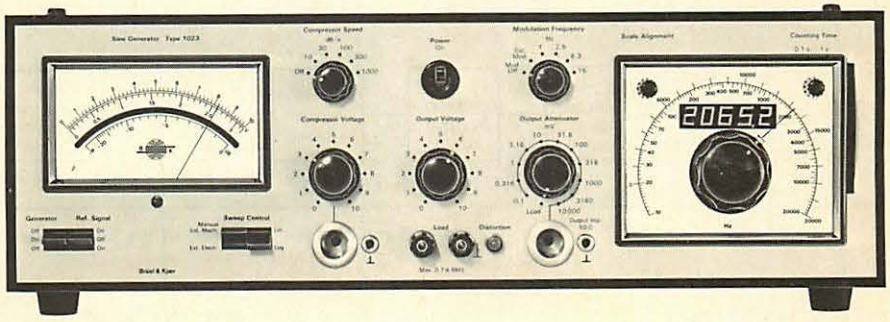
type 1023

# Sine Generator

FEATURES:

- Frequency coverage 10 Hz to 20 kHz in one range
- Lin and Log frequency scales
- High stability, voltage controlled oscillator
- Built-in frequency modulator
- Low distortion
- 5 digit frequency display, 0,1 or 1 s counting time
- Compressor circuit with 0 dB static regulation error
- Five compressor speeds from 10 to 1000 dB/s
- Greater than 60 dB dynamic range of compressor
- Power output for loudspeakers, etc.
- Precision output attenuator
- Noiseless generator stop function for reverberation measurements
- Built-in electronic voltmeter
- Manual, external electrical or external mechanical frequency sweep control
- Automatic frequency synchronization with Level or X-Y Recorders



- Output for exact frequency marking on Level Recorder Type 2307
- Tunes Heterodyne Filter 2020

USES:

*Electroacoustical measurements, such as:*

- Frequency response, distortion, and impedance of audio recording and reproduction equipment
- Frequency response and directional characteristics of microphones, loudspeakers, hydrophones, and projectors
- Investigations in anechoic and reverberation rooms
- Determination of audio filter characteristics
- Phase response
- Hearing aid frequency response calibration
- Automatic recording of harmonics with Tracking Frequency Multiplier 1901 and Filter 2020 or Analyzer 2010

*Building Acoustical measurements, such as:*

- Sound distribution
- Transmission loss
- Sound insulation
- Reverberation time

*Mechanical Dynamics measurements, such as:*

- Mechanical impedance
- Phase
- Vibration testing

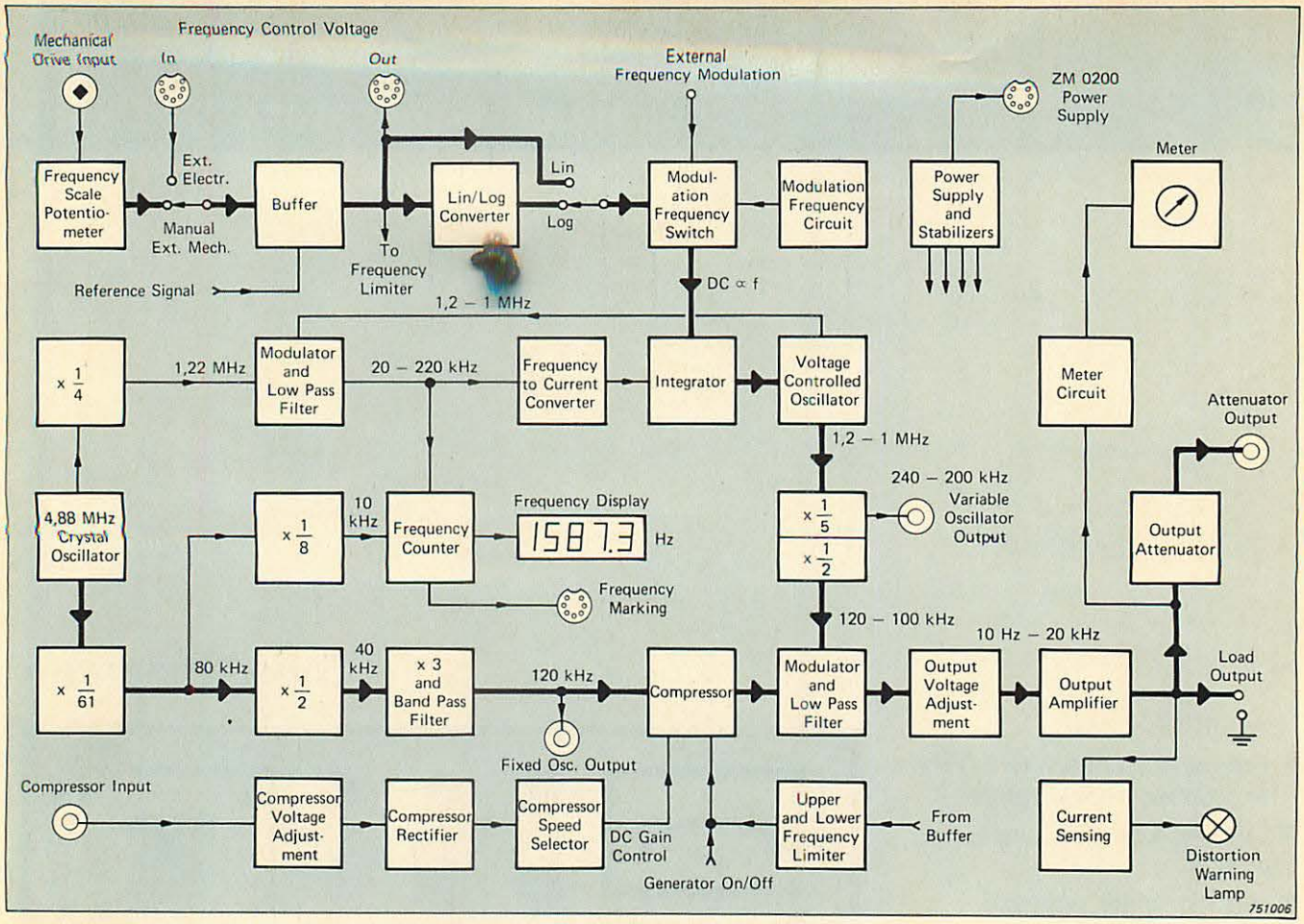



**Fig.1. Simplified block diagram of the Sine Generator**

# Introduction

The Sine Generator Type 1023 is a precision signal generator which covers 10 Hz to 20 kHz in one continuous range. Frequency modulation of the output signal is available. This is often used to prevent the generation of standing waves in building acoustic measurements.

In addition to the analogue frequency scale the instrument is equipped with an accurate frequency counter with a five digit frequency display. The 1023 can be swept both linearly and logarithmically, and scanning of the entire frequency range can be made manually, or remotely via a mechanical drive or an electrical signal. Hence, the Generator can be synchronized with a Level or X-Y Recorder to obtain a graphic record of the measurement result.

A major feature of the Sine Generator is the built-in compressor circuit which allows the output voltage to be controlled from an external source. In this way the level at a test object can be maintained constant when the frequency is swept, even if the load varies, as is the case with loudspeakers and vibration exciters for example. The compressor gives no regulation error for fixed frequency outputs, regardless of the degree of compression.

The built-in voltmeter is furnished with linear and dB scales, and indicates the voltage at either the attenuator output or the load output. 0,1 mV to 10 V RMS full scale is available at the attenuator output. The load output can supply 0 to 10 V RMS at 700 mA RMS which gives a max. output power of 7 W. This is enough to drive, for example, a Standing Wave Apparatus Type 4002, an Anechoic Test Chamber Type 4222, a Mouth Simulator Type 4227, or a Mini-Shaker Type 4810.

The 1023 can tune the Heterodyne Slave Filter Type 2020 so that constant-bandwidth analyses can be performed. Automatic harmonic analyses can be made when the Tracking Frequency Multiplier Type 1901 is included in the set-up.

For production testing and inspection of amplifiers, tape recorders, filters loudspeakers and other electroacoustic devices, the 1023 can sweep automatically with an Audio Frequency Response Tracer Type 4712.

# Description

The Sine Generator Type 1023 is a beat frequency oscillator which operates on the heterodyne principle using two high-frequency oscillators. One of these generates a fixed frequency while the frequency of the other can be varied continuously. The two signals are mixed in a modulator and the difference frequency is filtered through a low pass filter whereby a variable low frequency sinusoidal signal is obtained. The advantages of this principle compared with RC and function generators are its high frequency- and amplitude-stability and its abil-

ity to sweep continuously over a wide frequency range. In addition, the technique permits control of slave filters in exact synchronization with the output frequency. Fig.1 shows a simplified block diagram of Type 1023; the heavy lines indicate how the output signal is produced.

## GENERATOR SECTION

### High Frequency Oscillators

The fixed frequency oscillator is crystal controlled giving high stability. The various frequencies used in different parts of the instrument are derived from it via frequency converters. One of these signals, 120 kHz, is fed through the regulating compressor amplifier to a modulator and low pass filter where it is mixed with the voltage controlled oscillator (VCO) signal.

The frequency of the VCO is controlled by a DC voltage, which is supplied either from a high precision, low noise, conductive plastic potentiometer connected to the shaft of the frequency scale dial or from an external source for remote control. The DC voltage is used to perform a linear sweep while a logarithmic sweep is obtained by transforming the linear voltage ramp into a logarithmic characteristic in the built-in Lin-to-Log converter.

### Frequency Modulation

The Sine Generator features a sawtooth oscillator for frequency modulation of the output signal. The internal modulation frequencies of 1; 2,5; 6,3 and 16 Hz have a swing of ± 10% of the centre frequency up to 2,5 kHz, above which the frequency deviatin is a constant ± 250 Hz. External modulation or a fixed frequency offset is achieved by connection of an appropriate DC voltage to the instrument.

### Sweep Control

A friction clutch permits both manual and external mechanical sweep control; electrical sweep control is also provided for. This permits easy synchronization with a Level Recorder Type 2307 or 2309, or an X-Y Recorder such as Type 2308. The sweep can be either linear or true logarithmic from 10 Hz to 20 kHz.

The logarithmic sweep is normally used for frequency response measurements and in connection with constant percentage bandwidth filters, where it gives a uniform resolution. A linear sweep is preferred for phase response measurements on loudspeakers as the slope gives information about the group delay. The linear sweep is also used together with constant-bandwidth filters, since it then gives equal separation and resolution of harmonically related components. This is very useful for discovering harmonic relationships. It also allows minimum analysis time when used with a constant bandwidth slave filter such as Type 2020.

A 50:1 reduction gear is coupled to the shaft of the frequency scale dial to permit fine frequency adjustment of the output frequency. The control is situated to the right of the frequency scale.

### Frequency Range Adjustment

If desired, the frequency range can be narrowed by means of a frequency comparator circuit. This is controlled separately for the high and low ends of the scale by rear-panel, screwdriver-operated potentiometers.

### Digital Frequency Display

A counter circuit measures the frequency of the VCO signal, and the five digit frequency display is calibrated to read the output frequency of the generator. The counting time is selectable to be either 0,1 or 1 second. 0,1 s gives 10 frequency readings per secorid with a resolution of 1 Hz. The 1 s counting time gives one reading per second with a 0,1 Hz resolution up to about 9000 Hz. Above this frequency the counting time automatically switches to 0,1 s to prevent display overflow.

A special output from the counter is available for controlling the event marker on a connected level recorder. When uncalibrated chart paper is used with a linear sweep of the generator, for example, this facility ensures exact frequency calibration of the chart. The frequency marking is switchable to mark for shift of digit 2, 3 or 4 of the frequency display.

### Reference Signal

A toggle switch with positions "On", "Off", and "On" with self return, can provide a reference frequency of approx. 1000 Hz independent of the generator frequency setting. This is useful when automatic recordings are being made as it checks whether the pen deflection of the Level Recorder will be on scale at the middle frequencies where the highest amplitudes are most often found. It may also be used for easy recording of the reference signal preceeding frequency recordings to be used in conjunction with the Response Test Unit Type 4416.

### Generator On/Off

The generator output can be shut down with a toggle switch which has the positions "Off", "On", and "Off" with self return. It suppresses the output signal more than 70 dB (60 dB in 2 ms), and is very useful for reverberation time measurements, for example. The On/Off function can be remotely controlled so that reverberation decay curves can be recorded automatically on a level recorder.

## COMPRESSOR SECTION

The built-in compressor circuit provides for automatic regulation of the output level over a dynamic range of more than 60 dB. The compressor is of such a design that when dwelling at a single frequency the level regulation will be error-free regardless of the degree of compression. There are five compressor speeds to choose from: 10, 30, 100, 300, and 1000 dB/s, and the amount of compression is continuously adjustable.

## OUTPUT SECTION

The signal from the output amplifier is available at two different output terminals.

### Attenuator Output

Voltages between 100 μV and 10 V RMS for full meter deflection are available from this terminal. The output signal may be attenuated by up to 100 dB in accurate 10 dB steps, and the level is continuously variable within each step. All attenuator positions have an output impedance of 50 Ω.

**Load Output**

This terminal is a direct output from the amplifier. It has an output impedance of less than 0,2 Ω and the output level is continuously variable between 0 and 10 V RMS. With the Output Attenuator in position "Load", this output can provide a maximum current of 700 mA RMS which means 7 W into a 14,3 Ω load impedance. In the other attenuator positions the Load output is still available, but the maximum current is reduced by approximately 50 mA. A current sensing circuit lights the Distortion warning lamp when the current drawn from the output amplifier exceeds 700 mA.

## METER SECTION

The meter circuit uses an average detector calibrated to read the true RMS value of sinusoidal signals. The precision meter is equipped with a mirrored scale to prevent parallax errors. It indicates the unloaded output voltage of the generator in all the 50 Ω positions of the Output Attenuator. This is often called the electromotive force. In the Load position, 10 V RMS corresponds to full scale deflection and the influence of loading is seen on the meter.

# Examples of Use

Fig.2 suggests a number of possible instrument set-ups for the wide range of applications of the Sine Generator Type 1023.

**Frequency Response**

In the basic set-up, the sweep of the Sine Generator Type 1023 is controlled by the Level or X-Y Recorder and the resulting frequency response curve is automatically plotted on the preprinted level recorder paper (Fig.3).

The linear frequency sweep also available from the 1023 is especially of use when measuring on circuits, such as very sharp filters, whose characteristics cannot be displayed accurately on a normal logarithmic scale. The linear sweep can then provide a significant expansion of the scale giving greater resolution and accuracy, while still maintaining frequency calibration of the recorder paper via the frequency marking facility (Fig.4).

The compressor section of the 1023 permits a variety of frequency dependent measurements where a given parameter must be held constant. It is used, for example, when it is desired to generate a constant sound pressure necessary for microphone frequency response measurements, for keeping the vibration level of a vibration exciter constant, or for generating a constant current necessary for impedance measurements.

For frequency response measurements where the signal-to-noise ratio is poor, a band-pass filter synchronized in frequency with the 1023 may be included in the measuring circuit or the compressor loop or both. The Type 2020 Heterodyne Slave Filter is synchronized by means of high frequency tuning signals from the 1023 and provides a range of four narrow constant-bandwidths (3 to 100 Hz), mainly for linear frequency sweeping. The Type 1623 Tracking Filter can track the

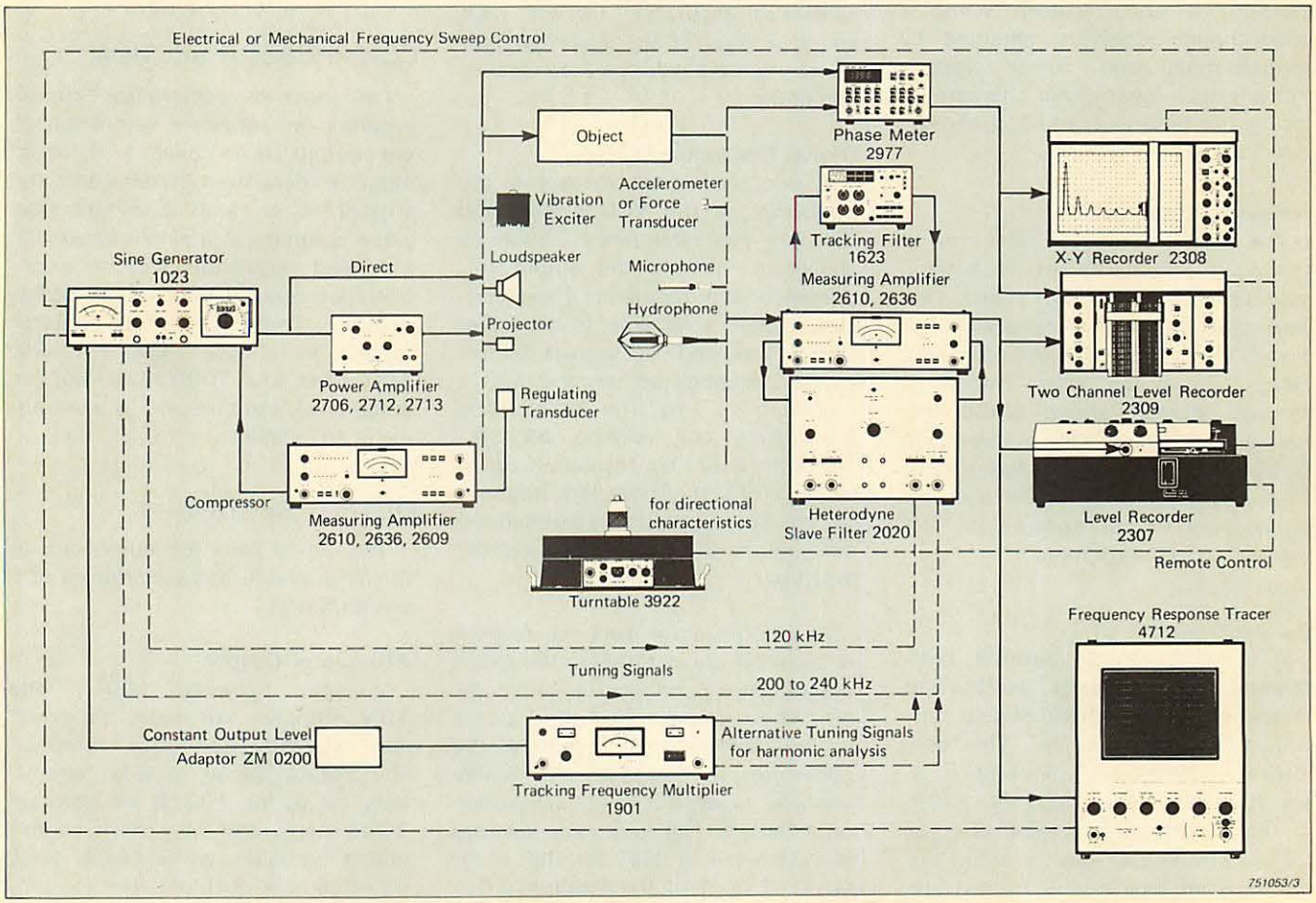



**Fig.2. Some practical measuring set-ups for a wide range of application**

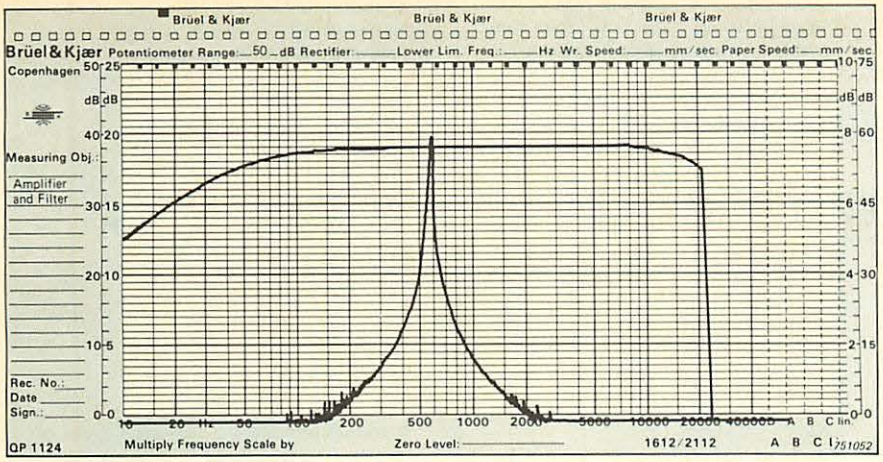



Fig.3. Frequency response of an audio amplifier and a narrow band filter

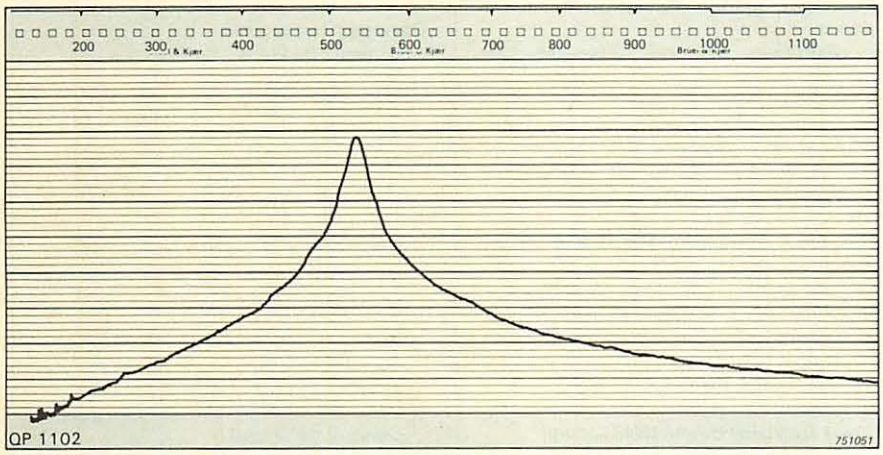



Fig.4. Frequency response of a narrow band filter plotted on an expanded scale using a linear sweep

1023 output directly and provides a range of three constant-percentage bandwidths (6%, 12% and 23%), mainly for logarithmic frequency sweeping.

### Distortion

The Heterodyne Slave Filter Type 2020 may also be used for measurements of total harmonic distortion. By operating the 2020 in the rejection mode, a sharp band-stop filter automatically follows the generator frequency in precise synchronization.

For the measurement of individual harmonic distortion, the Heterodyne Slave Filter Type 2020 is also used, but in the bandpass mode. In addition, a Tracking Frequency Multiplier Type 1901 is required to multiply the output frequency of the 1023 by an appropriate factor (selectable in steps of 0,1 from 0,1 to 99,9) to tune the 2020 to the desired harmonic. The distortion curves are then automatically plotted on the Level Recorder.

### Reverberation Time

The frequency modulation feature of the 1023 makes it well-suited for measurements of reverberation time. The warble tone generated has a wider frequency spectrum than a pure sine, and hence reduces problems caused by standing waves. The resulting decay curves are displayed on the Level Recorder, and the reverberation time is derived based on the slope of the curve.

### Phase

The linear sweep feature of the 1023 is also of use in loudspeaker phase response measurements in conjunction with a Phase Meter Type 2927. The linear sweep simplifies interpretation of the curves and permits easy calculation of the relative group delay of the various drivers of the loudspeaker system. The Phase Meter may also be used for phase measurements on amplifiers and for plotting the imaginary component of impedance.

### Other applications

The output level controls permit adjustments of signal levels from 10 $\mu$V to 10 V. Theis permits frequency response, distortion, and phase measurements of high gain circuits without the need for additional external attenuation. At the same time, the output power amplifier of the 1023 provides adequate power to drive a loudspeaker or small shaker table. However, this wide range of output levels may be too great to permit operation with certain other instruments which require a trigger signal, such as the Digital Storobscopes Types 4912 and 4913, Frequency Response Tracer Type 4712, or Tracking Frequency Multiplier Type 1901. When this is the case, a Constant Output Level Adaptor ZM 0200 is available. This adaptor provides a constant output level of approximately 1 V RMS which is suitable for triggering these instruments.

# Specifications 1023

**Output Waveform:**
Sinusoidal

**Frequency Range:**
10 Hz to 20 kHz in one continuous range, switchable linear or logarithmic

**Frequency Range Adjustment:**
Upper and lower frequency limit adjustable by rear-panel screwdriver-operated potentiometers

**Frequency Stability:**
Measured over 8 hours after 1 hour warm-up time
**Lin. Scale:** 0,1% + 1,5 Hz
**Log. Scale:** 0,2% + 1,5 Hz

**Amplitude Linearity:**
± 0,2 dB re 1 kHz, 10 Hz to 20 kHz

**Signal-to-Noise Ratio:**
> 70 dB

**Distortion** (each harmonic):
**Attenuator Output:**
< 0,1% 20 Hz to 20 kHz
< 0,15% 10 Hz to 20 kHz
**Load Output,** loaded 7 W:
< 0,15% 10 Hz to 20 kHz

**Frequency Scale:**
Linear and logarithmic scales
**Accuracy:**
**Lin:** ± 1% of tuned frequency
**Log:** ± 3% of tuned frequency

**Frequency Counter:**
Five digit 7-segment display
**Counting Time:** 0,1 s and 1 s, switch selectable. Automatic shift to 0,1 s above approx. 9 kHz. Automatic decimal point setting
**Accuracy:** ±1 on last digit ±20 ppm of tuning frequency (± 1 Hz and ± 0,1 Hz at counting times 0,1 s and 1 s respectively)

**Frequency Control:**
**Manual** coarse and fine adjustment over entire frequency range, 1:50 ratio for fine
**External Mechanical** via flexible shaft or chain drive, for example from Level Recorder Type 2307
33 rotations for full scale Log sweep, 30 for full scale Lin sweep
**External Voltage** from linear DC source, for example X-Y Recorder Type 2308, or from linear chart position potentiometer, for example Level Recorder Type 2307 or 2309. Full scale sweep: **Lin** 0 to 10 V DC, 2 Hz/mV. **Log** —1 to +10 V DC, 0,3 decade/V corresponding to 1 octave/V
**Voltage to Frequency Conversion:** Linearity 0,03% (lin scale)
**Operation with Frequency Response Tracer Type 4712:** Built-in sweep unit for direct connection to the 4712 (8-pin DIN socket "Frequency Control Voltage In")

**Frequency Marking** (7-pin DIN socket):
Output for controlling event marker on Type 2307 Level Recorder for exact chart calibration. Switchable to mark shift of digit 2, 3 or 4

**Frequency Modulation:**
**Modulation Swing:** ± 10% of tuned frequency up to max. ± 250 Hz
**Modulation Frequency:** 1; 2,5; 6,3; and 16 Hz, switch selectable. Provision for external modulation (8-pin DIN socket "Frequency Control Voltage In", 0,2 Hz/mV)

**Generator On/Off:**
Three position toggle switch, "Off", "On", and "Off" with self return. Suppresses the output signal more than 70 dB, 60 dB in approx. 2 ms
Noiseless. May be remotely controlled (7-pin DIN socket "ZM 0200 Power Supply")

**Reference Signal:**
Three position toggle switch, "On", "Off", and "On" with self return
**Reference Frequency:** 1000 Hz ± 3%, level is controlled by "Output Attenuator" and "Output Voltage" knobs

**Attenuator Output:** (B & K socket on front panel, parallel BNC socket on rear panel):
**Output Voltage:** 100 µV to 10 V RMS, variable in 10 dB steps, continuously variable within each step. Accuracy of steps ± 0,2 dB re 0 dB position (10 V)
**Output Impedance:** 50 Ω in all attenuator positions

**Load Output** (two banana sockets, parallel BNC socket on rear panel, short circuit protected):
**Output Voltage:** 0 to 10 V RMS continuously variable
**Max. Output Current:** 700 mA RMS, "Distortion" lamp lights for higher output current
**Output Impedance:** < 0,2 Ω
**Max. Output Power:** 7 W into 14,3 Ω load
**Min. Load Impedance at FSD:** 14,3 Ω

**Frequency Control Voltage In** (8-pin DIN socket)
**Sensitivity:** See under "Frequency Control"
**Input Impedance:** > 0,5 MΩ
**Input Voltage:** Min. —15 V, max. + 15 V
**Voltages available:** + 15,4 V and —1,35 V (max. current 10 mA) for Level Recorder Type 2307

**Frequency Control Voltage Out** (8-pin DIN socket):
Voltage follows frequency control voltage ± 2 mV whether supplied internally or externally
**Output Impedance:** < 1 Ω
**Min. Load Impedance:** 10 kΩ

**Fixed Oscillator Output** (BNC socket):
120 kHz sine wave, 150 mV RMS
**Min. Load Impedance:** 10 kΩ//300 pF

**Variable Oscillator Output** (BNC socket):
240 to 200 kHz unsymmetrical square wave, TTL output, 2,4 to 5 V peak-to-peak
**Min. Load Impedance:** 5 kΩ//300 pF

**ZM 0200 Power Supply** (7-pin DIN socket):
Supplies power to the optional Constant Output Level Adaptor ZM 0200. Contains also facility for remote control of "Generator On/Off" function
**Voltages Available:** ± 15,4 V (max. 50 mA) and + 5 V (max. 100 mA)

**Voltmeter:**
Electronic voltmeter with large, accurate taught-band instrument including mirrored scale. Indicates EMF (electromotive force) in attenuator positions and output voltage in position "Load"
**Scales:** 0 to 10 V, 0 to 3,16 V and —20 to 0 dB
**Rectifier:** Average, calibrated to read true RMS for sine signals
**Accuracy of Rectifier + Meter:** ± 1% of scale reading ± 1% of full scale deflection

**Compressor** (B & K socket on front panel, parallel BNC socket on rear panel):
**Amplitude Linearity:** ± 0,2 dB re 1 kHz, 10 Hz to 20 kHz
**Dynamic Range:** > 60 dB
**Regulation Characteristic:** 0 dB static error
**Input Voltage:** Min. 0,5 V RMS
**Input Impedance:** 25 kΩ//100 pF
**Rectifier:** Average
**Compressor Speeds:** 10, 30, 100, 300, and 1000 dB/s

**Warm-up Time:**
Approx. 15 s

**Electromagnetic Compatibility:**
Complies with Class B computing device of American FCC (Federal Communication Commission) Rules

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

**Storage Temperature**
—25°C to +70°C (—13°F to +150°F)

**Humidity:**
0 to 90% RH at 30°C, non-condensing

**Power Supply:**
100, 115, 127, 220, 240 V (± 10%); 50 to 400 Hz; approx. 40 VA. Complies with safety class I of IEC 348

**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 (model A):**
(Excluding feet, knobs, etc.)
**Height:** 133 mm (5,2 in)
**Width:** 430 mm (16,9 in)
**Depth:** 200 mm (7,9 in)

**Weight (model A):**
7,4 kg (16,3 lb)

**Accessories Included:**
2 B & K Coaxial Plugs JP 0101
2 BNC Coaxial Plugs JP 0035
2 7-pin DIN Plugs JP 0703
2 8-pin DIN Plugs JP 0802
1 Flexible Shaft UB 0041
1 Power Cable AN 0010
1 500 mA fuse VF 0023
1 250 mA fuse VF 0031

**Additional Accessory for Model C:**
1 Chain Drive Sprocket UT 0024

**Accessories Available:**
Constant Output Level Adaptor ZM 0200 (provides approx. 1 V RMS sine wave with same frequency as generator output. Distortion < 1%. S/N ratio > 40 dB. Min. load impedance 10 kΩ//1 nF)
Frequency Control Cable AQ 0034 (for use with Level Recorder Type 2307 and X-Y Recorder Type 2308)