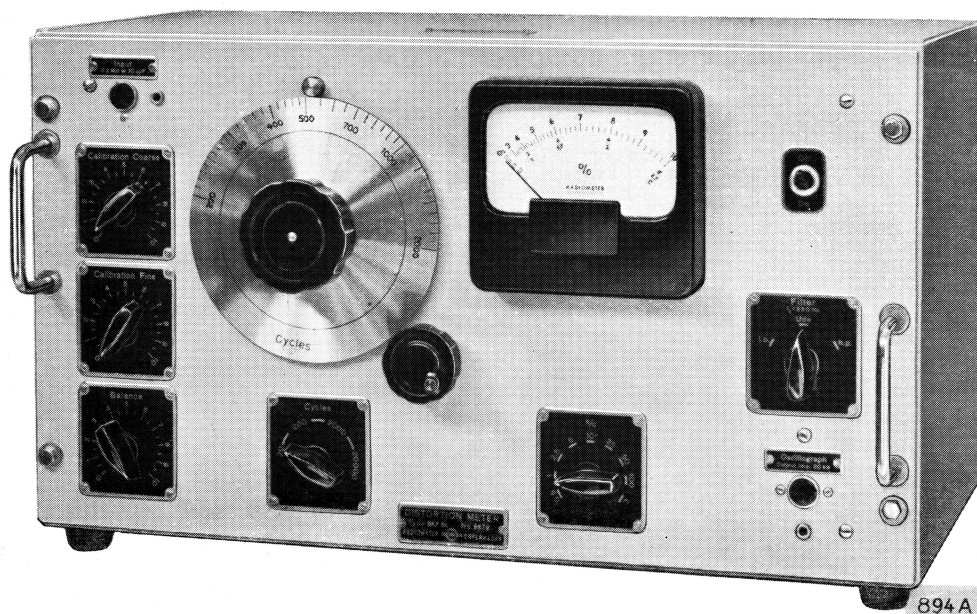


DISTORTION METER
TYPE BKF5



Distortion Meter type BKF 5

Introduction:

The type BKF5 Distortion Meter measures rms-distortion and hum level in audio-frequency circuits. Measurements on oscillators are made directly without any extra accessories. Measurements on amplifiers and radio receivers can be carried out in conjunction with a low-distortion audio oscillator as e.g. the type HO12 or HO31 Beat-Frequency Oscillators. Furthermore the type BKF5 Distortion Meter is able to measure modulation-distortion and hum percentage in the output of broadcast transmitters, when used in conjunction with a suitable monitor.

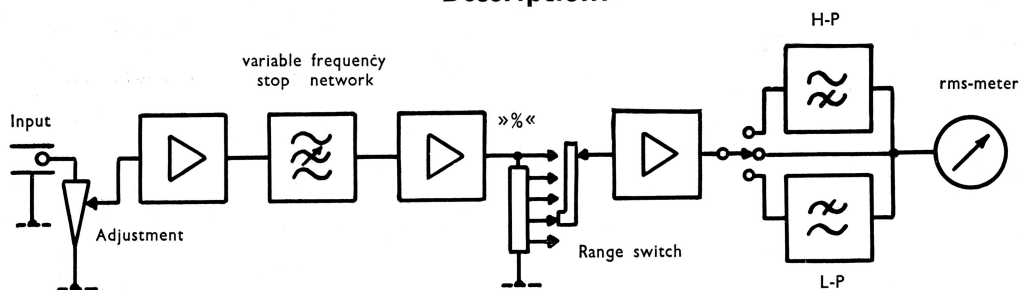
Special Features:

Direct reading frequency dial.

Measures total distortion, harmonics or hum separately.

The instrument measures the true rms value of the various harmonics in accordance with the definition of the distortion factor. Thus the reading is independent of the phase relation between the harmonics, unlike instruments in which linear rectification is used.

Description:



Schematic diagram of Distortion Meter type BKF5.

49803

The Distortion Meter consists essentially of a 3-stage amplifier containing a selective RC-network which can be sharply tuned to eliminate any frequency F , from 20–20,000 c/s.

In this way it is possible to eliminate the fundamental from the input signal, so that the output will contain only the harmonics and the hum components.

The frequency F is read directly on the main dial.

The output voltage is fed to a 2-stage vacuum-tube voltmeter. The voltmeter has an approximate square-law characteristic, giving a meter reading very nearly proportional to the rms-value of the applied signal. By means of built-in high-pass and low-pass filters, the meter is able to discriminate between harmonics and hum.

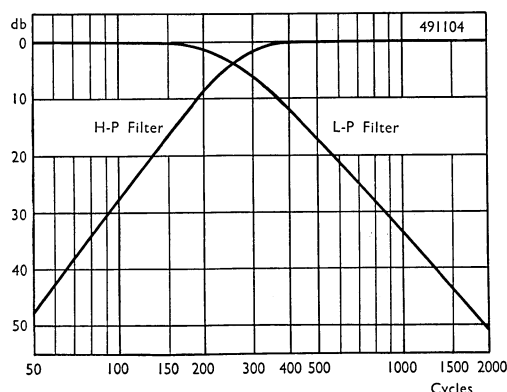
In case it may be of interest to further examine the distortion components, an oscilloscope e.g. type OSG41 or OSG42 can be connected in parallel with the meter through a separate jack. By means of Lissajous figures the predominant harmonics are easily determined.

The input circuit is asymmetrical but, as the input

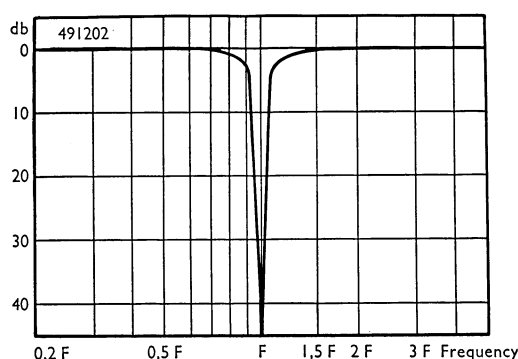
impedance is about 200 kilohms, the Distortion Meter can be connected to balanced circuits without severely disturbing the symmetry.

Operation:

The BKF5 Distortion Meter operates as follows: After adjustment of the amplifier sensitivity the fundamental frequency is balanced out by means of the main dial and an auxiliary knob for perfect resistance balance of the selective RC-network. When the meter reading has reached a minimum, the balancing is complete and the distortion or hum percentage is read directly from the meter in connection with the multiplier switch.



Typical filter characteristics.



Universal characteristic of selective amplifier.

SPECIFICATIONS:

Distortion range: 0.5, 1, 2.5, 5, 10, 25, 50, and 100% full scale.

Fundamental frequency range: 20–20,000 cycles in three ranges.

Distortion frequency range: 20–60,000 cycles.

Accuracy: For total distortion measurements within 5% of full scale or 0.1% distortion, whichever is the greater.

The harmonic distortion and the hum distortion are measured separately. The accuracy of the measurements depends on the relative magnitude of the two components as well as on the magnitude of the fundamental frequency. This accuracy can be estimated from the filter characteristics. E.g. when measuring on a fundamental frequency of 400 cycles, the lowest harmonic component is 800 cycles which is attenuated by 29 dB by the low-pass filter. In this case hum levels down to some 20 dB below the harmonics can be measured without appreciable error as the meter is very insensitive to other frequencies except the most powerful.

Residual distortion: less than 0.1%.

Sensitivity: Adjustable to signals down to about 150 mV rms.

Input impedance: 200,000 ohms unbalanced.

Power supply: 110, 127, 150, 200, 220 or 240 volts, 50 to 60 cycles.

Consumption: about 40 watts.

Mounting: grey enamelled aluminium panel mounted in metal cabinet. Panel dimensions suitable for mounting on 19" relay rack (panel height 265 mm).

Over-all dimensions: Length: 490 mm.
Height: 285 mm.
Depth: 250 mm.

Net weight: 20 kilos.

Accessory supplied: shielded cable that fits the input jack.

Data subject to change without notice.



DISTORTION METER

TYPE BKF5

The type BKF5 Distortion Meter measures distortion or hum in audio-frequency circuits.

It is adjustable to any frequency in the range from 20 cycles to 20,000 cycles. Frequencies up to 60,000 cycles are passed unattenuated by the amplifier circuits so that distortion measurements can be made on fundamental frequencies up to 20,000 cycles. The distortion is read directly from the meter, and values as low as 0.1% can be measured, since the lowest range is 0.5% full scale.

The Distortion Meter consists of a three-stage high-gain amplifier with an RC interstage coupling unit which balances to a sharp null, a calibrated attenuator for adjusting the sensitivity followed by a two-stage amplifier with a square law copper-oxide rectifier meter. A high-pass or a low-pass filter can be connected between amplifier and meter. The built-in power supply is voltage regulated. Line surges will have no appreciable effect except when the instrument is operated on the 0.5% scale.

The highest sensitivity of the instrument is about 0.15 volt, and the residual distortion is less than 0.1% (in the greater part of the frequency range it is less than 0.05%).

The input impedance is about 250 kilohms in series with 0.25 μ F.

The Distortion Meter operates as follows:

With the vacuum-tube voltmeter in its least sensitive position (% switch in position C) the input controls are set so that the meter gives full deflection. When the % switch is set to one of the other positions, the balancing RC coupling unit is switched on, and if the RC unit is tuned to the fundamental frequency of the input voltage, this frequency can be completely eliminated when the BALANCE potentiometer is turned to its correct position. The meter then indicates directly the distortion in per cent of the fundamental plus harmonics. When the fundamental frequency is higher than 400 cycles, it is possible to measure the

hum and the harmonics separately by connecting either the low-pass or the high-pass filter between the amplifier and the copper-oxide rectifier meter.

The high-pass filter attenuates 50 cycles by about 50 dB, 100 cycles by about 33 dB, and 150 cycles by about 13 dB. The low-pass filter attenuates 800 cycles by about 28 dB, 1200 cycles by about 39 dB, and 1600 cycles by about 47 dB.

The input voltage of the copper-oxide rectifier meter is present at the jack marked OSCILLOGRAPH and can be used for tracing Lissajous figures on an oscillograph. The input voltage of the Distortion Meter is then fed to the horizontal deflecting plates of the cathode-ray tube, and the harmonics are fed to the vertical plates from the jack OSCILLOGRAPH.

DIRECTIONS

Set the line switch to its correct position before connecting the instrument to the power line. When leaving the factory the line switch is in its 220 volt position, but the following positions are available: 110 - 127 - 150 - 200 - 220 or 240 volts. The switch is accessible when the instrument is removed from its case, and it is located below the line transformer together with a 1 amp fuse.

Connect the instrument to be measured to the input jack of the Distortion Meter. If the output impedance of the instrument is high, use a shielded cable so as to avoid hum. A voltage of about 0.15 volt is required. Set the % switch to its right-hand position (C), the filter switch to its mid position, and the frequency range switch so that the fundamental frequency is within the range chosen. Set the meter needle to the last division of the meter scale by means of the knobs OUTPUT COARSE and OUTPUT FINE. Then turn the % switch from position C to position 100 and tune the main dial and the balance potentiometer to minimum deflection. Afterwards repeat the tuning with the % switch set to the lowest position possible. Now the minimum deflection of the meter needle indicates the amount of harmonics plus hum. If the fundamental frequency is higher than 400 cycles, the harmonics and the hum components can be measured separately by switching in either the high-pass or the low-pass filter.

If you want to establish whether one of the harmonics is dominating, this can be done by tracing a Lissajous figure on the screen of a cathode-ray oscillograph. In that case also connect the horizontal amplifier of the oscillograph to the input

jack of the Distortion Meter and the vertical amplifier to the jack OSCILLOGRAPH. A figure resembling a U or ∞ will then indicate the second harmonic, while a \sim or $\infty\infty$ indicates the third harmonic. In general, however, the figures are not so simple.

ACCURACY

The distortion factor is defined as the rms value of the harmonics in per cent of the rms value of the fundamental frequency. However, the Distortion Meter measures in proportion to the total value of the fundamental plus harmonics. This does not affect the accuracy at low distortion factors. At higher values the reading has to be corrected by means of the formula:

$$d_{\text{actual}} = \frac{d_{\text{read}}}{\sqrt{1 - \left(\frac{d_{\text{read}}}{100}\right)^2}}$$

In addition the accuracy is affected by the copper-oxide rectifier meter which does not give the precise rms value under all conditions. In general the accuracy is about 5% of full scale for each range \pm residual distortion.

TUBE REPLACEMENT

Tubes No. 1, 2, 3, 4, and 5 are all of the type EF40.

Tubes No. 1 and 2 should preferably be aged specimens in order to avoid temporary resetting of the potentiometer SET TO MIN. OF RESIDUAL DISTORTION (E1 in the diagram). By means of this potentiometer the residual distortion of the Distortion Meter can be set to less than 0.05% with almost all specimens of the type EF40 tube in positions No. 1 and No. 2.

Tubes No. 3, 4, and 5 can be replaced right away and so can tube No. 6, a type EF80 or 6BX6, tube No. 7, a type EZ40, and tube No. 8, a type 150A1 glow-discharge tube.

TRIMMING THE INSTRUMENT

It will probably never become necessary to trim the Distortion Meter. However, it can be trimmed as follows:

- 1) Connect an AF oscillator (e.g. a Radiometer type HO12 Beat-Frequency Oscillator) to the input of the BKF5 and also connect the HO12 to the horizontal amplifier of an oscillograph. Connect the input of the vertical amplifier of the oscillograph to the output terminals of the BKF5. The Lissajous figure on the screen of the oscillograph greatly facilitates the trimming.
- 2) Set one switch to the range 20-200 c/s and the other to position C. Set the beat-frequency oscillator to 10 kc and the controls CALIBRATION so that the meter gives almost full deflection. Now set the trimmer between the anode of tube No. 4 and the grid of tube No. 3 so that the meter deflection does not vary when the dial of the BKF5 is turned through its range. The input impedance of tube No. 3 is thus made so high that the tube does not load the frequency determining network. The trimmer is accessible through hole No. 4 counted from the front plate when viewed from the bottom.
- 3) Then set the range switch to the 200-2000 c/s range. Set the dials of the HO12 and the BKF5 to 2000 c/s and the knob BALANCE to its mid position. Now set the trimmers T2a and T2b so that the meter gives minimum deflection. These trimmers are located as No. 2 and No. 6 (from the front plate).

Change the frequency of the beat-frequency oscillator to 200 c/s and tune the BKF5 to this frequency. If the dial reading is not 200 c/s ($\pm 1\%$), check the resistors of the frequency determining network and the dial mounting. To this end loosen the appropriate stop-screw located between the dial and the front plate and turn the tuning condenser to maximum capacity. The engraved mark beyond the 200 cycle line must then be opposite the index line. If not, loosen the coupling between the dial and the condenser and correct the mounting. If the accuracy of the dial is insufficient ($\pm 1\%$) in spite of the fact that the mounting of the dial and the value of the resistors are correct, it means that the tuning condenser has become defective and must be replaced together with its dial. This will only be the case if the condenser has been exposed to mechanical damage so that some of the plates have been bent.

If the knob BALANCE has to be turned more than some 90 degrees from its mid position, correct the resistor (B2 in the diagram) in series with the anode resistor of tube No. 2.

Now make sure that the BKF5 can be balanced over the entire range from 200 to 2000 c/s. If the alignment between the two sections of the condenser has suffered in the course of time, it will perhaps prove necessary to replace the shunt-resistor of the balance potentiometer with one of a somewhat higher value.

The trimming of the trimmers T3a and T3b is accomplished at 20,000 c/s with the knob BALANCE at its mid position. If the frequency determining resistors are within their limits of $\pm 1\%$, the dial and the balance will prove to be in order over the entire range from 2 to 20 kc. The trimmers are placed as No. 3 and No. 5 from the front plate.

The trimmers T1a and T1b of the 20-200 c/s range are set at 200 c/s and are located at positions No. 1 and No. 7 from the front plate.