with IEC 60318-1 Ear Simulators and Prepolarized 1/2" Microphones
- 45CC-5** Headphone Test Fixture with Mouth Simulator and Ext. Polarized 1/2" Microphones
- 45CC-6** Headphone Test Fixture with Mouth Simulator and Prepolarized 1/2" Microphones
- 45CC-7** Headphone Test Fixture with Mouth Simulator, IEC 60318-1 Ear Simulators and Ext. Polarized 1/2" Microphones
- 45CC-8** Headphone Test Fixture with Mouth Simulator, IEC 60318-1 Ear Simulators and Prepolarized 1/2" Microphones
- 45CC-9** Headphone Test Fixture with Externally Polarized 1/4" Microphones
- 45CC-10** Headphone Test Fixture with Prepolarized 1/4" Microphones
- 45CC-11** Headphone Test Fixture with Mouth Simulator and Ext. Polarized 1/4" Microphones
- 45CC-12** Headphone Test Fixture with Mouth Simulator and Prepolarized 1/4" Microphones

Specifications	4CC
IEC 61094-4 1/2" WS2P Microphones in the Ear Plate Plane	
Frequency response	3.15 Hz - 20 kHz
40AG dynamic range	25 dB(A) - 164 dB
40AO dynamic range	25 dB(A) - 150 dB
IEC 61094-4 1/4" WS3P Microphones in the Ear Plate Plane	
Frequency response	4 Hz - 70 kHz
40BP dynamic range	39 dB(A) - 169 dB
40BD dynamic range	44 dB(A) - 166 dB
Dimensions and weight	
Width between ears adjustable from	130 to 170 mm
Height of headband holder adjustable	from 75 to 135 mm
Horizontal position of headband holder	Adjustable, ± 5 mm
Ear plate angle	4.5° (ISO 4869-3)
Weight	3 kg
<i>For specifications for the 44AA Mouth Simulator, see page 69</i>	

## GRAS AL0030

### Production Line Acoustic Test Chamber



AL0030 Production Line Acoustic Test Chamber is an anechoic test chamber for acoustic production line testing of mobile devices, for example cell phones, tablets, Bluetooth speaker systems and similarly sized portable acoustic devices.

It is designed for quick and qualified acoustic test, including frequency response, THD, Rub & Buzz and microphone test, using optional sound source.

It provides a flexible platform that can be configured to suit specific requirements. It has a broad range of connections for injecting test and control signals to the Device Under Test (DUT).

Main features are:

- Repeatable testing and reliable data
- Easy open/close for quick and safe change of DUT
- Flexible test jig for easy adjustment to new DUT
- Flexible microphone mounting for both front- and backside speakers as well as edge-mounted speakers
- High-quality, high-sensitive 46BL ¼" CCP measurement microphone included
- Individually calibrated frequency response

AL0030 will speed up product development time significantly. It can be deployed almost anywhere and essentially offers a bench-top anechoic chamber providing highly repeatable data.

Specifications	AL0030
Frequency range*	100 Hz - 20kHz
Noise insulation (SIL)	> 25 dB (3rd octave)
Patch panel connectons**	4 x BNC socket 2 x USB 2 x mini DIN 4 pin
Operating temperature range	+ 5 °C to + 40 °C
Dimensions	Height: 52.8 cm Width: 42.4 cm Depth: 63.8 cm
Max. dimensions of DUT	300 x 200 mm (12" x 8")
Weight	39 kg

\* The recommended useful frequency range for AL0030 is from 100 Hz to 20 kHz. It can be used down to 50 Hz, however, below 100 Hz phenomena like room gain can make measurements unpredictable, and therefore we recommend 100 Hz as a practical lower limit.

\*\* A customized patch panel can be delivered on request.

# Power Modules

Measurement microphones and preamplifiers require special voltages for supply and polarization. There are two different supply principles. One is for the traditional voltage-driven preamplifiers, and one is for CCP (Constant Current Power) preamplifiers. Acoustic measurements also often require special signal conditioning such as A-weighting or high-pass filtering. Amplification or attenuation of the signal may also be necessary.

Standard externally polarized condenser microphones require a stable polarization voltage of 200 V DC for proper operation. This polarization voltage may be turned off in the power modules for use with prepolarized microphones too.

A-weighting is the most commonly used form of frequency weighting in acoustic measurements. It approximates the sensitivity of the human ear, which results in a more subjective measurement of noise.

Low-frequency acoustic signals generated, for example by wind flow, may overload the input section of the analyzer and subsequent measurement chain. This can be avoided by removing frequencies below 20 Hz with the high-pass filter of a power module.

The wide range of GRAS power modules can fulfil these requirements. Some are simple supplies that give only the special voltages required, whereas others also include signal conditioning.

CCP stands for “Constant Current Power” and describes GRAS power modules that maintain a constant level of current for driving CCP transducers such as GRAS CCP Preamplifiers, standard CCP microphone sets and special CCP microphones. Since the current is constant, the only thing that can vary with a CCP transducer under excitation is the supply voltage, which is analogous to its output signal.

Furthermore, since power is supplied via the same line as that used by the signal, only a coaxial cable is needed for connecting the transducer to the power module and subsequent analyzer.

There are also dedicated power modules for use only with GRAS low-noise measurement systems. They provide polarization and supply voltages for powering the special low-noise microphones and preamplifiers. The power modules are provided with a switch for selecting a response setting of either pressure or free-field.

Large systems for multi-channel acoustic measurements involving eight channels or more are most economically realized by using multi-channel power modules. Most GRAS power modules will fit into the optional GRAS 19” standard rack kit.

A combined power module and power amplifier is also available for electro-acoustic tests of smaller devices like receivers and mini speakers.

## GRAS 12AD

### 1-Channel Power Module



12AD is a 1-channel, battery-operated, microphone power module. It has a 7-pin LEMO 1B input connector for a microphone preamplifier and one BNC output socket. It can provide a polarization of 200 V for externally polarized or 0 V for prepolarized microphone cartridges.

A battery indicator is included to monitor battery condition as well as an input socket for an external power supply.

## GRAS 12AR

### 2-Channel Power Module



12AR is a 2-channel, battery-operated, microphone power module. It has two 7-pin LEMO 1B input connectors for microphone preamplifiers and two BNC output sockets. It can provide a polarization of 200 V for externally polarized or 0 V for prepolarized microphone cartridges.

A battery indicator is included to monitor battery condition as well as an input socket for an external power supply.

Specifications	12AD
Input Channels	7-pin LEMO 1B connectors
Output Channels	BNC socket
Preamplifier Supply	$\pm 15$ V
Output Impedance	Depends on preamplifier
Polarization Voltage	0 V or 200 V
Frequency Response	0.05 Hz - 200 kHz
Power Supply	4 x AA alkaline batteries (included) or 4.5 - 24 V DC mains adapter 115/230VAC) (not included)

Specifications	12AR
Input Channels	2 x 7-pin LEMO 1B connectors
Output Channels	2 x BNC sockets
Preamplifier Supply	$\pm 15$ V
Output Impedance	Depends on preamplifier
Polarization Voltage	0 V or 200 V
Frequency Response	0.05 Hz - 200 kHz
Power Supply	4 x AA alkaline batteries (included) or 4.5 - 24 V DC mains adapter 115/230 VAC) (not included)

## GRAS 12AK

1-Channel Power Module with Gain, Filters and SysCheck Generator



12AK is a 1-channel, battery-operated, microphone power module, amplifier and filter unit. It has a 7-pin LEMO 1B input connector for a microphone preamplifier and a BNC output socket. It has both instantaneous and latched overload indicators and a gain that can be set to 0dB, +10dB, +20dB, +30dB, +40dB or +50dB.

The A-weighting network fulfills the requirements of IEC 60651 for Type 0 and IEC 61672 Class 1 Sound Level Meters. The high pass filter is a 3-pole Butterworth filter with a cut-off frequency at 20 Hz.

A battery indicator is included to monitor battery condition as well as an input socket for an external power supply. It also has a built-in 1 kHz precision calibration generator with adjustable level for activating the SysCheck function in the 26AJ and 26AL preamplifiers. The generator can be activated either via a front-panel button or remotely via an input on the back of the module.

12 of these Power Modules can be mounted in the AK0040 Standard 19" Rack Kit.

Specifications	12AK
Input Channel	7-pin LEMO 1B connectors
Output Channel	BNC socket
Gain Settings	0 dB, +10 dB, +20 dB, +30 dB, +40 dB, +50 dB
Preamplifier Supply	28 V or 120 V
Output Impedance	30 Ω
Polarization Voltage	0 V or 200 V
Frequency Response	3.5 Hz - 200 kHz
A-weighting Network	IEC 60651 Type 0 and IEC 61672 Class 1
Power Supply	10 x AA alkaline batteries (included) or 12 - 18 V DC mains/line adapter for 115/230 VAC (included)

## GRAS 12AA

2-Channel Power Module with Gain, Filters and SysCheck Generator



12AA is a 2-channel, battery-operated, microphone power module, amplifier and filter unit. It has two 7-pin LEMO 1B input connectors for microphone preamplifiers as well as two BNC output sockets. Both channels have an overload indicator and a gain that can be set to -20dB, 0dB, +20dB or +40dB.

The A-weighting network fulfills the requirements of IEC 60651 for Type 0 and IEC 61672 Class 1 Sound Level Meters. The high-pass filters are 3-pole Butterworth filters with a cut-off frequency at 20 Hz.

A battery indicator is included to monitor battery condition as well as an input socket for an external power supply. It also has a built-in 1 kHz precision calibration generator with adjustable levels for both channels for activating the SysCheck function in the 26AJ and 26AL preamplifiers. The generator can be activated either via a front-panel button or remotely via an input on the back of the module.

12 of these Power Modules can be mounted in the AK0040 Standard 19" Rack Kit.

Specifications	12AA
Input Channel	2 x 7-pin LEMO 1B connectors
Output Channel	2 x BNC socket
Gain Settings	-20 dB, 0 dB, +20 dB, +40 dB
Preamplifier Supply	28 V or 120 V
Output Impedance	30 Ω
Polarization Voltage	200 V or 0 V
Frequency Response	3.5 Hz - 200 kHz
A-weighting Network	IEC 60651 Type 0 and IEC 61672 Class 1
Power Supply	10 x AA alkaline batteries (included) or 12 - 18 V DC mains/line adapter for 115/230 VAC (included)

## GRAS 12AG

### 8-Channel Power Module with Gain, Filters and SysCheck Generator



12AG is an 8-channel mains/line operated power module, but can also be powered by an external DC supply. It is built for multi-channel acoustic measurements, using pre-amplifiers and condenser microphones.

Each channel offers a choice of linear response, A-weighting and high pass filters, and has a built-in 1000 Hz oscillator, which enables a complete channel check when used in conjunction with preamplifiers having SysCheck or similar facility. The polarization voltage can be set to either 200 V or 0 V allowing the use of either externally polarized and prepolarized microphone cartridges. The preamplifier supply voltage can be selected internally to either 28 V or 120 V.

Each channel has a 7-pin LEMO 1B input connector for a microphone preamplifier, as well as indicators for instantaneous and latched overloads.

The gain in each channel can be selected individually in steps of 10 dB from 0 dB up to +50 dB. The high-pass filters are 3-pole Butterworth filters with a -1dB cut-off frequency at 20 Hz to remove unwanted low frequency signals, for example caused by wind-induced noise around the microphones. Two of these Power Modules can be mounted in the AK0040 Standard 19" Rack Kit.

Specifications	12AG
Input Channels	8 x 7-pin LEMO 1B connectors
Output Channels	8 x BNC sockets
Gain Settings	0 dB, +10 dB, +20 dB, +30 dB, +40 dB, +50 dB
Preamplifier Supply	28 V or 120 V
Polarization Voltage	0 V or 200 V
Frequency Response	3.5 Hz - 200 kHz
A-weighting network	IEC 60651 Type 0 and IEC 61672 Class 1
Output Impedance	30 Ω
Power Supply	12 - 18 V DC mains/line adapter for 115/230 VAC (included)

## GRAS 12AB

### 2-Channel Power Module for GRAS Intensity Probes



12AB is a 2-channel, battery-operated, microphone power module for use with the GRAS 50AI-B/-C/-D Sound Intensity Probe.

It has a 12-pin LEMO 1B input connector for direct connection with the intensity probe and two BNC output sockets for the microphone signals. It also has a 9-pin D-sub socket for connecting to the RS-232 port of a computer for software control of the remote control facilities of the GRAS 50AI Sound Intensity Probe.

A battery indicator is included to monitor battery condition as well as an input socket for an external power supply.

12 of these Power Modules can be mounted in the AK0040 Standard 19" Rack Kit.

Specifications	12AB
Input Channels	2 via 12-pin LEMO 1B connectors
Output Channels	2 x BNC sockets and 9-pin D-sub socket
Preamplifier Supply	28 V or 120 V
Polarization Voltage	0 V or 200 V
Frequency Response	0.05 Hz - 200 kHz
Power Supply	10 x AA alkaline batteries (included) or 12 - 18 V DC mains/line adapter for 115/230 VAC (included)

## GRAS 12AQ

**2-Channel Universal Power Module with Signal Conditioning and PC Interface**



12AQ is a 2-channel power module for powering microphone preamplifiers requiring a constant-current or constant voltage power supply. 12AQ is for general use in acoustic measurements as well as for intensity measurements, both in the laboratory and in the field. It has facilities for both manual control and remote control. Manual control is via front-panel switches and push buttons. Remote control is via RS-232 interface.

If a special filter function such as a HP-filter, LP-filter or BP-filter is required, it can easily be implemented in the module, as 12AQ is prepared with slots for extra filters.

## GRAS 12AL

**1-Channel CCP Power Module with A-weighting Filter**



12AL is a 1-channel CCP Power Module for powering microphone preamplifiers requiring a constant-current power supply, e.g. 26CB and 26CA. It can also power the 40SC Probe Microphone as well as the 40PH and 40PL Array Microphones.

12AL covers the frequency range from 1 Hz to 200 kHz and has a switchable A-weighting network and overload indicator. It is powered either by two internal batteries (LR6-AA) or by an external 3 - 6 V DC supply.

Specifications	12AQ
Traditional preamp. input:	
Connector	7-pin LEMO
Power Supply	$\pm 15V$ or $\pm 60 V$
Polarization	0 V or 200 V
CCP Preamplifier Input:	
Connector	BNC coaxial
Power Supply	4 mA sourced at 28 V DC
Signal Output	BNC coaxial connector
Gain	Adjusted, steps of 10 dB from -20 dB to +70 dB
Frequency Range	2 Hz to 200 kHz $\pm 0.2$ dB
Filters	HP filter 20 Hz. A-weighting IEC 61672 Class 1
Control Interface to host	Smart RS-232, MSG line
Power Supply	6 x LR14 alkaline batteries (included) or 8 - 18 V DC mains adapter for 115/230 VAC (included)

Specifications	12AL
Input Channel	BNC socket
Output Channel	BNC socket
Transducer Supply Current	4 mA sourced from 28 V
Frequency Response	1 Hz - 200 kHz
A-Weighted Network	IEC 60651 Type 0 and IEC 61672 Class 1
Power Supply	2 x AA alkaline batteries (included) or 3 - 6 V DC mains adapter for 115/230 VAC (not included)

## GRAS 12AN

### 4-Channel Power Module



12AN is a 4-channel power module for general use. It is a cost-effective solution with direct coupling (no filters), and is therefore ideally suited for infra-sound measurements. It can be used with all standard LEMO microphone sets and standard front-ends or acquisition units.

## GRAS 12AZ

### 4-Channel CCP Power Module



12AZ is a 4-channel power module for production line testing. It has three gain settings for optimization of the signal-to-noise performance. It can be used with all standard CCP microphone sets and standard front-ends or acquisition units.

Specifications	12AN	12AZ
Input Channels	4 x 7-pin LEMO 1B connector	4 x BNC sockets
Output Channels	4 x BNC sockets	4 x BNC sockets
Gain	-	0 dB, +20 dB, +40 dB
Preamplifier Supply	+/- 15 V	5 mA @ 28 V
Polarization	0 V or 200 V	0 V
Frequency Response	0.05 Hz - 200 kHz +/- 0.2 dB	1 to 300 kHz (+1/-3 dB @ Gain = 0 dB)
Power Supply (included)	4 x AA batteries or 6 - 20 V DC mains adapter for 115/230 VAC	6 - 20 V DC mains/line adapter for 115/230 VAC

## GRAS 12AU

### 1-Channel Universal Power Module with Signal Conditioning and Power Amplifier

12AU is a combined power module and power amplifier, optimized for production line testing of micro-speakers and receivers.

It will supply a CCP or a LEMO microphone set and condition the measured signal. In addition, it will drive a loud-speaker and continuously monitor the current and voltage for easy derivation of typical loudspeaker test parameters.



It is remotely controlled via its USB interface and, for this purpose, is delivered with a control program for Microsoft Windows®. It can be mounted in a 19" rack.

Specifications	12AU	
Traditional input	Connector	7-pin LEMO 1B series
	Power Supply	± 15 V
CCP Input	Connector	BNC
	Power Supply	2-20 mA
Polarization	0 V / 200 V (remote controlled)	
Output	BNC floating (2 kΩ/100 nF to power ground)	
Gain	0 - 50 dB in 10 dB steps (± 0.2 dB) (remote controlled)	
Bandwidth (-3dB)	1 Hz to 100 kHz	
Noise (relative to input) Input shorted (≥ 20 dB gain)	< 1.5 μVrms (20 Hz - 20 kHz)	
Input loaded with 20pF dummy mic.	< 5 μVrms (20 Hz - 20 kHz)	
High Pass Filter (remote controlled)	1 Hz (1. order) or 20 Hz (3. order Butterworth)	
Max Output Current	+/- 1.4 A	
Overload Detection (voltage & current)	LED indicators (remote controlled reading and reset)	
Current Output (voltage/current ratio)	1 V DC/1 A or 10 V DC/1 A	
Power Supply	115/230 VAC	

## GRAS 12HF

### 1-Channel Power Module for Low-noise Systems



12HF is a power module for single-channel, low-noise measurements using the matched, low-noise preamplifiers and high sensitive microphones of GRAS 40HF, 40HH and 40HT Low-noise Microphone Systems.

12HF provides:

- Polarization voltage (200 V) for the condenser microphone
- Voltage supplies ( $\pm 15$  V) for powering the microphone preamplifier
- A response setting of pressure or free-field

When fitted with the above matched preamplifiers and microphones, the 12HF supports the specifications of GRAS Low-noise Microphone Systems.

## GRAS 12HM

### 10-Channel Power Module for Low-noise Systems



12HM is a 10-channel power supply for multi-channel low-noise measurements with GRAS 40HF, 40HH and 40HT Low-noise Microphone Systems. With these, the 12HM can be used in sound-power measurements of low-noise products, such as disk drives, under anechoic and/or semi-anechoic conditions.

12HM provides:

- Polarization voltages (200 V) for up to 10 condenser microphones
- Voltage supplies ( $\pm 15$  V) for powering up to 10 microphone preamplifiers
- Individual response setting, pressure or free-field, for each channel
- Individual gain adjustment of  $\pm 3$  dB for each channel.

When connected to the above matched preamplifiers and microphones, each channel supports the specifications of GRAS Low-noise Microphone Systems.

Specifications	12HF	12HM
Input Channel	7-pin LEMO EGA 1B	10 x 7-pin LEMO EGA 1B
Output Channel	BNC coaxial	10 x BNC coaxial
Output Impedance	30 $\Omega$	30 $\Omega$
Polarization Voltage	200 V	200 V
Gain Adjustment/Channel	-	$\pm 3$ dB
Channel Separation	-	> 90 dB
Power Supply	4 x LR14 (C) batteries or (included) 6 - 20 V DC mains adapter for 115/230 VAC (included)	Mains adapter for 115 or 230 VAC - max. 35 VA (included)
Dimensions	Height: 132.6 mm (5 1/4") Width: 34.6 mm (1.3") Depth: 196 mm (7.7")	Height: 132.6 mm (5 1/4") Width: 420 mm (16 1/2") Depth: 196 mm (7.7")
Weight	620 g (1.3 lbs)	5.5 KG (12 lbs)

# | Accessories

GRAS Sound & Vibration offers a wide range of standard accessories in the form of cables, adapters, wind-screens and tripods for use in measuring setups.

These can be broadly divided into accessories for microphones, preamplifiers and outdoor microphones. Some are included with certain products, some are available as extras. All can be ordered individually.

The brief description given here as well as the information available on [www.gras.dk](http://www.gras.dk) will help you select what you need for your particular setup.

At all events, feel free to contact your local partner if you need advice or further information.

## 1/2" Microphone to 1/4" Preamp

- AF0008** Adapter for 1/2" Mic. and 1/4" Preamp.
- GR0010** Adapter for 1/2" Mic. and 1/4" Preamp.
- RA0003** Adapter for 1/2" Mic. and 1/4" Preamp.



AF0008



GR0010



RA0003



For any standard 1/2" microphone and 1/4" preamplifier. **AF0008**, included with 26AB. **GR0010**, included with 26AC, 26AL, 26AR and 26CB. **RA0003** for any standard 1/2" mic. of other brand and a GRAS 1/4" preamplifier.

## 1/4" Microphone to 1/2" Preamp Adapter

- RA0019** Adapter for 1/4" Mic. and 1/2" Preamp.



Inline stub adapter for connecting 1/4" microphone to 1/2" preamplifier

## 1" Microphone to 1/2" Preamp Adapter

- RA0017** Adapter for 1" Mic. and 1/2" Preamp.
- RA0073** Adapter for 1" Mic. and 1/2" Preamp.



RA0017



RA0073



**RA0017**. Head adapter for any standard 1" microphone and 1/2" preamplifier. **RA0073**. For 1" mic. with 1/2" preamp. The influence of RA0073 on the acoustic field is minimal.

## 1/4" Mic. to 1/4" Preamp., for intensity Probe

- RA0007** Adapter for 1/4" Mic. and 1/4" Preamp.



7,5 mm straight adapter for placing between a 1/4" microphone and a 1/4" preamplifier. Included with GRAS 40BI 1/4" Intensity Microphone set.

## 1/8" Microphone to 1/4" Preamp

- RA0063** Adapter for 1/8" Mic. and 1/4" Preamp.
- RA0082** Adapter for 1/8" Mic. and 1/4" Preamp., long



RA0063



RA0082



Adapters for using a 1/8" microphone with a 1/4" preamplifier. Can be used with any standard 1/8" microphone and 1/4" preamplifier such as 26AC.

**RA0063**. To reduce attenuation of the microphone signal, the guard ring of the preamplifier is extended through RA0063.

**RA0082**. Its extended length improves high frequency performance by reducing diffraction effects.

## Right-angled Adapters (90°)

- RA0001** 1/2" microphone to 1/4" preamplifier
- RA0190** 1/2" microphone to 1/2" preamplifier
- RA0006** 1/4" microphone to 1/4" preamplifier



RA0001



RA0190



RA0006



Right-angled adapters. Can be used with all standard microphones and preamplifiers.

## Tools for Gripping Microphones

- RA0161** Tool for gripping 1" Microphone
- RA0081** Tool for gripping 1/2" Microphone
- RA0200** Tool for gripping 1/4" Microphone
- RA0210** Tool for gripping 1/8" Microphone



With soft jaws for safely holding the microphone when unscrewing the protection grid or preamplifier.

## Rain Protection Caps

- RA0131** Rain-protection cap for 1/2" microphone
- RA0127** Rain-protection cap for 1/4" microphone
- RA0092** Rain-protection cap for array microphone



RA0131



RA0127



RA0092



**RA0131** includes a protection grid which has a central matching threaded stud.

**RA0127** includes a protection grid which has a central matching threaded stud.

**RA0092** is for use with GRAS array microphones 40PH and 40PL.

## Noisecones

- RA0020** 1/2" Noisecone
- RA0020-A** 1/2" Noisecone, aluminum for lightness
- RA0022** 1/4" Noisecone
- RA0173** 1/8" Noisecone



RA0020



RA0020-A



RA0022



RA0173



Noisecones for replacing the standard protection grid of a microphone when making acoustic measurements in high-speed laminar airflow. The tip should be pointed upstream in the laminar flow to reduce turbulence created by the microphone itself.

## Rain-resistant Grids

- RA0262** Rain-resistant grid for 1/2" microphone
- RA0336** Rain-resistant grid for 1/4" microphone
- RA0312** Rain-resistant grid for 1/8" microphone



RA0262 and RA0336 have a central threaded stud that can be used for mounting a Rain Protection Cap.

## GRAS RA0132

### Dehumidifier for 1/2" Microphones



For use at high humidity levels, only with rear-vented 1/2" microphones. An indicator on the side of the dehumidifier shows when it needs to be dried out.

## Microphone Tripods with 1/4" UNC-20 Threads

**AL0004** Small Lightweight Microphone Tripod

**AL0006** Microphone Tripod



- Standard mounting thread (1/4" UNC-20)
- Crank-adjusted centre column
- Rubber feet
- Adjustable tripod legs with locks

**AL0004.** Compact, light-weight tripod.

- Max. height 123 cm
- Retracted 24 cm

**AL0006.** A versatile and robust tripod. As AL0004, but stronger and more stable.

- Max. height 166 cm
- Retracted 66 cm

## Microphone Holders – Stainless Steel, Adjustable

**RA0093** 1/2" microphone holder, 5-click

**RA0096** 1/4" microphone holder, 5-click

**RA0094** 7 mm array microphone holder, 5-click



RA0093



RA0096



RA0094



Adjustable, high quality, stainless steel tripod adapters with 180° angular adjustment in steps of 45°.

## Microphone Holders – Stainless Steel, Fixed

**AL0012** 1/2" Microphone Holder

**AL0013** 1/4" Microphone Holder



AL0012



AL0013



For mounting microphone sets on tripods with a standard 1/4" UNC-20 thread. Can be used with the swivel head AL0005.

## Microphone Holders – POM, Fixed

**AL0008** 1/2" Microphone Holder, POM

**AL0028** 7 mm Microphone Holder, POM

**AL0029** 1/4" Microphone Holder, POM

**AL0035** 1/8" Microphone Holder, POM (not shown)



AL0008



AL0028



AL0029

## GRAS AL0005

**Swivel Head**



Lightweight swivel head for microphone holders, with a standard 1/4" UNC-20 thread.

### GRAS AL0003

#### Tripod Adapter for Microphones



AL0003 is an adapter with a swivel head for mounting 1/2" or 1/4" microphone sets on tripods with a standard 1/4" UNC-20 thread. Designed to minimize diffraction.

### 3/8" UNC-16 to 1/4" UNC-20

**SK0017** Tripod Thread Insert

**SK0057** Tripod Conversion Screw



**SK0017.** For adapting a female 3/8" UNC-16 thread to a male 1/4" UNC-20 thread.  
**SK0057.** For adapting the 3/8" UNC-16 thread of a tripod to 1/4" UNC-20 thread.

### GRAS RA0504

#### 1/2" GoPro Adapter



A specially-designed adapter that makes it possible to use the whole range of GoPro mounting accessories for mounting 1/2" microphone sets.

### GRAS AL0007

#### Clips for 1/4" Intensity Microphones



Set with microphone clips 12 mm and 25 mm for side-by-side mounting of a pair of 1/4" intensity microphones.

### MagMount™ Discs for 147AX

**RA0392-1** Pack of mounting discs, 5 pcs

**RA0392-10** Pack of mounting discs, 10 pcs



Discs for magnetic mounting of the 147AX. They can be screw-mounted or attached with glue or double-sided adhesive tape. The center tap ensures precise mounting of the 147AX.

## GRAS RA0077

NBS 9-A Coupler Adapter for 1/2" Microphone



RA0077 is an adapter for using a 1/2" microphone in the NBS 9-A Coupler RA0075.

## GRAS RA0011

Gooseneck



RA0011 is a 20 cm flexible gooseneck with 7-pin LEMO connectors for use with preamplifiers with integrated 7-pin LEMO connectors such as 26AJ, 26AK and 26AB. For example, it can be mounted between the preamplifier and a sound level meter in order to reduce reflections.

## GRAS RA0117

Coupler Adapter for 1/2" to 1/4" Microphone



RA0117 is an adapter for mounting a 1/4" microphone in couplers designed for 1/2" microphones.

## Random Incidence Correctors

**RA0122** For 1/2" free-field microphones

**RA0357** For 146AE 1/2" Free-field Rugged Microphone set



For use with 1/2" Free-field microphones when measuring in random-incidence sound fields.

## Transmitter Adapters

**RA0067** For 1/2" prepolarized microphones

**RA0086** For 1/4" ext. polarized microphones



RA0067



RA0086



RA0067 and RA0086 enable microphones (typically a 40BP 1/4" ext.pol. or 40AD 1/2 prepol.) to be used as high impedance sound sources. They take a calibration signal directly from a signal generator.

This makes the microphone behave like an electrostatic loudspeaker which, in a coupler, has a frequency response as good as when used as a microphone. The RA0067 can also be used with externally polarized microphones when used with 14AA Actuator Amplifier, which superimposes + 200 VDC polarization on the calibration signal.

**RA0067** has a BNC connector

**RA0086** has a microdot connector.

## 20 dB Attenuators

**RA0016** For externally polarized microphones

**RA0018** For prepolarized microphones



RA0016



RA0018



RA0016 and RA0018 are 20 dB attenuators for inserting between a 1/2" microphone and preamplifier. They attenuate the output signal of the microphone by 20 dB in order to avoid overloading the preamplifier or input module.

### GRAS RA0091

#### Insulated 1/2" Microphone Protection Grid



For avoiding ground loops, e.g. with RA0085 in telephone testing set-ups using 43AD Ear Simulator Kit.

### GRAS RA0140

#### Dummy 1" Microphone



For checking the inherent noise level of a preamplifier loaded purely by the capacitance of a 1" microphone.

## Capacitive Input Adapters

- RA0062** 20 pF Input Adapter for 1/2" preamplifier
- RA0062-S1** 50 pF Input Adapter for 1/2" preamplifier
- RA0080** 6 pF Input Adapter for 1/4" preamplifier



▼

**RA0062** is a 20pF input adapter for 1/2" preamplifiers. One end screws on to a 1/2" preamplifier and the other end has a BNC input connector. This enables connecting a signal generator to the input of the preamplifier. RA0062 can be used as a 20pF dummy load when short circuiting the BNC input.

**RA0062-S1** is a 50pF input adapter for 1/2" preamplifiers. One end screws on to a 1/2" preamplifier and the other end has a BNC input connector. This enables connecting a signal generator to the input of the preamplifier. RA0062 can be used as a 50pF dummy load when short circuiting the BNC input.

**RA0080** is a 6pF input adapter for 1/4" preamplifiers. One end screws on to a 1/4" preamplifier and the other end has a Microdot (UNF 10-32) input connector. This enables connecting a signal generator to the input of the preamplifier. RA0080 can be used as a 6pF dummy load when short circuiting the Microdot input.

## Inline Input Adapters

- AG0001** 7-pin LEMO to B&K
- AG0002** CCP Input Adapter
- AG0003** CCP to XLR Adapter
- RA0083** BNC to 7-pin LEMO
- RA0125** Microdot Input to 1/2" Preamplifier



▼

**AG0001** is an adapter for a 7-pin LEMO connector and a traditional 7-Pin B&K microphone input connector.

**AG0002** is an inline adapter for using a CCP preamplifier with a (constant-voltage) GRAS Power Module. One end plugs straight into the Power Module's input LEMO connector and the other end has a BNC socket for making a connection with a CCP preamplifier, e.g. CCP preamplifiers 26CB, 26CC (1/4") and 26CA, 26CF (1/2").

**AG0003** is an adapter for connecting a CCP compatible preamplifier to an input module with XLR connector and Phantom Supply (CCP) supply. AG0003 is provided with a BNC input connector.

**RA0083** is for utilising the signal and signal-ground pins only of the 7-pin LEMO input of a preamplifier power supply.

**RA0125** is an adapter for using a Microdot (UNF 10-32) input to a standard 1/2" preamplifier such as the 26AK. Useful when a high input impedance is required for transducers such as hydrophones and accelerometers. Including GR0010, it can be used with 1/4" preamplifiers as well, f.ex. 26AC.

## GRAS AC0001

### Calibration Control Box for 41AM/41CN



AC0001 is a control box with local and remote facilities for switching on/off the actuator calibration of 41AM and 41CN Outdoor Microphone Systems. It also has a BNC output for analyzing the signals from these Outdoor Microphone Systems. It can be connected to a 12 – 18 V DC mains/line adapter for powering 41AM and 41CN.

## GRAS RA0087

### Special Key



Used when dismantling the microphone assembly of the GRAS 41AM and 41CN Outdoor Microphone Systems.

## GRAS AM0029

### Pole Adapter



For mounting 41AM/41CN Outdoor Microphones on a pole. Has 1 1/2" RG (ISO 228/1) female thread. Also used with the Tripod Adapter AM0033 for mounting an Outdoor Microphone on a tripod.

## GRAS AM0033

### Tripod Adapter



For mounting 41AM/41CN Outdoor Microphones (fitted with Pole Adapter AM0029) on a tripod. Has 1 1/2" RG (ISO 228/1) male thread on top and 3/8" UNC-16 female thread at the bottom.

## GRAS AM0037

### Transport Protection Cap



For protecting the microphone assembly in GRAS 41AM/41CN Outdoor Microphones.

## GRAS AM0038

### Multi Spanner/Wrench



For dismantling the microphone assembly of 41AM/41CN Outdoor Microphones.

CABLES FOR OUTDOOR MICROPHONES  
– visit [www.gras.dk](http://www.gras.dk)

## GRAS AM0009

### Windscreens for 41AM/41CN



AM0009 is a set of five open-cell-structure foam windscreens for mounting on 41AM and 41CN Outdoor Microphone Systems.

## GRAS RA0009

### Adapter for Pistonphone calibration



RA0009 is an adapter for calibrating 41AM Outdoor Microphone System. It fits over the rain protection cap for 41AM and permits in-situ calibration using a pistonphone such as 42AA.

## GRAS AM0052

### Complete Windscreen/Birdspike for 41AM/41CN



AM0052 is a windscreen, complete with anti-bird spikes, for mounting on the 41AM and 41CN Outdoor Microphone Systems.

## GRAS RA0041

### Adapter for Pistonphone Calibration



RA0041 is an adapter for calibrating the 41CN Outdoor Microphone. It fits over the rain protection cap for 41CN and permits in-situ calibration using a pistonphone such as 42AA.

## GRAS AM0089

### Large Windscreen for 41AM/41CN



Spherical windscreen for 41AM and 41CN Outdoor Microphone Systems. Fits directly over the existing windscreen, accommodating the anti-bird spikes. Open-cell foam structure, 150 mm diameter.

## IEC60318-4 Ear Simulator – Accessories for Testing of ITE Hearing Aids

**GR0435** In-ear Adapter

**GR0436** Tube Stud



GR0435



GR0436



For testing of ITE hearing aids with an IEC60318-4 Ear Simulator, GR0435 or GR0436 are needed. The illustration to the right shows the context in which they are needed.



## IEC60318-4 Ear Simulator – Accessories for Testing of BTE Hearing Aids

**GR0437** Ear-mould Simulator

**GR0440** Tube stud

**GR0438** Union nut

**GR1176** Gasket



GR0437



GR0438



GR0440



GR1176



For testing of BTE hearing aids with an IEC60318-4 Ear Simulator, the items shown above are needed.

The illustration to the right shows the context in which they are used.



## IEC60318-5 1/2" 2cc Coupler – Accessories for Testing of ITE Hearing Aids

**GR0315** Gasket

**GR0319** Tube Adapter

**GR0317** Ear-mould Adapter

**GR0320** Union nut

**GR0318** Tube Adapter

**GR0321** In-ear Adapter



GR0318



GR0315



GR0317



GR0319



GR0320



GR0321



For testing of ITE hearing aids with a RA0038 1/2" IEC60318-5 Ear Simulator, the items shown above are needed.

The illustration to the right shows the context in which they are used.



## IEC60318-5 1" 2cc Coupler – Accessories for Testing of ITE Hearing Aids

<b>GR0316</b>	Union nut	<b>RA0017</b>	½" to 1" Adapter
<b>GR0723</b>	Tube Adapter	<b>RA0114</b>	¼"-button Adapter
<b>OR5003</b>	O-ring	<b>RA0115</b>	In-ear Adapter
<b>OR5389</b>	O-ring		



For testing of ITE hearing aids with an RA0113 1" IEC60318-5 Ear Simulator, the items shown above are needed. The illustration to the right shows the context in which they are needed.

## GRAS RA0052

### Test Jig



For use with GRAS couplers and ear simulators. It has an adjustable spring-loaded arm to exert a variable force on the test object.

## GRAS RA0070

### Test Base for Ear Simulators



Test base for GRAS ear simulators and couplers.

## GRAS RA0058

### 1/2" to 1" Microphone Adapter



Converts a 1/2" microphone (with grid removed) into a 1" microphone's dimensions (with grid). Allows mounting of 1" microphone protection grid. Typically used with 45CA Hearing-protector Test Fixture.

## GRAS RA0076

### Adapter for NBS 9-A Coupler RA0075



RA0076 is a thread adapter exclusively for use in connection with RA0052 Test Jig. It can also be used when upgrading the 43XX Series Ear Simulator Kits, except 43AF, where it is included.

### GRAS RA0085

#### Insulated Coupling for Artificial Ear



Can be used as a substitute for the snap coupler GR0336 in the 43AD Ear Simulator Kit to avoid ground loops.

### GRAS RA0088

#### In Ear Adapter



Moulding cup used to fit in-ear hearing aids to the RA0045 IEC60318-4 (former 60711) Ear Simulator.

### GRAS RA0116

#### Adapter for 1/2" Microphone



For use with RA0113 2cc Coupler.

### GRAS KB0110 & KB0111

#### Ear-mould Simulators



Ear-mould simulator for connecting a coupler holder to a BTE hearing aid via 2 mm (KB0110) or 3 mm (KB0111) plastic tubing.

### GRAS RA0172

#### Pinna Holder Kit for 45CA



Used for 45CA when configured with IEC 60318-4 Ear Simulator and KEMAR pinna.

### GRAS RA0307

#### Retrofit Kit with Anthropometric Pinna for 43AG and Knowles KEMAR



The items needed for retrofitting an anthropometric pinna on a GRAS 43AG (produced before April 2016) and on a Knowles KEMAR (produced before 2005).

## KEMAR Pinnae for GRAS 45BB, 45BC and 43AG



Standard KEMAR Pinnae, Soft		Standard KEMAR Pinnae, Hard	
KB1060	Small Right Pinna, 35 Shore 00	KB0060	Small Right Pinna, 55 Shore 00
KB1061	Small Left Pinna, 35 Shore 00	KB0061	Small Left Pinna, 55 Shore 00
KB1065	Large Right Pinna, 35 Shore 00	KB0065	Large Right Pinna, 55 Shore 00
KB1066	Large Left Pinna 35, Shore 00	KB0066	Large Left Pinna, 55 Shore 00
Sound Quality/Wide Aperture KEMAR Pinnae, Soft		Sound Quality/Wide Aperture KEMAR Pinnae, Hard	
KB1068	Small Right Pinna 35, Shore 00	KB0068	Small Right Pinna, 55 Shore 00
KB1069	Small Left Pinna 35, Shore 00	KB0069	Small Left Pinna 55, Shore 00
KB1090	Large Right Pinna, 35 Shore 00	KB0090	Large Right Pinna, 55 Shore 00
KB1091	Large Left Pinna, 35 Shore 00	KB0091	Large Left Pinna, 55 Shore 00
Anthropometric Pinnae for KEMAR		3-D Simulation of KEMAR with Pinnae	
KB5000	Large Right Anthropometric Pinna, 35 Shore 00	KB3000	45BB with Large Pinna, step file
KB5001	Large Left Anthropometric Pinna, 35 Shore 00	KB3001	45BB with Small Pinna, step file
KB5002	Large Right (mirrored left) Anthro. Pinna, 35 Shore 00	KB3002	45BB with Anthropometric Pinna, step file

## Pinnae for GRAS 45CA



Pinnae for 45CA, Soft and Anthro Pinna		Pinnae for 45CA, Hard	
KB1070	Large Right Pinna, 35 Shore 00	KB0070	Large Right Pinna, 55 Shore 00
KB1071	Large Left Pinna, 35 Shore 00	KB0071	Large Left Pinna 55, Shore 00
KB5010	Right Anthropometric Pinna for 45CA, 35 Shore 00	KB0072	Small Right Pinna, 55 Shore 00
KB5011	Left Anthropometric Pinna for 45CA, 35 Shore 00	KB0073	Small Left Pinna 55, Shore 00

## Pinnae for GRAS 45CB



Pinnae for 45CB Ansi Head	
KB0077	Large Right Pinna, 55 Shore 00
KB0078	Large Left Pinna, 55 Shore 00

## Anthropometric Pinna Upgrade Kits for KEMAR

- RA0308** Anthropometric Pinna Upgrade Kit for KEMAR 2005 - 2013
- RA0311** Anthropometric Pinna Upgrade Kit for KEMAR 2013 - present

## GRAS RA0143

### Ear Simulator Holder Kit for KEMAR



GR0917



GR0924



GR0958



GR1153

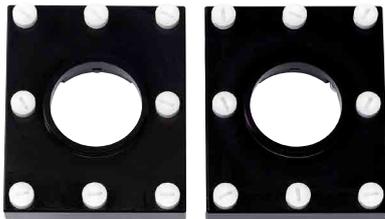


This retrofit kit enables mounting of the IEC 60318-4 (former 60711) Ear Simulator on KEMAR models earlier than 2005. It is delivered for one side with two types of ear canal extensions and microphone holders.

Pinnae for 45CB Ansi Head	
GR0917	Straight Ear Canal Extension
GR0924	VA-tapered Ear Canal Extension
GR0958	Holder for long 1/2" microphone
GR1153	Holder for short 1/2" microphone

## GRAS RA0251

### GRAS KEMAR Retrofit Kit for Binaural Hearing Aid Test



RA0249



RA0250



For testing of binaural hearing aids using RF communication, POM versions of the straight and the tapered ear canal extensions are available. To obtain the desired effect of non-interference with RF communication inside the head, KEMAR must also be fitted with POM ear holder plates. These are included.

Ear Canal Extensions (POM versions)	
RA0249	Straight POM Ear Canal kit for Kemar, Ø 7.5 mm, 8.3 mm long. Standardized according to IEC60318-7
RA0250	Tapered POM Ear Canal Kit for Kemar. Ø 9.85 tapering down to Ø 7.5 mm, 7.4 mm long

## Couplers for Pistonphones

- RA0023** 1" coupler for pistonphone
- RA0048** 1/2" coupler for pistonphone



▼  
Couplers for GRAS pistonphones.

## 1/2" Adapters for Pistonphones

- RA0049** 1/2" adapter for 1/4" microphone
- RA0069** 1/2" adapter for 1/8" microphone



▼  
Adapters for calibrating 1/4" and 1/8" microphones with a GRAS pistonphone fitted with a 1/2" Coupler.

## Calibration Adapters for 146AE and 147AX

- RA0341** Calibration adapter for 146AE
- RA0391** Calibration adapter for 147AX



▼  
For calibration of 146AE and 147AX respectively.

## GRAS RA0119

### Pistonphone Adapter



▼  
A pistonphone adapter for calibration checking the GRAS 43AE Ear Simulator when a pinna simulator is mounted on the RA0045 Ear Simulator.

## Couplers for Two-port Calibration

- RA0024** Coupler for two-port Calibration
- RA0042** Coupler for two-port Calibration, high pressure



▼  
Two-port high couplers for comparison calibrations between two 1/2" microphones; one of which is a reference microphone. Can also be used in measuring the P-I (Pressure-Intensity) Index of intensity probes at 250 Hz.

**RA0024** is for use with 42AA and 42AP Pistonphones.  
**RA0042** is a high-pressure version for use with the 42AC Pistonphone.

## GRAS RA0090

### 94 dB Pistonphone Coupler



▼  
A large-volume Coupler for enabling 42AA and 42AP Pistonphones to produce a sound pressure level of 94 dB instead of 114 dB re. 20  $\mu$ Pa. Essential when calibrating highly sensitive low-noise measuring systems, which would otherwise be overloaded by 114 dB.

## GRAS PR0001

Module for Array Microphones, wired



PR0001 is a mounting rail for GRAS CCP array microphones, e.g. 40PH or 40PL. The rail has a single 3 m cable which terminates in a 7-pin male LEMO connector. Adapter cables are available for splitting the signals to BNC or SMB connectors.

The design allows multiple-array configurations to suit various measurement requirements. In all cases, the fixed distance is 50 mm, resulting in an upper frequency of 3.4 kHz.

### Adapter Cables

**AC0015** Split cable from rail to 6 BNC connectors

**AA0016** Split cable from rail to 6 SMB connectors

## GRAS PR0002

Module for Array Microphones, variable



PR0002 has 23 positions for microphones, spaced at 25 mm intervals. The microphones can also be spaced with intervals of 50 mm, 75 mm or 100 mm. CCP cable is used. The holder RA0185 is available for mounting array microphones with SMB connector, and a special holder RA0245 is available for mounting 1/4" microphone sets with Microdot connector. To be mounted on the AL0006 Tripod and the stainless-steel RA0094 Tripod Adapter (for 8 microphones). These are standard solutions, but GRAS also offers alternative sizes and shapes of array modules.



RA0185



RA0245

## GRAS GR0625

End Piece Array Modules



For Array Module GRAS PR0001/PR0001-1 and PR0002.

## GRAS GR0630

Connecting Piece for Array Modules



Used to extend Array Module GRAS PR0001/PR0001-1 in the horizontal direction.

## GRAS GR0707

Spacer for Array



The 50 mm spacer is used to extend PR0001/PR0001-1 Array Module in the vertical direction.

### CCP Cable Holders

RA0185 Holder for cable with SMB connector

RA0245 Holder for cable with Microdot connector

## GRAS GR0107

Spacer Set for Array Modules



A set of 6 (50 mm) for PR0001/PR0001-1 Array Module.

## GRAS AC0016

Cable for Array Module PR0001



One end has a LEMO connector which plugs into the array module and splits into six SMB outputs on the ends of short cables

## GRAS AC0015

1-6 Split Cables for Array Modules



For use with PR0001 Array Module. One end has a LEMO connector, which plugs into the array module and splits into six BNC outputs on the ends of short cables.

## GRAS AK0040

### Standard 19" Rack Kit



AK0040 is a shelf for mounting instrument cabinets, e.g. GRAS Power Modules, and can itself be mounted in a standard 19" instrumentation rack via its flanges. It can house instruments 133 mm high and is wide enough to contain instruments up to a total width of 430 mm.

## GRAS AB0002

### Mains Adapter EU



Regulated 230 V AC  
- 15 V DC 7.5 W.  
Connector for European Union.

## GRAS AK0096

### Mounting Plate



For mounting two GRAS Power Modules (12AA/12AK) side-by-side.

## GRAS AB0003

### Mains Adapter USA



Regulated 110 V AC  
- 15 V DC 7.5 W.  
Connector for United States.

## GRAS AB0005

### Mains Adapter, EU/UK/USA



SMPS regulated 100–240 V AC - 6 V DC 10 W.  
Connector for European Union, United Kingdom, and United States.  
Specify connector when ordering.

## AB0006

### Mains Adapter UK



Regulated 230 V AC - 15 V DC 7.5 W  
Connector for United Kingdom.

## CCP Coaxial Cables, BNC-BNC for 1/2" Microphone Sets



- AA0035** 3 m
- AA0037** 10 m
- AA0039-CL** Customized length
- AA0056-CL** (RG174) Customized length

## CCP Coaxial Cables, SMB Angled-BNC For Array and QC Microphones



- AA0078** 3 m
- AA0080** 10 m
- AA0081-CL** Customized length

## CCP Coaxial Cables, Microdot-BNC For 1/4" and 1/8" Microphone Sets, max. temperature 70°C



- AA0070** 3 m
- AA0071** 5 m
- AA0072** 10 m
- AA0073-CL** Customized length

## CCP Coaxial Cables, SMB-SMB For Array and QC Microphones



- AA0043** 3 m
- AA0044** 10 m
- AA0083-CL** Customized length

## CCP Coaxial Cables, Microdot-Microdot CCP Coaxial Cables, Microdot-Microdot



- AA0064** 3 m
- AA0087-CL** Customized length

## CCP Coaxial Cable, SMB-Microdot CCP Coaxial Cable, SMB-Microdot



- AA0076-CL** Customized length

## CCP Coaxial Cables, SMB-BNC

CCP Coaxial Cables, SMB-BNC for Array and QC microphones



- AA0027** 3 m
- AA0028** 10 m
- AA0082-CL** Customized length

## High Temperature Cable, BNC-BNC for high-temperature applications



**AA0095-CL** Customized length

## CCP High Temperature Cable, Microdot-Microdot CCP Coaxial Cable, max temperature 150°C



**AA0064** 3 m

## CCP High Temperature Cable, Microdot-BNC CCP Coaxial Cables, Microdot-BNC for 1/4" and 1/8" Microphone Sets, max temperature 150°C



**AA0018** 3 m

**AA0061-CL** Customized length

## CCP High Temperature, Microdot-SMB CCP Coaxial Cables, Microdot-SMB, max temperature 150°C



**AA0049** 10 m

## Watertight and Heat Resistant CCP Cables



<b>AA0107</b>	1 m BNC - BNC
<b>AA0108</b>	3 m BNC - BNC
<b>AA0121</b>	5 m BNC - BNC w rubber sleeve
<b>AA0109</b>	10 m BNC - BNC
<b>AA0110</b>	30 m BNC - BNC

These cables are watertight and can be used at temperatures up to 125°C, for example with the 146AE 1/2" CCP Free-field Microphone Set.

AA0121 has a rubber sleeve at one end.

## Cable Replacement Kits for 147AX



<b>RA0393</b>	5 m
<b>RA0394</b>	10 m
<b>RA0395</b>	20 m
<b>RA0396</b>	Custom length

The repair kits comprise a key for screw-mounting one end of the cable to the 147AX' housing.

## LEMO Cables - Standard

Standard Cables 1B 7-pin LEMO to 1B 7-pin LEMO



- AA0008** 3 m
- AA0009** 10 m
- AA0020-CL** Customized length
- AA0089-CL** Customized length for panel mounting

## LEMO Cables - 4-pin to 7-pin

Standard Cables 4-pin LEMO to 1B 7-pin LEMO



- AA0057** 3 m

## LEMO Cables for Outdoor Microphones

LEMO Cables for Outdoor Microphones



- AA0003** 3 m
- AA0002** 10 m
- AA0015** 100 m - on cable drum
- AA0016** 200 m - on cable drum

## LEMO Cables - 5-pin to 7-pin

Standard Cables 5-pin LEMO to 1B 7-pin LEMO



- AA0091** 3 m
- AA0092-CL** Customized length

## LEMO Cables for Low-noise Systems

LEMO Cables for Low-noise Systems



- AA0046** 3 m
- AA0047** 10 m
- AA0053-CL** Customized length

## LEMO Cables for Intensity Probes

LEMO Cables for Intensity Probes



- AA0006** 2 m - 4-pin
- AA0021** 5 m - 12-pin

## Adapter Cables for 50AI and 60LK



- AC0002** Adapter Cable for GRAS 50AI-B for use with 01dB Symphonie
- AC0003** Adapter cable 12-pin LEMO to 2 x 7-pin LEMO for GRAS 50AI-C.
- AC0005** Adapter Cable for GRAS 50AI-D for Use with Müller BBM and OROS analyzers
- AC0008** Adapter Cable for GRAS 50AI-D for Use with 01dB Harmonie and Soundbook
- AC0010** Adapter Cable 18-pin LEMO to 2 x 7-pin LEMO
- AC0025** 3 m LEMO 4-pin to 4 x BNC Adapter Cable for 60LK

## GRAS AE0001

### Male Plug for 41AM/41CN



6-pin LEMO FFA.2S.306 male plug as supplied with 41AM/41CN

## GRAS AE0003

### Male plug for LEMO for Preampifier Cable



7-pin LEMO FGG.1B.307 male plug for preampifier cables

## GRAS AE0046

### BNC male - Microdot Female Adapter



Used for a cable terminated with a Microdot connector to connect to a BNC female (e.g. Power Module/Input Module)

## GRAS AE0074

### BNC Female-female Adapter



This adapter is used for interconnecting two cables which are terminated with BNC male connectors

## GRAS AE1002

### 7-pin LEMO 1B Series Female Connector



7-pin LEMO 1B series female connector for panel mounting

## GRAS AE1003

### 7-pin LEMO 1B series female connector



7-pin LEMO 1B series female connector for cable mounting

## GRAS PA0017

### Drum for 100 m cable



The PA0017 is a cable drum for approximately 100 m microphone cable

## GRAS PA0018

### Drum for 200 m cable



The PA0018 is a cable drum for approximately 200 m microphone cable

## Windscreens



The GRAS windscreens are all size optimized and their special, open-cell foam structure is designed to resist a humid environment and not influence the sound pressure measurement result significantly.

Frequency-dependent attenuation is to be expected, if the windscreen gets wet. Therefore windscreens are not intended as rain protection.

Large pressure fluctuations caused by turbulence can be attenuated by up to 20 dB.

Windscreens for outdoor microphones can be found on page 92.

### Spherical Windscreens

- AM0363** For 1" microphone
- AM0069** For 1/2" microphone
- AM0071** For 1/4" microphone
- AM0364** For array microphones



### GRAS AI0001

#### Elliptical Windscreen for Intensity Probes



Provides good protection at wind speeds of more than 0.5 m/s and is able to reduce pressure fluctuations caused by turbulence by up to 20 dB.

### Windscreen for 147EB - High Temperature

- AM0387-1** Windscreen, 1 pc
- AM0387-4** Windscreens, 20 pcs.



High-temperature windscreen especially designed for 147EB. It has a plastic ring inside that locks it to 147EB.

### Windscreen for 147AX - High Temperature

- AM0388-1** Windscreen, 1 pc
- AM0388-2** Windscreens, 5 pcs.



High-temperature windscreen especially designed for 147AX.

### GRAS AM0376

#### Elliptical Windscreen for Rugged CCP Intensity Probes



Fits the rugged CCP Intensity Probe 50GI-P and 50GI-RP.

### Windscreen for 146AE - High Temperature

- AM0391-1** Windscreen, 1 pc
- AM0391-2** Windscreens, 20 pcs.



High-temperature windscreen especially designed for 146AE. It has a plastic ring inside that locks it to 146AE.

12AA	78	41AC	39	67HA	30
12AB	79	41AM	38	67HB	30
12AD	77	41CN	38	67SB	73
12AG	79			67TS	27
12AK	78	42AA	52	67TS-1-CL	27
12AL	80	42AC	52		
12AN	81	42AE	54	90AA	56
12AQ	80	42AG	53	90AB	56
12AR	77	42AP	53	90CA -S2	57
12AU	81				
12AZ	81	43AA	60	146AE	14
12HF	82	43AB	60	147AX	14
12HM	82	43AC	61	147EB	25
		43AD	62		
14AA	54	43AE	62	AA0002	103
		43AF	61	AA0003	103
26AB	33	43AG	63	AA0006	103
26AC-1	33	43AH	65	AA0008	103
26AG	32	43AI	65	AA0009	103
26AH	32	43BA	64	AA0015	103
26AJ	32	43BB	64	AA0016	99
26AK	32			AA0016	103
26AM	32	44AA & 44AB	69	AA0018	102
26AN	33			AA0020-CL	103
26AR	33	45BB	70	AA0021	103
26AS	33	45BC	70	AA0027	101
26CA	34	45CA	72	AA0028	101
26CB	35	45CB	73	AA0035	101
26CC	35	45CC	74	AA0037	101
26CF	34	45EA	71	AA0039-CL	101
26CG	35	45EB	71	AA0043	101
26CI	34			AA0044	101
26CK	34	46AC	12	AA0046	103
26CS	35	46AD	15	AA0047	103
26HG	33	46AE	14	AA0049	102
		46AF	12	AA0053-CL	103
40AC	16	46AG	13	AA0056-CL	101
40AD	20	46AM	14	AA0057	103
40AE	19	46AN	29	AA0061-CL	102
40AF	16	46AO	15	AA0064	101
40AG	18	46AP	13	AA0064	102
40AI	21	46AQ	14	AA0070	101
40AK	21	46AR	12	AA0071	101
40AM	19	46AZ	29	AA0072	101
40AO	20	46BD	15	AA0073-CL	101
40AP	18	46BE	14	AA0076-CL	101
40AQ	19	46BF-1	12	AA0078	101
40AR	17	46BG	15	AA0080	101
40AU-1	17	46BH-1	13	AA0081-CL	101
40AZ	19	46BL	15	AA0082-CL	101
40BD	20	46BP-1	13	AA0083-CL	101
40BE	19	46DD	16	AA0087-CL	101
40BF	17	46DE	16	AA0089-CL	103
40BH	18	46DP-1	13	AA0091	103
40BI	21			AA0092-CL	103
40BP	18	47AC	29	AA0095-CL	102
40DD	20	47AD	26	AA0107	102
40DP	18	47AX	26	AA0108	102
40EN	17	47BX	26	AA0109	102
40GI	21	47DX	26	AA0110	102
40GK	21	47HC	43	AA0121	102
40HF	42				
40HH	42	50AI-B	46	AB0002	100
40HL	43	50AI-C	46	AB0003	100
40HT	42	50AI-D	46	AB0005	100
40LA	24	50GI-P	48	AB0006	100
40LS	24	50GI-R	47		
40PH	28	50GI-RP	48	AC0001	91
40PK	28	50VI-1	49	AC0002	103
40PL	28	51AB	55	AC0003	103
40PP	28			AC0005	103
40PS-1	24	60LK	49	AC0008	103
40SA	25	67AD	27	AC0010	103
40SC	25	67AX	27	AC0015	99

AC0016	99	GR0924	97	RA0049	98
AC0025	103	GR0958	97	RA0052	94
		GR1153	97	RA0056	68
AE0001	104	GR1176	93	RA0057	68
AE0003	104			RA0058	94
AE0046	104	KB0060	96	RA0062/-S1	90
AE0074	104	KB0061	96	RA0063	84
AE1002	104	KB0065	96	RA0067	88
AE1003	104	KB0066	96	RA0069	98
AF0008	84	KB0068	96	RA0070	94
		KB0069	96	RA0073	84
AG0001	90	KB0070	96	RA0075	65
AG0002	90	KB0071	96	RA0076	94
AG0003	90	KB0072	96	RA0077	88
		KB0073	96	RA0080	90
AI0001	105	KB0077	96	RA0081	84
AK0040	100	KB0078	96	RA0082	84
AK0096	100	KB0090	96	RA0083	90
		KB0091	96	RA0085	95
AL0003	87	KB0110 & KB0111	95	RA0086	88
AL0004	86	KB1060	96	RA0087	91
AL0005	86	KB1061	96	RA0088	95
AL0006	86	KB1065	96	RA0090	98
AL0007	87	KB1068	96	RA0091	89
AL0008	86	KB1069	96	RA0092	85
AL0010	55	KB1070	96	RA0093	86
AL0011	55	KB1071	96	RA0094	86
AL0012	86	KB1090	96	RA0096	86
AL0013	86	KB1091	96	RA0113	66
AL0017	55	KB3000	96	RA0114	94
AL0021	55	KB3001	96	RA0115	94
AL0028	86	KB3002	96	RA0116	95
AL0029	86	KB5000	96	RA0117	88
AL0030	75	KB5001	96	RA0119	98
AL0035	86	KB5002	96	RA0122	88
		KB5010	96	RA0125	90
		KB5011	96	RA0127	85
AM0009	92			RA0131	85
AM0029	91	OR5003	94	RA0132	85
AM0033	91	OR5389	94	RA0140	89
AM0037	91			RA0143	97
AM0038	91			RA0143	97
AM0052	92	PA0017	104	RA0161	84
AM0069	105	PA0018	104	RA0172	95
AM0071	105	PR0001	99	RA0173	85
AM0089	92	PR0002	99	RA0190	84
AM0363	105			RA0200	84
AM0364	105	RA0001	84	RA0210	84
AM0376	105	RA0003	84	RA0249	97
AM0387-1	105	RA0006	84	RA0250	97
AM0387-4	105	RA0007	84	RA0251	97
AM0388-1	105	RA0009	92	RA0252	65
AM0388-2	105	RA0011	88	RA0262	85
AM0391-1	105	RA0014	55	RA0307	95
AM0391-2	105	RA0014-S1	55	RA0308	97
		RA0015	55	RA0311	97
GR0010	84	RA0016	88	RA0312	85
GR0107	99	RA0017	84	RA0336	85
GR0315	93	RA0017	84	RA0341	98
GR0316	94	RA0018	88	RA0357	88
GR0317	93	RA0019	84	RA0391	98
GR0318	93	RA0020	85	RA0392-1	87
GR0319	93	RA0020-A	85	RA0392-10	87
GR0320	93	RA0022	85	RA0393	102
GR0321	93	RA0023	98	RA0394	102
GR0435	93	RA0024	98	RA0395	102
GR0436	93	RA0038	65	RA0396	102
GR0437	93	RA0039	66	RA0401	67
GR0438	93	RA0041	92	RA0402	67
GR0440	93	RA0042	98	RA0403	68
GR0625	99	RA0045	67	RA0404	68
GR0630	99	RA0045-S1	67	RA0504	87
GR0707	99	RA0045-S4	67		
GR0723	94	RA0045-S5	67	SK0017	87
GR0917	97	RA0045-S6	67	SK0057	87
		RA0048	98		

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