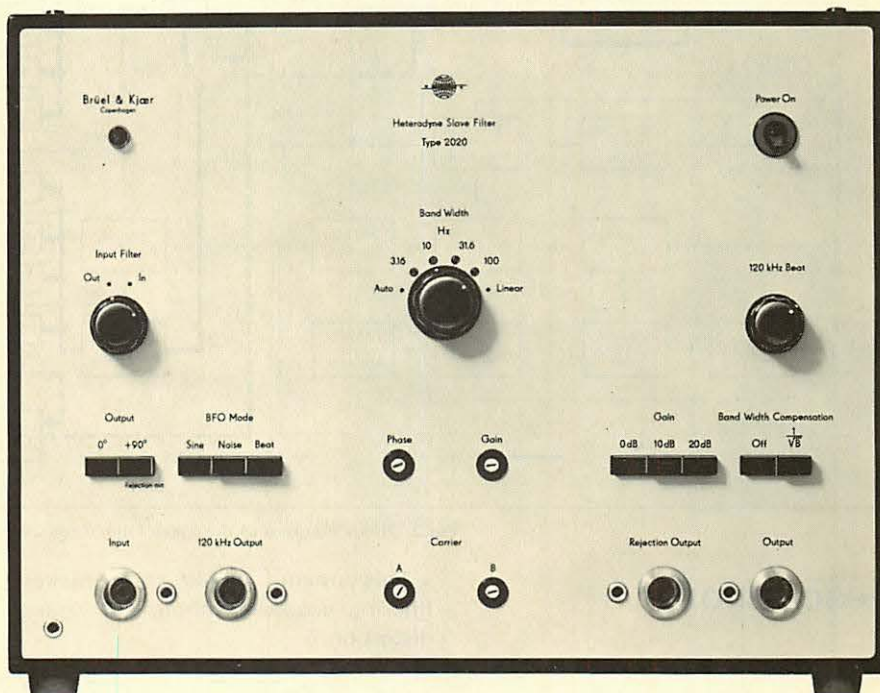


### FEATURES:

- Dynamic range > 70 dB
- Continuous rejection > 40 dB
- Frequency range 10 Hz to 20 kHz
- Four constant bandwidths included, 3,16; 10; 31,6; and 100 Hz
- Manual or remote control of bandwidth shift
- Phase difference between any two slave filters less than 1°
- Effective noise bandwidth 1,025 × 3 dB bandwidth
- Built-in bandwidth compensation
- 0° or + 90° phase shifted output

## Heterodyne Slave Filter



### USES:

- Selective measurements used as tracking filter or as slave filter
- Narrow band analysis with constant bandwidth
- Acoustic and vibration analysis
- Complex harmonic analysis
- Continuous distortion measurements
- Mechanical impedance studies
- Power Spectral Density measurements with automatic bandwidth compensation

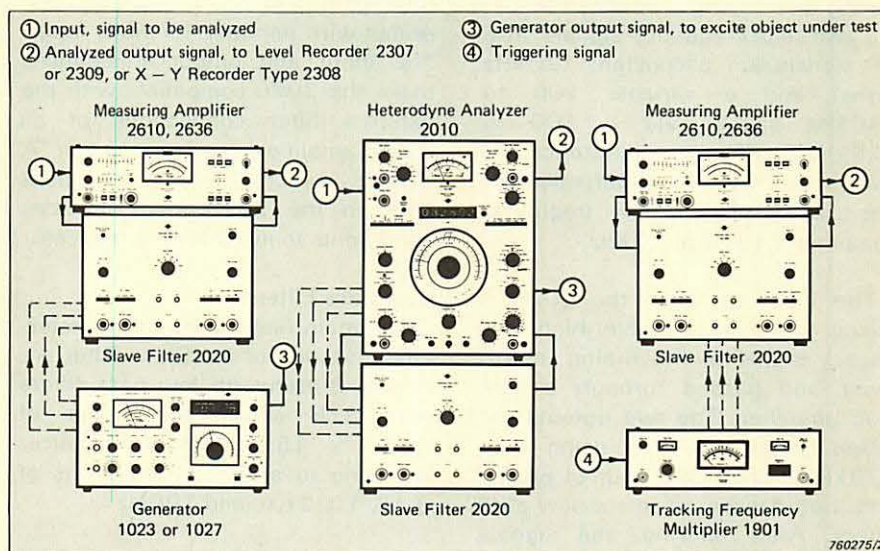


Fig. 1. Various instrument combinations with the 2020

The Heterodyne Slave Filter Type 2020 is a variable, narrow band, constant bandwidth filter which can be used in a great number of set-ups with B & K instrumentation.

It operates as a slave filter in the frequency range 10 Hz to 20 kHz when tuned from one of the B & K Generators Types 1023 and 1027 or from the Heterodyne Analyzer

Type 2010. All these tuning instruments can be driven from and synchronized with a Level Recorder Type 2307 or 2309, or X-Y Recorder Type 2308.



The 2020 operates as an automatic tracking filter in the frequency range 10Hz to 20kHz when tuned from the Tracking Frequency Multiplier Type 1901. This instrument locks onto and tracks the fundamental or a harmonic of practically any type of periodic waveform. The 1901 can tune two or

more 2020s forming an excellent set-up for making mechanical impedance measurements on rotating machinery. Further, the 1901 provides electrical control of the paper feed in the Level Recorder Type 2307 or X-Y Recorder Type 2308 so that a response curve versus RPM, for example, can be recorded.

Combined with one of the Measuring Amplifiers Types 2610 and 2636, and tuned from one of the instruments mentioned, the 2020 becomes a very versatile heterodyne analyzer for the audio frequency range.

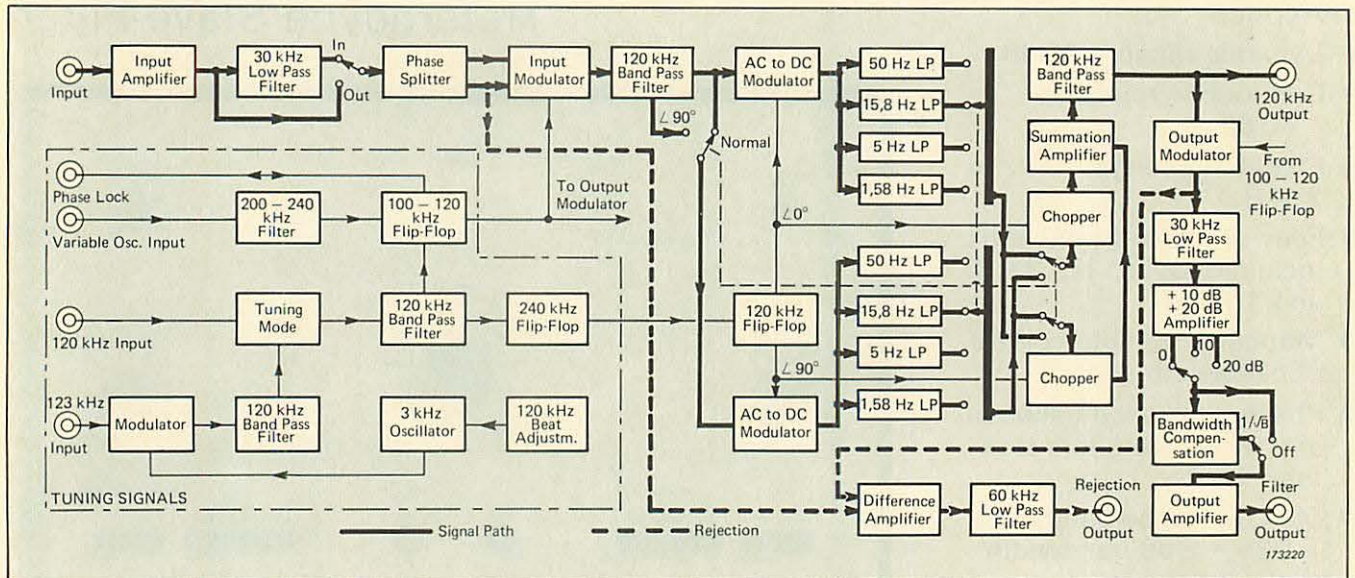


Fig. 2. Block diagram of the Slave Filter Type 2020

## Description

The principle of operation can be seen from the block diagram in Fig. 2. The synchronization with a tuning instrument is obtained by using two high frequency signals. The HF signals are a constant 120kHz signal and a variable 200 to 240kHz signal. Via a 100 to 120 kHz Flip-Flop the difference between the fixed and variable frequencies gives the low frequency component 10 Hz to 20 kHz.

The input signal to the 2020 is mixed with the variable high frequency signal of the tuning instrument and passed through a split load amplifier. The two outputs are mixed down to DC using two 120kHz signals, 90° out of phase, and then passed on to the low-pass filters. After filtering, the signals are chopped with the same two 120kHz signals 90° out of phase and summed. The resulting 120kHz signal is then mixed with the variable 100 to 120kHz to bring it back to its initial input frequency.

This unique construction makes filtering possible without any phase distortion.

### Input

The Slave Filter Type 2020 has unity gain in the pass band and operates with nominal 1 V RMS input. The input and output impedances make the 2020 compatible with the external filter connections of all B & K amplifiers and analyzers. A 30 kHz, switch selected, low pass filter in the 2020 input provides band limits to avoid IF disturbances.

### Low Pass Filters

The main filters used in the heterodyne section of the Slave Filter are 4 pole Butterworth low pass filters with 3 dB cut-off frequencies of 1,58; 5; 15,8; and 50 Hz corresponding to analysis bandwidths of 3,16; 10; 31,6; and 100 Hz.

The dynamic range of the filter is better than 70 dB. The effective bandwidth is 1,025 times the area of the rectangular pass band characteristic of an ideal filter.

### Selection of Filter Bandwidth

Parallel operation of all filter in-

puts provides transient-free bandwidth changes. Selection of filter bandwidth can be made manually or by remote control, where the 3,16 Hz bandwidth filter is in circuit and selection of the other three bandwidths is made via the Remote

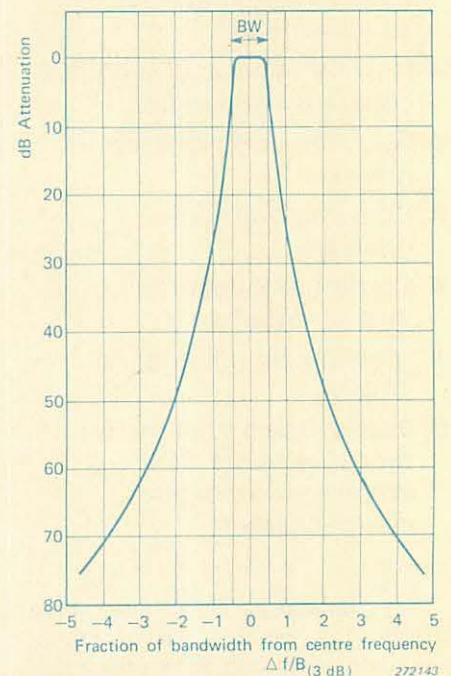


Fig. 3. 4-Pole Butterworth filter characteristic



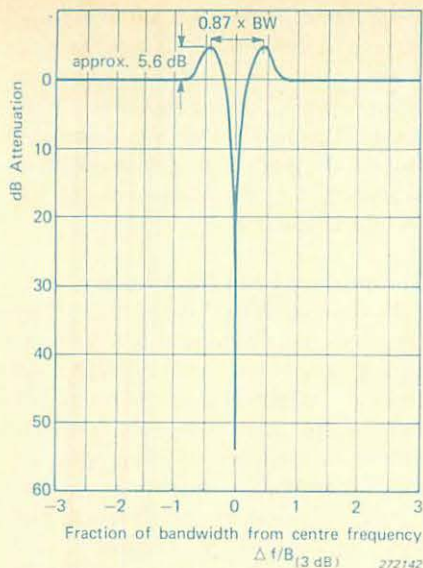


Fig.4. Typical frequency response of Type 2020 at the "Rejection Output"

Bandwidth Control socket at the rear of the instrument.

### Outputs

There are three outputs from the filter:

1. A low frequency output giving a signal identical to the fundamental of the input signal at the tuned-in frequency.
2. A rejection output, giving all components of the input signal except the fundamental.
3. A 120 kHz output, giving a 120 kHz signal with phase and amplitude information of the fundamental of the input signal. The phase can be shifted 90° by a front panel switch.

## Examples of Use

### Response Measurements

When tuned from a 1023 or 1027 Generator the Slave Filter is always tuned to the oscillator output frequency. System response measurements can be made under conditions of high noise or distortion either at spot frequencies or by using the Level Recorder Type 2307 or 2309, or X-Y Recorder Type 2308, to sweep the frequency band. The wide choice of bandwidths and the ability to operate with sinusoidal or swept narrow band stimuli provides a unique response measuring capability.

Applications include the measurement of sound and vibration transmission through complex structures in the presence of high ambient

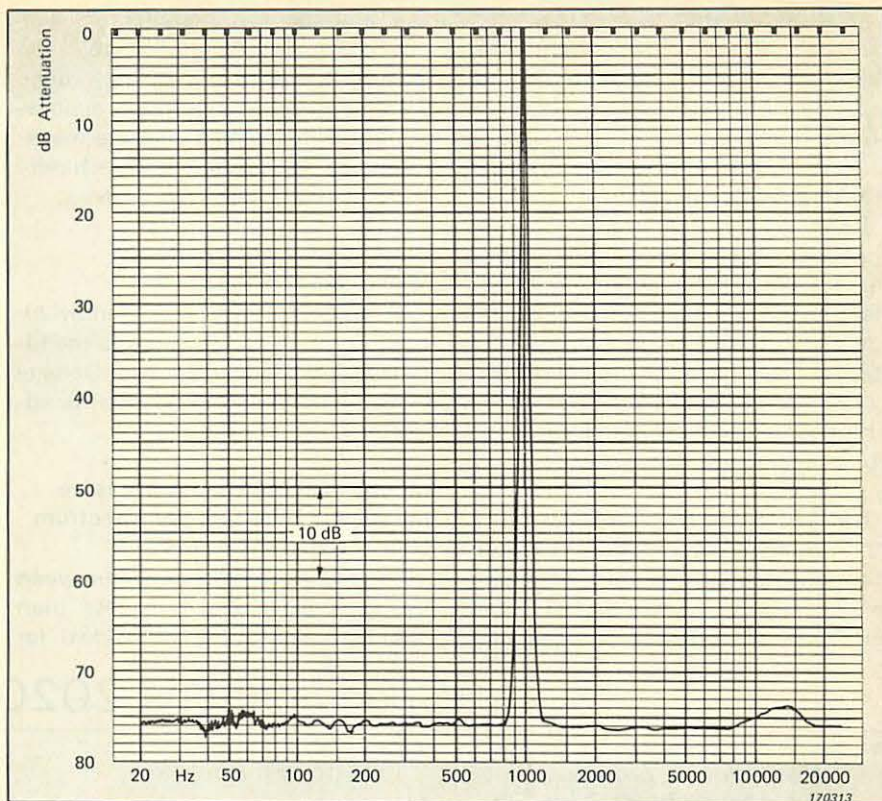


Fig.5. Filter response of the 10 Hz filter at 1000 Hz centre frequency recorded on a Level Recorder (Two 50 dB charts glued together)

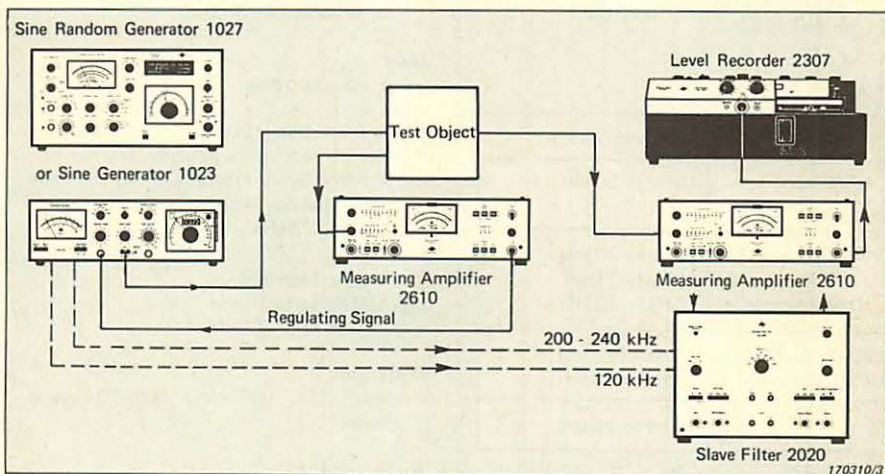


Fig.6. Typical instrument set-up for response measurement

noise signals, production line testing where quiet test enclosures are impractical, and low level testing where amplitude restrictions in the driving transducer demand low level measurements.

### Narrow Band Analysis

The Slave Filter Type 2020 tuned by a 1023 or 1027 Generator and coupled to any B & K measuring amplifier can be used as a narrow band analyzer. Bandwidths of 3,16; 10; 31,6; and 100 Hz are simply selected from the 2020 front panel or changed automatically by an op-

tional contact assembly on the tuning shaft of the signal generator.

The 2020 tuning range can be extended down to 4 Hz with a slight degradation of the slave filter's dynamic range below 10 Hz.

### Continuous Distortion Measurements

The rejection output of the 2020 slave filter contains all signal components except the fundamental frequency of the tuning instrument. The dynamic range of rejection is more than 50 dB from 10 Hz to



10 kHz and greater than 40 dB from 10 kHz to 20 kHz. Swept frequency distortion measurements down to 0.3% are possible in the 10 Hz to 10 kHz range.

### Tracking Analysis

Tuned from a Tracking Frequency Multiplier Type 1901, and combined with a Measuring Amplifier, the Slave Filter will perform as an automatic narrow band tracking analyzer. The 1901 automatically locks onto and tracks the fundamental or harmonic of practically any type of periodic waveform.

The 1901 can tune the Slave Filter to multiples and submultiples of the fundamental frequency. Multiplication factors between 0.1 and 99.9 can be selected in steps of

0.1 and the 1901 accepts triggering signals between 30 mV and 300 V RMS in the frequency range 10 Hz to 200 kHz. Typical applications for this combination are measurements on rotating machinery and automatic harmonic analysis.

### Power Spectral Density Measurements

A special mode with bandwidth compensation of  $1/\sqrt{B}$  makes the filter ideal for Power Spectral Density measurements independent of bandwidth.

### Mechanical Impedance Measurements and Cross Power Spectrum Density Measurements

The phase difference between any two Slave Filters is less than  $1^\circ$ . This makes the filter ideal for

mechanical impedance measurements, or for other purposes where phase comparison between two filtered signals is desired. For Cross Power Spectrum Density measurements  $0^\circ$  and  $90^\circ$  phase shift is available for measurement of co and quad spectra.

### Compressor Feed Back Loops

The Slave Filter Type 2020 can be used with standard B & K measuring amplifiers and analyzers to provide synchronous filtering of compressor control signals. The oscillator amplitude is controlled at the fundamental frequency undisturbed by noise or interference. For this application a second 2020 should be used as an external filter for the regulating 2610 in the setup in Fig. 6.

## Specifications 2020

<b>Tunings:</b> Heterodyne Principle, requires external HF signals. B & K instruments Types 1023, 1027, 2010 and 1901 may be used.  <b>Fixed signal:</b> 120 kHz <b>Variable signal:</b> 100 to 120 kHz or 200 to 240 kHz		<b>Bandwidths:</b> 3, 16; 10; 31, 6; and 100 Hz	<b>Output Phase:</b> "Output" and "120 kHz Output". Output phases can be shifted $90^\circ \pm 0.5^\circ$														
<b>Frequency Range:</b> <table border="1"> <thead> <tr> <th>Tuning Instrument</th> <th>Frequency Range</th> </tr> </thead> <tbody> <tr> <td>1023 lin and log modes</td> <td>10 Hz to 20 kHz</td> </tr> <tr> <td>1027 log mode</td> <td>20 Hz to 20 kHz</td> </tr> <tr> <td>1027 lin mode</td> <td>10 Hz to 2 kHz</td> </tr> <tr> <td>2010, log mode</td> <td>10 Hz to 20 kHz</td> </tr> <tr> <td>2010, lin mode</td> <td>10 Hz to 20 kHz</td> </tr> <tr> <td>1901</td> <td>10 Hz to 20 kHz</td> </tr> </tbody> </table>		Tuning Instrument	Frequency Range	1023 lin and log modes	10 Hz to 20 kHz	1027 log mode	20 Hz to 20 kHz	1027 lin mode	10 Hz to 2 kHz	2010, log mode	10 Hz to 20 kHz	2010, lin mode	10 Hz to 20 kHz	1901	10 Hz to 20 kHz	<b>Filter Type:</b> 4-pole Butterworth. Shape factor 5, 6. (Ratio between bandwidth at 60 dB cut-off to bandwidth at 3 dB)	<b>Remote Control:</b> Filter bandwidth selection
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<b>Dynamic Range:</b> > 70 dB. (Distance from noise level to nominal input voltage of 1 V RMS)		<b>Gain:</b> 0; 10; and 20 dB	<b>Temperature Range:</b> + 10 to + 40°C (+ 50° to + 104°F)														
<b>Input Impedance:</b> 1 MΩ		<b>Phase Distortion (120 kHz):</b> Max. $1^\circ$ difference between any two Heterodyne Slave Filters operated from the same tuning instrument in the range 10 Hz to 20 kHz	<b>Power Supply:</b> 100, 115, 127, 220 and 240 V (50 to 400 Hz) $\pm 10\%$ AC. 30 VA Complies with safety class I of IEC 348														
<b>Load Impedance:</b> > 10 kΩ		<b>Frequency Rejection:</b> > 50 dB up to 10 kHz > 40 dB up to 20 kHz	<b>Cabinet:</b> 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" racks)														
<b>Max. Input Voltage:</b> 1 V RMS, crest factor up to 4, 5		<b>Distortion:</b> Max. 0.5% at "Output" and "Rejection Output"	<b>Dimensions (A-cabinet):</b> <b>Height:</b> 280 mm (11.0 in) <b>Width:</b> 380 mm (14.9 in) <b>Depth:</b> 200 mm (7.9 in)														
<b>Max. Output Voltage:</b> 1 V RMS		<b>Noise and Hum:</b> <b>Rejection Output:</b> < 1 mV <b>LF and 120 kHz Output:</b> < 300 μV, typically 100 μV	<b>Weight (A-cabinet):</b> 12 kg (27 lb)														
		<b>Attenuation of Unwanted Signals:</b> The total attenuation including unbalance in modulators, DC drift, harmonic and subharmonic distortion better than 60 dB, 70 dB in a few hours, with adjustment of carrier controls on front panel.	<b>Accessories Included:</b> 7 screened plugs JP 0101 1 six-pin plug JP 4705 Power cord Various fuses														
		<b>Outputs:</b> "Output" (LF) "Rejection Output" (LF), -3 dB at 60 kHz "120 kHz Output" (IF)	<b>Accessories Available:</b> UG 3000, a 10:1 reduction gear for the flexible drive shaft between Generator and Level Recorder Type 2307														