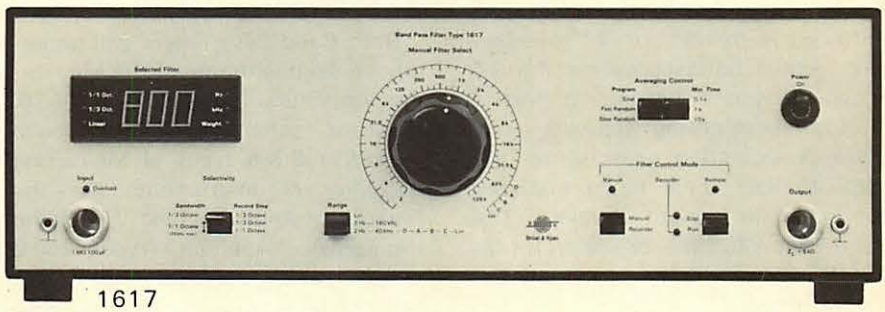
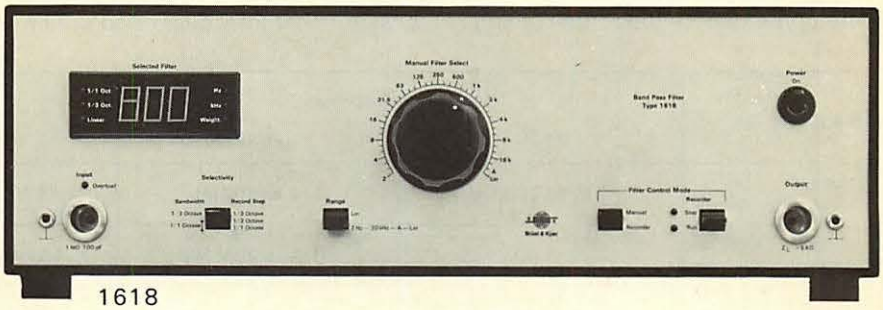
types 1617 and 1618

Third-Octave and Octave Band Pass Filters



1617



1618

GENERAL FEATURES:

- 41 third-octave filter bands, centre frequencies from 2 Hz to 20 kHz
- 41 overlapping octave bands, centre frequencies from 2 Hz to 20 kHz
- Third-octave and octave filters to IEC 225 - 1966, DIN 45 651 and 45 652, and ANSI S1.11-1966
- Digital display of selected bandwidth and centre frequency setting
- Built-in A-weighting network
- Manual plus electronic control of filter switching
- Automatic filter scanning via Level Recorder
- Selectable scan start frequency, reduces overall time for analysis
- Input overload warning

ADDITIONAL FEATURES TYPE 1617:

- 9 extra third-octave filter bands, centre frequencies from 25 to 160 kHz
- Built-in B-, C- and D-weighting networks
- Programs for automatic selection of Measuring Amplifier averaging time
- Automatic control of Level and X-Y Recorders
- IEC/IEEE interface for remote setting of controls via digital bus, and use of Graphics Recorder

USES:

In combination with suitable Measuring Amplifier

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

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 digital interface compatible with IEC 625-1/IEEE Std. 488 to permit direct control by other instruments and systems using these standards. 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 2610 or 2636. However, other instruments, such as earlier B & K types of Measuring Amplifier or instruments like the Frequency Analyzer Type 2120 and Heterodyne Analyzer Type 2010 which contain a Measuring Amplifier, can be employed. Together with the Band Pass Filters and a suitable measurement transducer and preamplifier combination, they permit a wide variety of signals to be measured and analyzed. With B & K Condenser Microphone, they form a sound measurement system fulfilling IEC R 651 (Type 0) for precision sound level meters.

Introduction

To aid selection of a suitable measuring instrument, summarized specifications for the instruments mentioned are given in Table 1. The basic system of Band Pass Filter Type 1618 with Measuring Amplifier Type 2610 (or earlier Type 2606 or 2608) is for analysis with manual selection of averaging time and automatic filter scanning controlled by the Level Recorder. Full ultization of all measurement and control possibilities, including automatic selection of averaging time is obtained using the Band Pass Filter Type 1617 together with Measuring Amplifier Type 2636 (or earlier Type 2607) or Frequency Analyzer Type 2120. With these combinations, either a Level or X-Y Recorder may be employed for recording analyses. Alternatively, with a Type 1617 and 2636 combination either an Alphanumeric or Graphics Recorder can be used.

B & K Type No.		Measuring Amplifiers		Frequency Analyzers	
		2610	2636	2010	2120
Amplifier Section	Linear Frequency Range	2 Hz to 200 kHz	1 Hz to 200 kHz	2 Hz to 200 kHz	2 Hz to 200 kHz
	Voltage Ranges	10 μV to 30 V FSD	10 μV to 30 V FSD	10 μV to 300 V FSD	10 μV to 300 V FSD
	Amplification	100 to −30 dB	100 to −30 dB	120 to −30 dB	120 to −30 dB
Indicating Modes	RMS	Fast - Slow 20 s Averaging	Fast — Slow 0,1 to 100 s Averaging*	Fast - Slow 0,1 to 100 s Averaging	Fast — Slow 0,1 to 300 s Averaging*
	Peak	1,7 dB/μs	0,05 — 0,5 — 5 dB/μs	—	0,4 dB/μs
	Impulse	—	✓	—	✓
	Hold	RMS — Peak	RMS - Peak - Impulse	—	Impulse
Inputs		Direct — Preamp.	Direct - Preamp.	Direct - Preamp.	Direct - Preamp.
Outputs	AC Lin	1 and 1,6 V FSD	1 and 5 V FSD	10 V FSD	10 V FSD
	DC Lin	—	0 — 12 V 5 V FSD	0 to 14,5 V 4,5 V FSD	0 to 14,5 V 4,5 V FSD
	DC Log	60 dB 5 V FSD	60 dB 5 V FSD	50 dB 4,5 V FSD	50 dB 4,5 V FSD
	Digital	—	IEC/IEEE Interface	—	—

* Remote control via averaging time programs of Band Pass Filter Type 1617

Table 1. B & K Measuring Amplifiers and Frequency Analyzers for use with Band Pass Filters Type 1617 and 1618

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 up to 5 V peak may be applied. Input and output are via coaxial B & K sockets on the front panel, paralled by BNC terminals on the rear.

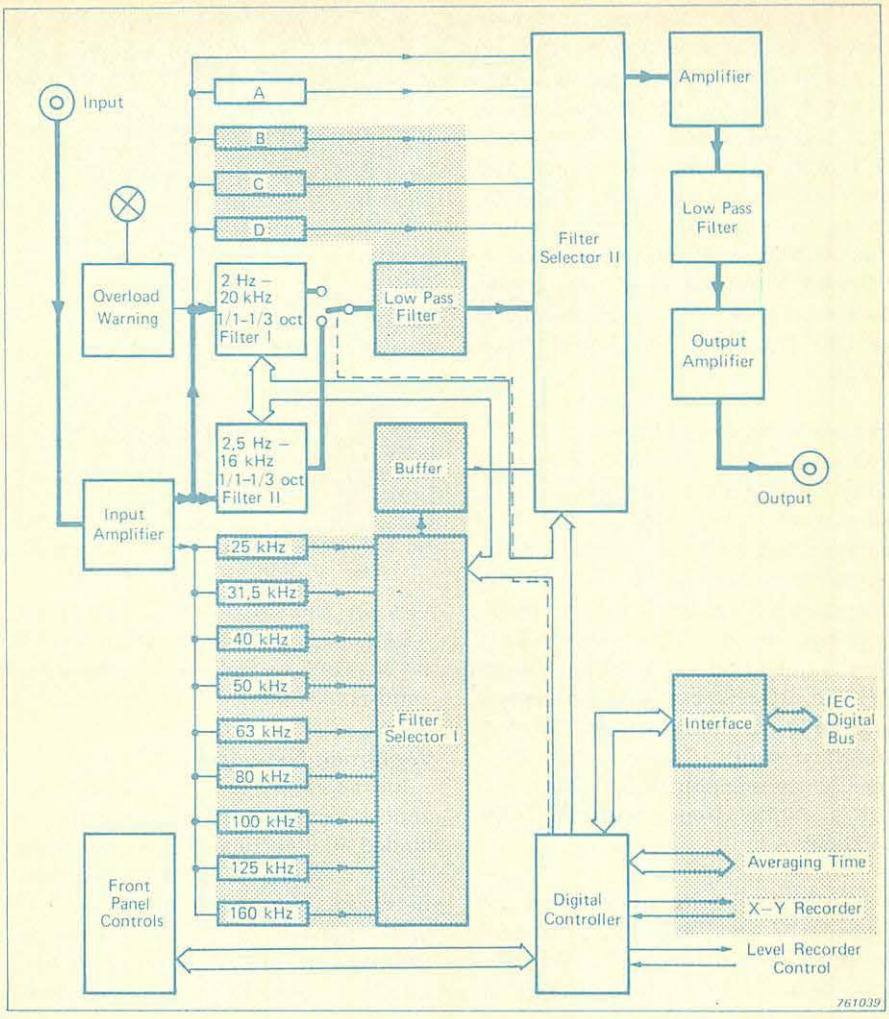


Fig.1. Block diagram of the Band Pass Filters Type 1617 and Type 1618

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 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-

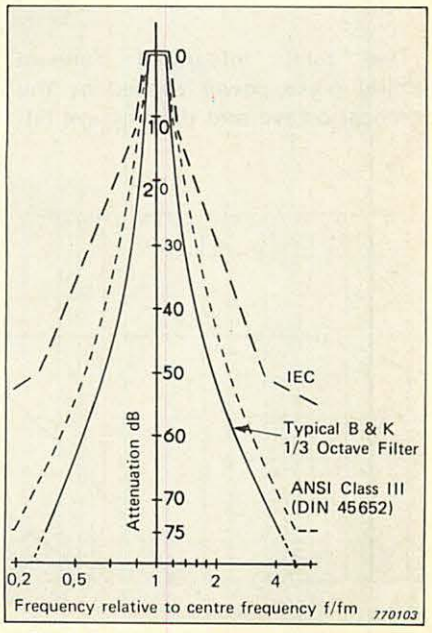


Fig.2. Typical third-octave filter response

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 Fil-

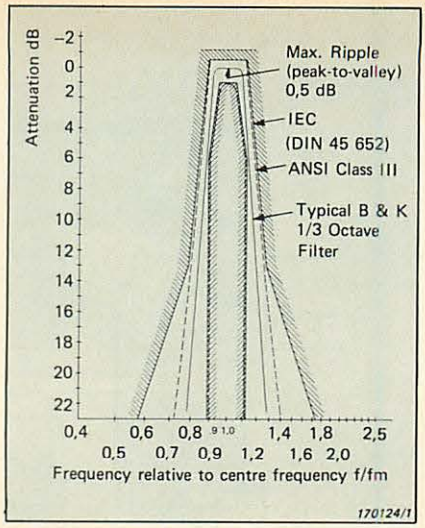


Fig.3. Top of a third-octave filter characteristic

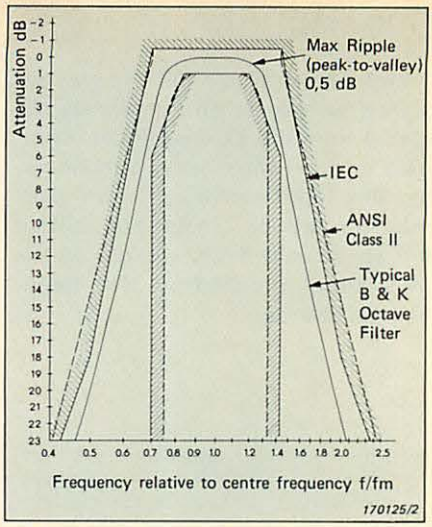


Fig.4. Top of a typical octave filter characteristic

ters in the Type 1617 and Type 1618 is equal to that which would be passed by an ideal octave or third-octave filter.

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 scales. One covers the full frequency range with graduations in

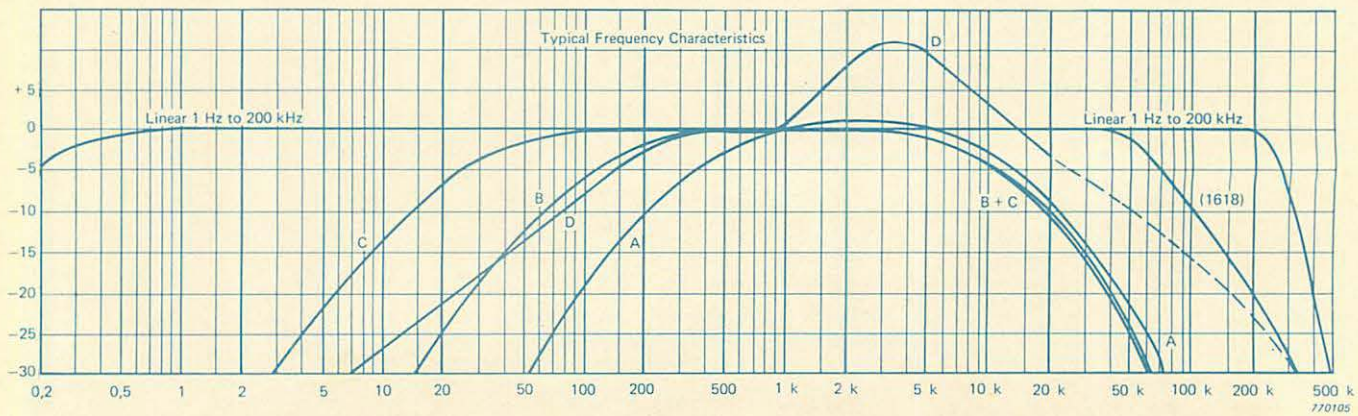


Fig.5. Weighting networks and Linear functions

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 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 2307, 2309 or 2317 is possible with both Band Pass Filters. With the Band Pass Filter Type 1617, however, either internal or external control via the IEC Interface of the instrument is possible thus permitting use of an Alphanumeric Printer Type 2312 or Graphics Recorder Type 2313 in the analysis set-up. Alternatively, an X-Y Recorder such as Type 2308 can be operated in synchronism with the filter. The appropriate cables for interfacing these instruments are indicated in Fig. 12.

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.

Averaging Time Control

This ability allows the Type 1617 to automatically step the averaging time of the Measuring Amplifier Type 2636 (or earlier Type 2607) and Narrow Band Frequency Analyzer Type 2120 during the course of a frequency scan. The advantage is that the averaging time can be kept short as possible to obtain an acceptable analysis time, yet long enough to achieve a good overall

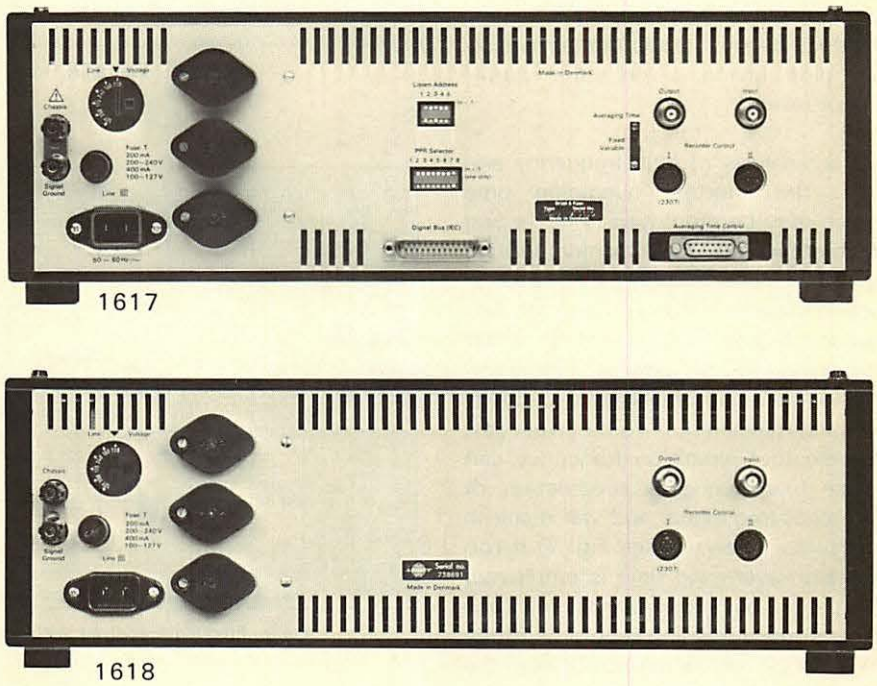


Fig.6. Rear panels of the Band Pass Filters

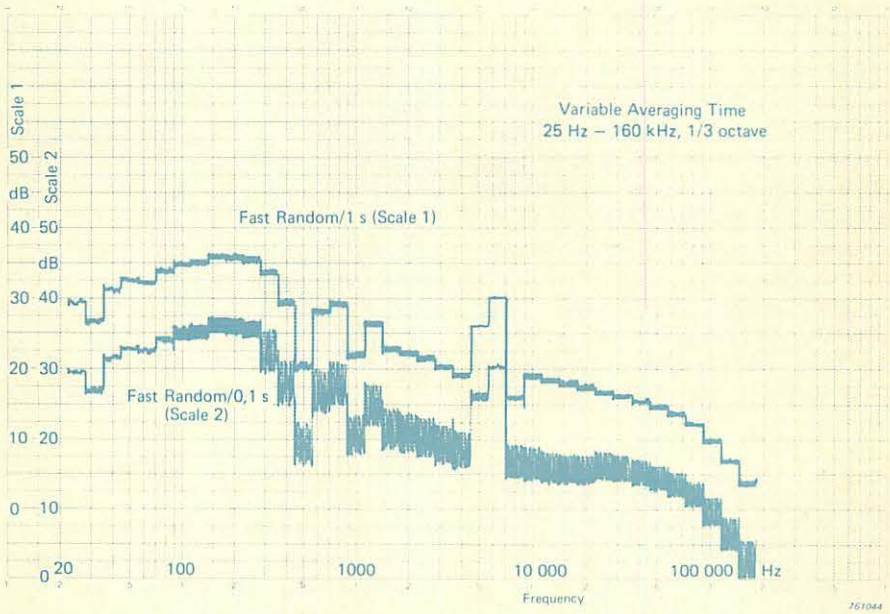


Fig.7. Conditions where longer averaging times are required for high frequency signals. The lower curve was made with too short averaging time, while for the upper curve, averaging was correct

confidence level and measurement accuracy at low as well as high frequencies.

The best analysis conditions are obtained when the product of the analysis bandwidth B (Hertz) and the averaging time T (seconds) is held constant throughout the scan. Accordingly the Type 1617 is equipped with a choice of averaging programs to suit analysis of "Sine", "Fast Random" and "Slow Random" signals, which help maintain the BT product as near constant as possible plus giving a constant confidence level.

For analysis of high frequency signals, the shortest averaging time which may be employed is 0,1 s and is determined by the maximum writing speed of the recording instrumentation. However, with certain high frequency signals the use of a longer averaging may be merited. For example, where noise or vibration of slowly rotating machinery is to be investigated, the low repetition frequency can cause low frequency modulation of the measured signal and will result in inaccurate analysis (see Fig. 7) if too short an averaging time is employed. To permit accurate analysis of such signals, the averaging programs of the Type 1617 can be set not to step the Measuring Amplifier below a minimum averaging time of 0,1 s, 1 s or 10 s. Fig. 8 indicates the particular averaging times and change-over frequencies of the different programs.

The choice of required averaging program is made using the Program and Min. Time – Averaging Control switches on the front of the Type 1617 which may be set as indicated in Table 3. Automatic selection of the programmed averaging time settings on the Measuring Amplifier is made via the 15-pin AVERAGING TIME CONTROL socket on the rear panel of the Type 1617 when its Averaging Time switch is set to "Variable".

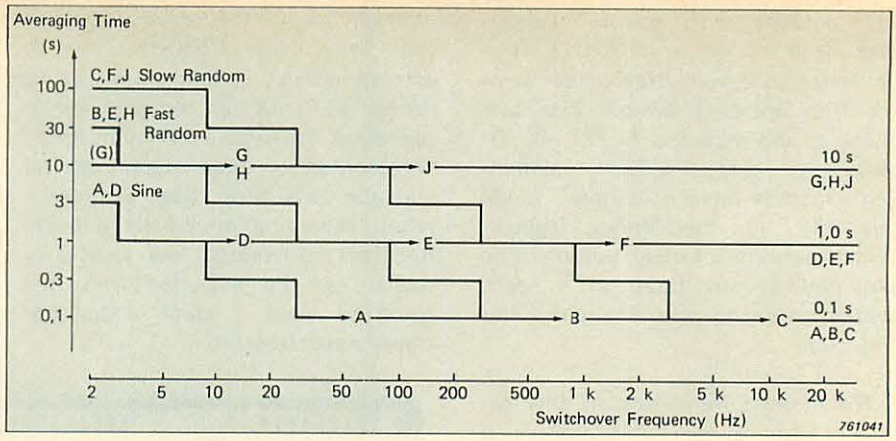


Fig.8. Averaging times and changeover frequencies

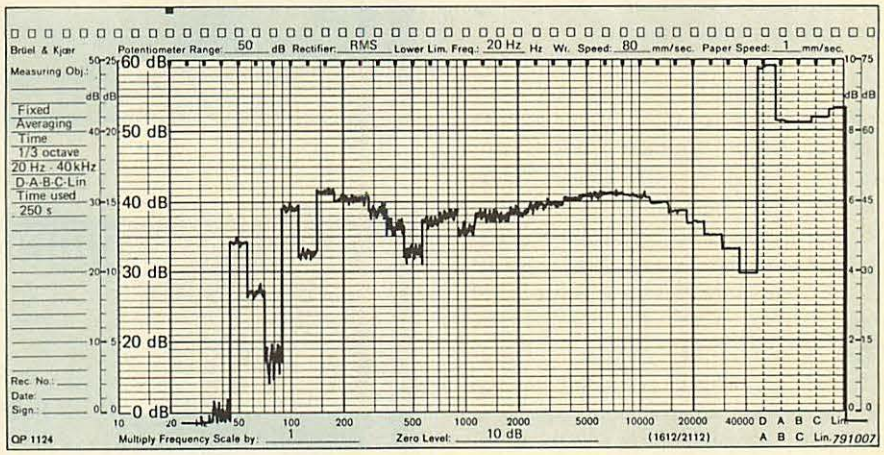


Fig.9. Frequency analysis with Level Recorder and fixed averaging time

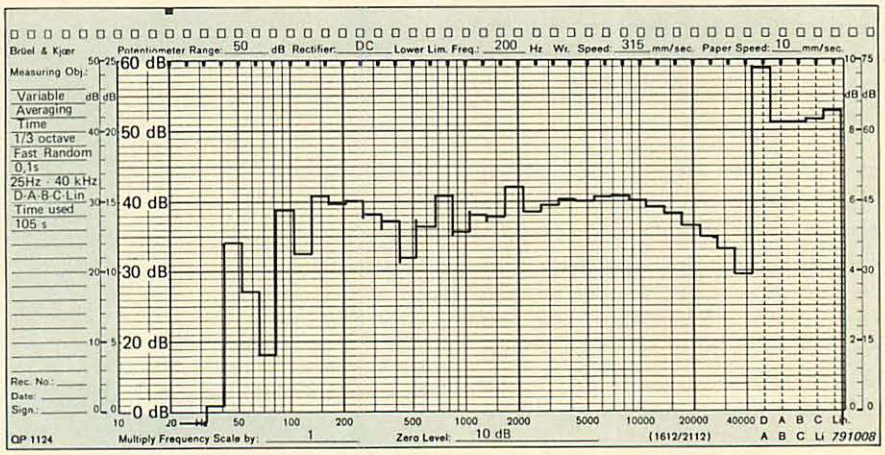


Fig.10. Frequency analysis with Level Recorder and variable averaging times

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 or X-Y Recorder, automatic averaging time control functions as follows. The Type 1617 starts by setting the Measuring Amplifier averaging time to the value programmed for the particular frequency band selected and keeps the paper drive or X-deflection of the Recorder stationary while the Measuring Amplifier rectifies and averages the measured signal. After a period of approximately five times the programmed averaging time it sets the Measuring Amplifier to hold the analyzed level while the Recorder plots the level by advancing the paper or stepping the pen to the next frequency band. The Type 1617 then stops the Recorder,

steps to the next filter band and selects the programmed averaging time, thus enabling it to continue with the analysis using the same control sequence. Typical Level and X-Y recorder read outs of analyses, employing fixed and variable averaging time control, are shown in Figs. 9, 10 and 11.

A similar control sequence is employed when using an Alphanumeric Printer or Graphics Recorder for read out of analyses results. With a Graphics Recorder either the filter center frequencies plus the corresponding signal level in each filter band can be printed, or a fully anotated, bar-spectrum plot of analyses similar to that presented on the display screen of the B&K Digital Frequency Analyzer Type 2131 can be obtained. However, before a graphic plot can be printed it is necessary that the entire frequency spectrum is entered.

Digital Interface

The Type 1617 is fully programmable via a built-in IEC 625-1 standard (IEEE std. 488 compatible) digital interface for Programmable Instrumentation. This permits the filter bandwidth, start band, analysis range and averaging programs to be selected remotely with aid of a programmable desk top calculator, for example, as well as permits on-line changes to be made to accomodate new events as they occur.

Remote digital control is selected via the Listen Address switches on the rear panel of the instrument. For a complete list of interface functions implemented by the Type 1617, the Specifications section of this Product Data should be consulted.

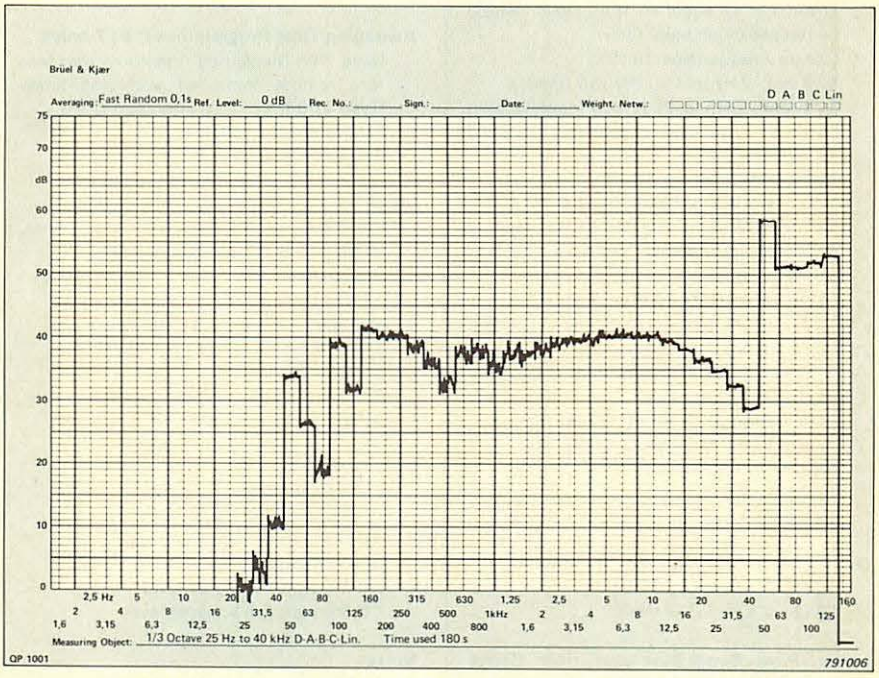


Fig.11. Frequency analysis with X-Y Recorder and variable averaging times

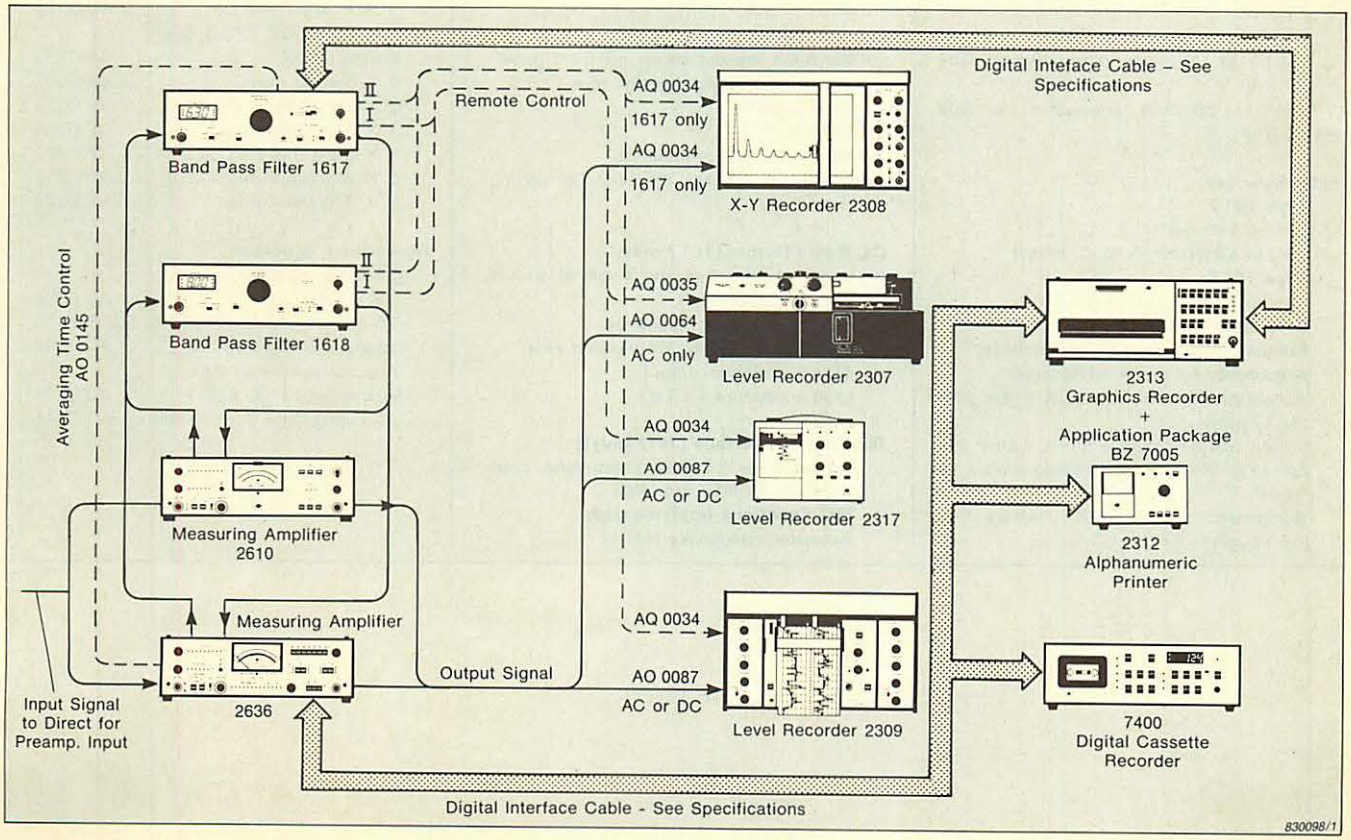


Fig.12. Connection possibilities with other B & K instrumentation

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 22,5 kHz attenuation is 0 dB ±0,3 dB
1 Hz to 28,2 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 R 651 (Type 0) 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

IEC Digital Interface (1617 only):
Conforms to IEC 625-1 standard, compatible with IEEE std. 488
IEC Functions Implemented:
Acceptor Handshake (AH 1)
Listener (L 2)
Remote Local (RL 2)
Parallel Poll (PP 2)

Temperature Range:
Operation: 5 to 40°C (41 to 104°F)
Storage: –25 to +70°C (–13 to +158°F)

Humidity:
0 to 90% RH (non-condensing at 30°C)

Electromagnetic Compatibility:
Complies with Class B computing device of the American FCC (Federal Communications Commision) Rules

Power Requirements:
Complies with Safety Class II of IEC 348
Supply Voltage: 100; 115; 127; 200; 220; 240 V (50 - 60 Hz) ± 10% AC
Power Consumption: ~37 VA (1617)
~30 VA (1618)

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 × Power Cable ..... AN 0020
1 × 25-pin IEC 625-1 Bus Connector Kit ..... UA 0793
2 × Banana Plugs ..... JB 0002
2 × BNC Coaxial Plugs ..... JP 0035
1 × 7-pin DIN Plug ..... JP 0703
1 × 8-pin DIN Plug ..... JP 0802
2 × 200 mA Fuses ..... VF 0012
2 × 400 mA Fuses ..... VF 0039

Accessories Available:
25-pin IEC 625-1 Interface Cable (2m) ..... AO 0194
25-pin IEC (maleslide-lock) to IEC 625-1 Interface Cable (2m) ..... AO 0184
Adaptor to convert IEEE instrument to IEC 625-1 ..... AO 0195
Averaging Time Control Cable .... AO 0145