type 2120

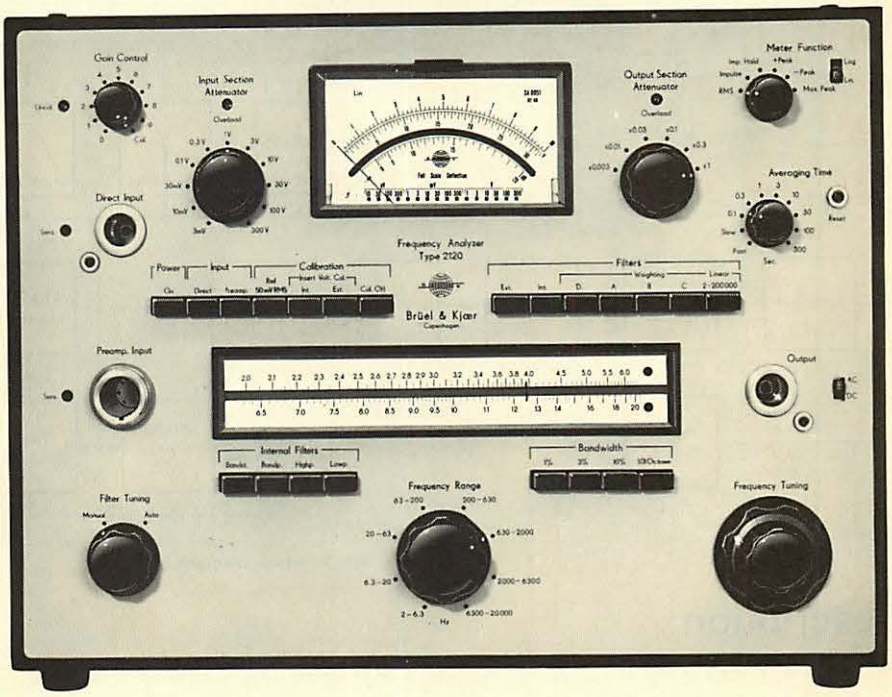
Frequency Analyzer

FEATURES:

- Selective frequency range 2 Hz to 20 kHz
- Linear frequency range 2 Hz to 200 kHz
- Measuring range 10 μV to 300 V RMS (700 V peak) full scale deflection
- Continuously variable bandpass filter with 1%, 3%, 10% and 1/3 octave relative bandwidths
- Equivalent octave selectivity of 70 dB, 60 dB, 45 dB and 30 dB
- Noise level down to 0,4 μV
- Bandstop filter, high pass filter and low pass filter continuously variable from 2 Hz to 20 kHz
- A, B, C and D weighting networks
- Automatic sweep with Level Recorder Type 2307
- Mains or 12 V DC operated
- Interchangeable meter scales

USES:

- Frequency analysis from 2 Hz to 20 kHz
- Distortion measurements
- Suppression of a single frequency or a frequency range
- Measurement of short duration signals (> 20 μs)
- Automatic recording of noise and vibration spectrograms
- Laboratory and field measurements



The Frequency Analyzer Type 2120 is a constant percentage bandwidth analyzer for use in the frequency range 2 Hz to 20 kHz in conjunction with the internal filters. It consists of a measuring amplifier combined with an active, continuously variable RC-filter complex which can be switched into four basic configurations. (1) As a constant relative bandwidth filter having four selectable bandwidths, 1%, 3%, 10% and 1/3 Octave. (2) As a tunable bandstop filter which will suppress a single frequency more than 60 dB; suppression at 0,5 f_o and 2 f_o is less than 1 dB. The bandstop mode can be used for distortion measurements down to a level of 0,1%. (3) As a tunable high pass filter and (4) as a tunable low pass filter. The internationally standardized weighting networks for sound measurements A, B, C and the D networks are included.

Provision is made for the connection of external filters to be used alone or in series with one of the internal filters. With external filters an extended frequency analyzing range is obtainable, for example from 2 Hz to 160 kHz with Bandpass Filter Type 1617, which is a third-octave filter set. When used with a Level Recorder Type 2307 a continuous sweeping frequency analysis can be made.

Used with a suitable B & K Condenser Microphone and Preamplifier combination, the 2120 fulfills IEC R 651 (Type 1 - Impulse) and DIN 45 633 (parts 1 and 2) for precision sound level meters.

Shock and vibration can be measured over wide dynamic and frequency ranges with the 2120 combined with one of the B & K vibration transducers. The peak indica-

tion is useful for measurement of short duration shocks (> 20 μs).

The Frequency Analyzer is modern and easy to operate. Measurement errors due to false operation are practically out of the question. The calibration procedure is simple and the instrument is extremely stable over long periods. The 2120 can be powered from AC mains or from a 12 V DC supply.

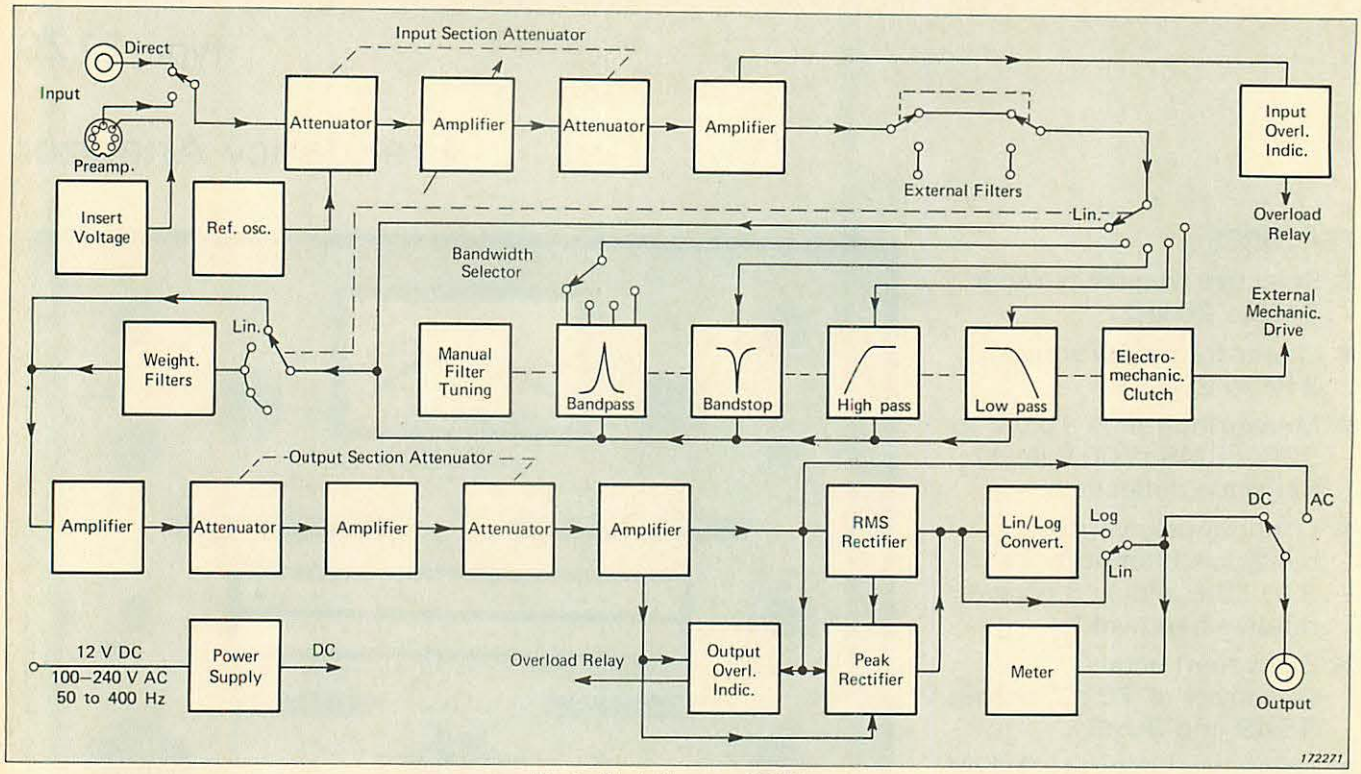


Fig. 1. Block diagram of 2120

Description

The main features of the Frequency Analyzer Type 2120 are described in the following text and a block diagram is shown in Fig. 1.

Inputs

Two alternative inputs are provided: "Direct Input" accepting B & K coaxial plugs, and "Preamp. Input" accepting the 7-pin plugs of B & K preamplifiers. The "Preamp. Input" socket also supplies stabilized voltages for the preamplifier and a 200 V precision polarization voltage for a condenser microphone. Each input has a separate screwdriver adjustable sensitivity control and additionally a 14 dB range of adjustment is available to both inputs to enable meter scale calibration for a very wide range of transducer sensitivities.

A special feature is a built-in 1 kHz oscillator for use in conjunction with B & K Preamplifier Type 2645 and B & K Sound Level Calibrator Type 4230 for Insert Voltage Calibration of microphones in accordance with IEC 327 and ANSI S1.10 1966. Provision is made for use of an external oscillator when this type of calibration has to be performed at other frequencies and levels.

High Linearity Amplifiers

Five stages of signal amplification with low distortion, low noise and high linearity are provided. The gain of the first stage is adjustable to compensate for different transducer sensitivities. The calibrated gain setting is used for accurate voltage measurements. An overall amplification of 120 dB, variable in steps of 10 dB is available. By lowering the gain of the input stage, voltages up to 700 V peak can be measured.

Attenuators

Two attenuators provide attenuation over a 150 dB range in accurate 10 dB steps. This gives the instrument a voltage measuring range from 10 μV to 300 V full-scale. The combined attenuator setting is displayed by indicator lamps on the meter scale enabling convenient reading of meter measuring range.

Overload Indicators

When using the 2120 in its linear mode, overload of the amplifiers can be observed on the meter. However, when the bandpass mode is used, signal components outside the filter passband will not show up on the meter. Therefore the output of the input amplifier is paralleled with a visual overload indicator. The output amplifier is furnished with a separate overload indicator to detect short pulses, which cannot be seen on the meter in the RMS mode. The overload levels are preset, but can be adjusted internally. The contacts of the relay which operates when the overload indicators are lit, are connected to the AVERAGING TIME socket at the rear panel of the instrument. This can be used, for example, to operate the Pen Lift or the Event Marking Pen of a Level Recorder Type 2307.

Reference Oscillator

A built-in oscillator supplies an accurate and stable 50 mV RMS, 1 kHz sinusoidal reference signal for calibration purposes.

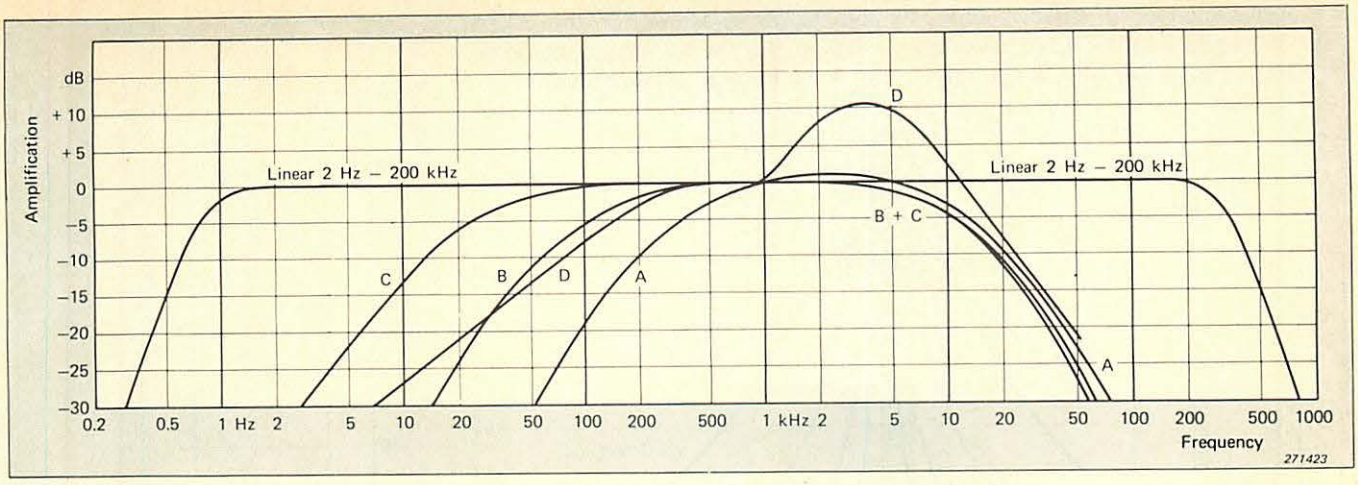


Fig.2. Frequency characteristics of the amplifier and weighting filters

Meter Rectifier Characteristics

The meter will give accurate readings of all commonly encountered random, quasi-random, periodic and complex waveforms. Both RMS and Peak values of a signal can be measured.

RMS Modes. The RMS rectifier circuit gives true RMS response within ±0,5 dB for signals with crest factor up to 5. Averaging times from 0,1 to 300 s can be chosen for continuous signals as well as "Fast" and "Slow" (see Fig.4) according to IEC R 651 (Type 1) and DIN 45633 (parts 1 and 2) for Precision Sound Level Meters. For impulse signals the max. RMS level is measured with a time constant of 35 ms and a decay time of 3 s as specified by the above recommendations. An Impulse Hold feature is provided to hold the max. value of a signal to enable convenient measurement of transient signals.

Peak Modes. With the Peak rectifier + peak, —peak, and max. peak of a signal can be indicated. In the "+ Peak" and "—Peak" modes the positive and negative peak value respectively is measured. In the "Max. Peak" mode the max. value of the signal is indicated regardless of polarity. The rise time is 20 µs, then the signal is held at its max. level for 400 ms, in order to allow the meter to deflect, and the decay time is selectable between 0,1 and 300 s. See Fig.4. Signals with a duration as short as 20 µs can be measured accurately this way.

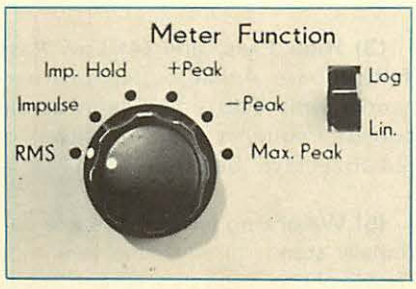


Fig.3. Meter Function switch

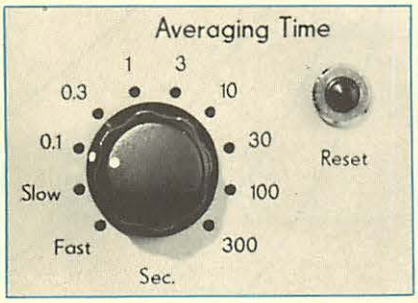


Fig.4. Averaging Time switch

When the "RMS" mode of measurement is in use, the meter deflection and DC output voltage can be reset to zero using either the RESET button on the instrument, or remote control via the AVERAGiNG TIME socket (see Fig.11). The averaging time is 0,1 s. In "Impulse Hold" or one of the Peak modes, the push button gives a decay time of 100 ms. In the "Peak" modes, remote reset gives a decay time of 10 ms, to permit the high scan rates required in automatic monitor and control systems.

If desired, fixed resistors or a potentiometer can be connected to the AVERAGING TIME socket giving different decay times. When this is done the 400 ms hold is not in operation.

Lin — Log Converter

A built-in linear to logarithmic converter provides a DC voltage proportional to the measured dB value at the DC output. In the "Log" mode the reading is linear over 50 dB. This mode is used in conjunction with scale SA 0053, which is a Log scale, reading both voltage and dB over a 50 dB range, or with scale SA 0059, which reads dB both linearly (20 dB) and logarithmically (50 dB). The other scales available are linear, and shall be used in the "Lin" mode. A wide dynamic range of more than 60 dB is covered by the DC output facilitating direct dB recording.

Interchangeable Meter Scales

Seven calibrated meter scales, and one uncalibrated, are included for direct reading of voltage and decibel in linear or logarithmic scales, sound level with 1" microphones, sound level with 1/2" microphones, and acceleration with 6 to 17 mV/g accelerometers. Scales are available on request for measurement of absorption coefficient, power spectral density, dBm and for use with 1/4" and 1/8" microphones, and with 1,7 to 6 mV/g and 60 to 170 mV/g accelerometers. Totally sixteen different scales

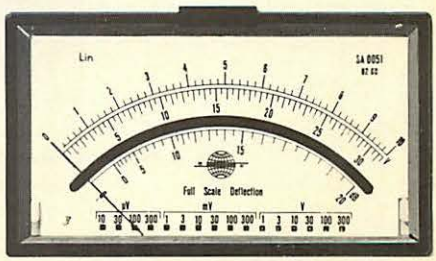


Fig.5. Meter scale SA 0051

are available, and for special applications, scales can be custom made to order. The range of interchangeable scales available for the 2120 enables the instrument to be used for a wide range of applications.

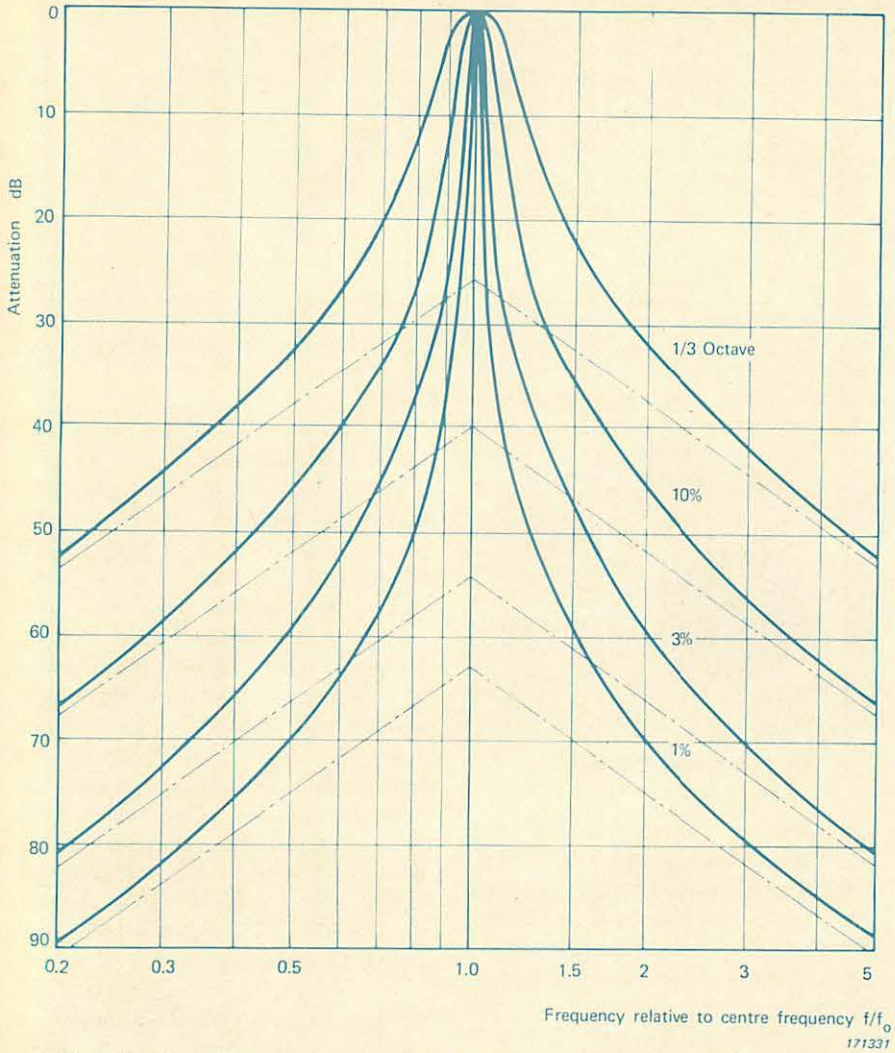


Fig.6. Bandpass filter selectivity curves for the four constant percentage bandwidths

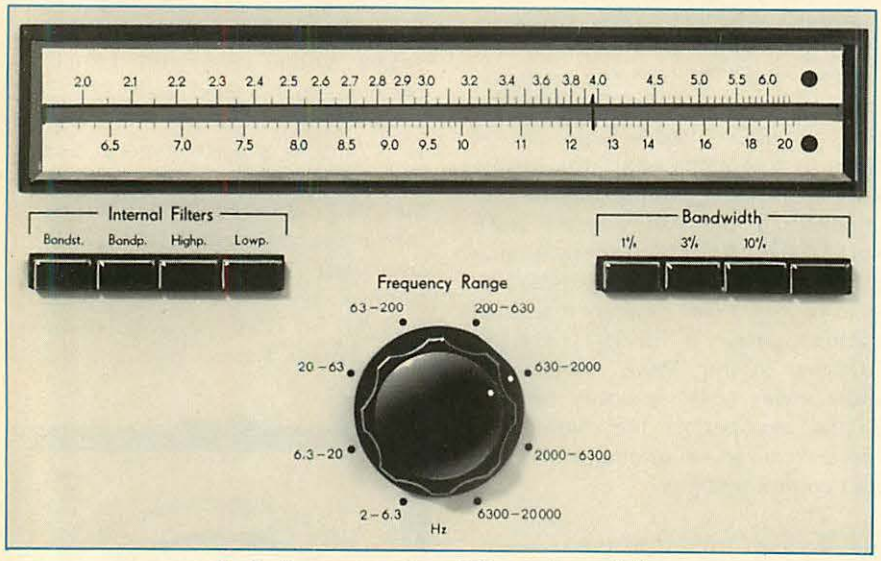


Fig.7. Frequency scale and filter section switches

Filters

The Frequency Analyzer filter network covers the frequency range 2 Hz to 20 kHz in 8 adjacent ranges. The filters in the 2120 are active, and consist of a filter type

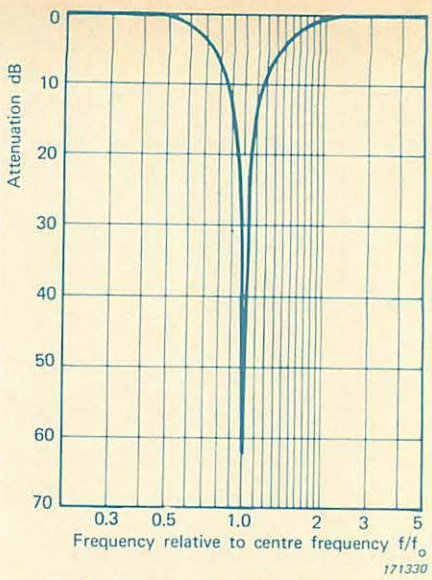


Fig.8. Bandstop filter rejection curve

called Distributed Infinite Gain network. This filter type features simple switching between four basic configurations giving bandstop, bandpass, low pass and high pass modes, with continuous tuning over a wide frequency range while maintaining high stability. Additionally the 2120 has four weighting filters, and external filters can be connected.

(1) Bandpass Filter is a narrow band filter with four constant relative bandwidths of 1%, 3%, 10% and 1/3 octave at the 3 dB attenuation level. In the "1%" and "3%" positions the filter consists of two single-pole butterworth filters in series; a 2-pole butterworth filter is selected in the "10%" and "1/3 Octave" positions. The octave selectivity is 70 dB, 60 dB, 45 dB, and 30 dB in the four bandwidth modes. The selectivity curves are shown in Fig. 6.

(2) Bandstop Filter. This has an attenuation of greater than 60 dB at the tuned frequency and an octave frequency attenuation of 1 dB. See Fig. 8.

(3) High Pass, and **(4) Low Pass Filters** have 4-pole butterworth networks with 3 dB attenuation at the tuned frequency and a slope of 24 dB/octave. See Figs. 9 and 10.

(5) Weighting Filters. The internationally standardized sound level meter weighting networks A, B, C, and the D network are included in the

2120. They can be used alone or in series with internal and external filters.

(6) External Filters. Provision is made for the connection of external filters to be used alone or in series with one of the internal and one of the weighting filters. Impedance requirements for external filters are given in the specifications. Some filters from the B & K range of filter sets that will be suitable are:

Bandpass Filters Types 1617 and 1618 which have third-octave and octave constant percentage bandwidths

and

Heterodyne Slave Filter Type 2020 which is a constant bandwidth filter set.

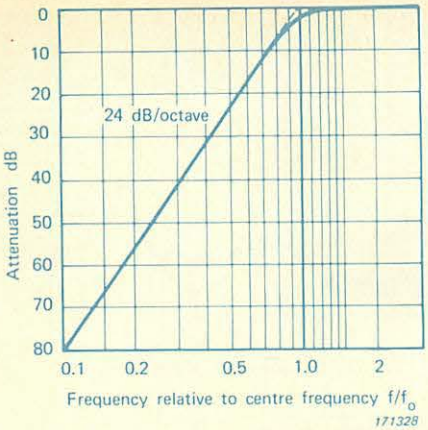


Fig.9. High pass filter limiting curve

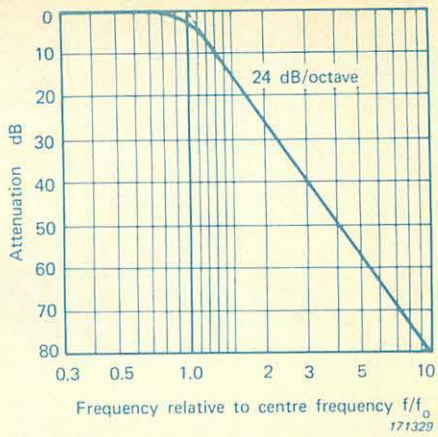


Fig.10. Low pass filter limiting curve

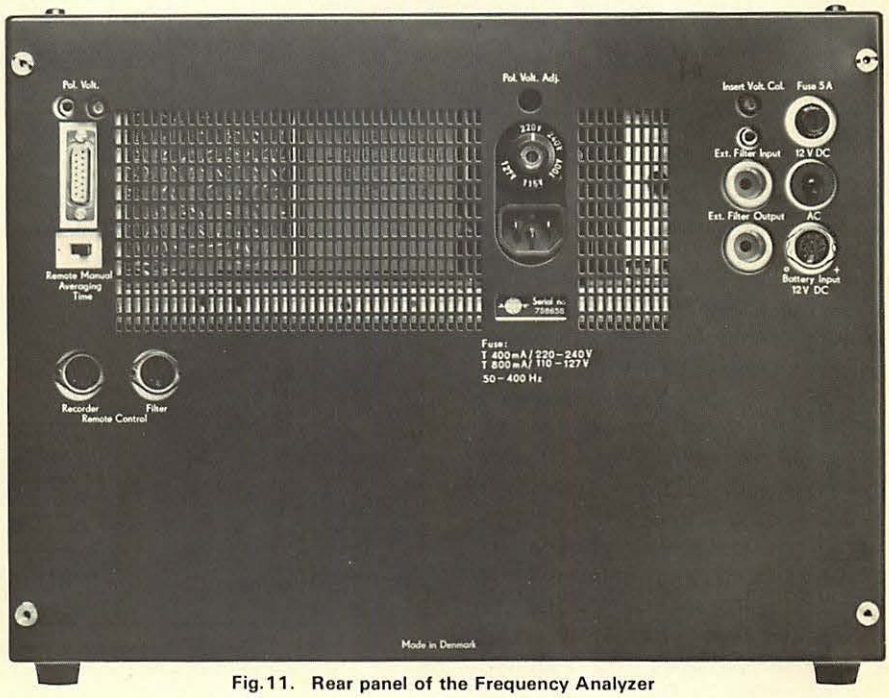


Fig.11. Rear panel of the Frequency Analyzer

Output

In the "RMS" modes the dynamic range of the meter output is 60 dB for a signal with crest factor 1,4 (sine). In the "Peak" modes the dynamic range is 50 dB. The output signal is obtainable either as an AC voltage or as a DC voltage. Both signals are fed to the output socket via a switch on the front panel. The AC output voltage for full scale deflection is 10 V RMS, and max. AC output voltage is 56 V peak. The DC output voltage is 0 to 4,5 V proportional to meter deflection from zero to full scale. Max. DC output voltage for the "RMS" modes is 15 V and for the "Peak" modes 25 V.

Recording

The signal at the output socket can be fed to a Level Recorder Type 2307. Provision is made for a flexible shaft from the Level Recorder to drive the frequency sweep of the 2120 continuously from 2 Hz to 20 kHz. An amplitude versus frequency spectrogram is thus obtained on a preprinted, frequency calibrated paper chart. An additional feature is the possibility of synchronization between the frequency sweep of the 2120, Filter Sets Types 1617 and 1618, and Level Recorder Type 2307, making it a simple matter to use these filters to obtain high attenuation outside the filter passband. The synchronization is obtained via the Remote Control sockets at the rear panel of the 2120.

Phase deviation

Switched to the linear mode, the measuring amplifier sections of two 2120s in tandem will have phase agreement within ± 5° in the range 5 Hz to 20 kHz.

AC or DC Power Supply

The 2120 can be powered from mains voltages from 100 V to 240 V AC (50 to 400 Hz), or from a 12 V DC supply. It can thus be used in the field for measurements of laboratory accuracy, powered from batteries.

Examples of Use

Analysis of Mechanical Vibration

Used in conjunction with B & K accelerometers and preamplifiers, vibration can be measured directly in the frequency range from 2 Hz to 60 kHz and in the acceleration range from less than 0,000002 g to several thousand g. The set-up in Fig.13 shows the 2120 used in con-

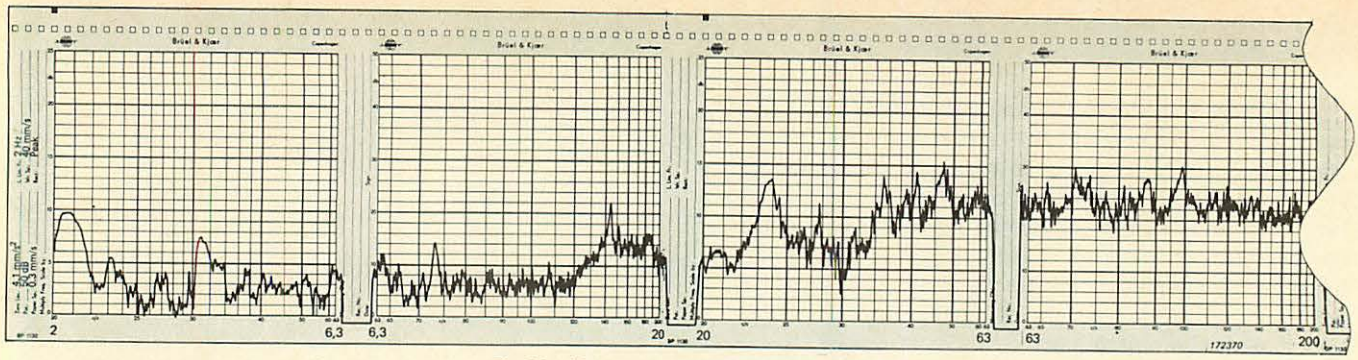


Fig.12. Frequency analysis of vibration

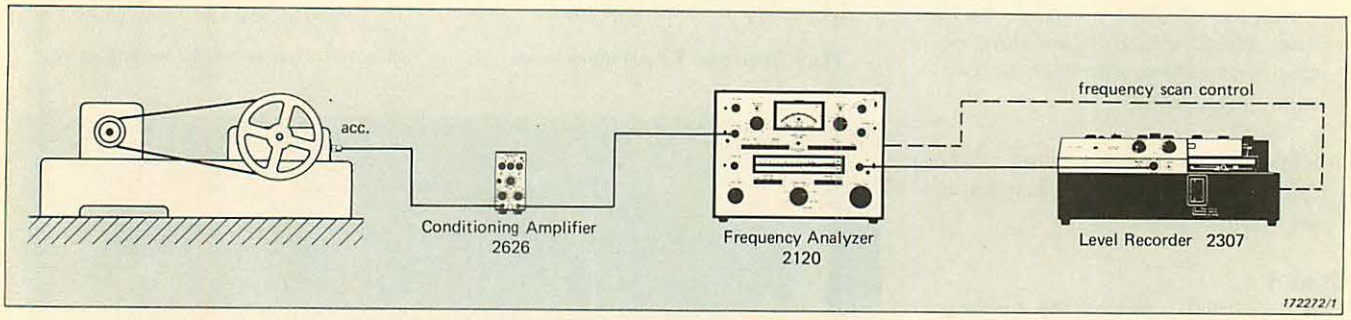


Fig.13. Set-up for automatic recording of vibration analysis

junction with a Level Recorder Type 2307 for automatic continuous constant percentage bandwidth analysis on a vibrating structure. The analysis is performed in the frequency range 2 Hz to 20 kHz with a constant relative bandwidth of only 1%. The Frequency Analyzer Type 2120 is particularly useful for investigation of low frequency phenomena, troubleshooting on engines, machines, gearboxes etc., and for many other types of analysis, where a narrow bandwidth is required. The recording in Fig.12 shows the acceleration level as a function of frequency. The intervals between the preprinted portions are due to the automatic range shifting of the analyzer.

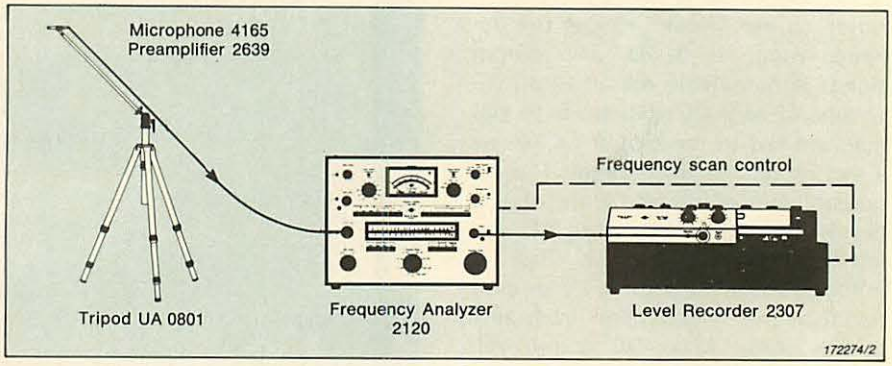


Fig.14. Set-up for automatic recording of sound analyses

Analysis of sound

A wide range of condenser microphones and preamplifiers is available from B & K for use with the 2120 for measurements in the frequency range 2 Hz to 140 kHz and covering a dynamic range of below 10 dB to 180 dB SPL. The 2120 is useful for all types of analysis requiring narrow bandwidth in the frequency range 2 Hz to 20 kHz, for instance, investigation of particular interesting parts of a sound analysis obtained with octave or third-octave filters, distortion measurements, or other types of analysis where a high resolution in frequency is desired. The set-up in Fig.14 shows the Frequency Analyzer used with a Level Recorder Type 2307 for automatic frequency analysis of sound. The recording in Fig.15 shows a sound analysis from 20 Hz to 2 kHz. A complete frequency analysis from 2 Hz to 20 kHz consists of 8 charts.

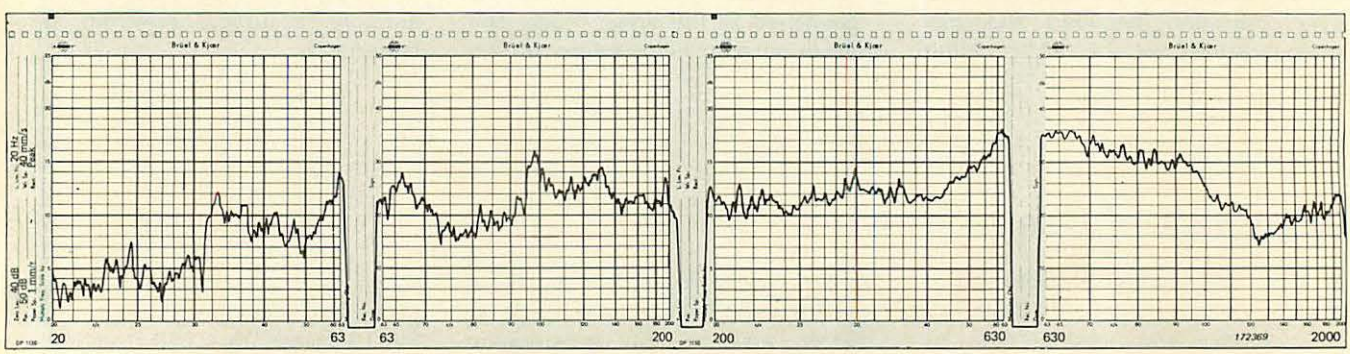
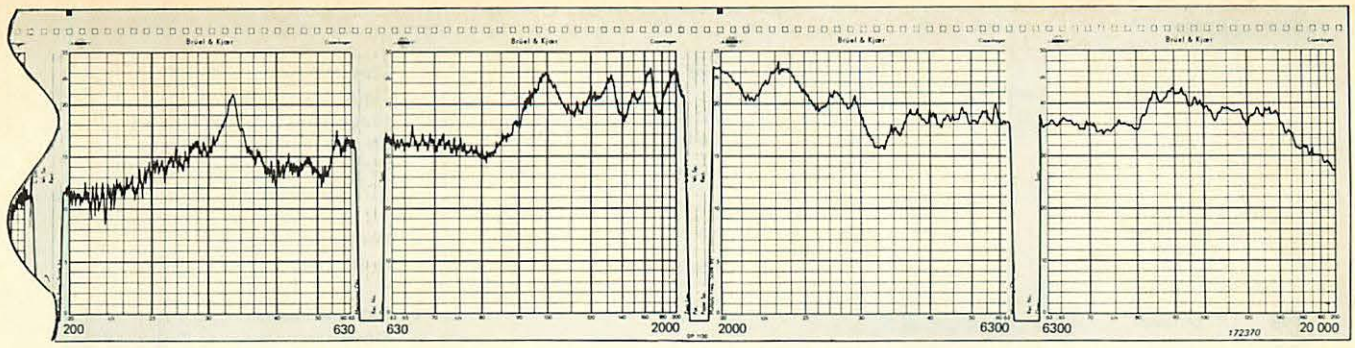


Fig.15. Frequency analysis of sound



Continued from Fig.12

Specifications 2120

MEASURING AMPLIFIER SECTION

Frequency Response:
(without filters)
2 Hz to 200 kHz ± 0,5 dB re. 1000 Hz
10 Hz to 50 kHz ± 0,2 dB re. 1000 Hz

Measuring Range:
(full scale deflection)
10 μV to 300 V (700 V peak)

Attenuators:
0 to 150 dB in steps of 10 dB

Accuracy of Input Attenuator:
± 0,1 dB re. "0,1 V" (1 kHz)

Accuracy of Output Attenuator:
± 0,1 dB re. "x 1" (1 kHz)
The measuring range setting is displayed on the meter scales (both attenuators)

Input Impedance:
"Direct Input": 1 MΩ//50 pF

Input Amplifier:
Gain: 50 dB, adjustable 40 — 54 dB
Distortion: 1 kHz, load 500 Ω)
< 0,01%
Hum: < 1 μV

Noise: (referred to input)
(typical, max. amplification and input short circuited)

Lin 2 Hz — 200 kHz:	< 7,0 μV RMS
A-weighting:	< 1,5 μV RMS
B-weighting:	< 1,6 μV RMS
C-weighting:	< 1,7 μV RMS
D-weighting:	< 4,0 μV RMS

Signal-to-Noise Ratio:
(Input Att. in positions 30 mV to 300 V)
> 80 dB

Output Amplifier:
Gain: 70 dB
Distortion:
(load 10 kΩ)
Output voltage 30 V RMS: < 1%
Output voltage 10 V RMS: < 0,3%
Output voltage 3 V RMS: < 0,1%

Noise:
(referred to input of output Amp.)
(typical, Lin 2 Hz to 200 kHz)
< 25 μV

Overload Indicators:
Input Overload Level: 5,6 V peak ± 1 dB
Output Overload Level: 56 V peak ± 1 dB
Internal adjustment of overload levels. Lamps light for overload pulse longer than 0,2 ms, remain lit for 0,5 s min. Relay output of overload function

Meter Characteristics:
"RMS Mode":
Accuracy: < ± 0,5 dB for crest factor 5
Averaging Times: 0,1 to 300 s and "Fast" and "Slow"
Dynamic Range: (crest factor up to 1,4) —50 dB to + 10 dB re full scale deflection

"Impulse Mode":
Accuracy: < ± 0,5 dB for crest factor 5
Meter Response: According to IEC R 651 (Type 1-Impulse) and DIN 45633 part 2
Impulse Hold: < 0,05 dB/s
Dynamic Range: —36 dB to + 10 dB re full scale deflection

"Peak Modes":
Modes: "+ Peak", "—Peak", and "Max. Peak"
Rise Time: 20 μs
Hold Time: 400 ms
Decay Times: 0,1 to 300 s
Dynamic Range: —36 dB to + 14 dB re full scale deflection

Lin-Log Converter:
Dynamic Range: 50 dB corresponding to full scale deflection from zero to full scale
Linearity: ± 0,5 dB

Output, DC Modes:
0 to 4,5 V proportional to meter deflection

Max. Output Voltage:
"RMS Mode": 25 V
"Impulse Mode": 15 V
"Peak Modes": 25 V

Output, AC Mode:
10 V RMS at full scale deflection
Max. AC output voltage: 56 V peak
Max. output current: 14 mA peak

Output Impedance:
AC: < 50 Ω
DC: 820 Ω

Load Impedance:
AC: > 16 kΩ//200 pF
DC: Short circuit protected

Meter Reset:
Meter Reset Button:
RMS, averaging time: 100 ms
Impulse, decay time: 100 ms
Peak, decay time: 100 ms

Remotely Controlled Meter Reset:
RMS, averaging time: 100 ms
Impulse, decay time: < 70 ms
Peak, decay time: 10 ms

Remote Control:
The averaging times and the meter reset can be remotely controlled from the AVERAGING TIME socket on the rear panel of the instrument (see Fig.11)

Phase Deviation between two instruments:
Max. ± 5°, 5 Hz to 20 kHz

Reference Voltage:
(built-in oscillator)
50 mV at 1 kHz, sinusoidal
Amplitude Stability:
2%, 5 to 40°C (41 to 104°F)
Frequency Stability:
2%, 5 to 40°C (41 to 104°F)
Distortion: 2%

FILTER SECTION

Tunable Frequency Range:
2 Hz to 20 kHz (filters 1, 2, 3 and 4)

Frequency Calibration:
± 1% (filters 1, 2, 3 and 4)

Frequency Stability:
0,5% per 20°C (36°F)

1. Bandpass Filters:

3 dB BW	Octave Selectivity
1%	70 dB
3%	60 dB
10%	45 dB
1/3 oct.	30 dB

Noise Level and Dynamic Range:

3 dB BW	2 Hz to 6,3 kHz	6,3 kHz to 20 kHz
1%	100 μV (80 dB)	175 μV (75 dB)
3%	100 μV (80 dB)	175 μV (75 dB)
10%	100 μV (80 dB)	100 μV (80 dB)
1/3 oct.	100 μV (80 dB)	100 μV (80 dB)

Frequency Response at f_0 within:

3 dB BW	20 Hz to 6,3 kHz	2 Hz to 20 kHz
1%	± 1,0 dB	± 2,0 dB
3%	± 0,5 dB	± 0,7 dB
10%	± 0,5 dB	± 0,5 dB
1/3 oct.	± 0,5 dB	± 0,5 dB

2. Bandstop Filter:
Attenuation at fo: > 60 dB
Attenuation at 0,5 f_0 and 2 f_0: 1 dB
Dynamic Range: > 70 dB
Noise Level: < 300 μV
Frequency Response Linearity:
(in pass band)
2 Hz to 20 kHz: ± 0,5 dB
2 Hz to 200 kHz: ± 1,0 dB

3. Low Pass and 4. High Pass Filters:
4-pole butterworth filters with 3 dB attenuation at f_0 and 24 dB/octave slope
Dynamic Range: > 70 dB
Noise Level: < 300 μV
Frequency Response Linearity:
(in pass band)
2 Hz to 20 kHz: ± 0,5 dB both filters
20 kHz to 200 kHz: ± 2,0 dB High Pass

5. Weighting Networks:
A, B, C and D to IEC R 651

6. External Filters:
Output Impedance to External Filter:
< 10 Ω
Min. Load Impedance: 500 Ω
Output Voltage: max. 5,6 V peak
Input Impedance from External Filter to 2120:
146 kΩ//100 pF

GENERAL

Warm-up Time:
10 s

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

Storage Temperature:
—25 to 70°C (—13 to 158°F)

Humidity Range:
0 to 90% relative humidity non-condensing at 30°C

Power Supply:
110, 115, 127, 220, 240 V AC ± 10%, 50 to 400 Hz, approx. 33 VA
Complies with Safety Class 1 of IEC 348

Alternatively:
12 V DC ± 10%, approx. 31 VA

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

Dimensions:
(A-cabinet)
Height: 280 mm (11,0 in)
Width: 380 mm (15,0 in)
Depth: 200 mm (7,9 in)

Weight:
(A-cabinet)
11 kg (25 lb)

Accessories Included:
UB 0041: Flexible shaft
AO 0013: B & K screened cable
JP 0802: 8-pin plug
JP 0703: 7-pin plug (2)
JP 1501: 15-pin plug
SA 0051: voltage and dB scale (mounted in the instrument on delivery)
SA 0052: dB and voltage scale (Lin)
SA 0053: dB and voltage scale (Log 50 dB)
SA 0056: scale for 1" microphone
SA 0057: scale for 1/2" microphone
SA 0058: scale for 6—17 mV/g accelerometer
SA 0059: dB Lin/Log scale (Log 50 dB, Lin 20 dB)
SA 0087: uncalibrated scale, linear graduation 0 to 100
Power cord
Various lamps and fuses

Additional Scales Avaialable:
SA 0054: Absorption Coefficient scale
SA 0055: Power Spectral Density scale
SA 0060: scale for 1/4" microphone
SA 0083: scale for 1/8" microphone
SA 0142: scale for 1,7 to 6 mV/g accelerometer
SA 0143: scale for 17 to 60 mV/g accelerometer
SA 0144: scale for 60 to 170 mV/g
SA 0198: scale for dB with Hydrophone 8101
Scales can be custom made to order