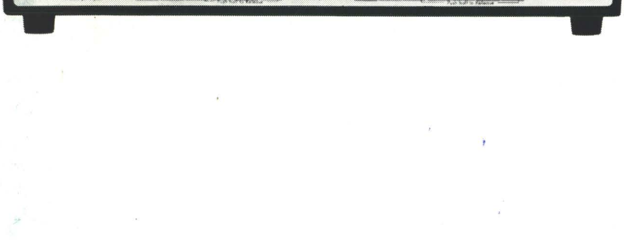
2607

Instructions and Applications

B K



Measuring Amplifier Type 2607

A portable instrument measuring true RMS signal levels with averaging times from 0.1 to 300 sec, and positive peak, negative peak, or maximum peak levels with a rise time of 20 μsec. With a B & K microphone and preamplifier it conforms to precision sound level meter recommendations and the DIN standard for impulse sound level meters.

BRÜEL & KJÆR

030-0149

MEASURING AMPLIFIER TYPE 2607

November 1970

CONTENTS

1. INTRODUCTION

The 2607 Measuring Amplifier is capable of an extensive range of sound, vibration and voltage measurements. It combines extreme versatility with a wide measurement range and laboratory precision. Used with one of the B & K condenser microphones and a suitable preamplifier, the 2607 becomes a precision sound level meter to the IEC Recommendation 179 and an impulse sound level meter to the German DIN Standard 45633 parts 1 and 2 (March 1967).

It is basically a wide range measuring amplifier for linear as well as logarithmic operation and includes true RMS and Peak rectifier circuits. The rectifier circuits contain time constants ranging from 0.1 to 300 sec which can be directly or remotely selected to give averaging times for RMS measurements and decay times for Peak measurements. A display meter with interchangeable meter scales on which the range setting is automatically indicated facilitates the direct calibration of the 2607 for sound pressure level, acceleration and voltage measurements.

Amongst other features are mains or battery operation, overload indicators on input and output sections, an internal calibration source and facilities for the insert voltage calibration of microphones.

The 2607 also contains the internationally standardized sound level meter frequency weighting networks A, B and C as well as the D network for jet engine noise measurement. For frequency analysis the 2607 may be used with the 1614/15 Filter Sets or the 2020 Heterodyne Slave Filter. The analysis may be recorded using the 2305 Level Recorder for which both AC and DC outputs are available on the 2607. Normally, however, the DC output will be preferred for recording since a fully averaged RMS signal level is provided, the accuracy of which is controlled by the time constants of the 2607. This is also an extremely important feature when digital processing of signal levels is to be performed.

2. CONTROLS

2.1. FRONT PANEL

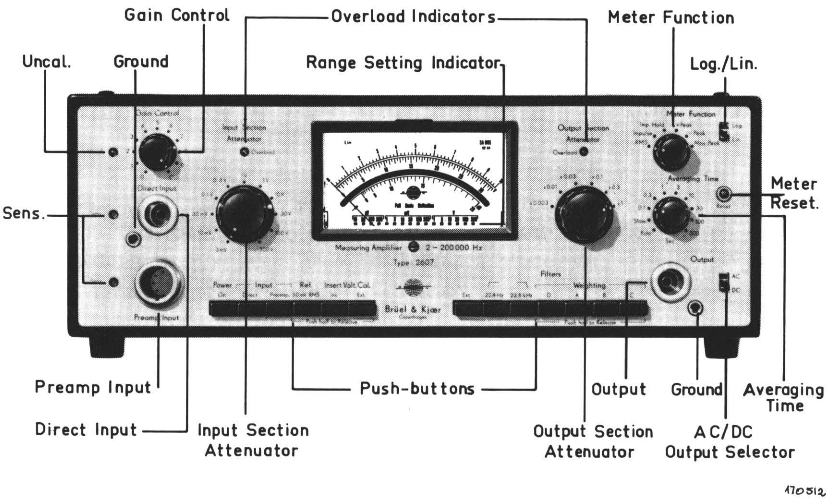


Fig.2.1. Front Panel of 2607

METER SCALE: Tilt the glass panel forward to slide the scale out.

Immediately below the meter are two rows of push-buttons. Their functions are as follows:

POWER: On/Off push-button for power.

INPUT: "Direct" input or input via "Preamplifier" may be chosen.

REF.: Supplies 50 mV, 1 kHz sine wave signal for internal calibration.

INSERT VOLT. CAL.:	Choice of "Internal" or "External" signal. "Internal" is 50 mV from the 1 kHz sine wave generator. "External" is for connection of a frequency generator via rear panel input. The load impedance is 1 kΩ. For use in connection with microphone input from the Insert Voltage Cathode Follower 2617.
EXT.:	Choice of external or internal filter selection.
22.4 Hz:	High pass filter with cut-off frequency at 22.4 Hz. Sets lower limit of audio frequency range.
22.4 kHz:	Low pass filter with cut-off frequency at 22.4 kHz. Sets upper limit of audio frequency range.
WEIGHTING:	For selection of one of the weighting networks D, A, B or C. When none are selected the amplifier has a linear frequency response from 2 Hz to 200 kHz.

The remaining controls and sockets on the front panel are:

GAIN CONTROL:	For continuous control of gain of the input amplifier. When in position "Cal." the gain is fixed. Maximum attenuation from "Cal." position is 10—11 dB. The control operates with either DIRECT or PREAMP. input selected.
UNCAL.:	This light operates when the GAIN CONTROL knob is in an uncalibrated position.
INPUT SECTION ATTENUATOR:	For attenuation of input signal by 10 dB steps. Voltages marked around the knob show the maximum input voltage (for full scale deflection) for each knob setting. By using the

Gain Control input voltages up to 700 V peak can be measured. See section 3.7.2.

OVERLOAD INDICATORS:	These indicate overload in input or output amplifiers. While the lights flash the meter reading is inaccurate and less than the correct value.
DIRECT INPUT:	Coaxial socket input to the input amplifier. Input impedance 1 MΩ//50 pF. Takes B & K plugs JP 0101.
PREAMP. INPUT:	7 pin socket for connection of B & K microphones via their preamplifiers. Input impedance is 900 kΩ//50 pF.
SENS.:	Two screwdriver operated potentiometers situated by their respective inputs. They adjust the gain of the input amplifier to compensate for different transducer sensitivities. They work independently of each other and each has a range of approx. 14 dB.
OUTPUT SECTION ATTENUATOR:	Stepped attenuator (10 dB steps) for attenuation of the signal level between filter outputs and the output amplifier. To ensure the best possible signal/noise ratio the knob should be kept as far clockwise as possible.
METER FUNCTION:	This selects the appropriate meter characteristics for RMS, Impulse and Peak measurements. In the "Impulse Hold" position the meter will hold the maximum impulse sound level value of the applied signal. In the "Peak" positions, the decay characteristic of the meter is as selected on the AVERAGING TIME control.
LOG/LIN:	Two position switch with the following functions: "Log". Meter display and DC output proportional to the measured dB value. Range 50 dB.

"Lin". Meter display as well as AC and DC outputs directly proportional to the input voltage.

AVERAGING TIME: For the selection of integrating time constants to give averaging and decay times ranging from 0.1 to 300 sec. for RMS and Peak measurements respectively. Time constants are also provided for "Fast" and "Slow" meter damping characteristics according to DIN and IEC standards.

RESET: Discharges the RMS and Peak Rectifier Circuits of the 2607 to reset the meter for RMS, Peak and Impulse measurements.

OUTPUT: Output socket for AC or DC recording. With AC the output impedance is 50Ω and the maximum output is 50 V Peak. The minimum AC load impedance is 16 kΩ//200 pF. With DC the output impedance is 820Ω and the output is from 0 to 4.5 V proportional to the meter deflection. The maximum overrange DC output for the RMS and Impulse modes is 15 V, and for the Peak mode 25 V.

AC/DC: Selects AC or DC output for recording.

2.2. REAR PANEL

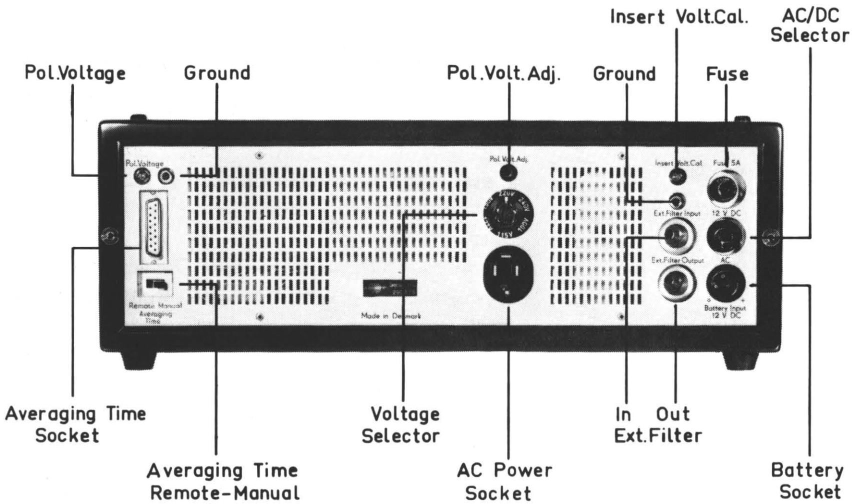


Fig.2.2. Rear Panel of 2607

POL. VOLT. ADJ.: Screwdriver adjustable potentiometer for microphone polarization voltage.

POL. VOLTAGE: Socket for measurement of polarization voltage with an external DC voltmeter having a rating of at least 20 kΩ/Volt. A ground socket is situated to the right of this socket.
NOTE: Only signal ground should be used when checking the polarization voltage. To select signal ground see section 3.1.3.

AVERAGING TIME SOCKET: 15 pin socket for remote selection of averaging and decay times for RMS and Peak measurements respectively.
This socket may also be used for the connection of an overload relay. For connections see section 3.9.

REMOTE-MANUAL: Switch for remote or manual selection of averaging and decay time constants. When in the "Remote" position time constants can be selected remotely via the AVERAGING TIME socket. In "Manual" position time constants selected manually via the AVERAGING TIME switch.

VOLTAGE SELECTOR: For selection of correct mains supply voltage. To turn the selector, unscrew central AC fuse with small coin or wide blade screwdriver.

AC POWER SOCKET: For connection of AC mains supply with provision for connecting one of the transformer shields to the earth of the mains supply. For connections see Fig.2.3.

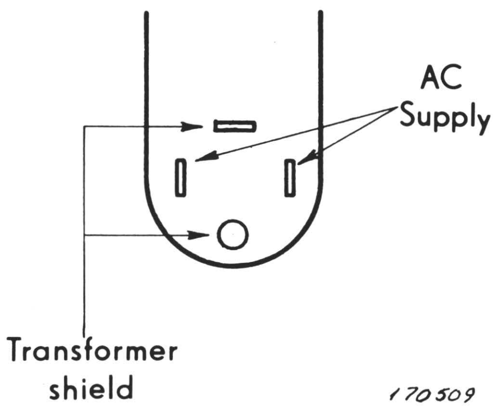


Fig.2.3. AC POWER socket

INSERT VOLT. CAL.: Socket for input signal from external generator. Load impedance 1 kΩ. A ground socket lies immediately below.

FUSE 5 AMP.: 5 Amp fuse for 12 V DC supply.

AC/DC SELECTOR: Switch to select operation from either mains or a 12 V DC supply.

BATTERY SOCKET: 3 pin socket for 12 V DC supply. For connections see Fig.2.4. The plug required is JP 4701.

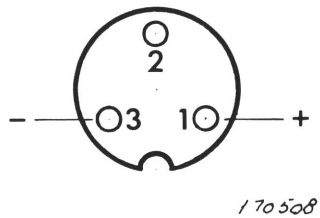


Fig.2.4. BATTERY socket

EXT. FILTER INPUT/OUTPUT: These sockets are for connection to an external filter and fit the standard B & K coaxial plugs. The input impedance of the External Filter Output is 146 kΩ//100 pF, while the output impedance of the External Filter Input is low ($<10\Omega$), but must not be loaded by less than 500Ω. Max. output voltage is 5.6 V peak.

3. OPERATION

3.1. ADJUSTMENTS

3.1.1. Preliminary Adjustments

Before the instrument is used, the following adjustments should be made:

1. With POWER off and any meter scale fitted, set the needle deflection to zero by using the mechanical adjuster under the meter scale.

2. Select "AC" or "DC" operation with the switch at the rear panel.

If an AC power supply is to be used check the voltage selector so that it is set to the correct line voltage. If not, remove the central fuse and adjust with a small coin or screwdriver.

If DC is used, 12 V ± 10% and approx. 2.6 amp. is necessary. It should be noted that with DC operation the scale lamps are not lit (saving 2 Watts). The range indicator lights still operate and show when the instrument is on.

The above adjustments are part of the normal operating procedure, but occasionally it may be found necessary to adjust the polarization voltage and the signal reference.

3.1.2. Polarization Voltage

The polarization voltage should be measured with a DC voltmeter (meter rating 20 kΩ/V) connected to the POL. VOLTAGE socket. Adjustment is carried out using the POL. VOLT. ADJ. potentiometer at the rear of the equipment.

3.1.3. Signal or Chassis Ground

Choice of chassis or signal ground is available to suit the requirements of a particular instrument set-up. Chassis ground is selected by setting the

CHASSIS switch to "On" while signal ground is obtained in the "Off" position. The CHASSIS switch is situated on the main printed circuit board on the underside of the apparatus. See Fig.3.1.

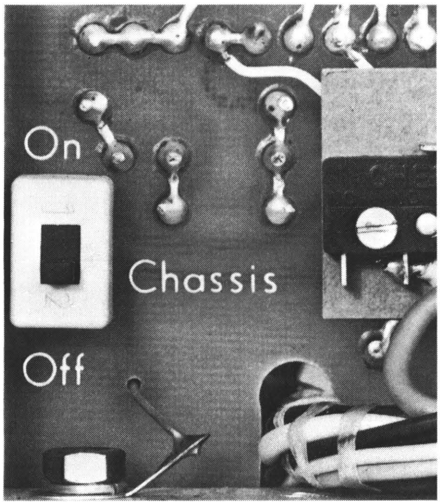


Fig.3.1. CHASSIS switch

3.2. CALIBRATION FOR SOUND MEASUREMENTS

3.2.1. Using Pistonphone or Sound Level Calibrator

1. Carry out the preliminary adjustments, if necessary.
2. Fit the meter scale appropriate to the sensitivity of the microphone being used. See Table 3.1.
3. Fit the microphone and associated preamplifier.
4. Set controls:

GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS"
AVERAGING TIME	"Fast"
REMOTE-MANUAL	"Manual"

5. Set the INPUT SECTION ATTENUATOR so that 120 dB (for pistonphone calibration) or 90 dB (for Sound Level Calibrator calibration) is indicated as the zero level on the meter scale.

Microphone Open Circuit Sensitivity	B & K Microphone Type	Scale No.
26 – 80 mV per N/m^2	4131 4132 4144 4145	SA 0056
2.5 – 10 mV per N/m^2	4133 4134	SA 0057
0.80 – 2.6 mV per N/m^2	4135 4136	SA 0060
0.4 – 1.6 mV per N/m^2	4138	SA 0083

Table 3.1. Microphone scales for use with 2607

6. Select the appropriate INPUT push button.
   Do not select any weighting network.
   Switch on and allow 30 sec for the 2607 to warm up.
7. Using a Pistonphone 4220 or Sound Level Calibrator 4230 the meter should read* 124 or 94 dB respectively. If it does not, adjust the SENS. potentiometer beside the input socket that is being used, until the correct deflection is obtained.

3.2.2. Using Internal Reference Voltage

1. Carry out the preliminary adjustments, if necessary.
2. Fit the meter scale appropriate to the sensitivity of the microphone being used. See Table 3.1.
3. Fit the microphone and associated preamplifier.
   Any microphone accessories can remain in position.
4. Set controls:

GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	"0.1 V"
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS"
AVERAGING TIME	"Fast"
REMOTE-MANUAL	"Manual"

*For the exact sound pressure, the Pistonphone or Sound Level Calibrator calibration chart should be consulted.

5. Select push buttons:
   "Ref."
   INPUT as appropriate
   Switch on and allow 30 sec. for the 2607 to warm up.
6. From the calibration chart of the microphone in use, determine its Open Circuit Sensitivity in mV per N/m^2. This must be corrected for the attenuation and capacitive loading of the preamplifier. For the Type 2619 Preamplifier with half inch or one inch microphones, the total change in sensitivity is less than 0.5 dB. For other types of preamplifier and other microphones, refer to the instruction manual for the preamplifier.
7. Using a small screwdriver adjust the SENS. potentiometer beside the input socket that is being used, until the required sensitivity is indicated on the meter scale marked Open Circuit Sensitivity.

3.3. MEASUREMENT OF SOUND

1. Calibrate the meter and microphone as described in section 3.2.
2. Hold the microphone steadily and at least 1 m away from the body or set it up on a tripod or other support that will not interfere with the sound field.
3. Select the weighting network to be used.
4. Keeping the OUTPUT SECTION ATTENUATOR in the "x 1" position as much as possible, adjust the INPUT SECTION ATTENUATOR to obtain a suitable meter deflection without overload.
   If the INPUT OVERLOAD lamp flashes turn the INPUT SECTION ATTENUATOR up.
   If the OUTPUT OVERLOAD lamp flashes turn the OUTPUT SECTION ATTENUATOR up.
5. The measured Sound Level or Sound Pressure Level is the sum of the meter reading and the attenuator setting displayed by the indicator lamp on the meter scale.
   In reporting sound levels it should always be stated which weighting network has been used, e.g. 60 dB (A), 60 dB (D) or for impulse measurements 60 dB (AI).
   The maximum SPLs that can be measured accurately with 1 inch and 1/2 inch microphones with respect to the crest factor of the signal can be seen in Fig.3.2.

For further information on sound measurements the booklet "Acoustic Noise Measurements" is available on request.

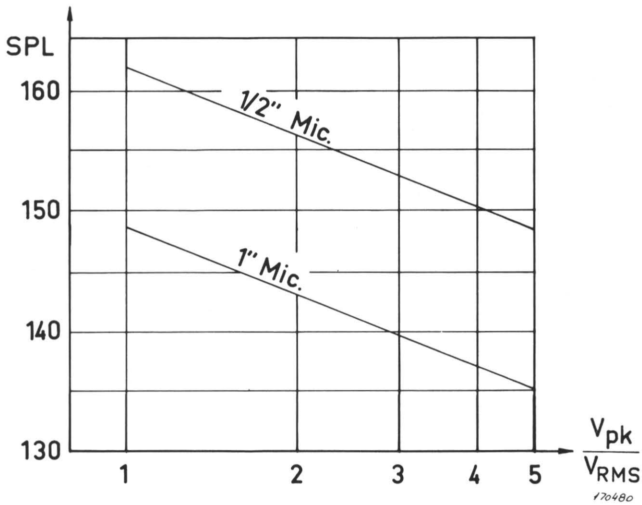


Fig.3.2. Max. SPL for 1 inch and 1/2 inch microphones

3.4. CALIBRATION FOR VIBRATION MEASUREMENTS

3.4.1. Using Accelerometer Calibrator 4291

1. Carry out the preliminary adjustments, if necessary.
2. Fit the meter scale appropriate to the sensitivity of the accelerometer being used. See Table 3.2.
3. Fit the accelerometer and associated preamplifier.
4. Set knobs:

GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"Max. Peak"
AVERAGING TIME	"Fast"
REMOTE-MANUAL	"Manual"

5. Set the INPUT SECTION ATTENUATOR so that a full scale deflection of 1 g is indicated on the indicator lights of the meter scale.
6. Select push-button INPUT "Preamp." or INPUT "Direct" according to requirement. Switch on and allow 30 sec. for the 2607 to warm up. Do not select any weighting networks.
7. Using the Acceleration Calibrator 4291 vibrate the accelerometer at 1 g peak.

Accelerometer Sensitivity mV/g	B & K Accelerometer Type	Scale No.
1.7– 6	4344	SA 0142
6– 17	4339 4343 4333 4335 4340	SA 0058
17– 60	4332 4334	SA 0143
60–170	4338	SA 0144

Table 3.2. Accelerometer scales for use with 2607

8. With a screwdriver adjust the SENS. potentiometer beside the input socket that is being used, until a deflection of 1 g Peak is obtained on the meter scale.

3.4.2. Using Internal Reference Voltage

1. Carry out the preliminary adjustments, if necessary.
2. Fit the meter scale appropriate to the sensitivity of the accelerometer being used.
3. Fit the accelerometer and appropriate preamplifier.
4. Switch on the instruments and allow 30 sec. for the 2607 to warm up before proceeding with calibration.
5. From the calibration chart of the accelerometer, calculate what acceleration level corresponds to a voltage output from the preamplifier of 50 mV RMS. For example if a B & K Type 4343 accelerometer of sensitivity 10.1 pC/g is used with a Type 2624 Charge Amplifier on a gain setting of 1 mV/pC, a voltage level of 50 mV RMS is produced by a signal of 4.95 g RMS.
6. Set the controls of the Amplifier to:

GAIN CONTROL	"Cal."
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS"
AVERAGING TIME	"Fast"
REMOTE-MANUAL	"Manual"
INPUT	as appropriate

7. Set the INPUT SECTION ATTENUATOR so that the acceleration level calculated in item 5 will appear on-scale. For the example given, the meter scale indication should be set for a full scale deflection of 10 g.
8. Select the "50 mV RMS" push-button and adjust the SENS. potentiometer beside the input socket in use so that the acceleration level calculated in item 5 is correctly indicated on the meter.

3.5. MEASUREMENT OF VIBRATION

1. Calibrate the meter as described in section 3.4 and if required turn the METER FUNCTION switch to "RMS".
2. Mount the accelerometer as rigidly as possible onto the measurement object, taking care to avoid cable whip.
3. Keep the 2607 as far away as possible from the vibration environment and any other unrequired influences.
4. Keeping the OUTPUT SECTION ATTENUATOR in the "x 1" position as far as possible, adjust the INPUT SECTION ATTENUATOR to obtain a suitable deflection without overload.
   If the INPUT OVERLOAD lamp flashes, turn up the INPUT SECTION ATTENUATOR knob.
   If the OUTPUT OVERLOAD lamp flashes, turn the OUTPUT SECTION ATTENUATOR up.
   For further information on vibration measurements the booklet "Mechanical Vibrations and Shock Measurements" is available on request.

3.6. CALIBRATION FOR VOLTAGE MEASUREMENTS

1. Carry out the preliminary adjustments, if necessary.
2. Fit voltage scale (SA 0051, SA 0052 or SA 0053).
3. Set knobs on 2607 to:

GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	"0.1 V"
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS"
AVERAGING TIME	"Fast"
REMOTE-MANUAL	"Manual"

4. Select push-buttons:

REF.	
INPUT	as required

   Do not select any filter.

The needle should now deflect to the red mark on the scale (i.e. indicate 50 mV). If it does not, adjust the SENS. potentiometer beside the appropriate INPUT socket.

3.7. VOLTAGE MEASUREMENTS

3.7.1. Input Voltages up to 300 Volts RMS

1. Calibrate the 2607 as described in section 3.6.
2. Set knobs:

GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	At suitably high level
OUTPUT SECTION ATTENUATOR	"x 1"
METER FUNCTION	"RMS"
AVERAGING TIME	"Fast", or as appropriate for analysis
REMOTE-MANUAL	"Manual"

3. Select push-button:

INPUT	as appropriate

4. Feed the unknown voltage to the appropriate INPUT, and adjust the INPUT SECTION ATTENUATOR until a suitable deflection is obtained. If the deflection is insufficient, even when the INPUT ATTENUATOR is in its 3 mV range, then adjust the OUTPUT ATTENUATOR.

3.7.2. Input Voltages up to 700 Volts Peak

Use can be made of the GAIN CONTROL to accommodate input voltages of up to 700 V peak. 700 V peak is the maximum peak input voltage rating of the 2607 when the 0.3 V to 300 V range settings of its INPUT SECTION ATTENUATOR are employed. For INPUT SECTION ATTENUATOR range settings of 3 mV to 0.1 V the maximum peak input voltage rating is 310 V peak for signal frequencies less than 60 Hz, 165 V peak for signal frequencies less than 400 Hz and 20 V peak for signal frequencies above 400 Hz. Under no circumstances should these maximum ratings be exceeded, as otherwise the instrument will be damaged.

To measure voltages up to 700 V peak the 2607 must first be calibrated to give exactly 10 dB attenuation.

To do this proceed as follows:

1. Repeat the calibration procedure in section 3.6.
2. With the needle set on the red mark (50 mV) set the INPUT ATTENUATOR to 30 mV causing the needle to deflect off scale.
3. Adjust the GAIN CONTROL to bring the needle back to the red mark. The 2607 is then calibrated so that 10 dB must be added to the value of all meter indications.

3.8. INSERT VOLTAGE CALIBRATION

When a Cathode Follower Type 2617 is used in conjunction with the 2607, 1 inch microphones can be calibrated by means of the Insert Voltage Method, which is a method for determining the open circuit sensitivity of the microphone. (The open circuit sensitivity of a microphone at a given single frequency is the voltage which appears at its terminals when the microphone is working into an effectively infinite impedance).

The principle of the Insert Voltage Method may be explained with reference to Fig.3.3.

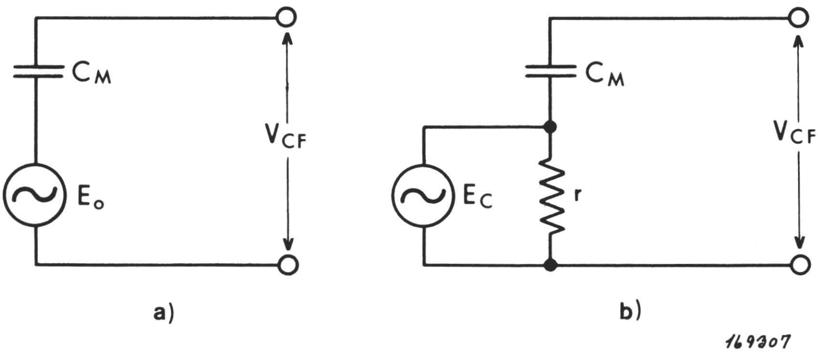


Fig.3.3. Insert voltage calibration of microphone

The condenser microphone (capacitance C_m) is first subjected to a sound pressure level. Let the open circuit voltage produced be E_o and the voltage at the cathode follower output be V_{CF} as in Fig.3.3a.

A small resistor "r" is then connected in series with the microphone and a voltage E_c applied across it as in Fig.3.3b. This insert voltage is adjusted so the voltage from the cathode follower is V_{CF} as before. Then $E_o = E_c$ and the open circuit sensitivity can be calculated from:

$$\text{Open Circuit Sensitivity} = \frac{E_c}{\text{sound pressure}}$$

When the 2617 is used with the 2607 the insert voltage E_c can be supplied in two ways. The internal oscillator can be used to give a voltage at a fixed frequency of 1 kHz or an external generator such as the Beat Frequency Oscillator 1022, can be used to give a signal at any other required frequency. With the internal reference oscillator a Sound Level Calibrator 4230 (frequency 1000 Hz) is an ideal sound source and with an external generator the Pistonphone 4220 (frequency 250 Hz) can also be used.

The procedures are as follows:

3.8.1. Using the Internal Reference Voltage

1. Fit the microphone to the 2617 preamplifier, and connect to the "Preamp." input of the 2607.
2. Apply the Sound Level Calibrator 4230 to the microphone and note the voltage produced from the cathode follower, V_{CF}.
3. Remove the sound source, depress the push-button "Int. Insert Volt. Cal." and adjust the GAIN CONTROL until V_{CF} is the same as before.
4. When this occurs the calibration voltage, E_c, from the reference oscillator is equivalent to the open circuit voltage of the microphone E_o. To measure the calibration voltage, press the "Ref." button and read it from the meter without readjusting the GAIN CONTROL. Then:

$$\text{Open Circuit Sensitivity} = \frac{E_c}{\text{sound pressure}}$$

N.B. The sound level calibrator produces a sound pressure* of 94 dB re 2.10^{-5} $N/m^2 = 1$ N/m^2 or 10 μbar.

3.8.2. Using an External Generator

1. Connect the external generator to the INSERT VOLT. CAL. socket on the rear panel of the 2607.

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* For the exact sound pressure the Pistonphone or Sound Level Calibrator calibration chart should be consulted.

2. Fit the microphone to the 2617 preamplifier and connect to the "Preamp." input.
3. Apply the sound source to the microphone and note the voltage produced from the cathode follower V_{CF}.
4. Remove the sound source. Adjust the frequency of the external generator to be the same as that of the sound source. Depress the push-button "Ext. Insert Volt. Cal." and adjust the output from the generator until V_{CF} is the same as before.
5. When this occurs the calibration voltage, E_c, is equivalent to the open circuit voltage of the microphone E_o. To measure the calibration voltage take a lead from the "Direct" input socket to the INSERT VOLT. CAL. socket to which the generator is connected. The calibration voltage can be read directly from the meter and the microphone's open circuit sensitivity determined.

$$\text{Open Circuit Sensitivity} = \frac{E_c}{\text{sound pressure}}$$

N.B. If the Pistonphone is used it produces a sound pressure* at 250 Hz of 124 dB re 2.10^{-5} N/m^2 = 31.6 N/m^2 or 316 μbar.

3.9. USE OF THE AVERAGING TIME SOCKET

The main uses of the AVERAGING TIME SOCKET of the 2607 are for the remote selection of averaging and decay time constants for RMS and

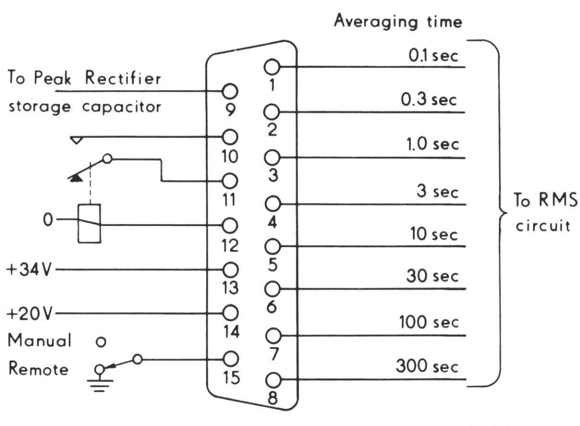

Fig.3.4. Internal connections to the AVERAGING TIME SOCKET of the 2607

Peak Measurements. However, it may also be employed as a remote reset for the meter in "Impulse Hold" measurements, or where a long decay time is to be cancelled, and to provide a remote indication of overload, for example when a recording is made using the 2305 Level Recorder. Connection of the socket is shown in Fig.3.4.

3.9.1. Remote selection of Averaging Time or Decay Time Constant

For the remote selection of averaging times and decay time constants, the AVERAGING TIME and REMOTE-MANUAL switches of the 2607 should be set to "300 sec." and "Remote" respectively. By shorting pin 15 to either of pins 1, 2, 3, 4, 5, 6, 7 or 8 as suggested in Fig.3.5, averaging times from 0.1 to 300 sec. may be selected.

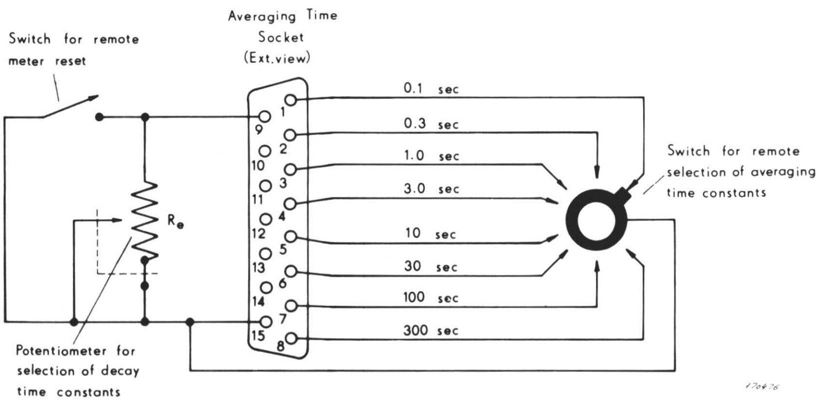

Fig.3.5. Remote selection of averaging and decay times using the AVERAGING TIME socket

Connection of a potentiometer to pins 15 and 9 of the socket connects the potentiometer directly across the Peak Rectifier storage capacitor. Adjustment of the potentiometer's resistance permits any decay time constant between 0.1 and 300 sec. to be selected according to:

$$TC = C_A \frac{R_A R_e}{R_A + R_e}$$

where C_A are R_A are the capacitance and resistance of the Peak Rectifier's decay time constant (3 μF and 100 MΩ respectively) and R_e is the resistance of the external potentiometer connected across it.

It should be noted that when decay time constants for peak measurements are selected remotely the 400 msec. peak meter hold facility is removed and consequently the accuracy of the meter reading cannot be guaranteed. However, the removal of the 400 msec. peak hold does have the overriding advantage that measurements of complex signals with peak repetition times less than 400 msec. can be made. For these measurements the DC OUTPUT may be used as its accuracy is not affected.

3.9.2. Remote Meter Reset

On a similar basis to the remote selection of averaging time or decay time constants, the AVERAGING TIME socket can be used to provide a remote meter reset facility. This is particularly useful when measuring impulsive signals with a long decay time constant selected and for "Impulse Hold" measurements. The rear panel REMOTE/MANUAL switch should be in its "Remote" position and the meter is then reset by a short circuit of pins 9 and 15 on the AVERAGING TIME socket.

3.9.3. Remote indication of overload

When recording from the 2607 any overload of its amplifiers can be automatically noted on the recording paper so avoiding mistakes in interpreting results. For this the overload relay of the 2607 can be used to operate either the Pen Lift or the Event Marking Pen of the Level Recorder.

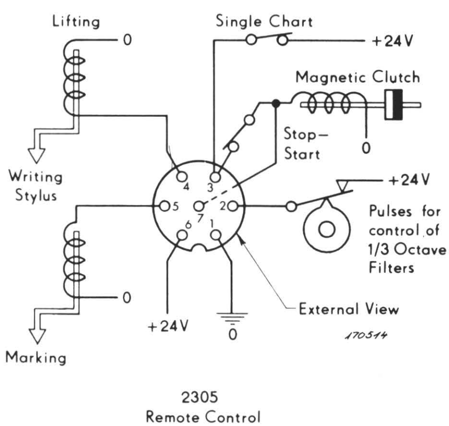

Fig.3.6. 2305 REMOTE CONTROL socket

To operate the Pen Lift short pins 12 and 13 of the AVERAGING TIME socket and connect pins 10 and 11 of the socket to pins 4 and 6 of the Level Recorder's REMOTE CONTROL socket. Connection of this socket of the Level Recorder is shown in Fig.3.6.

3.9.4. Operation of 2607 with Filter Set 1612

On occasions when it is required to use the Third Octave Filter Set 1612 with the 2607, and a 2305 Level Recorder is not employed, it is necessary to provide power for the output amplifier of the 1612. This could normally be provided by the remote control connection to the Level Recorder (connecting pin 6 of the 2305's REMOTE CONTROL to pin 5 of the 1612's REMOTE CONTROL, in addition to the normal switching cable AQ 0002). However, if the Level Recorder is not required, + 20 V DC can be provided from pin 14 of the AVERAGING TIME socket of the 2607. The power input to the 1612 is pin 5 of the 1612's REMOTE CONTROL socket. The negative return for the supply is via the screens of the coaxial cables used for connecting the INPUT and OUTPUT sockets of the Filter Set to the respective EXTERNAL FILTER INPUT and OUTPUT sockets of the 2607.

4. DESCRIPTION

The principle of operation of the 2607 will be described with reference to the block diagram of Fig.4.1.

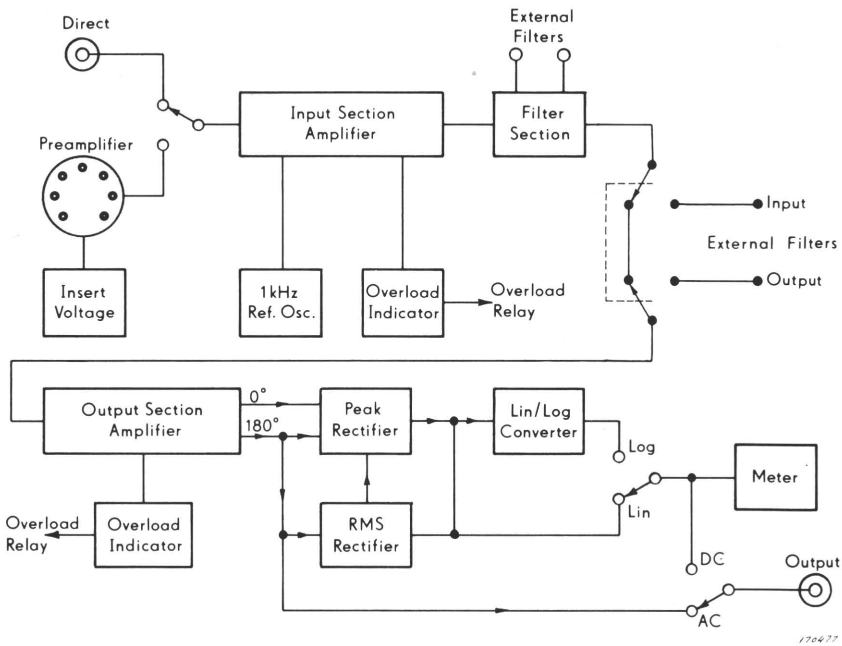

Fig.4.1. Block diagram of 2607

4.1. INPUT CIRCUIT AND INPUT AMPLIFIER

There are two alternative input sockets. One is the standard B & K coaxial socket. The other accepts the seven pin plugs of the B & K preamplifiers, supplying stabilized voltages for the preamplifiers and the 200 Volts polarization required for the condenser microphones.

Both inputs lead to the INPUT SECTION ATTENUATOR. This attenuator steps down the input signal in accurate 10 dB steps and can give a maximum attenuation of 100 dB. In the least sensitive position, voltages up to 300 Volts RMS can be measured, but if the extra attenuation of the GAIN CONTROL is used as well, input voltages up to 700 Volts peak can be measured. The GAIN CONTROL attenuator and the SENS. potentiometers are located in the first amplifier, varying feedback to adjust the overall gain of the amplifier. The GAIN CONTROL adjusts the gain of the first amplifier for both "Preamp." and "Direct" inputs. The two SENS. potentiometers adjust only the gain of the appropriate input, and are intended as compensation for different transducer sensitivities. The two sensitivity adjusters have an attenuation range of about 14 dB.

The first amplifier has a maximum gain of 50 dB. To obtain the best signal/noise ratio the amplifier is divided into two sections with an attenuator section in between. Both sections are similar, but on the first there is a balanced input stage to regulate the sensitivity of the two input sockets.

The first amplifier and its attenuator are to the same design as those of the Type 2606 Measuring Amplifier.

4.2. REFERENCE OSCILLATOR

A reference oscillator is built into the 2607 for calibration purposes. It is selected by push-button REF. and produces a stabilized sinusoidal voltage of 50 mV at 1000 Hz. Signal distortion is less than 2% and amplitude and frequency stability are both better than 2%.

4.3. INPUT OVERLOAD INDICATOR

When using the 2607 without any filters or weighting networks selected, it can be estimated that overload of the amplifiers exists from the overdeflection of the indicating meter. However when filters or weighting networks are employed certain signal components will be attenuated and will not show up on the meter even though the Input Section may be overloaded. Hence an overload detection circuit is placed immediately after the input amplifier.

The overload detection circuit is a form of comparator and operates an indicator lamp when the output of the Input Amplifier exceeds 5.6 V peak. The overload indicators will remain operating for more than 0.5 sec. even though the overload duration may be as short as 200 μsec.

The input overload indicator is connected in parallel with the output overload indicator so that when either one, or both are operated the overload relay is triggered. The overload relay output is via the AVERAGING TIME SOCKET (see section 3.9).

4.4. FILTER SECTION

Included in the 2607 are six filters, each having an input impedance of 146 kΩ. Fig.4.2 shows their characteristics. The A, B, C and D networks comply with the basic shape and tolerances set by the proposed amendment to the IEC Recommendation 179 for precision sound level meters (see Table 4.1). It should be noted that the tolerances set by the IEC amendment apply for the complete instrument with the microphone and preamplifier in a free sound field, with normal incidence of the sound pressure waves on the microphone's diaphragm.

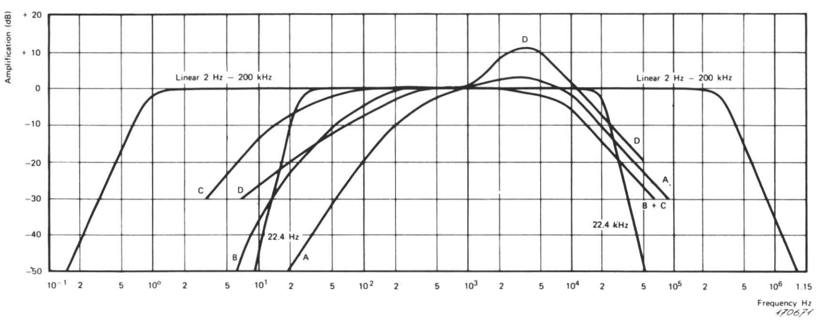

Fig.4.2. Characteristics of internal filters and weighting networks

The frequency range of the 2607 within ±0.5 dB band limits is 2 Hz to 200 kHz. However, in various measurements it is convenient to limit frequencies at either end or both ends of the pass band. This facility is provided by the internal 6-pole Butterworth high-pass and the 5-pole Butter-

Frequency Hz	Curve A dB	Curve B dB	Curve C dB	Tolerance Limits (dB) for Curves A, B and C		Curve D dB	Tolerance Limits (dB) for Curve D	
10	−70.4	−38.2	−14.3	3	−∞	−26.5	3.5	−∞
12.5	−63.4	−33.2	−11.2	3.0	−∞	−24.5	3.5	−∞
16	−56.7	−28.5	− 8.5	3.0	−∞	−22.5	3.5	−∞
20	−50.5	−24.2	− 6.2	3.0	−3.0	−20.5	3.5	−3.5
25	−44.7	−20.4	− 4.4	2.0	−2.0	−18.5	2.5	−2.5
31.5	−39.4	−17.1	− 3.0	1.5	−1.5	−16.5	2.0	−2.0
40	−34.6	−14.2	− 2.0	1.5	−1.5	−14.5	2.0	−2.0
50	−30.2	−11.6	− 1.3	1.5	−1.5	−12.5	2.0	−2.0
63	−26.2	− 9.3	− 0.8	1.5	−1.5	−11	2.0	−2.0
80	−22.5	− 7.4	− 0.5	1.5	−1.5	− 9	2.0	−2.0
100	−19.1	− 5.6	− 0.3	1.0	−1.0	− 7.5	1.5	−1.5
125	−16.1	− 4.2	− 0.2	1.0	−1.0	− 6.0	1.5	−1.5
160	−13.4	− 3.0	− 0.1	1.0	−1.0	− 4.5	1.5	−1.5
200	−10.9	− 2.0	0	1.0	−1.0	− 3.0	1.5	−1.5
250	− 8.6	− 1.3	0	1.0	−1.0	− 2.0	1.5	−1.5
315	− 6.6	− 0.8	0	1.0	−1.0	− 1.0	1.5	−1.5
400	− 4.8	− 0.5	0	1.0	−1.0	− 0.5	1.5	−1.5
500	− 3.2	− 0.3	0	1.0	−1.0	0	1.5	−1.5
630	− 1.9	− 0.1	0	1.0	−1.0	0	1.5	−1.5
800	− 0.8	0	0	1.0	−1.0	0	1.5	−1.5
1000	0	0	0	1.0	−1.0	0	1.5	−1.5
1250	0.6	0	0	1.0	−1.0	2.0	1.5	−1.5
1600	1.0	0	− 0.1	1.0	−1.0	5.5	1.5	−1.5
2000	1.2	− 0.1	− 0.2	1.0	−1.0	8.0	1.5	−1.5
2500	1.3	− 0.2	− 0.3	1.0	−1.0	10	1.5	−1.5
3150	1.2	− 0.4	− 0.5	1.0	−1.0	11	1.5	−1.5
4000	1.0	− 0.7	− 0.8	1.0	−1.0	11	1.5	−1.5
5000	0.5	− 1.2	− 1.3	1.5	−1.5	10	2.0	−2.0
6300	− 0.1	− 1.9	− 2.0	1.5	−2.0	8.5	2.0	−2.5
8000	− 1.1	− 2.9	− 3.0	1.5	−3.0	6.0	2.0	−3.5
10000	− 2.5	− 4.3	− 4.4	2.0	−4.0	3.0	2.5	−4.5
12500	− 4.3	− 6.1	− 6.2	3.0	−6.0	0	3.5	−6.5
16000	− 6.6	− 8.4	− 8.5	3.0	−∞	− 4.0	3.5	−∞
20000	− 9.3	−11.1	−11.2	3.0	−∞	− 7.5	3.5	−∞

Table 4.1. Weighting network characteristic and tolerances, in accordance with the proposed amendments (March 1970) to the IEC Publication 179

worth low-pass filter networks which have cut-off frequencies of 22.4 Hz and 22.4 kHz respectively. Both filters are active networks and may be connected in series with the weighting networks as well as with any external filters connected.

The characteristics of the high and low pass filters are given in Figs.4.3 and 4.4 respectively. These show that the tolerances of the attenuation slopes of the filters are within those set by the IEC Recommendation 223.

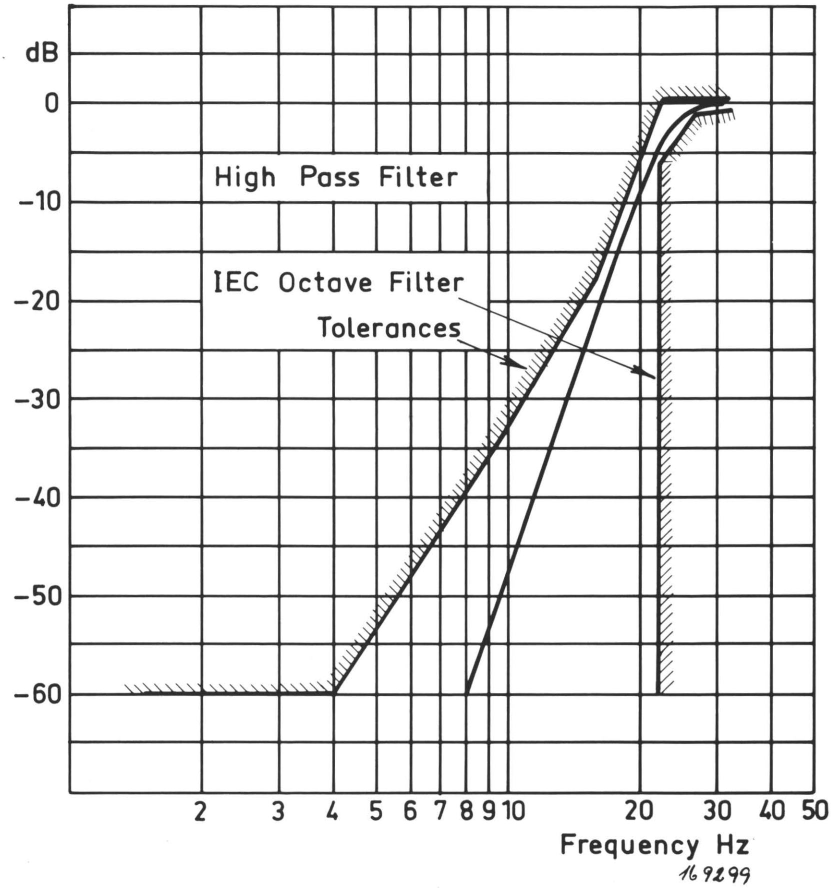

Fig.4.3. Characteristic of the 22.4 Hz High Pass Filter

4.5. OUTPUT SECTION AMPLIFIER

As with the Input Amplifier, the Output Section Amplifier is split up into a number of stages. The first stage includes a field effect transistor at its input to reduce the loading on the filters and to give the best overall signal to noise ratio. The first stage also includes a low-pass filter and the first section of the output attenuator. The filter has an attenuation slope of 18 dB/Octave and a 330 kHz cut-off frequency.

This is followed by a 20 dB amplifier stage and the second section of the

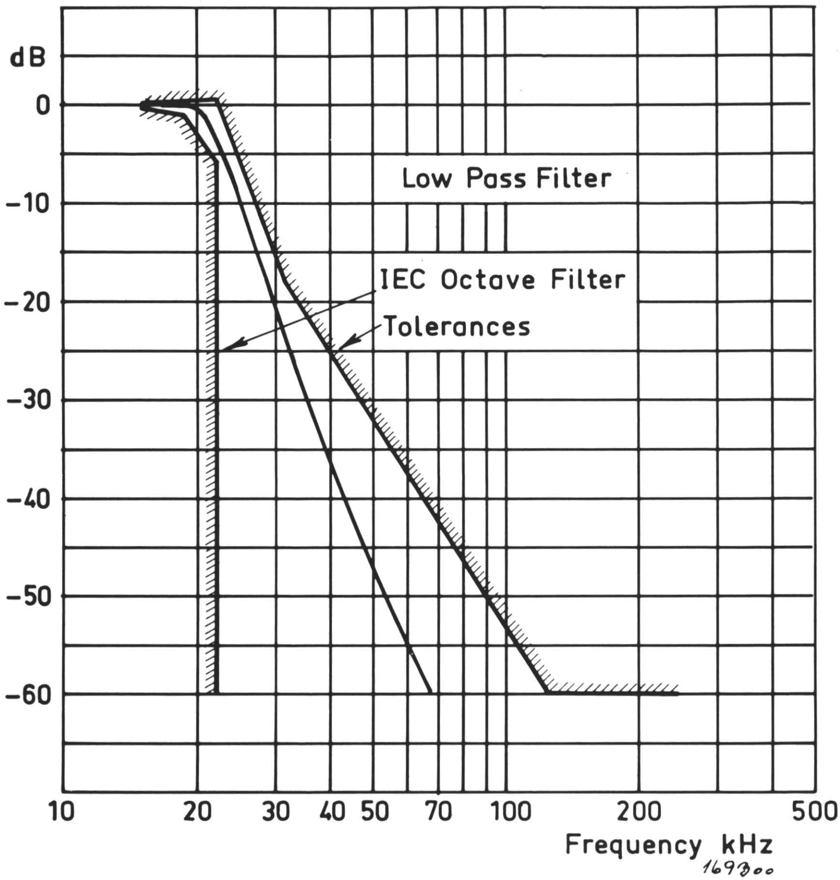

Fig.4.4. Characteristic of the 22.4 kHz Low Pass Filter

output attenuator. The two output attenuator sections are ganged and attenuate the amplified signal by up to 50 dB in accurate 10 dB steps.

The remaining amplifier stage of the Output Section splits the signal into two components, one in phase with the input signal which is amplified by 40 dB and the other 180^{o} out of phase (inverted) which is amplified by 50 dB.

For a meter reading, outputs are taken of both signals, while for an AC recording only the inverted signal is used and is available at the OUTPUT socket when the AC mode is selected.

4.6. OUTPUT OVERLOAD INDICATOR

In order to safeguard against signals of too high a peak value overdriving the RMS and Peak Rectifier circuits of the 2607, an Output Overload Indicator is provided. It is fitted to the two outputs of the Output Section and is triggered when the in-phase signal output exceeds 17.7 V peak or the inverted signal output exceeds 56 V peak. Its mode of operation is similar to that of the Input Overload Indicator (section 4.3) and it also is connected to the overload relay for remote indication via the AVERAGING TIME socket (section 3.9).

4.7. RMS DETECTION AND AVERAGING

Circuits for extracting the RMS value of an alternating signal consists in principle of squaring, averaging, and root extracting sections, as illustrated in Fig.4.5a. The Brüel & Kjær RMS detectors, however, modify this general principle by feeding back the voltage on the averaging capacitor to produce a "variable squaring" characteristic, as in Fig.4.5b, removing the necessity for a square root operation. The principle of the circuit and its difference

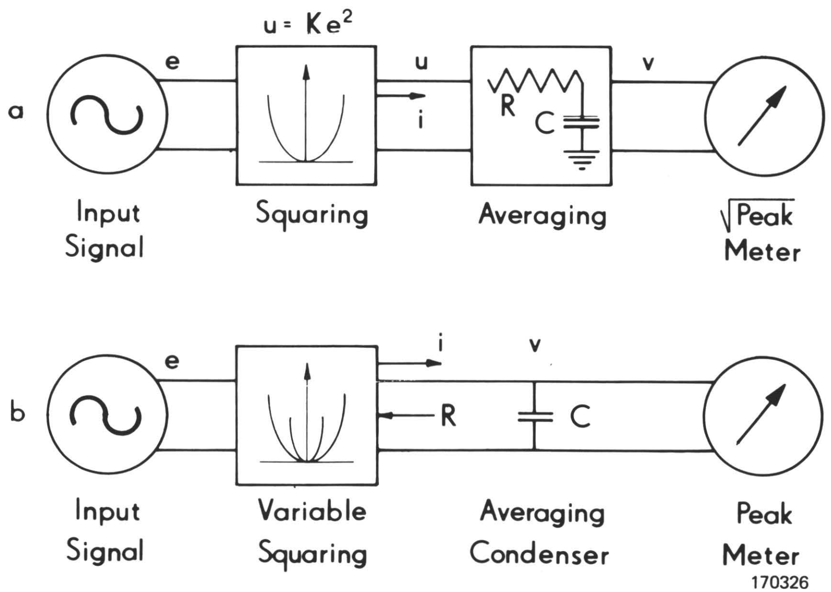

Fig.4.5. Principles of RMS Rectifier Circuit

from conventional RMS detectors is discussed in the Brüel & Kjær Technical Review, 1969 No. 1 ("Impulse Noise Measurements" by C. G. Wahrmann). The effective averaging time of the RMS circuit is approximately equal to the RC time constant of the detector (see also section 5.2).

A schematic diagram to illustrate the principle of the RMS detector of the 2607 is shown in Fig.4.6. At the input of the detector the inverted AC signal from the Output Section is amplified 20 dB and split into two components, one in phase with the Output Section signal and the other 180^{o} out of phase. These two signals are then applied to the two rectifying diodes D_1 and D_2 of the RMS Rectifier (Fig.4.6) which are biased off by a voltage on the averaging capacitor C_A. When the signal level at either of the rectifier inputs exceeds the level of the averaging capacitor bias, the diodes D_1 and

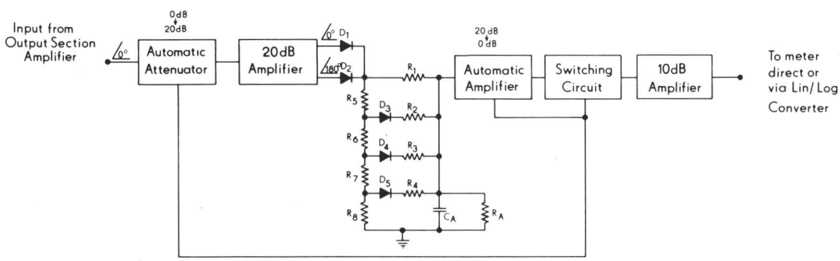

Fig.4.6. Schematic of RMS Rectifier Circuit

D_2 will conduct. If the instantaneous signal level is increased further, the rectifier current will rise linearly to charge the averaging capacitor via the resistor R_1 and to raise the voltage levels at the junctions of the resistance chain R_{5-8}. The resistance chain determines the instantaneous signal level for which the diodes D_{3-5} will conduct. As each diode conducts, the value of the averaging capacitor's charging resistance, set by R_{1-4}, is reduced, causing the slope of the rectifier current v. instantaneous input voltage curve to increase. The magnitude of the resistors can be selected to form a parabola, which is the characteristic required from the squaring circuit. Fig.4.7 illustrates this principle if the full scale deflection curve is considered, for which the slope of inclined line is due to resistor R_1 (Fig.4.6). As the diodes D_{3-5} switch in parallel resistors, so the slope of the inclined line will be increased in a series of limbs to improve the approximation to the ideal parabola at high instantaneous values of the input voltage e. The three diodes provide a total of five limbs on the parabola approximation, permitting the detector to measure signals with crest factors up to 5 with an accuracy of ± 0.5 dB.

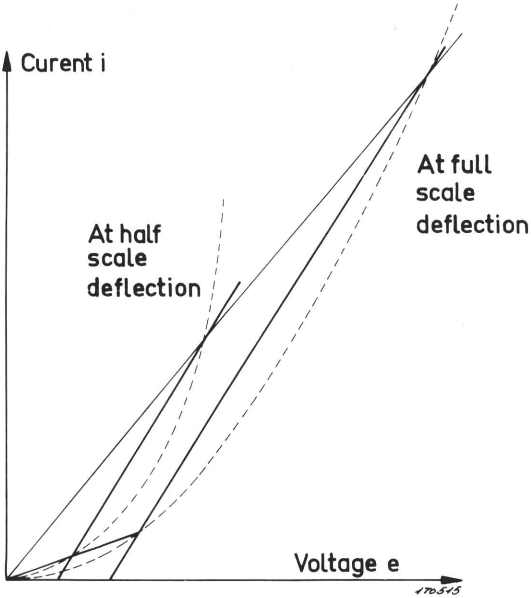

Fig.4.7. Current-Voltage characteristic of RMS detector

As the charge on the averaging capacitor is changed so is the voltage across the averaging capacitor. This alters the bias applied to the diodes, resulting in a displacement of the RMS Rectifier's characteristic. The whole effect is equivalent to a multiplication of the parabola's size by a constant factor equal to that by which the voltage on the averaging capacitor was changed. From Fig.4.7 it can be seen that this corresponds to a root extraction process, as the charging current is now proportional to the input voltage. Consequently the RMS circuit's output will be linear even though the RMS Rectifier's instantaneous voltage characteristic is a parabola.

At the same time as the averaging capacitor C_A is charged a discharge current proportional to the voltage across the averaging capacitor flows through the averaging resistor R_A. Therefore if the voltage on the averaging capacitor remains constant for a period of time equal to or exceeding the time constant of the averaging network (C_A in parallel with R_A) the charging current can be considered proportional to the RMS value of the input voltage.

The averaging circuit of the 2607 is rather more complex than the schematic (Fig.4.6) implies, since it is in fact made up of a number of averaging networks which give averaging times ranging from 0.1 to 300 sec. and includes time constants which give "Fast" and "Slow" meter response characteristics. A time constant is also provided to give the 35 m sec. rise time recommended by DIN 45633 and the extension proposal for IEC 179 for Impulse Sound Level Meters.

The averaging capacitors in the RMS Rectifier of the 2607 are all interconnected using FET gates which may be controlled from either the REMOTE CONTROL socket or the AVERAGING TIME switch of the 2607. This permits automatic as well as manual selection of averaging times. The gates allow all the averaging capacitors in the circuit to charge to the level of the RC network selected. This does not alter the averaging time of the selected network, but does prevent it from discharging unnecessarily and producing a temporarily inaccurate output or meter reading when a longer averaging time is selected.

To obtain the widest possible dynamic range for the RMS Rectifier, two attenuators are employed in the RMS circuit. These are operated automatically via a Switching Circuit which is triggered when the signal level is higher than that corresponding to 20 dB below FSD (Full Scale Deflection). When triggered, the attenuators effectively attenuate the signal level at the input to the RMS Rectifier by 20 dB and boost its output by an equal amount. The attenuators are automatically reset by the Switching Circuit when the meter indication falls to 25 dB below FSD. The 5 dB difference between the Switching Circuits triggering levels removes the possibility of signal ripple causing the dynamic range to be extended accidentally. The overall RMS circuit gain is therefore not changed, but the dynamic range is, and is extended to 50 dB.

The linear DC output from the RMS Rectifier which is now proportional to the RMS value of the signal applied to the 2607 is amplified 10 dB by the final stage of the RMS circuit and passed to the display meter or to the Lin/Log Converter. The RMS value can be read directly from the meter when it is used with any one of the Lin meter scales supplied with the 2607.

4.8. PEAK RECTIFIER

Three types of peak measurement are possible with the 2607. These are "+ Peak", "—Peak" and "Max. Peak", which can be selected by the METER FUNCTION switch. This switch connects either one or both of the Output

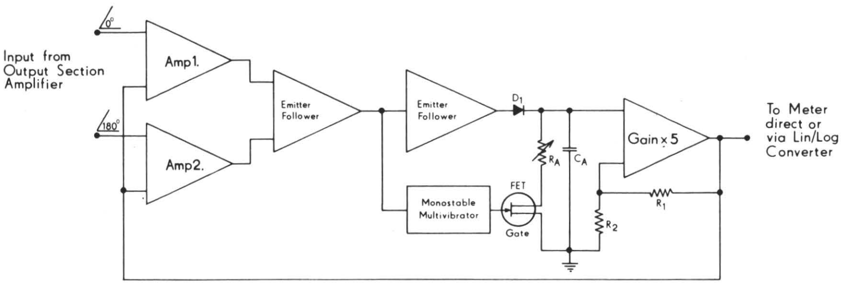

Fig.4.8. Schematic of Peak Rectifier Circuit

Section Amplifier outputs to the Peak Rectifier. A schematic diagram of the Peak Rectifier is given in Fig.4.8.

For "+ Peak" measurements the in-phase signal from the Output Section is attenuated 10 dB by a potential divider and passed to one of the two similar Peak Rectifier differential input amplifiers, the outputs of which are paralleled using two separate emitter follower networks to reduce loading. The input to the second differential input amplifier is left disconnected since it is only used for "–Peak" and "Max. Peak" measurements.

The amplifiers are high gain devices and act as fast voltage switches. With feedback from the Peak Rectifier output their switching action is inhibited so that they produce a pulse with a peak value equal to that of the input signal and with a rise time of approximately 20 µsec. The pulse is then rectified by a peak diode detector and passed to an integrating network where its max. value is stored in a capacitor.

To allow the meter of the 2607 to register signals with peak durations as short as 20 µsec. the output of the first emitter follower also fires a monostable multivibrator which in turn opens a FET gate breaking the storage capacitors discharge path. After approximately 400 msec. the multivibrator closes the gate to discharge the stored signal by introducing a bleed resistance in parallel with the storage capacitor. The discharge time is in fact the product of the storage capacitor and bleed resistance values (i.e. the integrating time constant). Only the bleed resistance is varied to alter the discharge time, and decay time constants from 100 msec. to 300 sec. may be selected manually using the AVERAGING TIME switch.

For removal of the 400 msec. hold and for decay time constants other than those selectable via the AVERAGING TIME switch, but less than

300 sec., an external bleed resistance may be connected directly to the storage capacitor as shown in section 3.9.1. This facility will also be found useful as a remote reset for Peak and Impulse Hold measurements.

The final stage of the Peak Rectifier is a third differential amplifier which feeds the display meter of the 2607, either directly, or via the Lin/Log Converter. Its gain is limited to 14 dB by feedback from its output which also inhibits the switching action of the two differential input amplifiers as mentioned previously.

For "—Peak" measurement the Peak Rectifier processes the inverted signal from the Output Section as if it were a positive peak. The signal is applied to the second differential input, while the in-phase signal to the first is disconnected.

"Max. Peak" measurements are made using both the Output Section outputs, each using one of the two Peak Rectifier inputs. The paralleled outputs of the two emitter followers combine both the positive and the inverted negative peak signals so that only the maximum value of the largest peak is rectified and stored.

The Peak Rectifier may also be utilized for the measurement of impulsive sounds to DIN standards, for which "Impulse" and "Impulse Hold" measurement positions are provided on the METER FUNCTION switch. This connects the RMS circuit to the Peak Rectifier, which except for the removal of the 400 msec. peak hold, measures the RMS voltage in a similar way to that discussed for "+ Peak" measurements.

For measurements using the "Impulse" mode, the METER FUNCTION switch selects an RMS circuit averaging time constant of 35 msec. and Peak Rectifier decay time constant of 3 sec. $\pm$0.5 sec. This is as recommended by the German DIN standard 45633 for Impulse Sound Level Meters. The standard also recommends certain measurement characteristics for the instrument as a whole. These are summarized as follows:

> For a single sinusoidal tone burst, having a frequency of 2 kHz, a duration t_i and a constant amplitude, the reading relative to the reading for the continuous signal shall be as stated in Table 4.2.
>
> For a sinusoidal signals having a frequency of 2 kHz, a duration of 5 msec., a repetition frequency f_p and a constant amplitude, the reading relative to the reading for the continuous signal shall be as stated in Table 4.3.

Tone Burst duration t ms	Reading with respect to reading of continuous signal dB	Tolerance dB
continuous	0	
50	−1.2	±1
20	−3.6	±1.5
10	−6.0	±2
5	−8.8	±2
2	−12.6	±2

Table 4.2. Requirements of DIN 45633 for response of an Impulse Sound Level Meter to single impulses

Repetition frequency f_p Hz	Reading with respect to reading of continuous signal dB	Tolerance dB
continuous	0	
100	−2.7	±1
50	−5.1	±0.5
20	−7.6	±2
10	−8.5	±2
5	−8.7	±2
2	−8.8	±2

Table 4.3. Requirements of DIN 45633 for response of an Impulse Sound Level Meter to repeated impulses

For "Impulse" measurements the 2607 meets the measurement characteristics given. Although the DIN Standard does not directly specify that these characteristics are also applicable for "Impulse Hold" measurements, measurements made using the "Impulse" and "Impulse Hold" modes of the 2607 will give rise to identical meter readings for the test conditions specified. This is because the meter reading for "Impulse" and "Impulse Hold" measurements is determined purely by the peak value of the voltage on the RMS circuit's averaging capacitor, the time constant of which is the same for both types of measurement. The measurement of single impulses will, however, be more easily carried out using the "Impulse Hold" mode, since the decay of the voltage on the Peak Rectifier's storage capacitor is <0.05 dB/sec. at 25°C in this mode. The "Hold" action can be released by pressing the METER RESET button.

4.9. LIN/LOG CONVERTER

For a DC output or meter display proportional to the logarithm of the measured signal dB value the 2607 employs a Lin/Log Converter which has a dynamic range of over 50 dB and a measurement accuracy of ±0.5 dB at 25°C. A schematic diagram of the converter is shown in Fig.4.9.

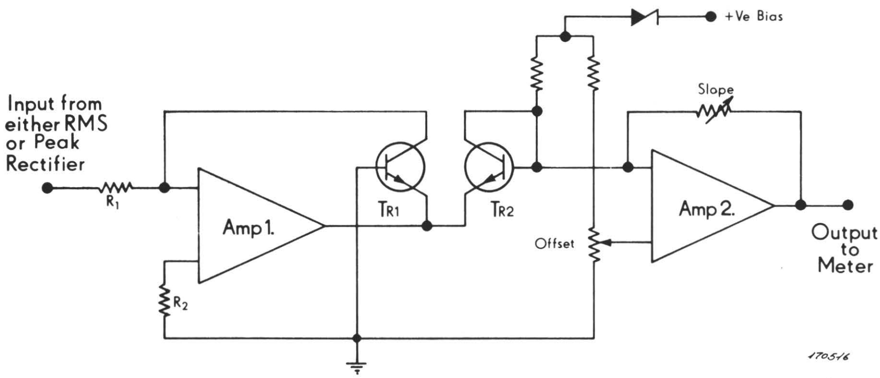

Fig.4.9. Schematic of Lin/Log Converter

Here the linear DC output signal from the RMS or Peak Rectifier circuits is applied to an operational amplifier which amplifies and inverts the signal to forward bias the emitter-base junction of a transistor Tr_1, which is in the amplifier's feedback loop. The forward bias characteristics of Tr_1 are such that its emitter-base voltage is proportional to the logarithmic value of its collector current. Now since the collector current of Tr_1 is supplied from the signal applied to the converter via the resistor R_1, the voltage appearing at the amplifier's output will be proportional to the logarithmic value of the applied signal.

However, the offset voltage of Tr_1 has also to be considered, as this produces an error voltage at the amplifier's output. This error is cancelled by passing the amplifier's output signal through a transistor Tr_2, which has similar offset voltage characteristics as Tr_1.

The final stage of the converter amplifies and inverts the signal to produce an output which is in phase with the converter's input signal. Feedback to the input of this stage adjusts the slope of the converter's Lin-Log characteristic.

4.10. POWER SUPPLY

This is split into several sections. Most of the amplifiers are supplied by a stabilized ±20 V supply which has a current limiter to protect both the amplifier and the power circuits.

The polarization voltage for the microphone and the high voltage for the output amplifiers are supplied from 150 V and 300 V transformer tappings which are subsequently regulated. A 12 V stabilized power supply is used for the microphone preamplifier heater.

A normal DC-AC push-pull converter is used when the instrument is powered by a 12 V battery. The operating frequency of the converter is about 60 Hz.

4.11. OVERALL CHARACTERISTICS

4.11.1. Dynamic Range

The dynamic range of the 2607 is not only determined by the various amplifier and rectifier sections of the instrument, but also by the setting of the INPUT and OUTPUT SECTION ATTENUATORS. For AC measurements using the Input and Output Section Amplifiers of the 2607 with no filters or weighting networks selected, the dynamic range is as given in Table 4.4. The overall gain of the Input and Output Section Amplifiers for various INPUT and OUTPUT SECTION ATTENUATOR settings is given in Table 4.5.

INTPUT SECTION ATTENUATOR

OUTPUT SECTION ATTENUATOR	3 mV	10 mV	30 mV – 300 V
x 0.003	>10 dB	>20 dB	>30 dB
x 0.01	>20 dB	>30 dB	>40 dB
x 0.03	>30 dB	>40 dB	>50 dB
x 0.1	>40 dB	>50 dB	>60 dB
x 0.3	>50 dB	>60 dB	>70 dB
x 1	>60 dB	>70 dB	>80 dB

Table 4.4. Dynamic range of AC OUTPUT of the 2607 as a function of attenuator settings

OUTPUT SECTION ATTENUATOR

INPUT SECTION ATTENUATOR	x 0.003	x 0.01	x 0.03	x 0.1	x 0.3	x 1
3 mV	120	110	100	90	80	70
10 mV	110	100	90	80	70	60
30 mV	100	90	80	70	60	50
0.1 V	90	80	70	60	50	40
0.3 V	80	70	60	50	40	30
1 V	70	60	50	40	30	20
3 V	60	50	40	30	20	10
10 V	50	40	30	20	10	0
30 V	40	30	20	10	0	–10
100 V	30	20	10	0	–10	–20
300 V	20	10	0	–10	–20	–30

Table 4.5. Gain (dB) of the 2607 from the DIRECT and PREAMP. INPUTS to the AC OUTPUT as a function of attenuator settings

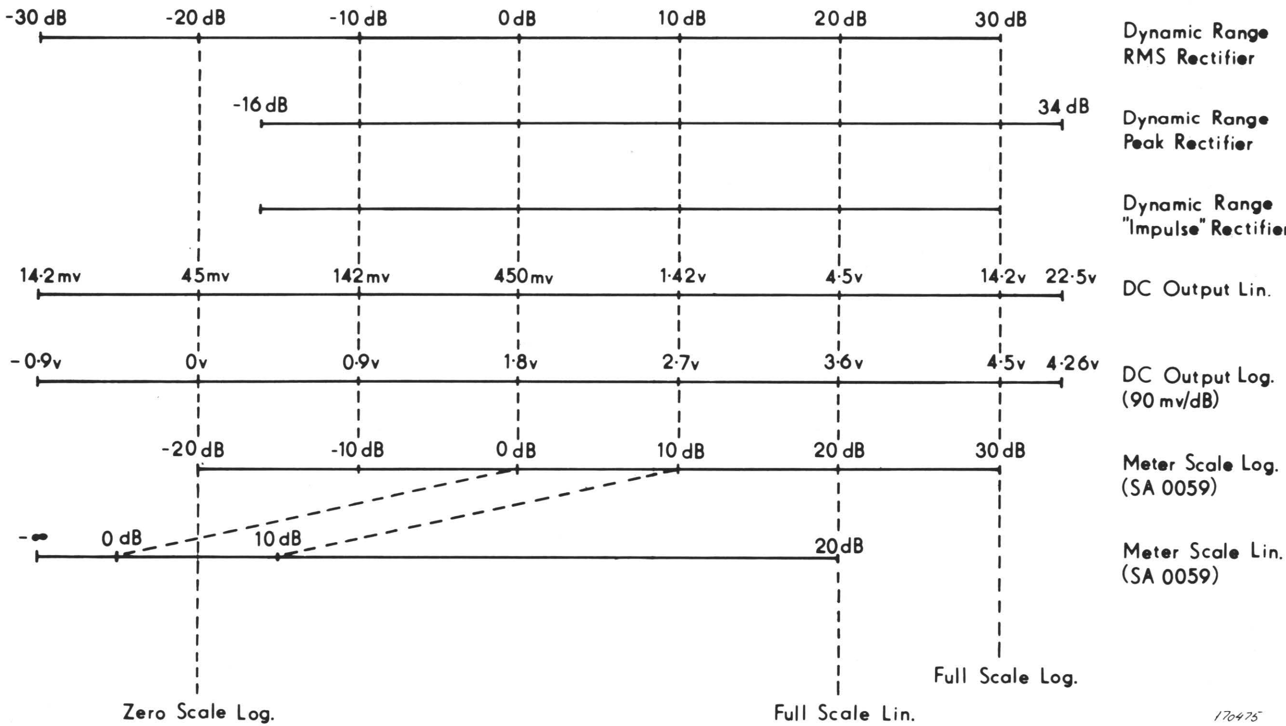

Fig.4.10. Dynamic range of Rectifier Circuits

For DC measurements the dynamic range of the various rectifier circuits is given in Fig.4.10 which also gives the open circuit DC output voltage for different meter scale deflections for both "Log" and "Lin" modes of the 2607.

4.11.2. Frequency and Phase Characteristics

The frequency response of the 2607 without filters is 2 Hz to 200 kHz ±0.5 dB as shown in Fig.4.2. Naturally, when high or low pass filters or weighting networks are employed with the 2607 this range is considerably reduced as Fig.4.2 also shows. For this reason it is important to consider the upper limiting frequency of the system, since when measuring signals containing many significant harmonics, some harmonic components may be attenuated giving an incorrect measurement.

The phase response of the 2607 is shown in Fig.4.11. From this it can be seen that, as with most amplifiers, the 2607 suffers from phase distortion both at high and low frequencies. However, the phase difference between any two 2607s over the 5 Hz to 20 kHz range is less than 5°.

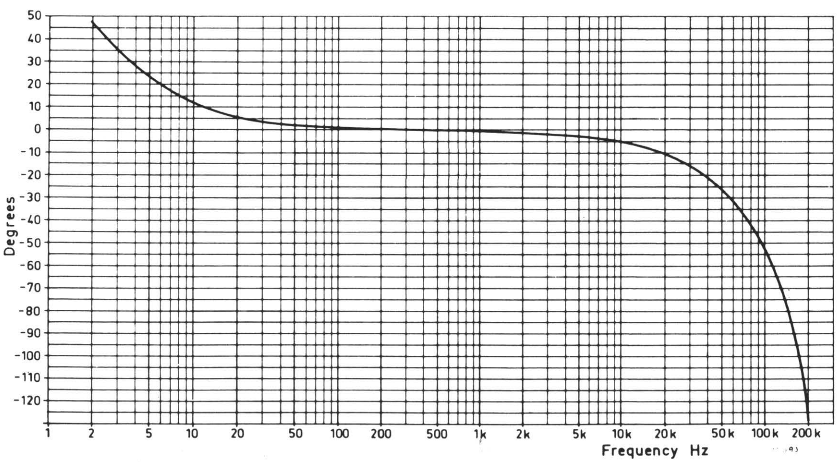

Fig.4.11. Phase response of 2607 without filters

The phase response of the 2607 with high and low pass filters is shown in Fig.4.12 and is chiefly determined by the phase characteristics of the filters themselves.

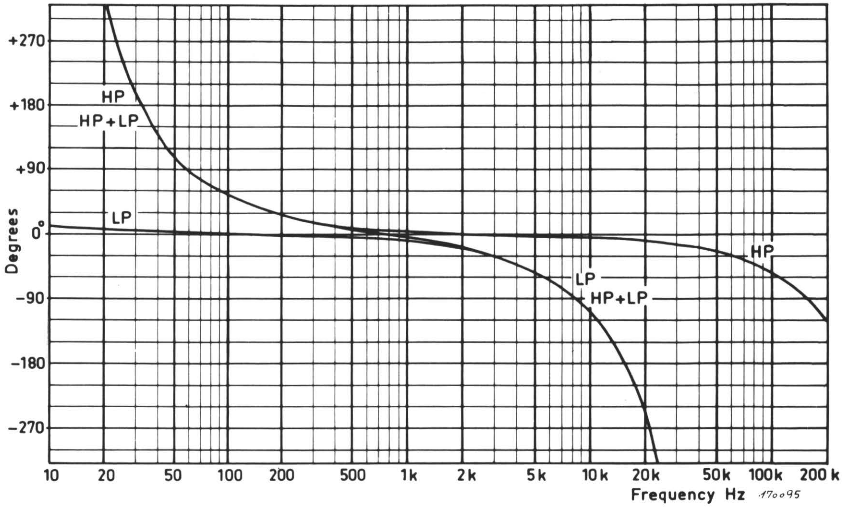

Fig.4.12. Phase response of 2607 with 22.4 Hz high pass and 22.4 kHz low pass filters

For RMS measurements the phase response of the 2607 will not influence the measurement accuracy since any change in phase relationship between different components of a signal will not affect its RMS value. This also applies for Peak and Impulse measurements provided the signal is sinusoidal and does not contain any phase related frequency components. However, if the signal is complex and does contain phase related frequency components (as in the case of a square wave signal) the measurement accuracy will be affected.

Measurements made on a symmetrical square wave signal (see Fig.4.13) using a 2607 show that the effect of phase distortion on Peak and Impulse measurement is mostly predominant at low frequencies. This is mainly due to the fact that harmonic components of the signal phase lag the fundamental. At 2 Hz, Peak and Impulse indications are affected by up to 8 and 6 dB respectively. However, at 100 kHz both Peak and Impulse indications are within 0.05 dB of the true value even though the high frequency harmonic components of the 100 kHz square wave signal are heavily attenuated by the cut-off frequency of the 2607.

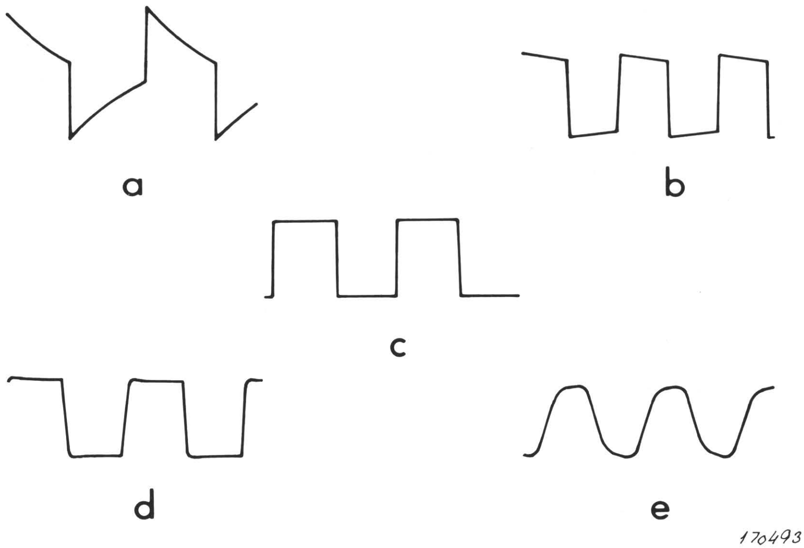

Fig.4.13. *Typical output waveforms from 2607 for symmetrical square-wave input with repitition frequencies of*
a) 5 Hz
b) 50 Hz
c) 1 kHz
d) 10 kHz
e) 100 kHz

5. FREQUENCY ANALYSIS AND RECORDING

5.1. GENERAL

In the majority of noise and vibration investigations the signal to be measured will be complex. Therefore the use of the 2607 with the 1614 or 1615 Filter Sets for 1/3 or 1/1 Octave analysis or with the 2020 Heterodyne Slave Filter will provide more meaningful results. It is with such analysis applications in mind that the complex RMS rectifier with a wide selection of averaging times was developed. In this chapter, it is proposed to cover the essential theoretical background to frequency analysis in order to emphasize the importance of averaging time in RMS measurements. Additionally, the practical procedure for recording a frequency analysis is described as are other useful applications.

5.2. RMS MEASUREMENTS AND STATISTICAL ACCURACY

In any true RMS measurement system the accuracy of the data obtained is not only dependent on the system accuracy but also on the inaccuracies arising from the effect of statistically random signals on the system's averaging process. To understand how these inaccuracies arise it is necessary to consider the RMS value of a signal which is defined:

$$\psi = \sqrt{\lim_{T \to \infty} \frac{1}{T} \int_0^T x^2(t)\, dt} \qquad 5.1.$$

where T is referred to as the averaging time
$x(t)$ is a time varying signal
ψ is the RMS value of x over an averaging time T

It can be seen from equation 5.1 that to obtain the true RMS value of a statistically random signal the averaging time would have to be infinitely long. Of course, in practice this is impossible to realize and consequently the RMS value of a random signal will fluctuate when displayed on a meter or other readout device employing a more practical averaging time. The shorter the averaging time, the greater will be the fluctuations.

Equation 5.1. also shows that the level of the RMS fluctuation depends on the measurement bandwidth, since if the averaging time is kept constant and the measurement bandwidth is decreased, the level of the RMS fluctuation will increase.

A simple relationship providing a measure of the statistical RMS fluctuation ϵ (i.e. the possible range of error in the averaged RMS signal) is:

$$\epsilon = \frac{1}{2\sqrt{BT}} \qquad 5.2.$$

where B is the measurement, or signal frequency, bandwidth (whichever is the smallest) in Hz, and T is the averaging time or signal duration (whichever is the smallest) in sec. This expression is an approximate relation but carries sufficient accuracy for BT products greater than 5. It expresses the limits of signal variation to a confidence level of approx. 68%. To obtain higher confidence levels the approximate relations apply that the variation limits are $\pm 2\,\epsilon$ for a confidence level of 95% and within $\pm 2.5\,\epsilon$ for a confidence limit of 99%. For further details on the derivation of equation 5.2 and its application, refer to "Measurement and Analysis of Random Data" by J. S. Bendat and A. G. Piersol (John Wiley 1967) and to statistical textbooks on the chi-square distribution.

Equation 5.2 shows that if the averaging time is decreased and the level of RMS fluctuation is increased, the signal can be estimated as random. However, if the level remains roughly the same, the signal can be estimated as periodic. Also, if the measurement bandwidth is decreased to increase the frequency resolution then the averaging time must be increased to obtain the same measurement accuracy.

It can be seen therefore that equation 5.2 provides a useful relationship for determining a practical averaging time for minimizing the fluctuations.

In a measurement system employing the 2607 Measuring Amplifier the signal fluctuations are averaged by the amplifier's RMS circuit and the RMS value fed to both the display meter and the DC OUTPUT.

Therefore for DC recording the amplifier's AVERAGING TIME switch may be used to select averaging times from 0.1 to 300 sec. (±20%). In the "Fast" and "Slow" positions of this switch the averaging times are 0.1 and 1 sec. respectively.

5.3. PRACTICAL NOTES ON RECORDING ANALYSES

In recording a frequency analysis from the 2607 and an external filter, the choice is available whether to record the unaveraged AC output or the RMS or Peak rectified signal from a DC output. With an AC output, the 2607 is similar in performance to the B & K Type 2606, and it is with a DC output that the 2607 has marked advantages over the 2606. In the following sections, the recording of frequency analyses using the 1614 or 1615 filter set with the 2305 Level Recorder will be considered. For completeness, procedures for both AC and DC recordings are given.

5.3.1. Averaging Time with AC Recording

With AC output from the 2607, RMS averaging of the recorded signal is performed entirely by the Level Recorder. The principal control of the Level Recorder which determines its averaging time is the WRITING SPEED selector. The relation between Averaging Time and the Writing Speed of the Level Recorder is given in Table 5.1. The averaging times given in Table 5.1 are approximate values and are valid for measurement bandwidths greater than the minimum bandwidths specified. They were obtained in recent (October 1970) measurements on the Level Recorder using a random signal input.

5.3.2. Level Recorder setting for DC Output of 2607

In recording the DC output of the 2607, the Level Recorder should be used in its DC mode.

To minimize overshoot while making a DC recording and for the averaging time constants of the 2607 to override the averaging effect to the recorder's pen, the Level Recorder's WRITING SPEED control should be set for an averaging time equal to or less than that selected on the 2607. For small signal fluctuations (± 2.5 dB) the Level Recorder's averaging times for various settings of the WRITING SPEED control are given in Table 5.1. It should be stressed that the averaging times quoted in Table 5.1 are only approximate and were obtained from tests on the Level Recorder using random noise.

WRITING SPEED mm/sec.	AVERAGING TIME sec.	MINIMUM MEASUREMENT BANDWIDTH Hz
1000	0.015	400
800	0.020	200
630	0.025	135
500	0.035	100
400	0.050	60
250	0.090	35
160	0.116	25
100	0.300	15
63	0.55	7
40	1.0	4
25	2.1	2
16	5.7	1
8	60.0	<1

Table 5.1. Relation between writing speed of the 2305 Level Recorder and RMS signal averaging time

5.3.3. Filter Scanning Speed

When a 1614 or 1615 is used in the measurement system the filter scanning speed will be another factor influencing the measurement accuracy. This is a direct function of the Level Recorder PAPER SPEED

RANGE POTENTIOMETER	PAPER SPEED (mm/sec.) 1/3 Octave	PAPER SPEED (mm/sec.) 1/1 Octave
50 dB	$<\frac{0.3}{T}$	$<\frac{1}{T}$
25 dB	$<\frac{1}{T}$	$<\frac{3}{T}$
10 dB	$<\frac{3}{T}$	$<\frac{10}{T}$

Table 5.2. Maximum paper speeds of the Level Recorder which permit full response of the Recorder to a signal averaged on the 2607 with an Averaging Time T for third octave and octave analysis

which must be set slow enough to allow the recorder's stylus to respond fully to a new level every time the spectrometer's filters are switched to a new frequency band. If the PAPER SPEED is set incorrectly and the filter scanning speed is too fast, the filtered frequency components will not have time to be averaged and the effective averaging time will be reduced.

Some useful relationships for determining the correct PAPER SPEED control setting on the recorder for DC recording, which also take into account the averaging time setting of the 2607 as well as the dynamic range of the measurements and the type of analysis are given in Table 5.2.

For AC recording a single relationship serves and this is given by:

$$\text{PAPER SPEED} = \frac{x}{75} \cdot \text{WRITING SPEED}$$

where x is the distance in mm on the recording paper corresponding to the spectrometer's bandwidth. For Recording Paper Type QP 1124, x equals 5 mm for one third octave. The frequency scale is logarithmic.

5.4. ANALYSIS PROCEDURE

5.4.1. DC Recording

The recording technique which makes best use of the 2607 features is recording from the DC output. In this case the wide dynamic range (50 dB)

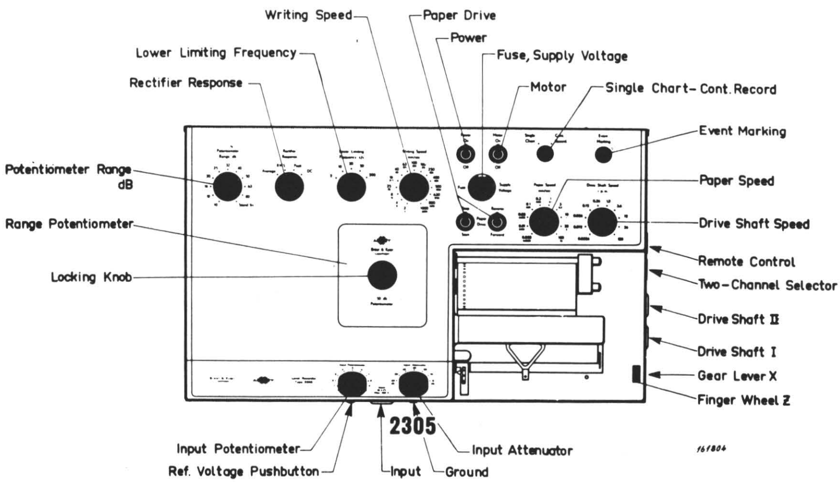

Fig.5.1. 2305 Level Recorder controls

and the wide range of selectable averaging times of the RMS rectifier is fully used. To illustrate the recording procedure, use of the 1614 Filter Set and the 2305 Level Recorder with the 2607 will be described. For other types of extension filter, the procedure will be modified as described in the individual instruction manual for the filter. The controls of the Level Recorder are identified in Figs.5.1 and 5.2.

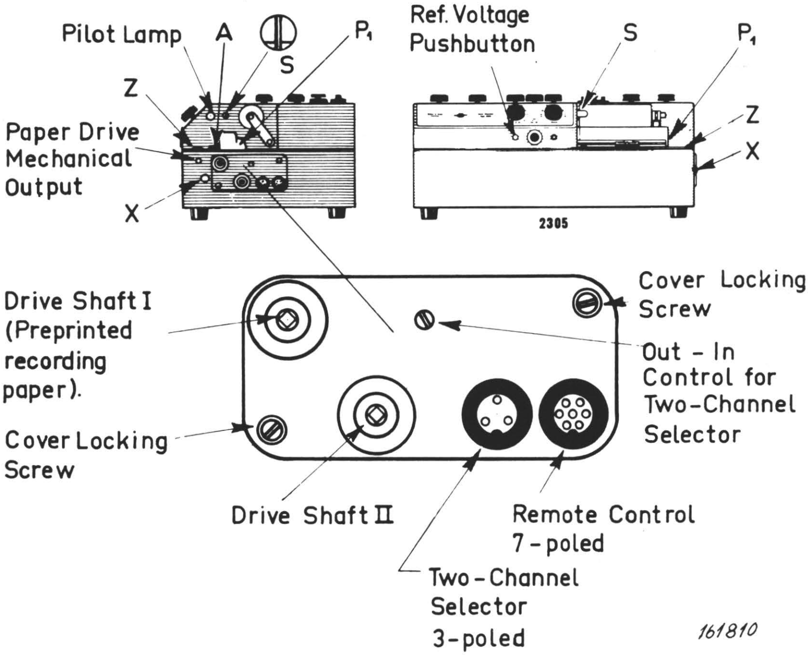

Fig.5.2. 2305 Level Recorder controls

To record an analysis proceed as follows:

1. Connect the instruments as shown in Fig.5.3. The REMOTE CONTROL sockets of the Level Recorder and Filter Set should be connected using Control Cable AQ 0019.

2. Select Filter Set controls:

POWER	"On"
SCANNING	"Manual"
LIN	"1.8 Hz – 200 kHz"

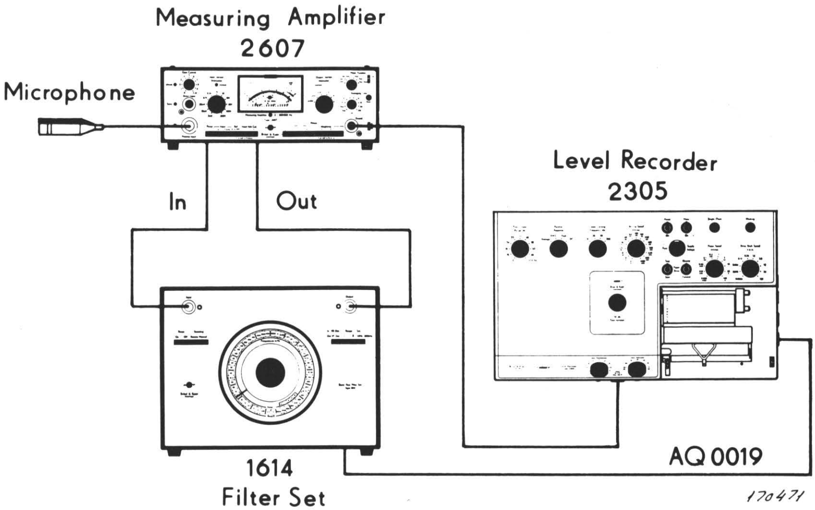

Fig.5.3. Arrangement for recording an analysis

3. Set the control knobs on the Level Recorder to:

POTENTIOMETER RANGE	"50"
RECTIFIER RESPONSE	"DC"
WRITING SPEED	As required (see Table 5.1)
POWER	"On"
MOTOR	"On"

The LOWER LIMITING FREQUENCY can be set to any value except 200 Hz for DC operation. Since the input signal to the 2305 is chopped to convert it to AC, the lower frequency limit of the input signal will not be affected in accuracy by this control on the Level Recorder. LOWER LIMITING FREQUENCY selection should therefore be on the basis of stable operation of the writing system.

4. The INPUT POTENTIOMETER and INPUT ATTENUATOR of the 2305 can be adjusted so that the 2305 pen deflection equals the meter deflection on the 2607. To do this set the OUTPUT of the 2607 to "DC" and calibrate the instrument as described under the appropriate section for sound, vibration, or voltage in Chapter 3.

SOUND. With a Pistonphone (124 dB) or Sound Level Calibrator (94 dB) the pen should be adjusted to 4 dB above one of the thick lines on the recording paper (Fig.5.4). The thick line then corresponds to 120 or 90 dB respectively.

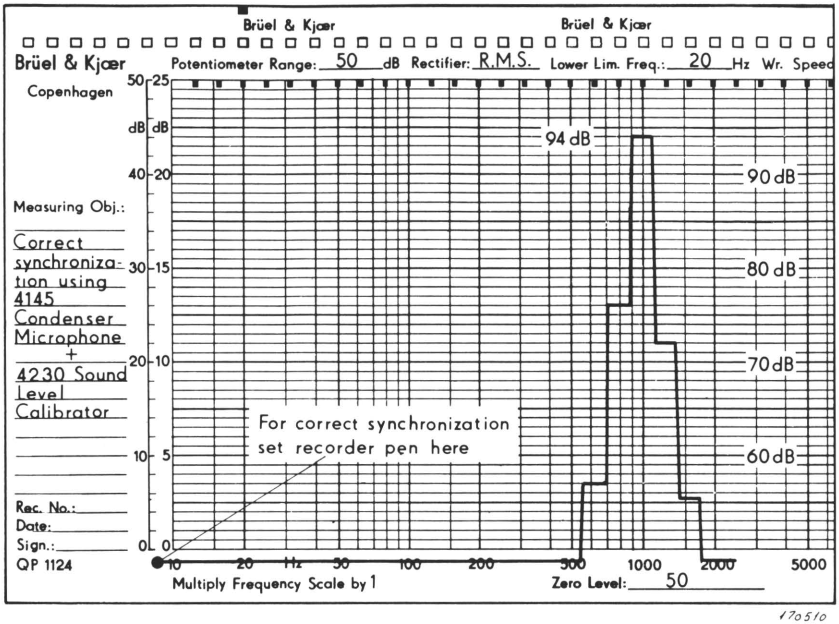

Fig.5.4. Spectrum for correct synchronization

With the built-in reference source adjust the meter deflection to the correct position on the "Microphone Open Circuit Sensitivity" scale and note the value of the corresponding deflection on the dB scale. The pen should be set to this dB value on the paper:
e.g. If the microphone has an open circuit sensitivity of 40 mV per N/m^2, 40 on the open circuit sensitivity scale corresponds to nearly 6 dB above a thick line on the paper. The thick line will then correspond to a SPL of 90 dB.

VIBRATION. When the Accelerometer Calibrator 4291 is used, 0.71 g RMS corresponds to 3 dB below full scale. Then pen should be set to 3 dB below a thick line on the paper. The thick line will then correspond to an acceleration level of 1 g RMS.

VOLTAGE. With the built-in reference, 50 mV corresponds to 14 dB on the dB scale (of scale Sa 0037) so set the pen to 4 dB above a thick line on the paper. The thick line will then correspond to 31.6 mV.

5. Two types of recording can be made:

   a) CONTINUOUS RECORDING
   For recording over any chart length the Gear Lever X (Fig.5.1 or 5.2) can either be pushed "IN" or pulled "OUT". When "IN", set the required paper speed (Table 5.2) according to the large figures around the PAPER SPEED knob and when "OUT" to the small figures.
   To start the paper moving set the PAPER DRIVE switches to "Stop" and "Forward", depress the SINGLE CHART CONT. RECORD push-button and turn clockwise to CONT. RECORD. To stop, release the push-button.

   b) SINGLE CHART
   For automatic recording over one 250 mm chart length, pull the Gear Lever X "OUT" and select the required paper speed according to the small figures around the PAPER SPEED knob.
   To start the paper moving, set the PAPER DRIVE switches to "Start" and "Forward", depress the SINGLE CHART CONT. RECORD push-button and release after the chart has travelled 20 mm or more. The paper should continue to move, but will stop automatically after one chart length or less.

6. Once the paper has stopped adjust the Finger Wheel Z (Fig.5.1 or 5.2) so that the stylus rests just before the 10 Hz line on the chart (see Fig.5.4). To remove backlash in the paper drive the paper should be shifted so that it approaches the correct point in the reverse direction (towards the recorder). For example, if the paper is to be shifted to a higher frequency, the chart is first moved forward to a position beyond the desired point and then reversed to the correct point.

7. Turn screw S (Fig.5.2) until the screw marking is in its upper position. This selects the recorder's control pulses to synchronize the filter switching.

8. Set Filter Set controls:

FILTER SWITCH	4 Third Octave positions anti-clockwise from the 25 Hz Filter
RANGE	As required
SCANNING	"Remote"
Select "1/3 Octave" mode	

9. To check synchronization between the chart movement and filter switching the response of the calibration source can be recorded by depressing the SINGLE CHART-CONT. RECORD push-button for a single chart recording. For correct synchronization using the sound or voltage calibration sources the 800 Hz and 1 kHz filters should switch on the 900 Hz chart line and with the 4291 Accelerometer Calibrator the 80 Hz and 100 Hz filters should switch on the 90 Hz line.
If synchronization is incorrect, then the chart position can be readjusted using Finger Wheel Z.

10. If not already connected, apply the signal for analysis and change the following Measuring Amplifier controls:

INPUT	As required
REF	"50 mV" in the out position
INSERT VOLT. CAL.	"Int." and "Ext." in their out positions
INPUT AND OUTPUT SECTION ATTENUATORS	Adjust to obtain a suitable recorder pen deflection, keeping the OUTPUT SECTION ATTENUATOR in the "X 1" position if possible
AVERAGING TIME	As required (see Table 5.1)

11. Note the new Meter Range setting on the Measuring Amplifier and proceed as follows:
For logarithmic potentiometers the dB change produced by an increase in METER RANGE INDICATOR setting should be added to the recorder chart's calibrated reference level, while any decrease should be subtracted. If for example the RANGE INDICATOR setting is increased from 80 dB for calibration to 100 dB for measurement, the change in indicator setting would be + 20 dB and a chart's calibrated reference value of 94 dB would become 114 dB. Similarly if the indicator setting is decreased from 80 dB to 50 dB the change would be —30 dB and the reference level would become 64 dB.

12. Start the recording by pressing the Level Recorder's push-button SINGLE CHART-CONT. RECORD.

13. Release the button to stop the recording.

5.4.2. AC Recording

The dynamic range of the AC output of the 2607 is as given in Table 4.4, section 4.11.1. This indicates that it will normally be possible to employ any of the four Logarithmic Range Potentiometers of the 2305. Procedure will be the same for each Logarithmic Range Potentiometer.

For recording an analysis with the 1614 Filter Set and the 2305 Level Recorder, procedure is similar to that of section 5.4.1 except for the following amendments. The item numbers are those used in section 5.4.1.

3. RECTIFIER RESPONSE of the 2305 should be set to "RMS" and LOWER LIMITING FREQUENCY to a value below the lowest frequency required from the analysis.

4. The 2607 output switch must be set to "AC".

10. AVERAGING TIME of the 2607 can be set to "Fast" in order to obtain meter monitoring of the output signal.

5.5. POWER SPECTRAL DENSITY

When the 2607 is combined with the 2020 Heterodyne Slave Filter as shown in Fig.5.5 and a 1022 BFO or 1024 Sine Random Generator provides the control frequencies for the 2020, power spectral density (P.S.D.) measurements can be made.

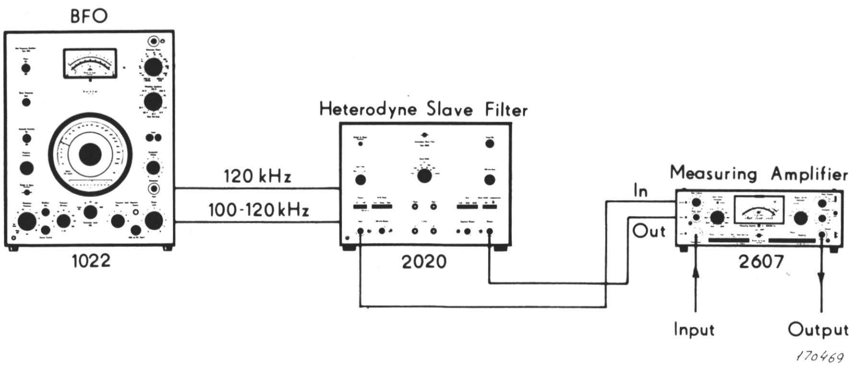

Fig.5.5. Power spectral density measurements

The meter circuit of the 2607 measures the RMS value of the filter output which is then squared to obtain the mean square value using the 2607 meter scale SA 0046. This scale calibrated in V^2/Hz permits the P.S.D. to be read directly when the $1/\sqrt{B}$ Bandwidth Compensation of the 2020 is actuated.

For further information on the operation of the 2020, the 2020 Instruction Manual should be consulted, while for P.S.D. measurement the booklet "Frequency Analysis and Power Spectral Density Measurements" is available on request.

5.6. TAPE RECORDING

For many applications regarding the measurement and analysis of sound and vibration, the use of the 7001 Tape Recorder will be found very convenient especially when employed with the 2607 Measuring Amplifier.

The 7001 has four tape speeds ranging from 1.5 to 60 inches/sec. as well as two measurement channels and a voice channel. The measurement channels have a linear response ranging from DC to 20 kHz depending on the tape speed selected and can be connected directly to the OUTPUT socket of the 2607 as shown in the recording set-up in Fig.5.6. The 2607 is well suited to this application since when set to AC and no filters or weighting networks are selected it will serve as a high quality linear input amplifier to the recorder.

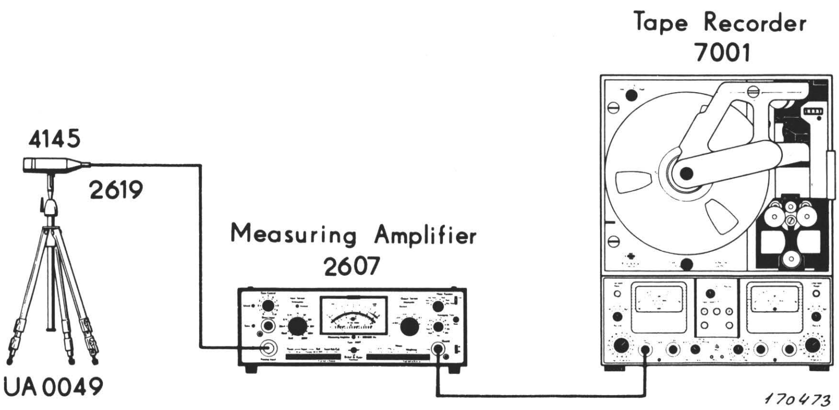

Fig.5.6. Recording with 7001 Tape Recorder

The 2607 will also serve as an input amplifier to other types of tape recorder provided that their input impedance is greater than 5 kΩ and their recording level is approximately 5 V RMS. For recorders with a recording level considerably less than 5 V RMS the circuit in Fig.5.7 should be used to attenuate the recorders input signal, as this gives a better signal to noise ratio than the attenuation provided by an increase in 2607 range setting.

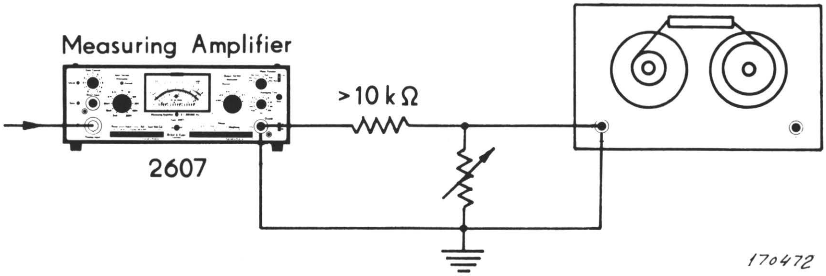

Fig.5.7. Attenuation of 2607 output for tape recording

For an analysis of a tape recording, the information to be processed is made into a tape loop and fitted to the loop adapter of the 7001 in the instrument set-up shown in Fig.5.8. A 440 Hz pulse can then be recorded on the tape loop using the recorder's voice channel and marker signal. This

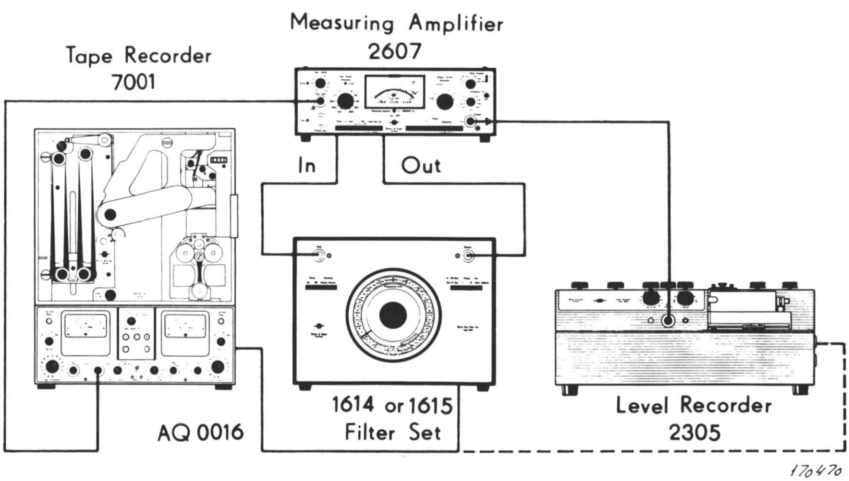

Fig.5.8. Frequency analysis using 7001 tape recorder

permits the recorder to switch the Filter Set automatically when the control cable AQ 0016 is connected from the recorder to both the Filter Set and the 2305 Level Recorder which gives a graphical display of the analysis on frequency calibrated paper. Synchronization is obtained between the filter switching and the movement of the recording paper when the time taken to complete one tape loop cycle is longer than the time required for the recording chart to advance a 1/3 Octave.

Tape splice noise in the recorded loop can be excluded from the analysis by use of a device such as the B & K Type 5559 Tape Splice Noise Eliminator (available only on special order).

Using such a loop arrangement for RMS measurements, there is no advantage in selecting an AVERAGING TIME longer than the time for a complete loop cycle. One of the most useful applications of the 2607 with such a tape loop analysis is that of impulse analysis, where the Peak measurement facility can be used to advantage in making a Fourier analysis of a recorded impulse. The loop can be analyzed at selected frequencies to build up directly the Fourier spectrum of the pulse.

The 7001 will also prove useful in providing a frequency transformation for analysis of frequency components below the 20 Hz lower limiting frequency of the standard 2113. The transformation is obtained by playing back the recorded information at a speed greater than that used for the original recording. In this way the analysis of signals down to 0.5 Hz can be performed with only one frequency transformation.

For further information on the operation and uses of the 7001 Tape Recorder, its instruction manual should be consulted.

6. ACCESSORIES

6.1. GENERAL

The combinations of accessories that can be used with the 2607 can be seen in Figs.6.1 and 6.2. The specifications of these accessories can be found in the B & K Short and Main Catalogues which are available through your B & K Agent.

6.2. RACK MOUNTINGS

The 2607 is available in "A", "B" and "C" models. Model "A" is the standard version and is the 2607 in a light metal cabinet which with the addition of a mahogany case KA 0026 makes the "B" model, or alternatively with the addition of a 19 inch metal rack mounting frame KS 0014 makes the "C" model. Both the mahogany case and the metal rack mounting frame are available separately.

For mounting together a combination of B & K instruments, rack KQ 0077 accepts the 2607 together with the Beat Frequency Oscillator 1022 (or Sine-Random Generator 1024), the Heterodyne Slave Filter 2020, and the Level Recorder 2305. Rack KQ 0078 is also available for mounting the 2607 and Level Recorder 2305 together with the Beat Frequency Oscillator 1022, or the Sine Random Generator 1024, or the Tape Recorder 7001.

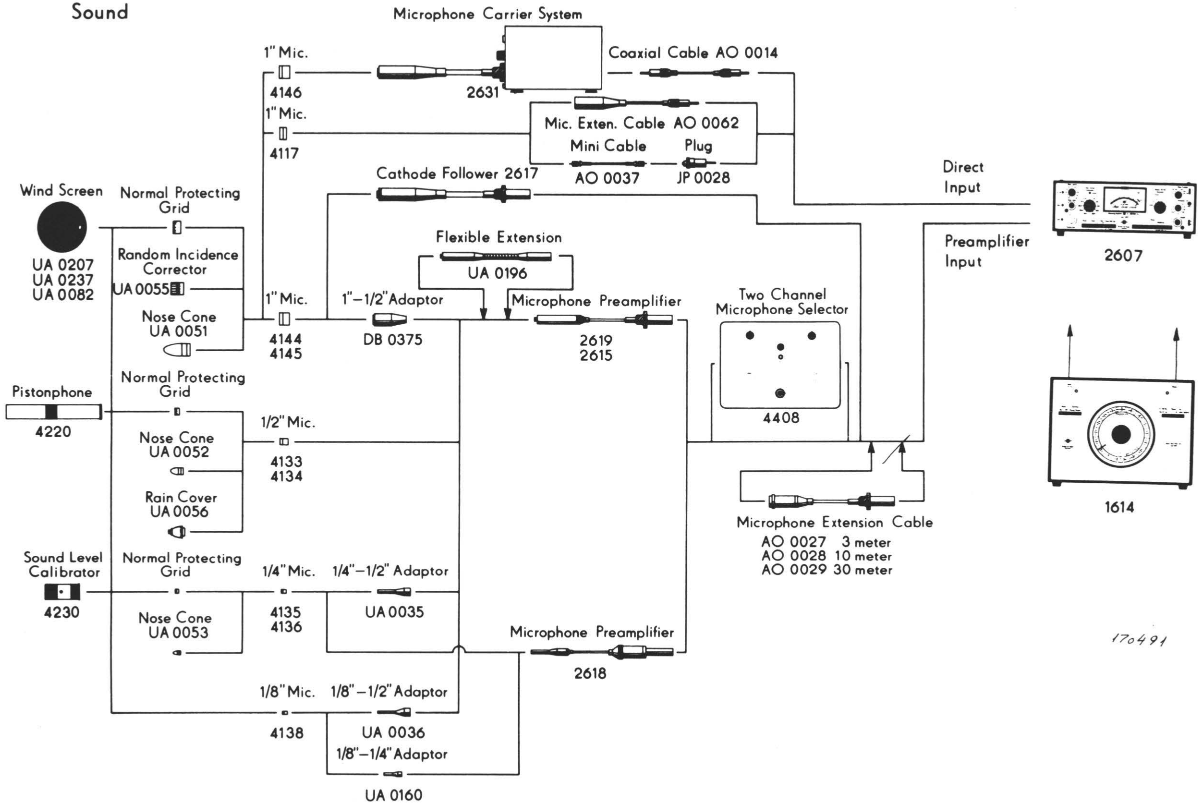

Fig.6.1. Accessories for measurement of sound

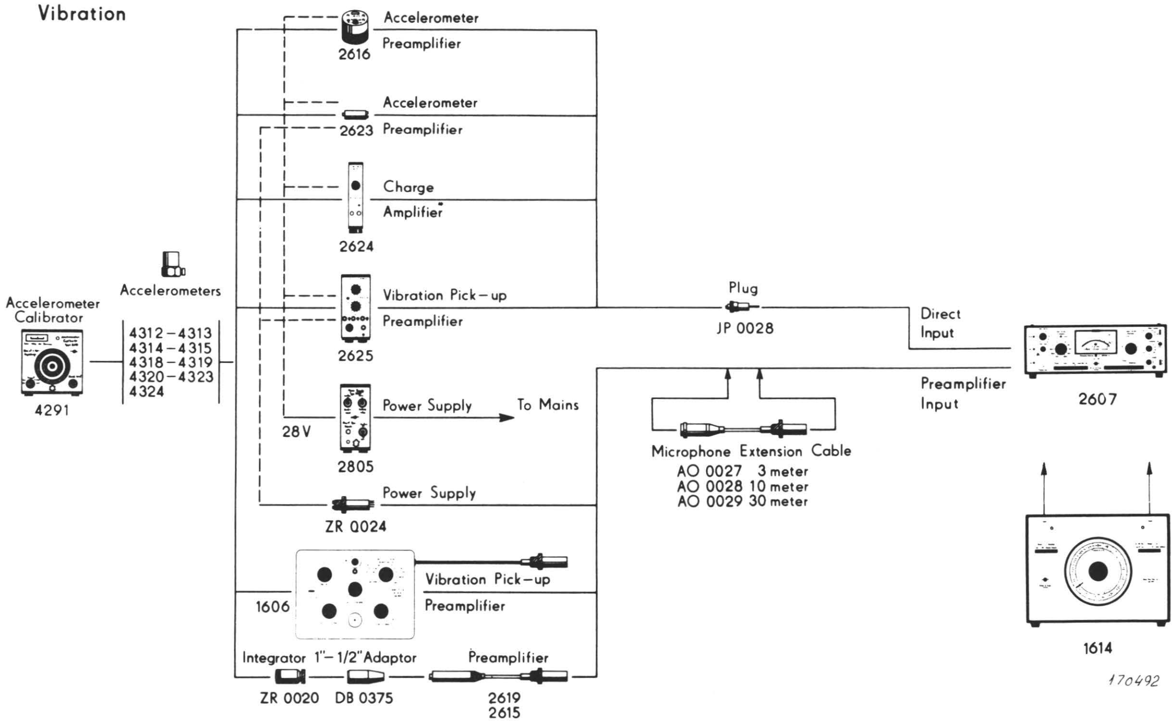

Fig.6.2. Accessories for measurement of vibration

7. SPECIFICATIONS

AMPLIFIER RESPONSE:

Measuring Range:	10 μV – 300 V RMS for FSD on meter display
Frequency Range:	2 Hz to 200 kHz ±0.5 dB 10 Hz to 50 kHz ±0.2 dB
Phase Deviation:	±5° between two instruments in the 5 Hz to 20 kHz range
Total Amplification:	120 dB

INPUT:

Input Impedance	
Direct Input:	1 MΩ//50 pF
Preamp. Input:	In accordance with B & K Microphone Preamplifiers

Maximum Input Voltage:

Input Section	
Attenuator setting	
0.3 V to 300 V:	700 V peak
3 mV to 0.1 V:	310 V peak for signal frequencies $<$ 60 Hz 165 V peak for signal frequencies $<$400 Hz 20 V peak for signal frequencies $>$400 Hz

FREQUENCY NETWORKS:

High Pass Filter:	22.4 Hz slope 24 dB/Octave (see also Fig.4.3)
Low Pass Filter:	22.4 kHz slope 24 dB/Octave (see also Fig.4.4)
A, B and C Weighting:	In accordance with proposed amendment to IEC 179–1965 for precision sound level measurements
D Weighting:	In accordance with proposed standard

ATTENUATOR RANGE:

Input Section:	3 mV to 300 V in 10 dB steps. Accurate to within ±0.1 dB at 1 kHz relative to 100 mV position
Output Section:	x 0.003 to x 1 in 10 dB steps. Accurate to within ±0.1 dB at 1 kHz relative to x 1 position
Total Range:	0–150 dB in 10 dB steps

RECTIFIER CHARACTERISTICS

RMS:

Indication:	±0.5 dB for crest factors up to 5 (14 dB) except where limited by maximum peak input voltage
Averaging Times:	0.1–0.3–1–3–10–30–100–300 sec. ±20% plus time constants for "Fast" and "Slow" meter characteristics according to IEC 179–1965.
Dynamic Range:	60 dB
Accuracy:	±0.3 dB from 10 dB above to 40 dB below FSD at 25°C ±0.5 dB from 40 to 50 dB below FSD at 25°C
Temperature Coefficient:	<0.03 dB/°C

Impulse:

Indication:	"Impulse" according to DIN 45633 part 2 (March 1967) plus "Impulse Hold" facility which is better than 0.05 dB/sec. at 25°C
Dynamic Range:	46 dB

Peak:

Indication:	"+ Peak", "–Peak" and "Max. Peak"
Rise Time:	20 µsec.
Decay Time Constants:	0.1–0.3–1–3–10–30–100–300 sec. ±20%
Dynamic Range:	50 dB
Accuracy:	±0.5 dB from 10 to 14 dB above FSD at 25°C ±0.3 dB from 10 dB above to 30 dB below FSD at 25°C ±0.5 dB from 30 to 36 dB below FSD at 25°C
Temperature Coefficient:	<0.03 dB/°C

LIN/LOG CONVERTER:

Dynamic Range:	>50 dB at DC Output. 50 dB corresponds to scale deflection from zero to full scale
Accuracy:	±0.5 dB at 25°C
Temperature Coefficient:	<0.03 dB/°C

OUTPUTS:

AC:

Output Voltage:	10 V RMS corresponding to FSD
Maximum Output:	50 V peak into 16 kΩ//200 pF
Output Impedance:	<50Ω

DC:

Output Voltage:	4.5 V corresponding to FSD
Maximum Output:	22.5 V
Output Impedance:	820Ω

OVERLOAD INDICATORS:

Input Overload Level:	5.6 V peak for overload exceeding 0.2 msec.
Output Overload Level:	56 V peak for overload exceeding 0.2 msec.

Lamps light for overload pulse longer than 0.2 msec. and remain lit for 0.5 sec. minimum.

REFERENCE VOLTAGE:

Signal:	50 mV at 1 kHz
Stability:	±2% at 5 to 40°C for both amplitude and frequency
Distortion:	<2%

EXT. FILTER CONNECTIONS:

Ext. Filter Input:

Output Impedance:	<10Ω
Load Impedance:	>500Ω
Maximum Output:	5.0 V peak

Ext. Filter Output:

Input Impedance:	146 kΩ//100 pF

HUM AND DISTORTION:

Input Section:

Hum:	<1 μV with input short circuited
Distortion:	<0.01% with 1 V across 500Ω at external filter socket

Output Section:

Hum:	<10 μV with external filter socket short circuited

<20 μV with external filter socket open circuit

Distortion: <0.3% with 10 V across 10 kΩ at output

NOISE (typical figures – input short circuit to ground and maximum gain)

Input Section and Filters:

Linear (2 Hz–200 kHz)	<7.0 μV RMS
High Pass (22.4 Hz–200 kHz)	<7.0 μV RMS
Low Pass (2 Hz–22.4 kHz)	<2.5 μV RMS
A Weighting	<1.5 μV RMS
B Weighting	<1.5 μV RMS
C Weighting	<1.7 μV RMS
D Weighting	<4.0 μV RMS

Output Section:

Linear (2 Hz–200 kHz)	<20 μV RMS
Operating Temperature:	5 to 40°C

POWER REQUIREMENTS:

AC Power Socket:

Voltage:	100, 115, 127, 150, 220, 240 Volts ± 10% 50–400 Hz
Consumption:	33 Watts approx.

Battery Socket:

Voltage:	12 V DC ± 10%
Consumption:	31 Watts approx.

DIMENSIONS:

Cabinet Type A:
Height 132 mm (5.2 in)
Width 380 mm (15.0 in)
Depth 200 mm (7.9 in)
Weight 7.6 kg (16.7 lb)

ACCESSORIES SUPPLIED:

AN 0005/6:	Power cable and plug
AO 0013:	B & K coaxial cable
JP 4701:	3-pin plug
JP 1501:	15-pin plug

SCALES SUPPLIED:

SA 0051:	Voltage and dB scale (mounted in the instrument on delivery)
SA 0052:	Lin. voltage and dB scale
SA 0053:	Log. voltage and dB scale (50 dB)
SA 0056:	26–80 mV per N/m^2 microphone scale
SA 0057:	2.6–10 mV per N/m^2 microphone scale
SA 0058:	6–17 mV/g accelerometer scale
SA 0059:	dB Lin/Log scale (Log 50 dB, Lin 20 dB)
SA 0087:	0–100 scale

SCALES AVAILABLE:

SA 0054:	Absorption Coefficient scale
SA 0055:	Power Spectral Density scale
SA 0060:	0.8– 2.6 mV per N/m^2 microphone scale
SA 0083:	0.4–106 mV per N/m^2 microphone scale
SA 0084:	dB/dBm scale
SA 0142:	1.7–6 mV/g accelerometer scale
SA 0143:	17–60 mV/g accelerometer scale
SA 0144:	60–170 mV/g accelerometer scale

Scales can be custom made to order.

B & K INSTRUMENTS:

ACOUSTICAL....
Condenser Microphones
Piezo-Electric Microphones
Microphone Preamplifiers
Microphone Calibration Equip.
Sound Level Meters
(general purpose-precision-
and impulse)
Standing Wave Apparatus
Tapping Machines
Noise Limit Indicators

ELECTROACOUSTICAL....
Artificial Ears
Artificial Mouths
Artificial Mastoids
Hearing Aid Test Boxes
Telephone Measuring Equipment
Audiometer Calibrators
Audio Reproduction Test Equip.

STRAIN....
Strain Gauge Apparatus
Multipoint Panels
Automatic Selectors
Balancing Units

VIBRATION....
Accelerometers
Accelerometer Preamplifiers
Accelerometer Calibrators
Vibration Meters
Magnetic Transducers
Capacitive Transducers
Vibration Exciter Controls
Vibration Programmers
Vibration Signal Selectors
Mini-Shakers
Complex Modulus Apparatus
Stroboscopes

GENERATING....
Beat Frequency Oscillators
Random Noise Generators
Sine-Random Generators

MEASURING....
Measuring Amplifiers
Voltmeters
Deviation Bridges
Megohmmeters

ANALYZING....
Band-Pass Filter Sets
Frequency Spectrometers
Frequency Analyzers
Real-Time Analyzers
Slave Filters
Psophometer Filters
Statistical Analyzers

RECORDING....
Level Recorders
(strip-chart and polar)
Frequency Response Tracers
Tape Recorders

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Orboe Print · Copenhagen · Denmark