ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Bruel & Kjaer 1618* at our website: ***Click HERE***

BAND PASS FILTER
TYPE 1618

Valid from serial no. 725507

Revision April 1979

This apparatus has been designed and tested according to Class II of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in safe condition. The present instruction manual contains information and warnings which should be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

CONTENTS

1. INTRODUCTION AND SPECIFICATIONS (PRODUCT DATA) **1**

2. CONTROLS **9**

2.1. FRONT PANEL 9
2.2. REAR PANEL 10

3. OPERATION **12**

3.1. PRELIMINARY ADJUSTMENTS 12
Selection of Mains Voltage 12
Mains Fuse Checks and Replacement 12
Mains Connections 12
Grounding Considerations 12
3.2. USE WITH MEASURING AMPLIFIER 13
3.3. USE WITH SOUND LEVEL AND VIBRATION METERS 14

4. RECORDING OF FREQUENCY ANALYSES **16**

4.1. USE WITH LEVEL RECORDERS TYPE 2306 AND 2309 16
4.2. USE WITH LEVEL RECORDER TYPE 2307 19

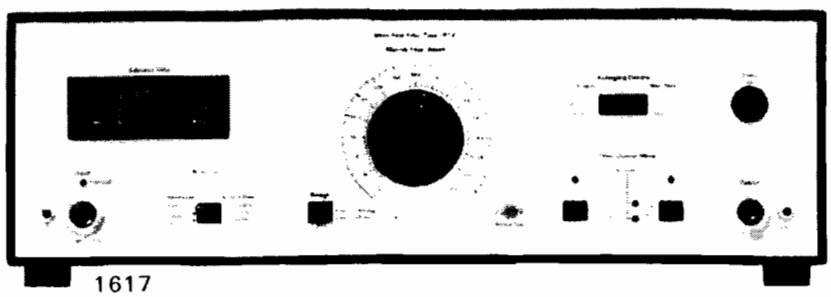
5. SPECIAL CONSIDERATIONS IN FREQUENCY ANALYSIS **23**

5.1. FILTER DEFINITIONS 23
The Ideal Filter 23
Bandwidth 23
Octaves and Third Octave 24
Specified Filter Frequencies 24
5.2. RMS MEASUREMENT AND STATISTICAL ACCURACY 25
5.3. PRACTICAL ANALYSIS OF STATIONARY SIGNALS 26
Averaging Time 26
DC or AC Recording 27
Writing Speed 27
Paper Speed 28

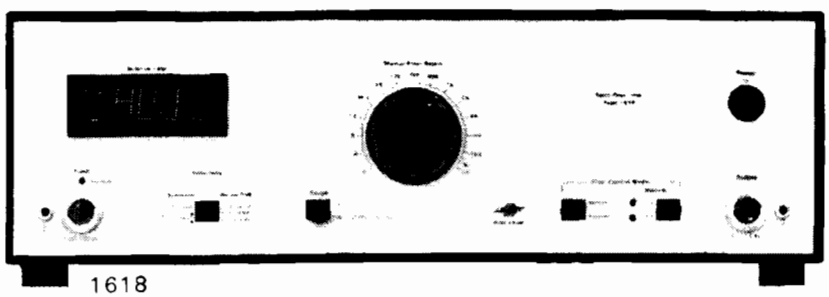
6. SERVICE AND REPAIR **29**

types 1617 and 1618

Third-Octave and Octave Band Pass Filters



1617



1618

GENERAL FEATURES:

- 41 third-octave filter bands, centre frequencies 2 Hz to 20 kHz
- 41 overlapping octave filter bands, centre frequencies 2 Hz to 20 kHz
- Third-octave and octave filters in accordance with IEC 225 - 1966, DIN 45651 and 45652, and ANSI S1.11-1966
- Digital display of selected centre frequency and bandwidth
- Built-in A-weighting network
- Electronic control of filter switching
- Manual or Level Recorder controlled filter scanning
- Selectable scan start position to save time, eliminates low frequencies when required
- Input overload warning circuit
- Floating or grounded signal input

ADDITIONAL FEATURES TYPE 1617:

- 9 third-octave filter bands, centre frequencies 25 kHz to 160 kHz
- Built-in B, C, D-weighting networks
- Comprehensive connection facilities for use with other instruments
- Operation of front panel controls via built-in IEC Interface
- Selection and control of averaging time program for the measuring instrument

USES:

(With suitable Measuring Amplifiers)

- Third-octave and octave frequency analysis of sound and vibration
- Measurement of frequency response
- Measurement of sound transmission loss
- Measurement of vibration isolation
- Testing acoustic materials
- Recording of spectrograms with constant confidence level (1617)

The Third-Octave and Octave Band Pass Filters Type 1617 and Type 1618 are key links in any instrumentation chain for measurement and recording of the frequency spectra of sound, vibration, and electro-acoustic signals. Several novel features have been incorporated, including electronic filter switching and digital indication of the selected filter. The Band Pass Filter Type 1618 is the basic instrument, while the Type 1617 combines an extended frequency range with comprehensive control and synchronisation facilities for use with other instruments.

The Type 1618 has filter band centre frequencies from 2 Hz to 20 kHz that can be divided into 41 third-octave bands, or 41 overlapping octave bands covering the 14 octave frequency range. It has a built-in A-weighting network, and there is indication given when the level of the signal being analyzed overloads the input section. The Band Pass Filter has provision for filter scanning controlled by B & K Level Recorders.

The Type 1617 has filter band centre frequencies from 2 Hz to 160 kHz that can be divided into 50 third-octave bands. It has 41 overlapping octave bands covering 14 octaves from 2 Hz to 20 kHz. In addition to the A-weighting, it includes B, C, and D-weighting networks, and there is also an input overload indicator lamp. Filter scanning can be controlled by a Level Recorder, and there is a built-in interface to the proposed IEC Digital Bus Standard to permit direct control by other instruments and systems using this standard. A DC ramp output can control the X-axis of an X-Y Recorder, and a control circuit is included to select averaging time programs for use by the measuring instrument.

Both Band Pass Filters will generally be used with one of the Measuring Amplifiers Type 2606, Type 2607, or Type 2608, but other instruments such as the Frequency Analyzer Type 2120 and the Heterodyne Analyzer Type 2010 can be employed. Connected to a B & K Condenser Microphone, these measuring instruments all form a sound measurement system that satisfies IEC 179 for precision sound level meters, while Type 2606, Type 2607, and Type 2120 satisfy IEC 179A for Impulse measurement.

All three Measuring Amplifiers can be employed with either Band Pass Filter, so that selection of which Measuring Amplifier to use will largely depend on the particular measurement application. Table 1 shows the various combinations available, together with brief specifications, and the type of measurement and analysis possible. The basic system of Type 1618 and Type 2608 is for RMS measurement in the audio frequency range, with filter selection by Level Recorder. Optimum utilisation of all measuring modes and control possibilities is obtained with a combination of Type 1617 and Type 2607, which gives the ability to measure and analyze in the frequency range from 2 Hz to 160 kHz, obtaining RMS and Peak values from all commonly encountered random, quasi-random, periodic, and complex waveforms. This combination can be used together with an X-Y Recorder such as Type 2308.

Measuring Amplifiers	Band Pass Filter Type 1618	Band Pass Filter Type 1617
General: Freq. Range: 2 Hz — 200 kHz Dyn. Range: 10 μV — 300 V Fast and Slow averaging Input overload warning	**General:** Freq. Range: 1.4 Hz — 22 kHz 41 third-oct. bands 41 overlapping octave bands A-weighting filter	**General:** Freq. Range: 1.4 Hz — 180 kHz 50 third-oct. bands 41 overlapping octave bands A, B, C, D-weighting filters Averaging time programs Control via built-in IEC interface DC ramp for X-Y Recorder control
Type 2608 and 2121 RMS measurement Crest factors up to 5 AC output to Level Recorders A-weighting network	RMS measurement	
	20 Hz — 22 kHz (Audio frequencies)	20 Hz — 180 kHz
	Manual or remote control of filter scanning	
		Digital bus control of filter scanning
	Measurements can be made at lower frequencies if the averaging ability of a Level Recorder 2307 is used	
Type 2606 RMS and Peak measurement Impulse and Hold modes Crest factors up to 40 AC or DC outputs to Recorders A, B, C, D-weighting networks Range settings shown on meter scale	Comprehensive RMS measurement at high crest factors	
	20 Hz — 22 kHz (Audio frequencies)	20 Hz — 180 kHz
	Manual or remote control of filter scanning	
		Digital bus control of filter scanning
	Measurement in Peak or Impulse Modes	
	1.4 Hz — 22 kHz	1.4 Hz — 180 kHz
	RMS measurements can be made at lower frequencies if the averaging ability of a Level Recorder 2307 is used	
Type 2010 (RMS only), 2607, & 2120 RMS and Peak measurement Impulse and Hold modes Crest factors up to 5 AC or DC outputs to Recorders 50 dB logarithmic DC output proportional to RMS Level A, B, C, D-weighting networks Range settings shown on meter scale	Measurement of RMS and Peak values of all commonly encountered random, quasi-random, periodic, and complex waveforms	
	1.4 Hz — 22 kHz	1.4 Hz — 180 kHz
	Manual or remote control of filter scanning	
	Manual control of averaging time for 2607, 2120, or 2010	
		Digital bus control of filter scanning and averaging times for 2607 and 2120
		This combination gives optimum use of all measurement and control facilities, including X-Y recording (not 2010)

Table 1. Band Pass Filter and Measuring Amplifier Combinations

Description

Both Band Pass Filters are designed to operate on the signals obtained from the External Filter terminals of the Measuring Amplifiers, but any input signal of approximately 1 V RMS with a crest factor less than 5 can be accepted (the higher crest factor capability of the Type 2606 can be used at lower signal levels). Input and output are via coaxial B & K sockets on the front panel, paralled by BNC terminals on the rear.

Filter I Centre Frequency Hz	Filter II Centre Frequency Hz	1/3 Octave Bandwidth at 3.7 dB Hz Approx.
2		0,46
	2,5	0,50
3,15		0,73
	4	0,92
5		1,16
	6,3	1,45
8		1,83
	10	2,30
12,5		2,90
	16	3,70
20		4,60
	25	5,8
31,5		7,3
	40	9,2
50		11,6
	63	14,5
80		18,3
	100	23
125		29
	160	37
200		46
	250	58
315		73
	400	92
500		116
	630	145
800		183
	1000	230
1250		290
	1600	370
2000		460
	2500	580
3150		730
	4000	920
5000		1160
	6300	1450
8000		1830
	10000	2300
12500		2900
	16000	3700
20000		4600
25000		5800
31500		7300
40000	Additional 1/3-octave filters in 1617	9200
50000		11600
63000		14500
80000		18300
100000		23000
125000		29000
160000		37000

Table 2. Filter centre frequencies in preferred series. Heavy type denotes preferred series for full-octaves

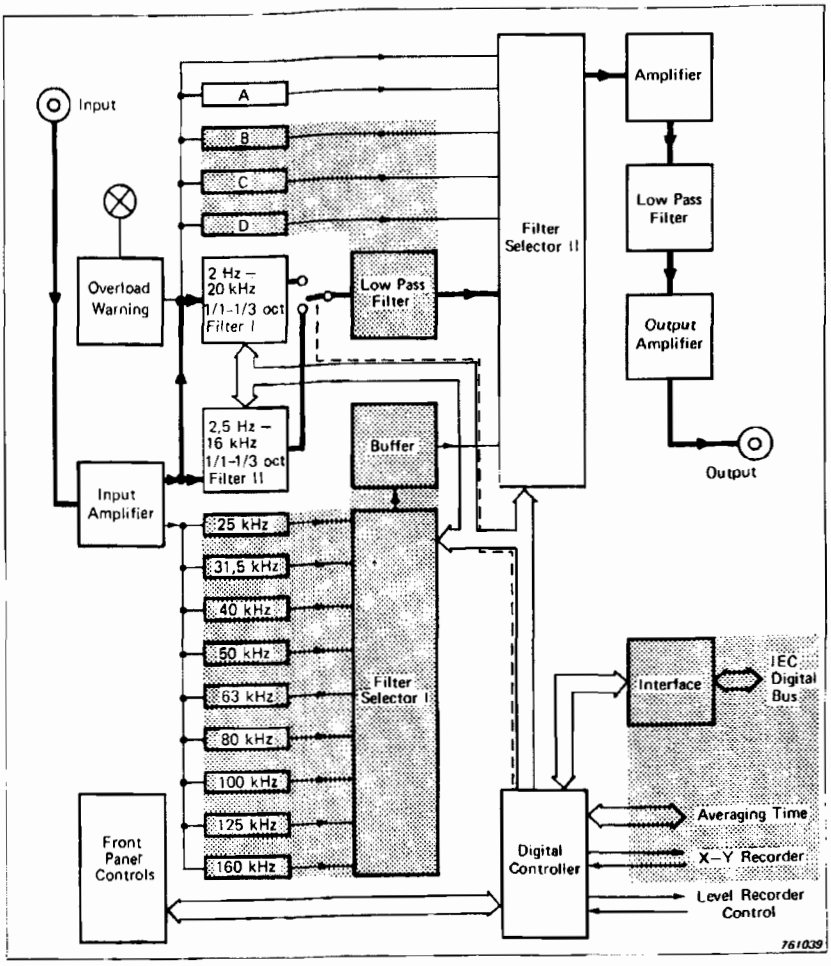


Fig.1. Block diagram of the Band Pass Filters Type 1617 and Type 1618

Fig.1 is a block diagram valid for both versions of Band Pass Filter, where shaded areas represent features found only in the Type 1617.

Third-Octave Band Pass Filters

The active Filter sections consist of a matched pair of variable frequency six-pole Butterworth filters which can be electronically switched to yield third-octave or full-octave bandwidths. Between them the two Filters cover the frequency range from 2 Hz to 20 kHz centre frequencies, with each Filter being switched to alternate third-octave centre frequencies in the preferred series (see Table 2).

In the Band Pass Filter Type 1617 there is an additional set of third-octave Filters with centre frequencies between 25 kHz and 160 kHz, to extend the high frequency range of the instrument.

The filter characteristics of the individual third-octave Filters used in these instruments fulfil the requirements of IEC 225 — 1966, DIN 45652, and ANSI S1.11-1966 Class III, which are the most rigor-

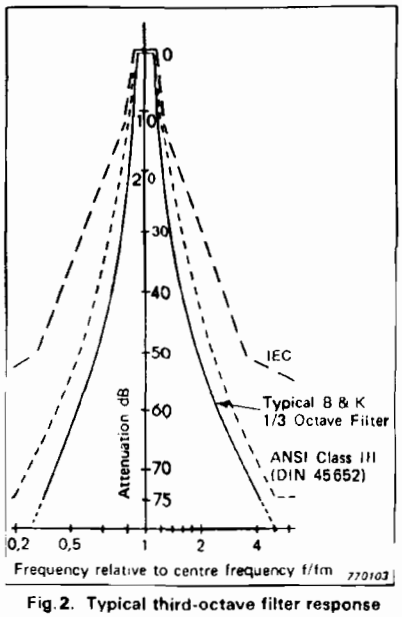


Fig.2. Typical third-octave filter response

ous standards applying to third-octave filters. The response curve for a typical third-octave filter is shown in Fig.2, and the top of the curve in the enlarged view in Fig.3. The IEC, DIN, and ANSI limitations are also indicated in both Figures. Peak-to-valley ripple in the pass band is less than 0,5 dB with attenuation within ± 0,5 dB. Attenuation of frequencies outside 5× and 1/5 of the band centre frequency is better than 75 dB.

Octave Band Pass Filters

Octave Filters are formed in both Band Pass Filters by electronically altering the components and characteristics of the Filter circuits. This arrangement gives a flat crest to the characteristic curve, and low peak-to-valley ripple. The octave Filters cover the frequency range from 2 Hz to 20 kHz centre frequencies, selectable at third-octaves in the preferred series. There is no provision for connection of full-octave filters at higher frequencies in either Filter Set.

All octave Filters contained in the Type 1617 and Type 1618 conform to IEC 225 — 1966, DIN 45651, and ANSI S1.11-1966 Class II, which are the strictest standards for octave filters. Fig.4 shows the top of a typical octave filter characteristic, attenuation outside 8× and 1/8 of the band centre frequency is better than 60 dB. Peak-to-valley ripple is less than 0,5 dB, while attenuation in the pass band is within ± 0,5 dB.

The total integrated random (white) noise power passed by the practical octave and third-octave Filters in the Type 1617 and Type 1618 is equal to that which would be passed by an ideal octave or third-octave filter.

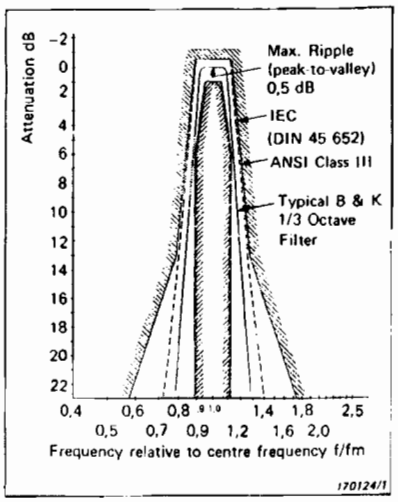


Fig.3. Top of a third-octave filter characteristic

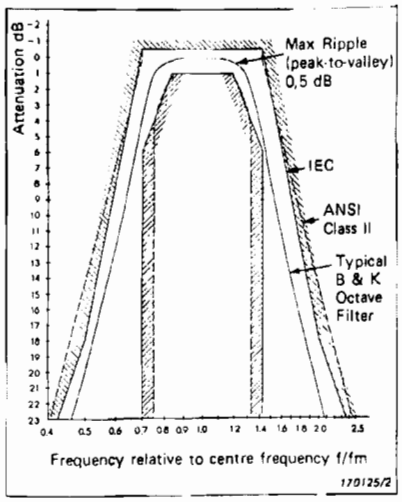


Fig.4. Top of a typical octave filter characteristic

Weighting Networks

In addition to the Linear response, and A-weighting network included in the Type 1618, the Type 1617 contains B- and C-weighting networks, plus the D-weighting network specified in IEC 537 for measurement of aircraft noise. The frequency responses of the four weighting networks are shown in Fig.5. The Figure also indicates the Linear range 1 Hz to 200 kHz obtainable from the Type 1617, and the Linear range 1 Hz to 40 kHz from the Type 1618.

Filter Selection and Scanning Ranges

Filter switching is accomplished electronically by FET switches in the Filter Selectors that are regulated by the Digital Controller acting on instructions from internal or remote control settings. Bandwidth of the Filter in use is selected by the three position Selectivity switch, giving a choice of third-octave bandwidth scanning in third-octave steps, octave bandwidth scanning in third-octave steps (with adjacent bands partially overlapping), or octave bandwidth scanning in full-octave steps.

Manual selection of any particular Filter band is made by turning the Manual Filter Selector control to the required position. On the Band Pass Filter Type 1618 the Manual Filter Selector has a scale graduated in third-octave centre frequencies from 2 Hz to 20 kHz, plus the two positions "A-weighting" and "Linear". There are two measuring ranges on the Band Pass Filter Type 1617, selected by the Range switch, and hence two frequency

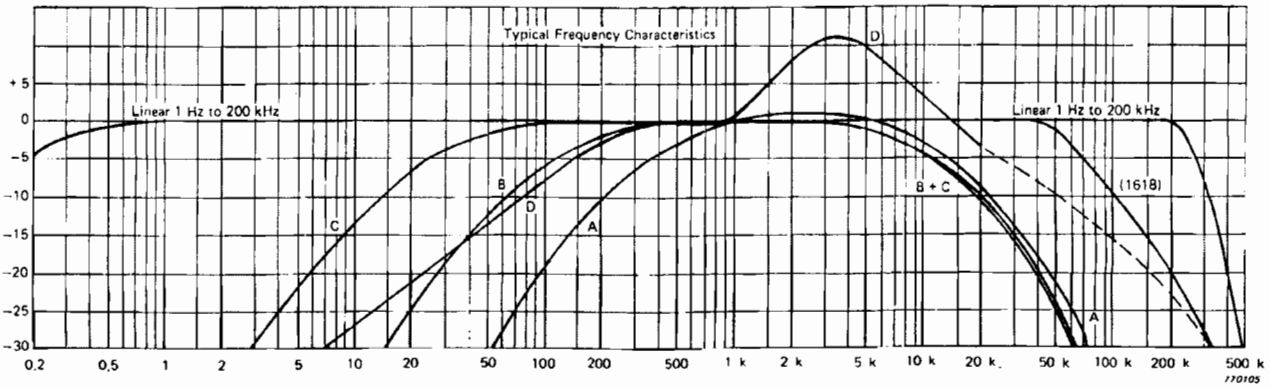


Fig.5. Weighting networks and Linear functions

scales. One covers the full frequency range with graduations in third-octaves with centre frequencies from 2 Hz to 160 kHz. The other range covers third-octave centre frequencies between 2 Hz and 40 kHz, and includes A-, B-, C-, D-weighting, and a Linear position. Both models have a "Linear" mode available on the Range switch, which permits a Linear output to be obtained at any point in a scan, without moving the Manual Filter Selector.

The centre frequency of the selected Filter band is indicated on a half-inch digital display that also shows whether the Filter is functioning as a third-octave or as an octave filter, or whether a weighting network has been selected.

Filter Scanning

In addition to its control of the Filter switching as directed by the Manual Filter Selector, the Digital Controller can operate the Filter scan on the commands of an external source. Control by a Level Recorder Type 2306, Type 2307 or Type 2309 is possible with both Band Pass Filters. On the Type 1617 control can also be exercised via the built-in IEC Interface, or an X-Y Recorder such as Type 2308 can be operated in synchronism with Filter scanning (possible with Type 2607 Measuring Amplifier or equivalent).

Selection of manual or recorder control is made by the Filter Control Mode Manual/Recorder switch, while the Stop/Run switch enables the Recorder in use to be controlled from the Band Pass Filter. This control facility is blocked when "Manual" is selected, or when the Type 1617 is being controlled via the Interface.

When operating in any remote control mode, the progress of the scan can be followed on the Digital Display, as the Manual Filter Selector does not rotate during an automatic scan. The Filter frequency sweep always starts from the band in which the Manual Filter Selector is standing, it sweeps through the selected range, and being internally actuated, it returns instantly to its starting point. This saves analysis time when low frequencies (with correspondingly long averaging times) will not be required while operating the Type 1617 with an X-Y Recorder, or under digital control via the Interface bus. Similarly, when recording sound on a Level Recorder, unwanted low frequency bands can be excluded from the trace to yield a clear audio frequency spectrogram.

Connections for synchronisation with a Level Recorder Type 2307 is made via a 7-pin DIN socket on the rear panel (see Fig.6). Connection to a Level Recorder Type 2306 is achieved via an 8-pin DIN socket, which with the Type 1617 is also used for X-Y recording.

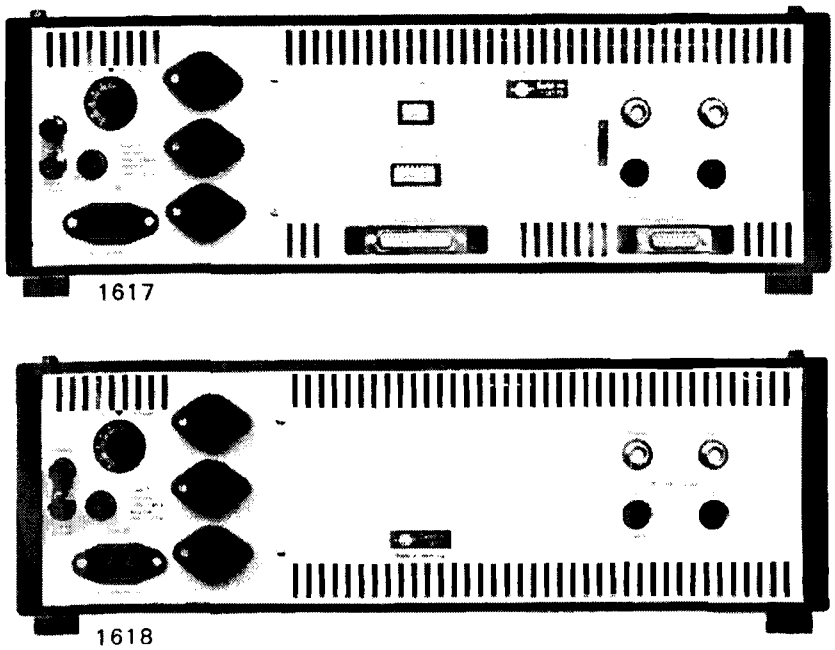


Fig.6. Rear panels of the Band Pass Filters

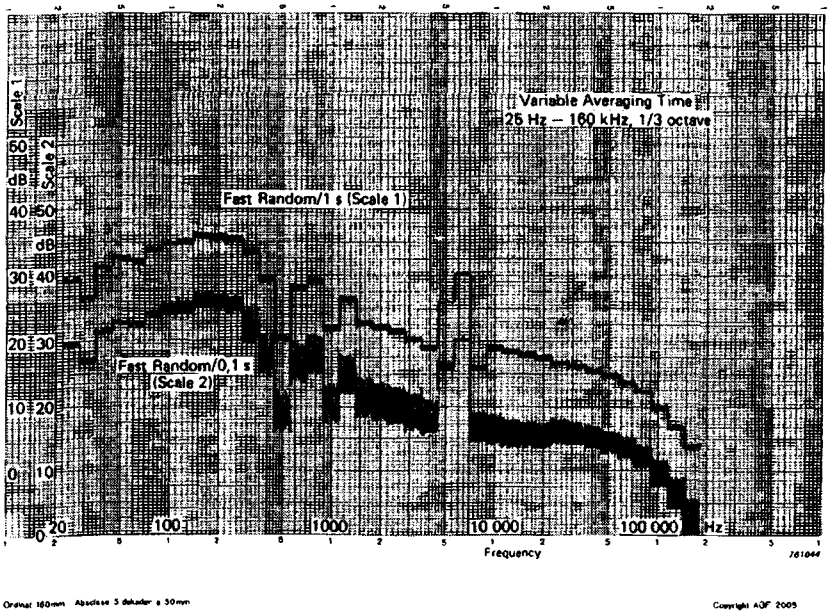


Fig.7. Conditions where longer averaging times are required for high frequency signals. The lower curve was made with too short averaging time, while for the upper curve, averaging was correct

Averaging Time Control

This ability, allows the Type 1617 to vary the averaging time of the Measuring Amplifier Type 2607 or the Narrow Band Analyzer Type 2120 during the course of the frequency scan. The advantage is that the averaging time can be kept as short as possible to maintain an acceptable analysis time, while being long enough at lower frequencies to achieve optimum measuring accuracy, i.e. to maintain a good confidence level. The best analysis conditions are obtained when the product of bandwidth B (in Hz) and averaging time T (in s) is held constant throughout the scan. Therefore the Type 1617 is equipped with averaging time programs which can be selected according to test conditions to maintain the BT product as near constant as possible and give a constant confidence level.

At higher frequencies, if a constant BT product is to be maintained, the averaging time becomes so short that the writing speed of the Recorder will be the practical limitation on the speed of the analysis. Therefore the shortest averaging time that can be selected by the programs in the Type 1617 is 0,1 s. However, some high frequency signals like the noise or vibration from a slowly rotating machine may have a low repetition frequency that causes low frequency modulation as shown in Fig.7, where 0,1 s averaging time is too short. To allow satisfactory averaging times to be selected for this type of signal, a choice of three minimum times (0,1 s, 1,0 s, and 10 s) is provided on the Type 1617. Fig.8 is a chart indicating the averaging times and change-over frequencies in the nine programs available, together with the minimum and maximum averaging times.

When operating with variable averaging times, selection of the required program is made with the two Averaging Control switches on the front panel, and the Recorder Averaging Time switch on the rear panel must also be set to "Variable Averaging Time". Table 3 shows how the programs can be selected by suitable combination of the Program and Minimum Time switch positions. The programs are obtained via the 15 lead AVERAGING TIME CONTROL socket on the rear panel.

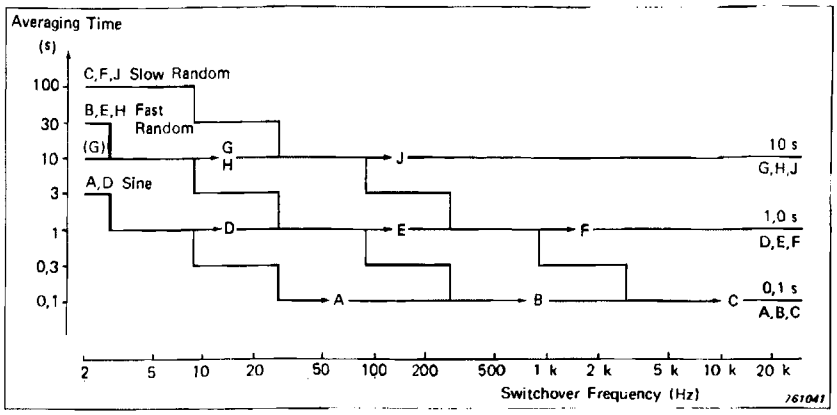


Fig.8. Averaging times and changeover frequencies

Minimum Av. Time(s)	0,1	1,0	10
Slow Random	C	F	J
Fast Random	B	E	H
Sine	A	D	(G)

Table 3. Selection of the required averaging time program

With a Level Recorder, automatic averaging time control functions as follows. The scan starts with the Recorder being held for a period of five times the programmed averaging time for the band, during which time the pen comes up to the correctly averaged level. Then a long averaging time is selected that keeps the output constant while the Recorder draws the trace by advancing the paper at high speed to the next frequency band. The Filter steps to the next band in the sequence, and the programmed averaging time is selected, after which the Recorder hold period begins again.

Using an X-Y Recorder, where the X-axis is controlled by the DC ramp output from the Type 1617, the Recorder pauses for five times the averaging time, and then takes eight steps through each third-octave band.

Figs.9, 10, and 11 show analysis of the same input signal recorded using three different methods to illustrate their relative merits.

Built-in IEC Interface

The Type 1617 is fully programmable via a built-in interface that satisfies the requirements of the proposed IEC Standard Digital Interface for Programmable Instrumentation. This permits the filter frequency bandwidths, and averaging time to be varied in an arbitary sequence, and recording initiated to suit any particular measuring program. It also permits on-line changes to be made to accomodate new events as they occur.

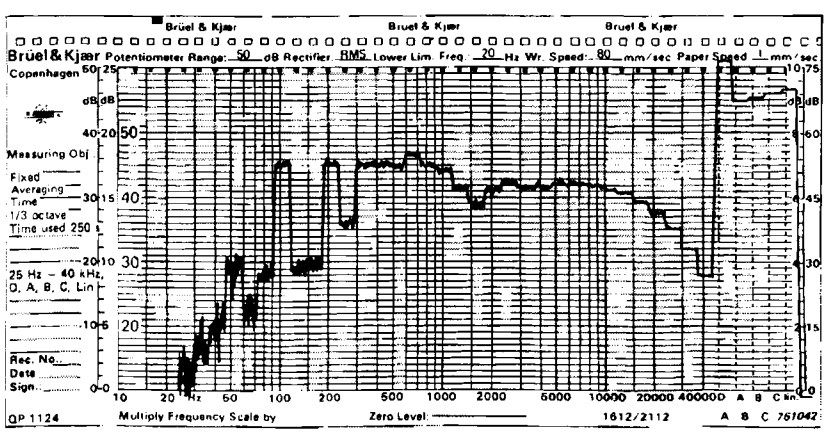


Fig.9. Frequency analysis with Level Recorder and fixed averaging time

The following interface functions are available on the Type 1617:

Acceptor Handshake (AH1)
Listener Function (L2)
Remote Local Function (RL2)
Parallel Poll Function (PP2)

Busy is indicated via NRFD (not ready for data) hold method when the Band Pass Filter is feeding a Recorder.

A Listen Address switch on the rear panel allows the instrument Listener address to be set for use with remote digital control. There is a PPR Selector for setting the Parallel Poll Response, used here to report whether there has been an overload in the Input Amplifier since the previous interrogation. This is used to assess the validity of the levels measured in the filter bands.

Connection to the digital bus is made via the 25-lead plug on the rear panel of the instrument.

Operation with other instruments

Fig. 12 shows the connection possibilities with other Brüel & Kjær instruments, including the cables required.

The Band Pass Filters can also be employed as external filters for B & K Sound Level Meters and Vibration Meters.

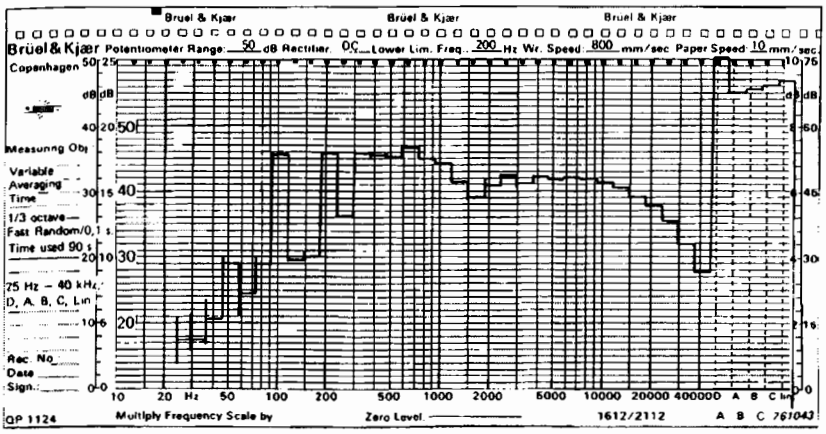


Fig. 10. Frequency analysis with Level Recorder and variable averaging times

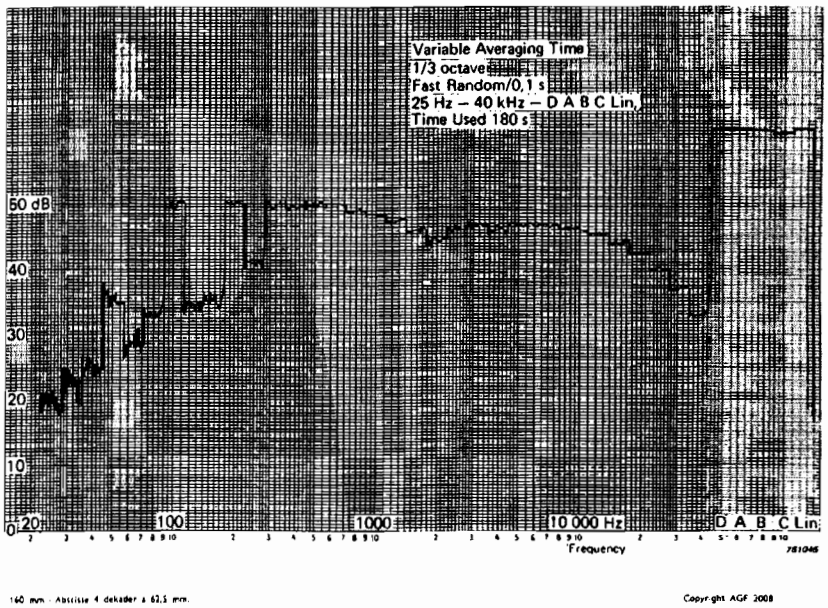


Fig. 11. Frequency analysis with X-Y Recorder and variable averaging times

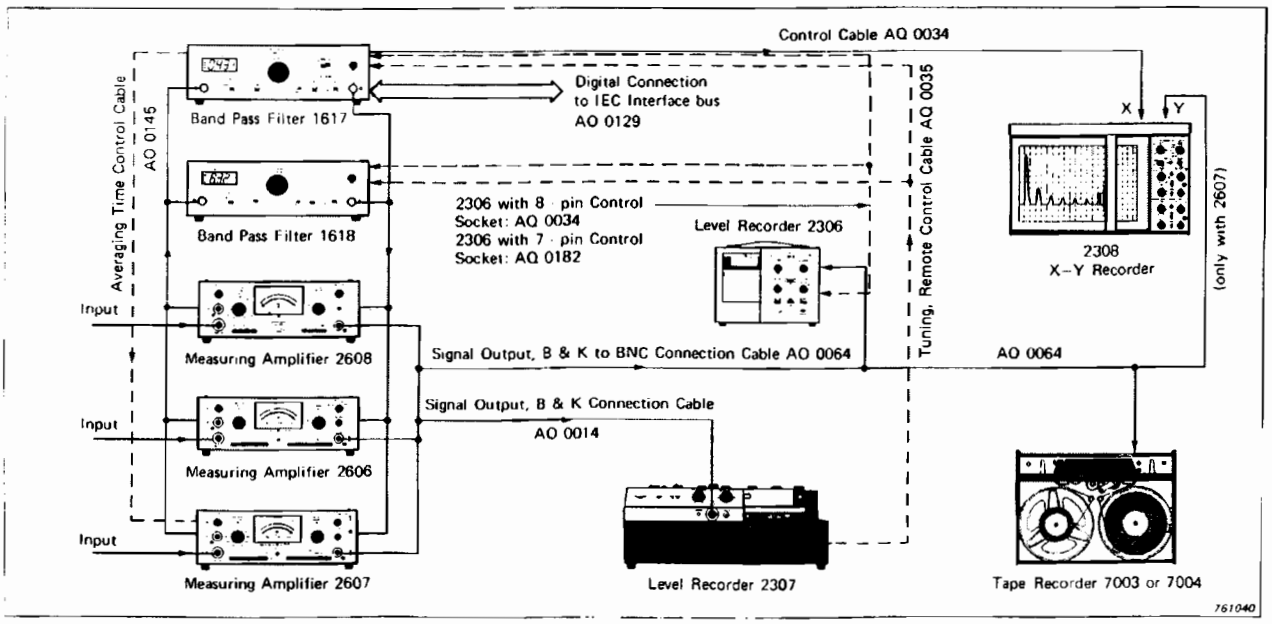


Fig. 12. Connection possibilities with other B & K instrumentation

Specifications 1617 and 1618

Band Pass Filters:
In accordance with IEC 225 1966, DIN 45651 and 45652, and ANSI S1.11-1966 best classes
The total integrated random white noise power passed by the filters in these instruments is equal to that which would be passed by an ideal filter
Centre Frequencies 1617:
1/3 oct: 2 Hz to 160 kHz (50 bands)
1/1 oct: 2 Hz to 20 kHz (41 overlapping bands at 1/3 octave intervals covering 14 octaves)
Centre Frequencies 1618:
1/3 oct: 2 Hz to 20 kHz (41 bands)
1/1 oct: 2 Hz to 20 kHz (41 overlapping bands at 1/3 octave intervals covering 14 octaves)
Attenuation Outside Pass Band:
1/3 oct: > 75 dB at 5× and 1/5 centre frequency
1/1 oct: > 60 dB at 8× and 1/8 centre frequency
Attenuation at Centre Frequency (f_m):
1/3 oct and 1/1 oct: 0 dB ± 0,5 dB
Maximum Peak-to-Valley Ripple:
1/3 oct: 0,5 dB
1/1 oct: 0,5 dB

Overall Selective Frequency Range:
1617: 1,4 Hz to 180 kHz
1618: 1,4 Hz to 22 kHz

Linear Pass Band (Available from Range switch or Manual Filter Selector):
1617:
1,6 Hz to 160 kHz attenuation is 0 dB ± 0,3 dB
1 Hz to 200 kHz attenuation is 0 dB ± 0,5 dB
1618:
1,6 Hz to 31,5 kHz attenuation is 0 dB ± 0,3 dB
1 Hz to 40 kHz attenuation is 0 dB ± 0,5 dB

Filter Selection:
Type 1617:
2 Hz to 160 kHz
2 Hz to 40 kHz, D, A, B, C, Linear
Type 1618:
2 Hz to 20 kHz, A, Linear
Switching control:
Manual: from "Manual Filter Selector"
Automatic: from a Level Recorder
Automatic: to control an X-Y Recorder (1617 only)
(When scanning octave filters, either full-octave or third-octave stepping can be selected)
Automatic: via the IEC interface bus (1617 only)

Weighting Networks:
Curves A, B, and C are in accordance with IEC 179 for precision sound level meters (1618 has A-weighting only)
Curve D is in accordance with IEC 537

Averaging Time Programmes (1617 only):
Used with Measuring Amplifiers that feature remote controlled averaging times (Type 2607)
Programmes Available:
See Table 3 and Fig.8

Input:
Via B & K coaxial socket on front panel, paralleled by BNC socket on rear
Impedance:
1 MΩ || 100 pF
Voltage:
1 V RMS nominal
5 V peak maximum
5,6 V (± 0,3 V) overload warning lamp lights

Distortion:
Band Pass Filters:
< 0,1% with 1 V signal level
< 0,3% with 3,6 V signal level
Linear Range:
< 0,1% with 1 V signal level
< 0,3% with 3,6 V signal level

Noise:
< 150 μV (typ. 100) Band Pass Filters
< 110 μV (typ. 80) A, B, and C-weighting networks
< 250 μV (typ. 180) D-weighting network
< 100 μV (typ 80) Linear range

Output:
Via B & K coaxial socket on front panel, paralleled by BNC socket on rear
Impedance:
< 50Ω
Minimum Load Impedance:
5 kΩ || 1 nF for less than ± 0,2% reading error

DC Ramp Output (1617 only):
Used for controlling the X-axis of an X-Y Recorder
0 V at the starting frequency
0,208 V per 1/3 octave increase rate
10,4 V maximum output
Load impedance > 10 kΩ

Digital Bus Interface (1617 only):
Conforms with the proposed IEC Standard Digital Interface for Programmable Instrumentation
Contains the following functions
Acceptor Handshake (AH1)
Listener Function (L2)
Remote Local Function (RL2)
Parallel Poll Function (PP2)

Environmental Conditions:
Operating Temperature Range:
5°C to 40°C (41°F to 104°F)

Storage Temperature:
—25°C to + 70°C (—13°F to + 158°F)
Permitted Humidity Range:
The outputs from the instruments are accurate between 0 and 90% relative humidity, provided there is no condensation

Power Requirements:
100, 115, 127, 200, 220, 240 V AC ± 10%
50 to 400 Hz
1617: approx. 37 VA
1618: approx. 30 VA
Comply with IEC 348 Class II

Cabinet:
Supplied as model A (light-weight metal cabinet), B (model A in a mahogany cabinet), or C (as A but with flanges for standard 19" rack mounting)

Dimensions:
Height: 133 mm (5,25 in)
Width: 430 mm (16,9 in)
Depth: 200 mm (7,9 in)

Weight:
1617: 6,5 kg (14,3 lb)
1618: 6,3 kg (13,9 lb)

Accessories Included:
1 AN 0010 Power cable
2 JB 0002 Banana plug
2 JP 0035 BNC plug
2 JP 0101 B & K coaxial plug
1 JP 0703 7-pin DIN plug
1 JP 0802 8-pin DIN plug
2 VF 0012 Fuse

Accessories Available:
See Fig.12.

2. CONTROLS

2.1. FRONT PANEL

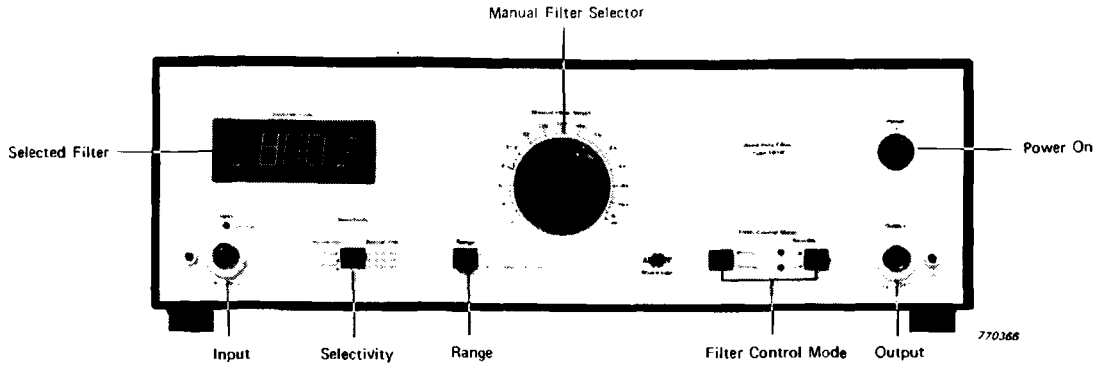


Fig.2.1. Front panel controls of the Type 1618

POWER ON: Power is on with the switch in the up position. Warm-up time is approximately five seconds.

MANUAL FILTER SELECTOR: A rotary switch that selects the filters and weighting networks when operating in the "Manual" control mode. The filter selected is shown on the frequency scale.

SELECTED FILTER: A digital display that shows the centre frequency of the selected filter. The display also indicates the bandwidth chosen, and whether a linear or weighted response has been selected.

INPUT: Standard B & K coaxial socket, fitting JP 0101 Plugs, paralleled by a BNC socket on the rear panel. There is an input "Overload" lamp, and a separate ground terminal. The maximum input voltage is 5 V, and the impedance is 1 MΩ in parallel with 100 pF.

SELECTIVITY: A three-position switch that selects the bandwidth of the filters, and the centre frequency step length for full-octave scanning. Functions are as follows:

Upper position: third-octave bandwidth with scanning in third-octave steps.

Middle position: full-octave bandwidth with scanning in third-octave steps, with overlapping.

Lower position: full-octave bandwidth with automatic scanning in full-octave steps.

RANGE: A two-position switch to select the narrow band range, or "Linear", for both manual and remote controlled operation. Functions are as follows:

Upper position: "Linear" range from 1 Hz to 50 kHz, independent of the position of the MANUAL FILTER SELECTOR.

Lower position: "2 Hz to 20 kHz A-Lin.", filters are selected automatically, or by the MANUAL FILTER SELECTOR.

FILTER CONTROL MODE: Two switches that control how the filters are selected, plus two LED indicators.

The left-hand switch can select "Manual" so that the filters are chosen by the MANUAL FILTER SELECTOR or it can select "Recorder" mode allowing filter selection to be made by external control.

The right-hand switch enables the Recorder in use to be controlled from the Band Pass Filter. This facility is blocked when "Manual" has been selected. Two LEDs light to indicate whether "Stop" or "Run" is selected.

OUTPUT: Standard B & K coaxial socket, fitting JP 0101 Plugs, paralleled by a BNC socket on the rear panel. There is a separate ground terminal. Impedance less than 20 Ω, minimum load impedance 5 kΩ in parallel with 1 nF.

2.2. REAR PANEL

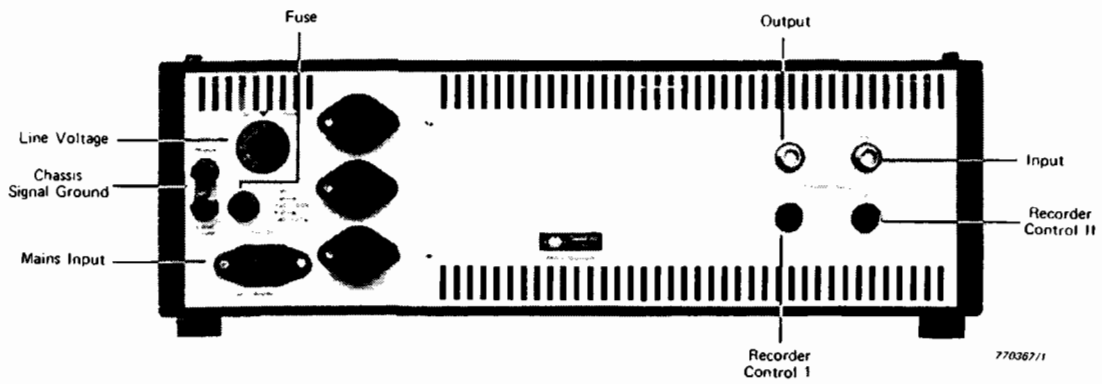


Fig.2.2. Rear panel connections of the Type 1618

CHASSIS-SIGNAL-GROUND: A pair of clamping terminals with a shorting strap, permiting the signal ground to be connected to the instrument chassis. See section 3.1.4.

LINE VOLTAGE: Voltage selector for operation of the 1618 from 100, 115, 127, 200, 220 and 240 V (50 to 400 Hz) single phase, AC mains lines. To select the correct voltage setting see section 3.1.

LINE INPUT: Input socket accepting the Power Cable AN 0020 provided, for connection of an AC mains supply. Before connecting the apparatus to a supply, the mains voltage setting and fuse checks given in section 3.1 should be carried out.

FUSE: Fuse holder containing a 200 mA slow blow fuse for operation from 200 to 240 V AC mains lines. For 100 to 127 V operation, a 400 mA slow blow fuse should be fitted. See section 3.1.

OUTPUT: BNC socket in parallel with front panel output socket.

INPUT: BNC socket in parallel with front panel input socket.

RECORDER CONTROL I: 7-pin DIN socket for remote switching of the filters by a Level Recorder Type 2307. For connections see Fig.2.3.

RECORDER CONTROL II: 8-pin DIN socket for remote switching of the filters by a Level Recorder Type 2306 or 2309. For connections see Fig.2.4.

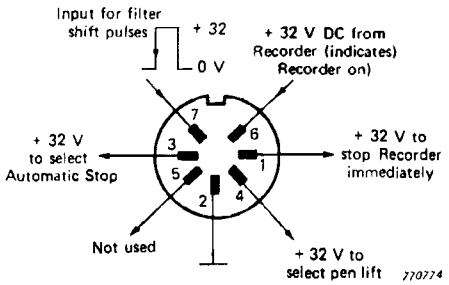


Fig.2.3. RECORDER CONTROL I viewed from outside the socket

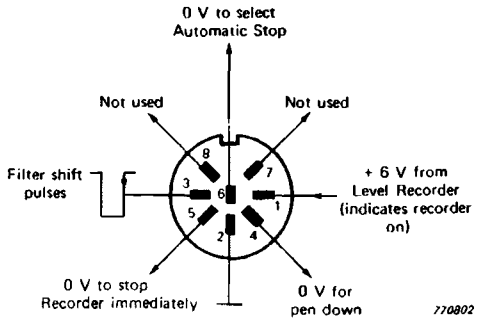


Fig.2.4. RECORDER CONTROL II viewed from outside the socket

⚠ **Warning:** The 1618 is designed to be operated with its signal ground lines and chassis always at earth potential. Never let the signal ground terminals, socket screens or chassis float at any other potential, as this will impair the operating safety of the 1618 and may damage the instrument.

3. OPERATION

3.1. PRELIMINARY ADJUSTMENTS

Before connecting a mains supply the following checks and adjustments should be carried out to ensure safe operation of the apparatus.

3.1.1. Selection of Mains Voltage

The 1618 may be powered from a 100, 115, 127, 200, 220 or 240 V (50 to 400 Hz) AC mains supply. To select the correct mains voltage setting, use a small coin or wide blade screwdriver to turn the LINE VOLTAGE selector on the rear panel so that the appropriate voltage indication on the selector faces the arrow marked on the panel.

3.1.2. Mains Fuse Check and Replacement

The mains fuse is contained in the fuse holder just beneath the LINE VOLTAGE selector. To release the fuse use a screwdriver to turn the centre of the holder. For operation from 100 to 127 V mains supplies the fuse should be an 400 mA slow blow (B & K No. NF 0039), whilst for 200 to 240 V supplies it should be a 200 mA slow blow (B & K No. VF 0012). Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

3.1.3. Mains Connections

Once the mains voltage setting and fuse have been checked, the mains supply may be connected to the LINE INPUT socket of the 1618 using the Power Cable AN 0020 provided. The LINE INPUT socket is not equipped with a chassis terminal for connection to the protective ground contact of a mains socket outlet, as the high standard of protective insulation of the 1618 makes this unnecessary.

3.1.4. Grounding Considerations

When using the 1618 in complex measurement set-ups together with (other) mains operated equipment, mains frequency pickup by ground loops may cause measurement errors. To prevent this without prejudicing the operating safety of the measurement set-up, the 1618 and other instruments with which it is used must be properly grounded. To do this proceed as follows:

1. Connect the signal ground lines of all instruments together. This is done automatically through the screens of the input and output cables.

2. If instruments equipped with a mains input chassis terminal are included in the set-up, then ensure that all have their chassis connected to mains ground and that one and only one of them has its chassis connected to signal ground.

3. If instruments without a mains input chassis terminal are included in the set-up and these are used free standing without their cabinets touching, then ensure that all of them have their chassis connected to signal ground.

4. If instruments without a mains input chassis terminal are mounted in a metal instrumentation rack, together with one or more instruments that have a mains input chassis terminal, then ensure that their chassis is disconnected from signal ground.

5. If instruments without a mains input chassis terminal are mounted in a metal instrumentation rack without an instrument having a mains input chassis terminal present, then ensure that one and only one of them has its chassis connected to signal ground.

6. Isolate the measurement transducer housing or disconnect the measurement system signal ground from grounded measurement sources.

The signal ground and chassis of the Type 1618 are normally connected by the metal strap between the ground terminals on the rear panel. If necessary the strap may be removed to isolate the signal ground from chassis ground.

3.2. USE WITH MEASURING AMPLIFIER

The 1618 Band Pass Filter may be used with any Measuring Amplifier or Electronic Voltmeter which is equipped with sockets for connection of an external filter. Suitable types of Measuring Amplifier available from B & K are indicated in Fig.3.1. These have an overall frequency range extending from 2 Hz up to 200 kHz and for sound, vibration and voltage measurements may be connected with a wide range of measurement transducers and preamplifiers. The 1618 may be connected in series with, or in place of any internal weighting network of the Measuring Amplifiers, forming a powerful measurement set-up for octave and third octave frequency analysis of signals. The analyzed signal level can be read directly from built-in meter of the Measuring Amplifier. The basic operating procedure is as described below.

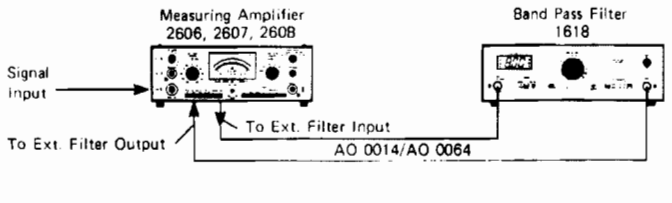


Fig.3.1. B & K Measuring Amplifiers for use with Band Pass Filter Type 1618

1. Carry out the necessary preliminary adjustments. See section 3.1 of this Instruction Manual and the Instruction Manual for the particular Measuring Amplifier employed.

2. Connect the Filter Set and Measuring Amplifier as indicated in Fig.3.1.

3. On the Filter Set set the Power switch to "On" and the RANGE switch to "Lin".

4. With the Measuring Amplifier set to "Ext. Filter" calibrate it for sound, vibration or voltage measurements as described in its Instruction Manual.

5. Turn the INPUT and OUTPUT SECTION ATTENUATOR knobs of the Measuring Amplifier to their extreme clockwise position and disconnect the reference source.

6. Set Filter Set controls:

SELECTIVITY	"Bandwidth" and "Record Step" as required
RANGE	"2 Hz — 20 kHz — A — Lin"
FILTER CONTROL MODE	"Manual" — "Stop"
MANUAL FILTER CONTROL	Required octave, third octave, A weighting or Lin. frequency band in which measurements are to be taken.

7. Apply the signal to be measured to the appropriate INPUT socket on the Measuring Amplifier and step the INPUT SECTION ATTENUATOR knob anti-clockwise to obtain a suitable meter deflection without the INPUT OVERLOAD lamp flashing on the Measuring Amplifier and Filter Set.

   If the deflection is insufficient even when the INPUT SECTION ATTENUATOR is in its extreme anticlockwise position, then step the OUTPUT SECTION ATTENUATOR knob until a suitable deflection is obtained without overload.

8. The signal level within the selected frequency band can be read from the meter where 0 dB or full scale corresponds to the value indicated by the range indicator lamps and/or the INPUT and OUTPUT ATTENUATOR knob settings of the Instrument. See Instruction Manual for appropriate Measuring Amplifier.

   When reporting measured levels it should be stated which octave, third octave, weighting or linear frequency band has been used.

9. Use the MANUAL FILTER SELECTOR to select other frequency bands for measurements in the same way.

3.3. USE WITH SOUND LEVEL AND VIBRATION METERS

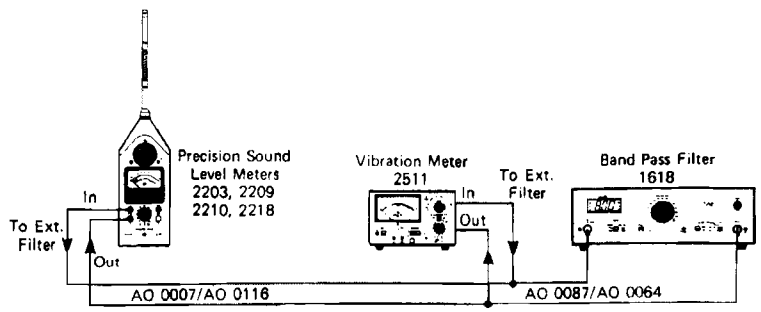


Fig.3.2. Use of the 1618 Band Pass Filter with B & K Sound Level and Vibration Meters

As indicated in Fig.3.2 the 1618 Band Pass Filter may be used for octave and third octave measurements with a portable Sound Level Meter or Vibration Meter. Operation is

similar to that described in the Instruction Manual for the particular Sound Level Meter or Vibration Meter employed, except that for measurements its external filter mode should be selected.

Note: For octave and third octave measurements with autoranging instruments, the manual range control mode should be used.

4. RECORDING OF FREQUENCY ANALYSES

For fully automatic recording of octave and third octave analyses on frequency graduated paper, the 1618 may be used with the portable Level Recorders Types 2306 and 2309 or the main operated Level Recorder Type 2307. Switching of the Band Pass Filter centre frequency is accomplished using the filter shift pulses generated by the Level Recorders. Operation depends on the particular Level Recorder used and is described in the following sections.

4.1. USE WITH LEVEL RECORDERS TYPES 2306 AND 2309

The instrument arrangement for automatic recording of octave and third octave analyses with the 2306 and 2309 Level Recorders is shown in Fig.4.1. Also indicated are the necessary remote control cables for application of the Level Recorder filter shift pulses to the RECORDER CONTROL II socket of the 1618 Band Pass Filter in the arrangement.

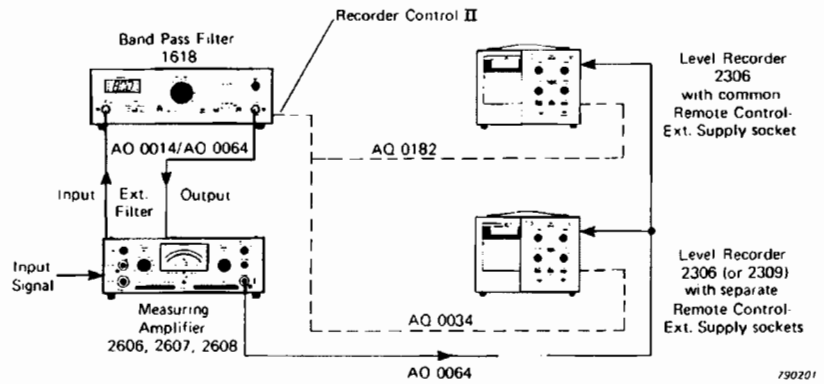


Fig.4.1. Use of Level Recorders Types 2306 and 2309 for automatic recording of octave and third octave analyses

With 2306 Level Recorders before serial no. 576700 a 3,3 kΩ resistor must be soldered to print board XC 1062 (see Fig.4.2) to permit correct synchronization. For access to XC 1062, disconnect all power from the Level Recorder and remove the four screws under the black snap-on caps at each corner of the rear panel. XC 1062 is located behind print boards XC 1059 and 1060 which may be released by unscrewing the two screws and two spacers at the top of the respective boards. Modification should be performed only by persons qualified in the service and maintenance of electronic measuring instrumentation.

The procedure for recording an octave or third octave analysis is given below. This is given with reference to the 2306, however, a similar procedure may be used with the 2309 Level Recorder.

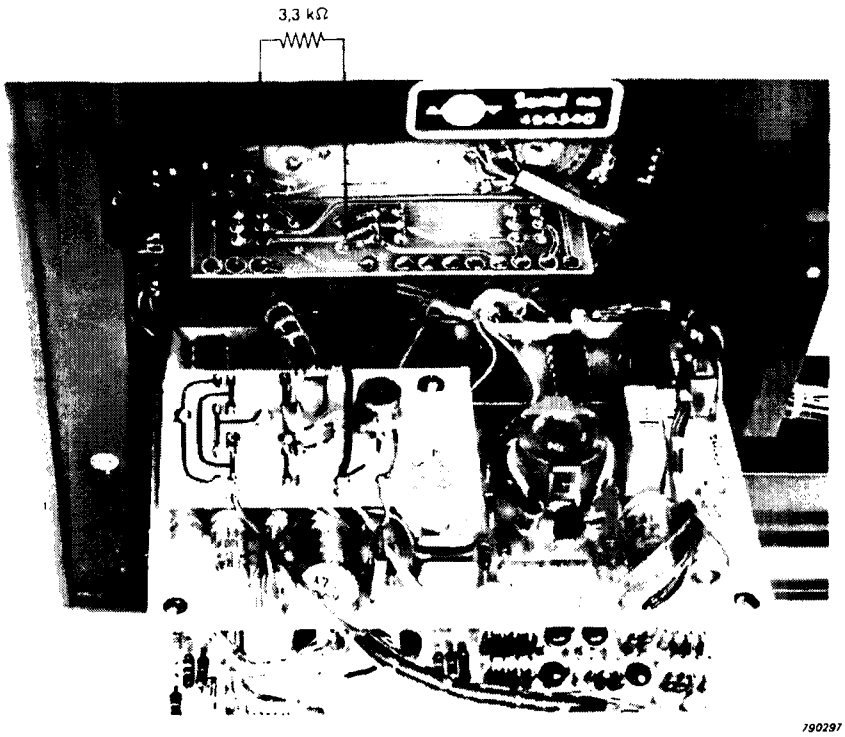


Fig.4.2. Modification of Level Recorders Type 2306 before serial no. 576700

1. Connect the Band Pass Filter, Measuring Amplifier and Level Recorder as shown in Fig.4.1.

2. Fit the Level Recorder with a 50 dB Range Potentiometer, plus pen and roll of frequency graduated Recording Chart QP 0143 or QP 0124.

3. Set Level Recorder controls

SENSITIVITY	"0"
RECORDING MODE	"AC Log", "DC log" or "DC Lin" whichever is appropriate for Measuring Amplifier output signal. See Level Recorder Instruction Manual.
WRITING SPEED/LF LIMIT	Lower frequency limit and effective averaging time suitable for recording section 5.3.3
PEN DRIVE	"On"
PAPER SPEED	As required, but not "30 mm/s". See section 5.3.4
PAPER DRIVE	"Off"
POWER	"On"

The pointer of the BATTERY indicator should deflect to the right-hand region of its scale. If in the left hand region, replace or recharge the internal batteries of the Level Recorder.

4. Calibrate the Band Pass Filter and Measuring Amplifier combination as described in items 1 to 4 of section 3.2.

5. Keeping the reference source connected, step the INPUT SECTION ATTENUATOR

knob of the Measuring Amplifier one step anticlockwise and adjust the GAIN CONTROL knob to obtain full scale pointer deflection on the indicating meter.

6. Keeping the reference source connected, calibrate the Level Recorder so its pen deflection corresponds with the meter indication of the Measuring Amplifier. This depends on the record mode selected and may be performed as follows:

   "AC and DC Log" record modes: Adjust the SENSITIVITY knob of the Level Recorder to move the pen to the thick line ("50 dB") at the top of the recording chart.

   "DC Lin" record mode: Disconnect the cable from the SIGNAL INPUT socket of the Level Recorder and adjust the DC LIN. POSITION knob to move the pen to the thick line ("0 dB") at the bottom of the recording chart. Reconnect the SIGNAL INPUT socket cable and adjust the SENSITIVITY knob to move the pen to the thick line ("50 dB") at the top of the chart. If the pen position cannot be adjusted, then carry out the adjustment with the POLARITY REVERSER switch of the Level Recorder set to its opposite polarity. To improve the accuracy of the calibration, turn the INPUT SECTION ATTENUATOR knob of the Measuring Amplifier two steps clockwise (i.e. decrease sensitivity by a factor of 10) and adjust the DC LIN. POSITION knob to move the pen to a level graduation on the chart corresponding with the level indicated by the indicating meter. Finally, return the INPUT SECTION ATTENUATOR knob to its original position and adjust the SENSITIVITY knob so that the pen is immediately over the thick line (50 dB) at the top of the chart.

   Once correctly adjusted avoid touching the DC LIN POSITION and SENSITIVITY knobs of the Level Recorder or calibration will be lost.

7. Disconnect the reference source and set Band Pass Filter controls:

SELECTIVITY	"Bandwidth" and "Record Step" as required
RANGE	"2 Hz - 20 kHz - A - Lin"
FILTER CONTROL MODE	"Recorder" — "Stop"
MANUAL FILTER CONTROL	To centre frequency of the octave or third octave band in which analysis is to commence.

8. Set the PAPER DRIVE button of the Level Recorder to "On" and press the right hand FILTER CONTROL MODE switch of the Band Pass Filter to "Run", letting the paper drive forward until it stops automatically. The 1/3 OCTAVE light on the level Recorder should now be lit, indicating that the paper drive was stopped at the instant the Band Pass Filter was stepped to the start of the octave or third octave in which analysis is to commence. To maintain this exact starting point, keep the PAPER DRIVE and POWER push-button set to "On" (inner position)

9. On the Level Recorder, set the PEN DRIVE button to "Off" and slide the pen by hand to the thick line (50 dB) at the top of the recording chart. This is printed with third octave centre frequency markings ☛ spaced at 5 mm intervals.

10. For third octave or octave analysis in third octave steps, use the PAPER ADJUSTMENT wheel to advance the paper to a position where the pen is 2,5 mm before the centre of the frequency marking ☛ corresponding with the centre frequency of the third octave band in which analysis is to commence.

    For octave analysis in octave steps, move the recording paper forward to a position where the pen is 7,5 mm before the frequency marking ☛ corresponding with the centre frequency of the octave band in which analysis is to commence.

The paper position and filter switching are now synchronized.

11. Turn the INPUT SECTION ATTENUATOR and GAIN CONTROL knobs of the Measuring Amplifier to their extreme clockwise position and apply the signal to be analyzed.

12. Set the RANGE switch on the Band Pass Filter to "Lin" and step the INPUT SECTION ATTENUATOR knob of the Measuring Amplifier to obtain a suitable meter deflection without the INPUT OVERLOAD lamp lighting.

    If the deflection is insufficient even when the INPUT SECTION ATTENUATOR is in its extreme anticlockwise position, then stop the OUTPUT SECTION ATTENUATOR knob until a suitable deflection is obtained without overload.

13. Set the PEN DRIVE button of the Level Recorder to "On".

14. Set the RANGE switch on the Band Pass Filter back to its "2 Hz — 20 kHz — A — Lin" mode and press the right-hand FILTER CONTROL MODE switch to "Run" to commence recording.

The Level Recorder will start and will drive the frequency graduated paper forward until the end of the chart. Each time the pen passes the chart position for a filter change, the 1618 will step to the next frequency band under the control of the Level Recorder. At the end of the analysis the 1618 resets itself to the correct starting frequency.

To record another analysis, use the PAPER ADJUSTMENT wheel to advance the paper to the correct starting position on the next chart and press the right-hand FILTER CONTROL MODE switch to "Run" to start recording. Do not set the POWER and PAPER DRIVE buttons to "Off", or the exact filter shift position will be lost.

4.2. USE WITH LEVEL RECORDER TYPE 2307

The instrument arrangement for automatic recording of octave and third octave analyses with the 2307 Level Recorder is shown in Fig.4.3. For application of the Level Recorder filter shift pulses to the RECORDER CONTROL I socket of the 1618 Band Pass Filter, the Remote Control Cable AQ 0035 is required.

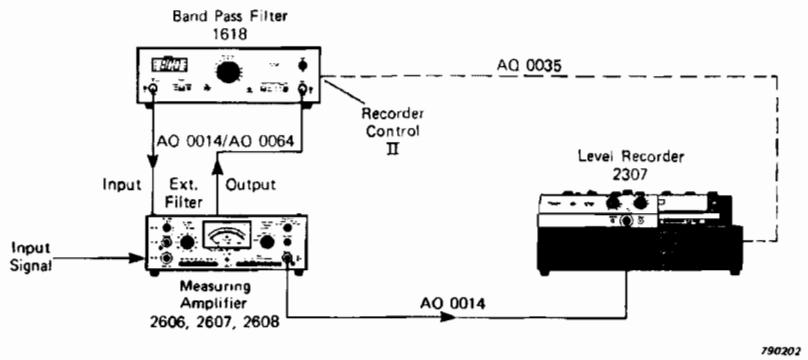


Fig.4.3. Use of Level Recorder Type 2307 for automatic recording of octave and third octave analyses

The calibration and synchronization procedure used for recording octave and third octave analyses with the 2307 Level Recorder is described below. For convenience calibration

is given with reference to the use of the 2307 with a 50 dB Range Potentiometer. For use with a 25 or 75 dB Range Potentiometer a similar procedure may be used.

1. Connect the Band Pass Filter, Measuring Amplifier and Level Recorder as shown in Fig.4.3.

2. Fit the Level Recorder with a 50 dB Range Potentiometer, plus pen and roll of frequency graduated recording paper QP 1143 or QP 1153.

3. Set Level Recorder controls:

POTENTIOMETER RANGE	"50 dB"
RECTIFIER RESPONSE	"DC" for DC recording, "RMS" for AC recording depending on Measuring Amplifier output.
LOWER LIMITING FREQUENCY	"200 Hz" for DC recording. Less than or equal to start frequency of analysis for AC recording.
WRITING SPEED	For effective averaging time in accordance with start frequency of analysis. See section 5.3.1.
PAPER DRIVE FUNCTION	"Continuous F"
PAPER SPEED	"10 mm/s". Note for filter shift pulses the PAPER SPEED slider switch must be set to "mm/s"
POWER	"On"

4. Calibrate the Measuring Amplifier and Band Pass Filter combination as described in items 1 to 4 of section 3.2.

5. Keeping the internal or external reference source used for calibration connected, turn the INPUT SECTION ATTENUATOR knob of the Measuring Amplifier one step anticlockwise and adjust the GAIN CONTROL knob to obtain full scale pointer deflection on the indicating meter.

6. Keeping the reference source connected, adjust the INPUT ATTENUATOR and INPUT POTENTIOMETER of the Level Recorder to move the pen to the thick line (50 dB) at the top of the recording chart.

   The Level Recorder is now calibrated so that full scale pen deflection corresponds exactly with full scale pointer deflection on the Measuring Amplifier, whatever measurement range is selected. Avoid touching the INPUT POTENTIOMETER AND INPUT ATTENUATOR of the Level Recorder of calibration will be lost.

7. Disconnect the reference source and set Band Pass Filter controls:

SELECTIVITY	"Bandwidth" and "Record Step" as required
RANGE	"2 Hz - 20 kHz - A - Lin"
FILTER CONTROL MODE	"Recorder"
MANUAL FILTER SELECTOR	To centre frequency of octave or third octave band in which analysis is to commence.

8. To commence synchronization of the chart position with the filter switching of the Band Pass Filter, turn the PAPER ADJUSTMENT and AUTOMATIC STOP wheels of the Level Recorder so that the white spots marked on the wheels coincide and appear near the top of the opening on the front of the Recorder.

9. Momentarily press the PAPER DRIVE "Start" button on the Level Recorder and wait until the paper drive stops automatically.

10. Set the PEN DRIVE to "Off" and move the pen by hand to the thick line (50 dB) at the top of the recording chart. This is printed with third octave frequency markings spaced at 5 mm intervals.

11. Lift up the paper clip above the paper drive sprocket wheel and pull the recording paper forward to a position where the pen is approximately 2,5 mm (third octave) or 7,5 mm (octave) before the centre of the frequency marking corresponding with the centre frequency of the third octave or octave frequency band in which analysis is to commence.

12. If the pen is less (or greater) than 2,5 or 7.5 mm in front of the required centre frequency marking on the paper, note the distance the paper is out of alignment and turn the AUTOMATIC STOP wheel so that its white spot is a corresponding distance below (or above) the white spot on the PAPER ADJUSTMENT wheel.

13. Push the PAPER ADJUSTMENT wheel upwards so that its white spot is near the top of the opening on the front of the Recorder, and press the PAPER DRIVE "Start" button. The paper will start to move forward and should stop automatically at the required starting point on the chart. If not repeat items 12 and 13.

14. Set the PAPER DRIVE FUNCTION switch on the Level Recorder to "Stop" and on the Band Pass Filter press the right-hand FILTER CONTROL MODE switch to "Run".

15. Slowly rotate the FILTER SHIFT SYNC. wheel on the Level Recorder downwards until the digital display on the Band Pass Filter indicates a change in filter centre frequency. Rotate the wheel a further distance just short of 5 mm downwards.

16. Set the right-hand FILTER CONTROL MODE switch on the Band Pass Filter to "Stop" and on the Level Recorder set the PAPER DRIVE FUNCTION switch back to its "Continuous F" position. The paper position is now synchronized with the filter switching.

17. Turn the INPUT SECTION ATTENUATOR and GAIN CONTROL knobs of the Measuring Amplifier to their extreme clockwise position and apply the signal to be analyzed.

18. Set the RANGE switch of the Band Pass Filter to "Lin" and step the INPUT SECTION ATTENUATOR knob of the Measuring Amplifier to obtain a suitable meter deflection without the INPUT OVERLOAD lamp flashing.

    If the deflection is insufficient, even when the INPUT SECTION ATTENUATOR is in its extreme anticlockwise position, then step the OUTPUT SECTION ATTENUATOR knob until a suitable deflection is obtained without overload.

19. Set the PEN DRIVE switch of the Level Recorder to "On" and lower the pen lift cam.

20. Set the RANGE switch on the Band Pass Filter back to its "2 Hz — 20 kHz — A — Lin." mode and press the right-hand FILTER CONTROL MODE switch to "Run" to commence recording.

The Level Recorder will start to run and will drive the recording paper forward one complete chart length of 250 mm, so that the pen is at the start position for the next chart. Each time the pen passes the chart position for a filter change, the Recorder causes a band shift in the Band Pass Filter. Simultaneously, the signal level in the frequency band is plotted out by the Recorder pen to give a frequency spectrogram of the whole frequency range being scanned. At the end of the range, the Recorder pen is lifted, the Type 1618 shifts back to its starting frequency and the recorder runs forward to the starting point of the next chart.

If it is required to change the start frequency of the analysis, lift up the guide clip above the paper drive sprocket wheel and pull the paper forward to a position where the pen is 2,5 mm (third octave) or 7,5 mm (octave) before the centre of the frequency marking ☛ corresponding with the centre frequency of the third octave or octave band in which analysis is to commence. No further readjustment of the PAPER ADJUSTMENT, AUTOMATIC STOP or FILTER SHIFT SYNC. wheels is needed.

Note: To avoid disturbance from noise during filter shift, there must be a certain minimum dwell time between filter steps at the low frequency end of the range. Suitable time intervals occur when the following paper speeds are maintained.

Filter bands 2 Hz to 10 Hz	Paper speed ⩽ 1 mm/s
Filter bands 10 Hz to 25 Hz	Paper speed ⩽ 3 mm/s
Filter bands above 25 Hz	Paper speed ⩽ 10 mm/s

Correct choice of writing speed will normally require equally low paper speeds, so that in practice there will be no disadvantage. See section 5.3.

5. SPECIAL CONSIDERATIONS IN FREQUENCY ANALYSIS

5.1. FILTER DEFINITIONS

5.1.1. The Ideal Filter

An ideal band pass filter is one which has zero attenuation within its pass band and infinite attenuation at all other frequencies. The ideal filter is compared with a practical filter in Fig.5.1.

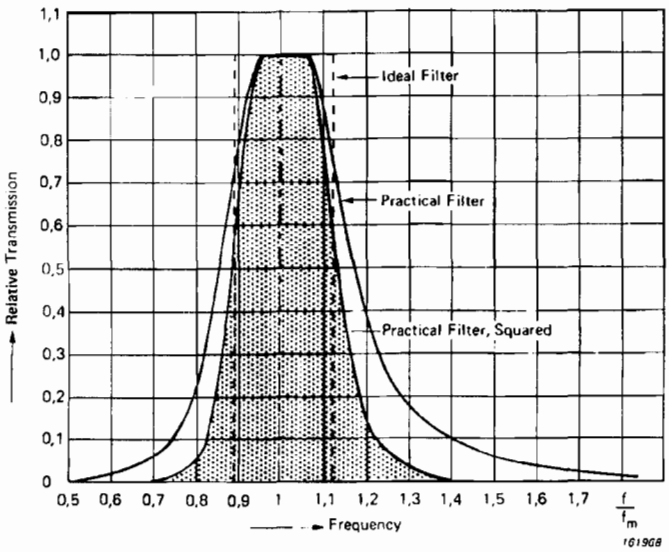


Fig.5.1. Ideal and practical filters

5.1.2. Bandwidth

Whereas the bandwidth of an ideal filter can be precisely specified as in 5.1.1, two definitions of the bandwidth of a practical filter are in common use. The —3 dB bandwidth is defined by the points on the filter characteristic at which the voltage transmission is 3 dB below the maximum transmission level (i.e., the point at which power transmission is halved). This case is illustrated in Fig.5.1 together with the ideal filter of the same bandwidth.

The Effective Bandwidth of the filter (sometimes referred to as the Effective Noise Bandwidth) is the bandwidth of the ideal filter which would pass the same amount of white noise power as the specified filter. This is the definition of bandwidth on which the octave and third-octave filters of the Type 1618 are based. Since noise power is proportional to the square of noise voltage, the area below the "Practical Filter Squared" char-

acteristic of Fig.5.1 is equal to the area below the ideal filter characteristic when the ideal and practical filters have the same Effective Bandwidth.

5.1.3. Octaves and Third Octaves

An Octave is the interval between two frequencies having a ratio of two, i.e.

$$f_u = 2\, f_l \tag{5.1}$$

or

$$\frac{f_u}{f_l} = 2 \tag{5.2}$$

where f_u and f_l are upper and lower frequencies respectively.

Similarly, fractions of octaves are defined by:

$$\frac{f_u}{f_l} = 2^n \tag{5.3}$$

where n is the fraction of the octave.

Therefore, third octaves are defined by:

$$\frac{f_u}{f_l} = 2^{1/3} = 1{,}259 \tag{5.4}$$

Since the centre frequency is defined by:

$$f_m = \sqrt{f_u \times f_l} \tag{5.5}$$

and the bandwidth:

$$B = f_u - f_l \tag{5.6}$$

it follows that:

$$B = K f_m \tag{5.7}$$

where K is a constant depending on the ratio between f_u and f_l. For third octaves K = 0,231, and for octaves K = 0,707. The bandwidth of the filters in percent is given by K × 100.

5.1.4. Specified Filter Frequencies

The octave and third-octave filters in the Type 1618 have centre frequencies on the scale recommended by IEC Publication 225. This relates the frequency scale to 1 000 Hz reference since the centre frequencies are calculated according to:

$$f_m = 1000 \times 10^{\frac{3n}{10}} \text{ for Octave filters} \tag{5.8}$$

and

$$f_m = 1000 \times 10^{\frac{n}{10}} \text{ for Third Octave filters} \tag{5.9}$$

where n = ± 1, ± 2, ± 3, etc..

(ASA standards say $f = 10^{\frac{n}{10}}$ where n is a positive or negative whole number equal to the band number.)

Upper and lower filter band frequencies f_u and f_l follow from the effective bandwidth of the filter, B, and the relationships:

$$f_m = \sqrt{f_u f_l} \tag{5.10}$$

$$B = f_u - f_l \tag{5.6}$$

5.2. RMS MEASUREMENT AND STATISTICAL ACCURACY

The Band Pass Filter Type 1618 is intended primarily for the analysis of signals whose properties do not change with time. These "stationary" signals are subdivided into two broad classifications. **Deterministic** signals, with a time history that can be specified exactly at every point in time, are assumed to consist entirely of discrete sinusoidal components at different frequencies. **Random** signals, where only the statistical properties can be specified, have a frequency spectrum that is distributed continuously with frequency. Briefly, deterministic signals have spectra that contain discrete frequency components, while random signals have a continuous type spectrum.

In any system for obtaining true RMS values, the accuracy of the data recorded depends not only upon the accuracy of the system as a whole, but also on the accuracy of the statistical averaging process employed for stationary signals. To understand these relationships* it will be necessary to examine the RMS value of a stationary signal, which can be defined as follows:

$$\psi = \sqrt{\lim_{T_A \to \infty} \frac{1}{T_A} \int_0^{T} x^2 (t)\, dt} \tag{5.11}$$

where T_A is the averaging time
$x_{(t)}$ is a time varying signal
ψ is the RMS value of x over an averaging time T_A

It can be seen from equation (5.11) that to obtain the true RMS value of a stationary signal, the averaging time would have to be infinitely long. As this condition is impossible to realise in a practical measuring system, the RMS value of a stationary signal may fluctuate when shown on a meter or some other display or readout device that employs a more realistic averaging time. The shorter the averaging time used, the greater will be the fluctuation.

From equation (5.11) it can also be shown that the observed level of RMS fluctuations will increase if the averaging time is held constant while the measuring bandwidth is decreased. That is, the level of the fluctuation depends on the measuring bandwidth.

* A considerably more detailed discussion of the problems and relationships involved in frequency analysis is contained in the B & K Handbook on Frequency Analysis by R.B. Randall.

A simple measure of the statistical RMS fluctuation for random signals (the possible range of error in the averaged RMS signal) is given by:

$$\epsilon = \frac{1}{2\sqrt{BT_A}} \qquad (5.12)$$

where ϵ is the fluctuation
B is the measuring bandwidth, or signal frequency bandwidth (whichever is the smaller) in Hertz
T_A is the averaging time, or signal duration (whichever is the smaller) in seconds.

This expression is an approximate relationship, but carries sufficient accuracy for BT products greater than 5. It expresses the limits of the signal variation to a confidence level of approximately 68%, i.e. there is a 68% probability that the result will be within $\pm \epsilon$ of the true value.

5.3. PRACTICAL ANALYSIS OF STATIONARY SIGNALS

The following parameters must be considered:

1. Averaging Time
2. DC or AC recording
3. Recorder Writing Speed
4. Recorder Paper Speed

5.3.1. Averaging Time

Use equation (5.12) to obtain a suitable averaging time for **random** signals, depending upon the desired accuracy. Table 5.1 gives a range of standard deviations (in dB) for a series of averaging times and frequencies. Normally the lowest frequency in the analysis governs the averaging time selected. However, for each half decade that frequency is increased, the averaging time can be reduced by a factor of $\sqrt{10}$ (normal steps on B & K Measuring Amplifiers).

As the bandwidth of octave-band filters is three times greater than that of third octaves, averaging times for them should be reduced by a factor of 3 from the values given in Table 5.1.

T_n (s) \ Centre Frequency (Hz)	2	3,15	10	31,5	100	315	1 k	3,15 k	10 k
0,1						1,5	0,9	0,5	0,3
0,3					1,5	0,9	0,5	0,3	
1				1,5	0,9	0,5	0,3		
3			1,5	0,9	0,5	0,3			
10		1,7	0,9	0,5	0,3				
30	1,2	0,9	0,5	0,3					
100	0,7	0,5	0,3						

Fast Random

Slow Random

770412

Table 5.1. Standard error (ϵ) in dB for third-octave filters in combination with various averaging times

The major requirement for **deterministic** signals is that the ripple be reduced to an acceptable level. Where only a single sinusoidal component is included in the bandwidth the ripple will be reduced to less than ± 1/4 dB for:

$$T_A \geqslant \frac{3}{f} \qquad (5.13)$$

where f is the frequency of the single component.

If the bandwidth contains several sinusoidal components, which is possible with third-octave analysis, Equation (5.13) still applies when f is interpreted as the minimum separation of any two of the components (lowest beat frequency). When a large number of components are contained within the bandwidth, as at higher frequencies the signal should be treated as random.

5.3.2. DC or AC Recording

Generally, it is preferable to use DC recording when possible, but where no DC output is available from the Measuring Amplifier, or where it has a dynamic range less than required, AC recording must be employed. Using AC recording it is possible to achieve a 75 dB dynamic range with an appropriate potentiometer in the Level Recorder (not Type 2306). Where a choice between DC and AC recording has to be made, the paper speed obtained for either possibility should be investigated, as AC recording can be just as fast, and may be preferable, to give averaging times less than 0,1 second for example.

5.3.3. Writing Speed

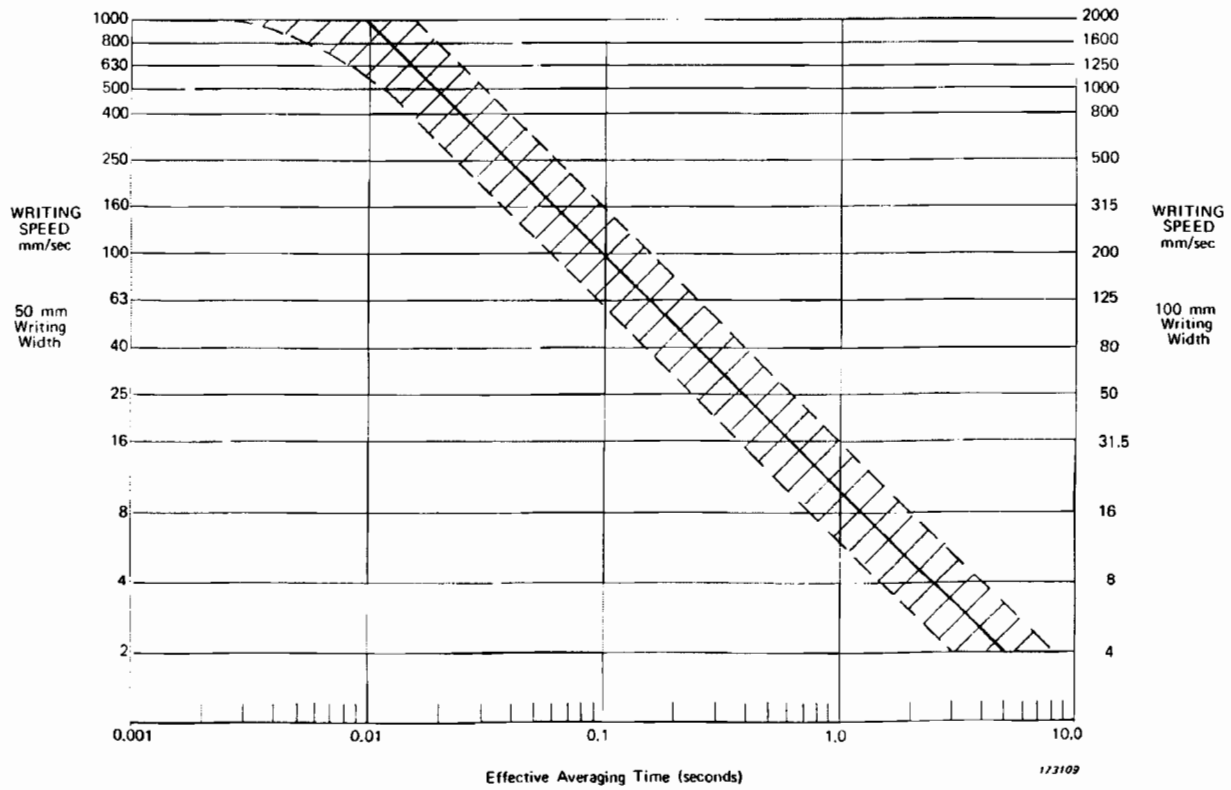


Fig.5.2. Effective averaging times as a function of the Level Recorder writing speed

For DC recording it is possible to select a writing speed of 250 mm/s on the Type 2306, and 1 000 mm/s on the Type 2307. In practice set as high a value as possible without introducing instability.

The writing speed for AC recording is determined by the averaging time required. Suitable writing speeds can be selected from the shaded portion of Fig.5.2, which is valid for both types of Level Recorders.

5.3.4. Paper Speed

The paper speed should be chosen so that the Recorder pen can attain the correct level for each measuring band, and remain at that level for a while before the next filter band is selected.

Normally, for DC recording it will be the rate of fall of the detector, with maximum 8,7 dB per selected averaging time, that limits the sweep rate. Table 5.2 gives suitable paper speeds for the normal range of averaging times, based on the assumption that the time required to sweep over a bandwidth is equal to five averaging times. With the Type 1618, normally the step between filters will be attained in less than 2 mm (i.e. 40% of the bandwidth), and even in the very worst case of a single sinusoidal component located between two filters, it will be reached with 75% of the bandwidth.

Averaging Time T_A (s)	0,1	0,3	1	3	10	30	100	300
Paper speed for DC recording (mm/s)	10	3	1	0,3	0,1	0,03	0,01	0,003

770409

Table 5.2. Paper speeds for DC recording

Where the spectrum is known to be relatively flat with a maximum fall less than 5 dB between adjacent filter bands, it is possible to increase paper speed by one step (i.e. a factor of approximately 3). The time taken to sweep over one bandwidth will be approximately 1,6 times the averaging time, which is about the minimum required for the detector to respond, even on peaks.

The same basic considerations apply for AC recording, except that it will be the writing speed rather than the averaging time which determines how rapidly the recording pen can respond to a new level. Table 5.3 gives suitable paper speeds for the range of writing speeds available. Once again these may be increased by one step when the spectrum is known to be relatively flat.

Writing speed (mm/s) (100 mm paper)	4	8 – 16	31,5 – 50	80 – 125	200 – 2000
Paper speed for AC recording (mm/s)	0,1	0,3	1	3	10

770410

Table 5.3. Paper speeds for AC recording (Type 2307)

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP