Product Data

Sound Power Source — Type 4205

USES:

- ❍ Determination of sound power output of equipment by the Substitution Method
- ❍ Determination, by the Juxtaposition Method, of sound power output of equipment which cannot be switched off or easily moved
- ❍ Measurement of loudspeaker efficiency
- ❍ Reverberation time measurements
- ❍ Sound insulation measurements
- ❍ Sound distribution measurements

FEATURES:

- ❍ Calibrated sound power output, continuously variable from 40 to 100 dB (re 1 pW)
- ❍ Selectable wide band or octave-band noise output
- ❍ White-noise frequency range 50 Hz to 10 kHz
- ❍ Pink-noise frequency range 100 Hz to 10 kHz
- ❍ Compatible with other Brüel & Kjær instruments for use in portable analysis systems
- ❍ Overload warning light
- ❍ Remote control facility to switch generator on or off
- ❍ Generator can be stopped instantly (<30 ms)
- ❍ Facility for connection of external filter or weighting networks
- ❍ Compact, portable and battery operated

Introduction

Sound Power Source Type 4205 enables the sound power output of machines and other devices to be easily determined by the Substitution and Juxtaposition Methods. Its small size, low weight and battery operation make Type 4205 suitable for both field and laboratory use.

Type 4205, in conjunction with Portable Level Recorder Type 2317 and Sound Level Meter Type 2236 or 2260, forms a set of battery-operated equipment for measurements of building acoustics parameters such as reverberation time, sound absorption, sound transmission and sound distribution.

Type 4205 can be used to measure the efficiency of loudspeakers, that is, the ratio of the acoustical power output of the loudspeaker to the electrical power supplied to the loudspeaker expresses as a percentage.

Description

Sound Power Source Type 4205 is a calibrated sound source whose output can be varied continuously between 40 and approximately 100 dB re 1 pW. This is equivalent to a sound pressure level of 92 dB for wide-band noise, at a distance of 1 m from the Type 4205, over a reflecting plane assuming a perfect hemispherical radiation pattern. The output can be wide-band pink noise in the frequency range 100 Hz to 10 kHz, or you can select octave-band filtered noise by using one of seven built-in octave band-pass filters.

The controllable output means that the sound power source is eminently suitable for making in-situ sound power measurements on machines which cannot be switched off or easily moved.

Sound Power Source Type 4205 consists of two separate units: the generator, containing all the controls, filters, battery pack, amplifiers and meter, etc., and Sound Source HP 1001 containing two loudspeakers and the associated crossover networks. Fig. 1 shows a simplified block diagram of the complete instrument.

The generator produces a white noise signal in the frequency range 50 Hz to 10 kHz with a frequency response of ±1 dB. This signal is obtained from the White Noise Output socket. The signal also passes through a pink noise filter and amplifier to an External Filter Output where the voltage is suitable for use with a Brüel & Kjær Octave or Third Octave Filter Set.

The Sound Power Spectrum switch can be used to select one of the seven internal octave filters, the Wide Band mode or the External Filter mode as required. The filters conform with ANSI S 1.11–1966 Class I (Fig. 2).

The sound power output of HP 1001 is controlled by an attenuator with a 40 dB range in steps of 10 dB and also by a continuously variable potentiometer.

When the sound power source is correctly calibrated, the meter indicates the emitted sound power in dB re 1 pW. The meter averaging times are governed by the position of the Sound Power Spectrum Switch and are as follows: 10 s in the 125 Hz and 250 Hz bands and the external filter position; 3 s in the 500 Hz and 1 kHz bands; and 1 s in the 2 kHz, 4 kHz, 8 kHz and Wide Band positions.

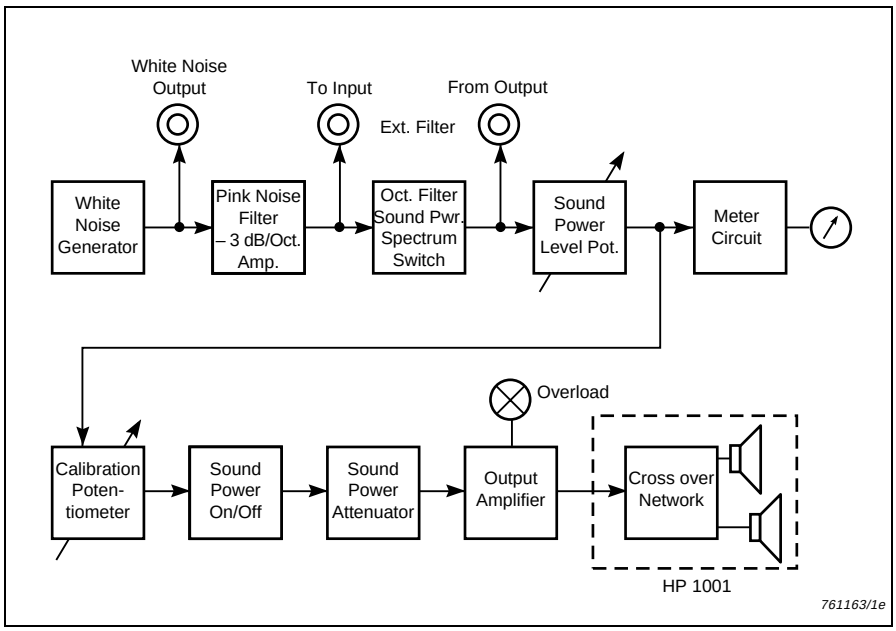

Fig. 1 Simplified block diagram of Sound Power Source Type 4205

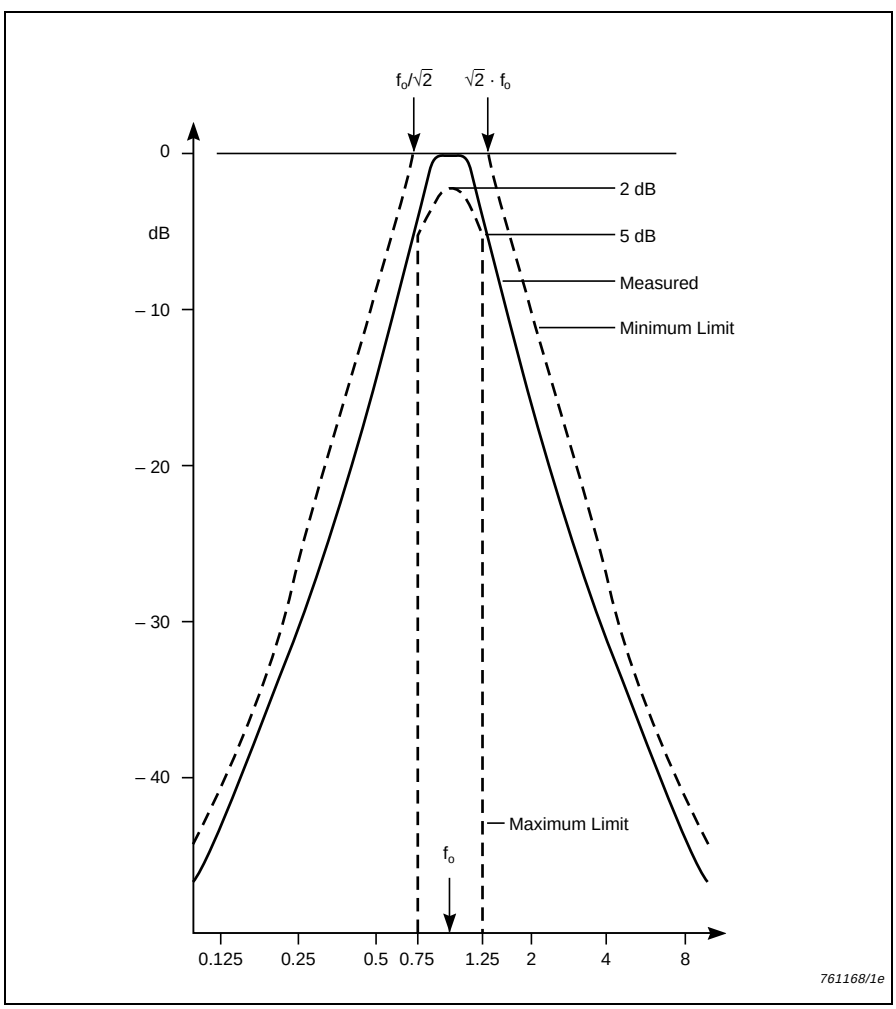

Fig. 2 Typical filter characteristic showing the limits as stipulated by American Standard for Octave Filters S.1.11–1966

An on/off circuit enables the sound power to be switched off almost instantaneously (<30 ms). Another circuit cuts off the signal to the sound source for approximately 3 seconds when the instrument is switched on, thus preventing overload from large transients.

The overload indicator lights up if the RMS output voltage exceeds 7.25 V, or if the average current to the sound source exceeds 0.6 A.

Type 4205 can be powered by an internal Power Pack (Battery Box ZG 0146 containing 6 NiCd batteries), a plug-in Power Supply ZG 0342, or an external DC supply. An internal DC convertor, protected by a thermal overload cut-out, produces the voltages necessary to drive each part of the circuitry.

Sound Source HP 1001 is driven by the generator via a 10 m cable.

The sound source contains two loudspeakers and their crossover units. A woofer loudspeaker is used for the 125 Hz, 250 Hz, 500 Hz and 1 kHz octave bands and a dome tweeter for the 2 kHz, 4 kHz and 8 kHz octave bands.

To calibrate Type 4205, a $^1/_2$″ free-field microphone, Type 4190 or 4191, either directly mounted on a sound level meter or connected by a cable to a sound measuring system, is placed in the mounting frame on the HP 1001. This mounting provides a fixed reference position for the microphone during calibration. The sound power level is set to a value of 75 dB, then the calibration potentiometer, for each octave band, is adjusted until the sound power level in each band, as measured by the microphone, is the same as the value stated in the table printed on the side of the sound source. The accuracy of the emitted sound power when the instrument is calibrated is given in the specifications.

Graphs of the white noise and pink noise from Type 4205's generator against frequency are shown in Fig. 3. A typical sound power spectrum for Type 4205 operating in the wide band mode measured in third octave bands, is shown in Fig. 4.

Typical directional characteristics for Type 4205 are shown in Figs. 5 and 6. In practice, Type 4205 is usually placed on a reflecting surface. Therefore, the directional characteristics were measured by placing the sound source on a reflecting plane in an anechoic room. Interference caused by the reflected sound waves is the principal reason for the irregularities in these characteristics. The interference patterns are especially noticeable at high frequencies.

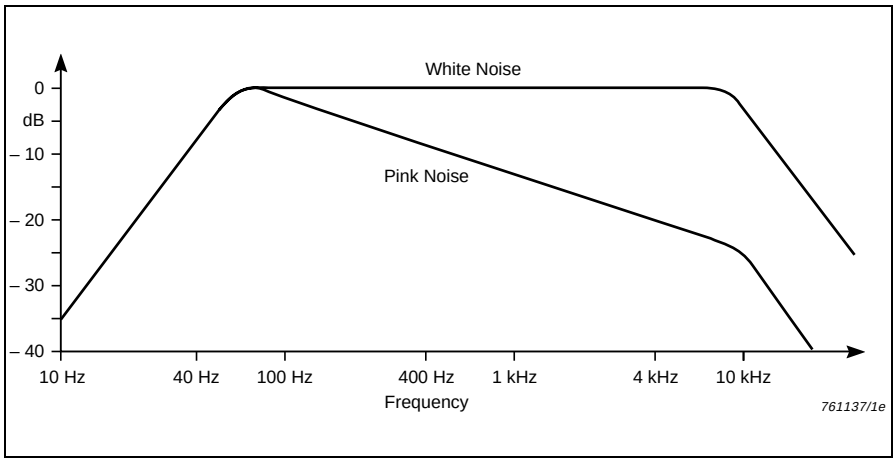

Fig. 3 White and pink noise outputs from the 4205

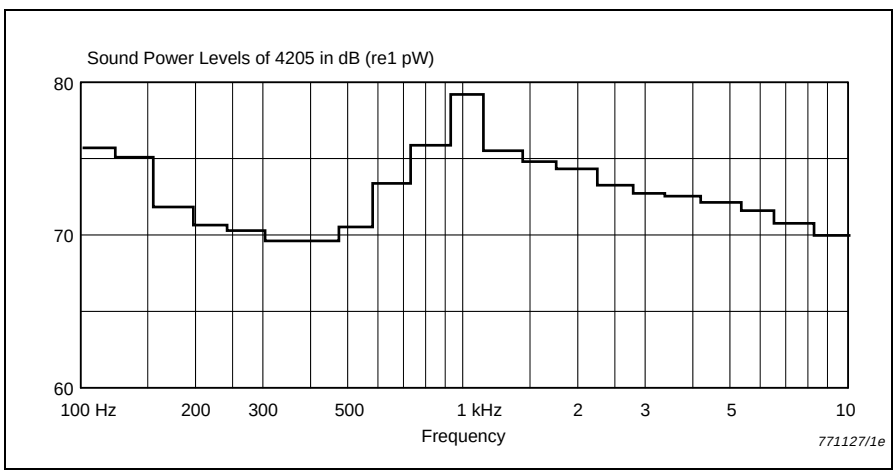

Fig. 4 Typical sound power spectrum for Type 4205 operating in a wide band mode measured in $^1/_3$-octave bands

Use of Type 4205 for Sound Power Measurements

When assessing the noise emission of a machine, it is insufficient to quote only the sound pressure level measured using the "A" weighting network, since the level measured depends on the environment. It is generally accepted that the sound power emitted by the machine should be determined, as this gives an indication of the noise output that is virtually independent of the environment.

Although sound intensity instrumentation for the direct measurement of sound power is available, indirect methods are used for standardised tests. These involve measurement of sound pressure levels and acoustical properties in the machine's environment.

The sound power, P, and the sound pressure, p, are related by:

$$20\log\frac{p}{p_0} = 10\log\frac{P}{P_0} + 10\log\left(\frac{Q(\theta,\phi)}{4\pi r^2} + \frac{4}{R}\right) \qquad (1)$$

where

$p_0 = 2\times10^{-5}$ Pa
$P_0 = 10^{-12}$ W
Q = directivity factor of the sound source in the direction (θ,ϕ)
r = distance from source to measuring microphone
R = $S\alpha/(1-\alpha)$, the Room Constant
S = total surface area of the room
α = average absorption coefficient of area S

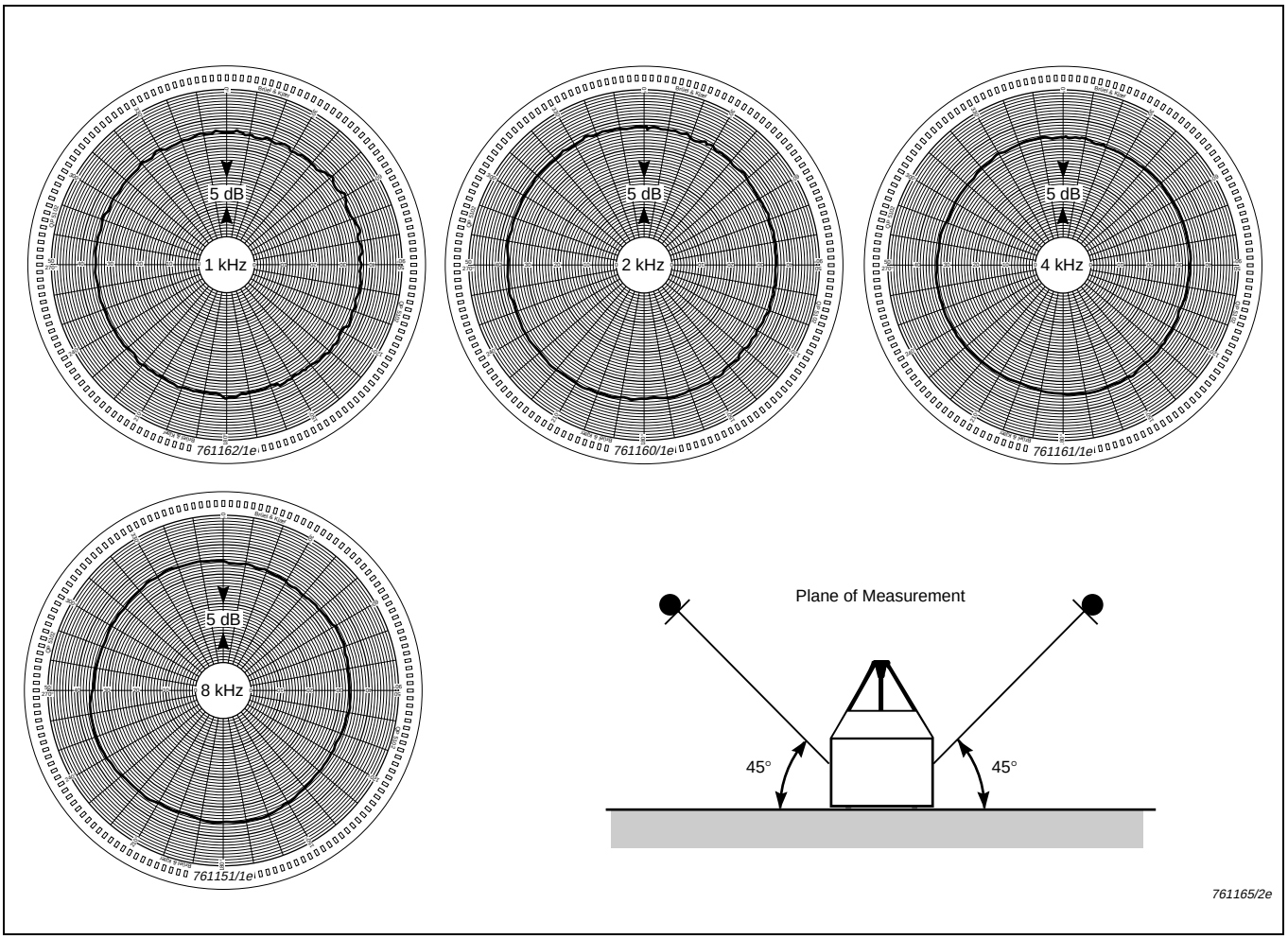

Fig.5 Typical horizontal directional characteristics

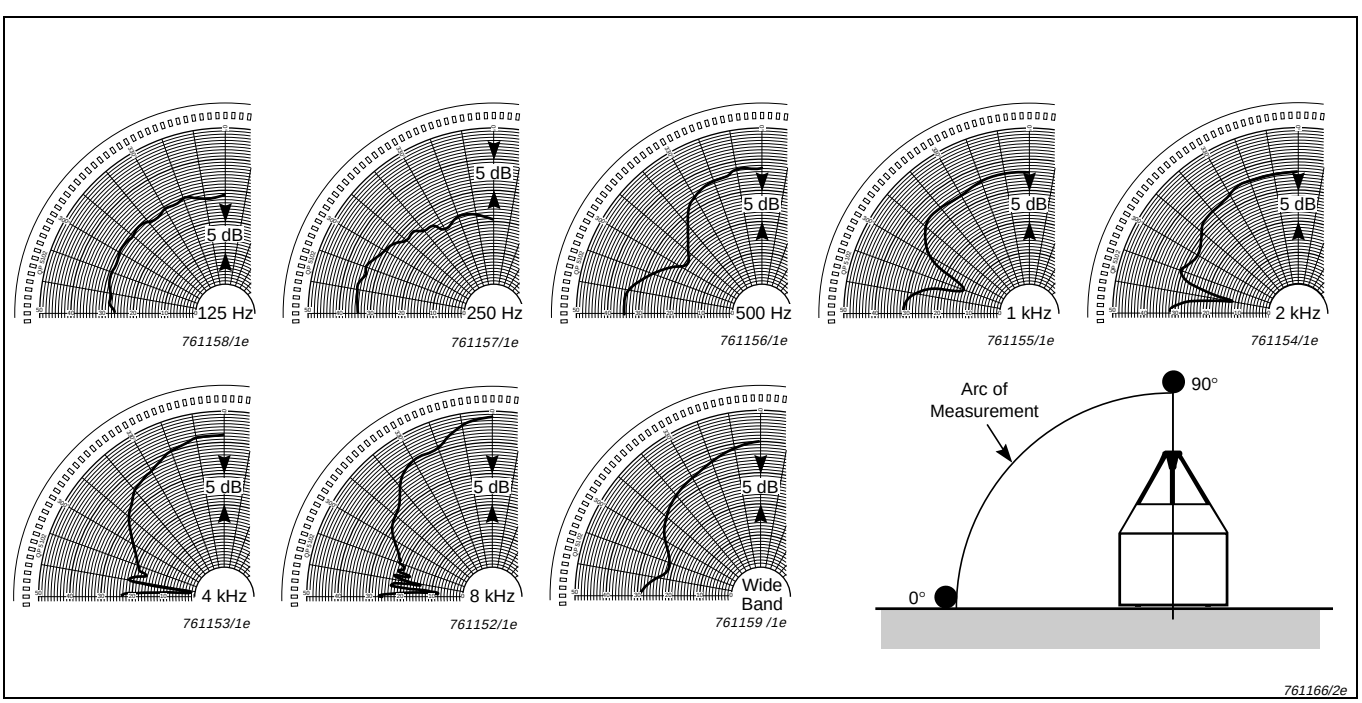

Fig.6 Typical vertical directional characteristics

The first term inside the brackets is the direct component of the sound field obeying the inverse square law; the second term is the reverberant component of the sound field governed by the acoustic absorption properties of the room and its contents. This latter component can be determined by measurement of the reverberation time, or by calculation using the tabulated absorption coefficients of the surfaces and contents of the room and their respective areas.

Evaluating sound power using equation (1) is an involved process. Therefore, other methods have been devised where the sound power output of the machine is compared to that emitted by a calibrated sound source [1]. Sound Power Source Type 4205 enables these comparison methods to be used. There are three such methods: the Substitution, Superposition and Juxtaposition methods. Two of them are described here.

Substitution Method

This method can be used when you can switch off, or easily move, the appliance or machine whose sound power output you are determining.

When the machine is operating, measure the "A" weighted sound power level produced at a known position in the reverberant field with a sound level meter. Then remove the machine and replace it with Sound Source HP 1001. Set the sound power spectrum switch on the generator to the Wide Band position and increase the power output of the source until the same value of sound pressure level is obtained. When this condition is attained, the sound power output of the calibrated source is equal to that of the machine and can be read directly from the scale on the generator.

Juxtaposition Method

If the machine cannot be switched off or moved, then the following procedure can be used. Place the sound source next to the device under test. Measure the "A" weighted sound pressure level due to the device alone at a known position in the reverberant field, equidistant from the test object and the sound source. Switch the sound source on and increase its power output until the sound pressure level at the monitoring position has increased by 3 dB. Both the machine and sound source now have the same sound power output which can be read directly from the scale on the generator.

The noise sources must be placed close enough to one another, so that the standing wave characteristics of the enclosure are similarly excited by each source. The enclosure will then have a minimal effect on the sound power levels.

Ideally, the spectrum shape of the added sound power should be similar to that of the device under test. This is not very critical, especially if the reverberation time of the enclosure is approximately constant over the frequency range of interest [2].

If the octave band sound power levels of the machine are required, then the same procedure can be employed for each of the seven octave filters in Type 4205. However, the octave band filter in the Sound Level Meter (Type 2236 or 2260) must be used when measuring the 3 dB increase in sound pressure level in the respective octave bands.

References

[1] "The Use of a Reference Sound Source in Studying Industrial Noise" by *P. François* and *D. de Montussaint*, Internoise '72 Proceedings, Washington DC, Oct. 4 – 6, 1972

[2] "Simple Sound Power Measurements" by *J. Moir and W.R. Stevens*, Applied Acoustics Vol. 7, No. 1, Jan. 1974, pp. 15–22

Specifications 4205

Acoustical:

SOUND POWER LEVEL:
Range: 40 to approx. 100 dB re 1 pW in 10 dB steps (attenuator), continuously variable within each step (potentiometer). Overload indication for max. sound power level. See table
On/Off Control: suppresses the A-weighted Sound Power Level to below 30 dB re 1 pW (2-position toggle switch)
Power contribution due to demodulation (EN 50082–2):
Normal operation (only loudspeaker connected to Type 4205)**:** < 50 dB re 1 pW
Any cables connected: < 65 dB re 1 pW
DIRECTIONAL CHARACTERISTICS:
See Figs. 5 and 6
SOUND POWER SPECTRUM:
Wide band noise in the frequency range 100 Hz to 10 kHz (see Fig. 4)
Octave band noise in 7 freq. bands: 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 8 kHz

Electrical:

EXTERNAL FILTER:
To Input:
Signal: Pink noise in the freq. range 100 Hz to 10 kHz (Fig. 3)

Sound Power Level dB re 1 pW	Octave			Wide Band
	125 Hz	250 Hz to 2 kHz	4 kHz to 8 kHz	
40 to 50	±2 dB	±1.5 dB	±2 dB	±2 dB
50 to 90	±1.5 dB	±1 dB	±1.5 dB	±1.5 dB
90 to 95	–2.5 to +1.5 dB	±1 dB	±1.5 dB	±1.5 dB
95 to max. level	–3 to +1 dB	–1.5 to +1 dB	–2 to +1.5 dB	–2 to +1.5 dB

Output Voltage: 0.7 V RMS ±0.1 V
Freq. Response: ±1.5 dB
Output Impedance: <10 Ω
Min. Load Impedance: 500 Ω|| 2 nF
From Output:
Input Impedance: 150 kΩ|| 1 nF
Input Voltage for full defl.: 115 mV RMS
Max. Input Voltage: 10 V peak
WHITE NOISE:
Freq. Range: 50 Hz to 10 kHz (Fig. 3)
Output Voltage: 1 V RMS ±0.1 V
Freq. Response: ±1 dB
Output Impedance: <10 Ω
Min. Load Impedance: 5 kΩ|| 2 nF

REMOTE CONTROL:
Sound Power Level on/off may be remotely controlled:
0 – 0.8 V: Off
2.5 – 5 V: On
THERMAL PROTECTION:
The instrument is protected against damage during overload by thermal shutdown of internal supply voltages
FILTER CHARACTERISTICS:
Conform to ANSI S1.11–1966, Class I

Specifications 4205 (cont.)

General:

POWER SUPPLY:
Internal: from 6 NiCd batteries in Battery Box ZG 0146 or from Power Supply ZG 0342
External: +6.6 to +15 V, approx. 12 W
N.B. Dry cells should not be used with this instrument
BATTERY CHECK:
When the "Batt. Check" push button is pressed the supply voltage is indicated on the meter
OPERATING TIME:
(with fully charged NiCd batteries)
Approx. 2 hours at max. Sound Power Level
Approx. 10 hours at 80 dB re 1 pW Sound Power Level
RECHARGING NiCd BATTERIES:
From Power Supply ZG 0342
From Battery Charger ZG 0113 or from an ordinary 12 V car battery
Charging time is approx. 14 hours
AIR PRESSURE RANGE:
930 to 1070 hPa
DIMENSIONS:
Generator:
Height: 132.6 mm (5.2 in)
Width: 209.5 mm (8.3 in)
Depth: 200 mm (7.9 in)
Sound Source:
Height: 345 mm (14 in)
Diameter: 240 mm (9.5 in)
WEIGHT:
Generator: 3.0 kg (6.6 lb.)
Sound Source: 3.5 kg (7.7 lb.)
CABINET:
Brüel & Kjær modular cabinet, $^{6}/_{12}$ of 19″ rack module

COMPLIANCE WITH STANDARDS:

CE	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive.
Safety	EN 61010–1 (1993) and IEC 1010–1 (1990): Safety requirements for electrical equipment for measurement, control and laboratory use.
EMC Emission	EN 50081–1 (1992): Generic emission standard. Residential, commercial and light industry. EN 50081–2 (1993): Generic emission standard. Industrial environment. CISPR 22 (1993): Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
EMC Immunity	EN 50082–1 (1992): Generic immunity standard. Residential, commercial and light industry. EN 50082–2 (1995): Generic immunity standard. Industrial environment. See **On/Off Control** **Note:** The above is guaranteed using accessories listed in this Product Data sheet only.
Temperature	IEC 68–2–1 & IEC 68–2–2: Environmental Testing. Cold and Dry Heat. Operating Temperature: +5 to +40°C Storage Temperature: –25 to +70°C IEC 68–2–14: Change of Temperature: +5 to +40°C (2 cycles, 1°C/min.)
Humidity	IEC 68–2–3: Damp heat: 90% RH (non-condensing at 40°C)
Mechanical	Non-operating: IEC 68–2–6: Vibration: 0.3 mm, 20 m/s^2, 10–500 Hz IEC 68–2–27: Shock: 750 m/s^2 IEC 68–2–29: Bump: 1000 bumps at 250 m/s^2
Enclosure	IEC 529: IP 20
Reliability	MIL-HDBK 217 F, GB (Part-stress): MTBF >45000 hours (max. 2.2% errors/1000 h)

Ordering Information

Type 4205 Sound Power Source
Includes the following accessories:
HP 1001: Sound Source
ZG 0146: Battery Box
6 × QB 0008: NiCd batteries, 1.2 V, 4 Ah
AQ 0160: Cable
JP 0703: 7-pin plug
JP 0802: 8-pin plug
2 × VF 0019: Fuses, 3.15 A, 250 V
KF 0079: Dust cover

Optional Accessories

ZG 0342: Power Supply
ZG 0283: Battery Charger
AQ 0035: Cable (1.2 m, for charging batteries with ZG 0342)
AQ 0157: Charging Adaptor

Brüel & Kjær reserves the right to change specifications and accessories without notice

Brüel & Kjær

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