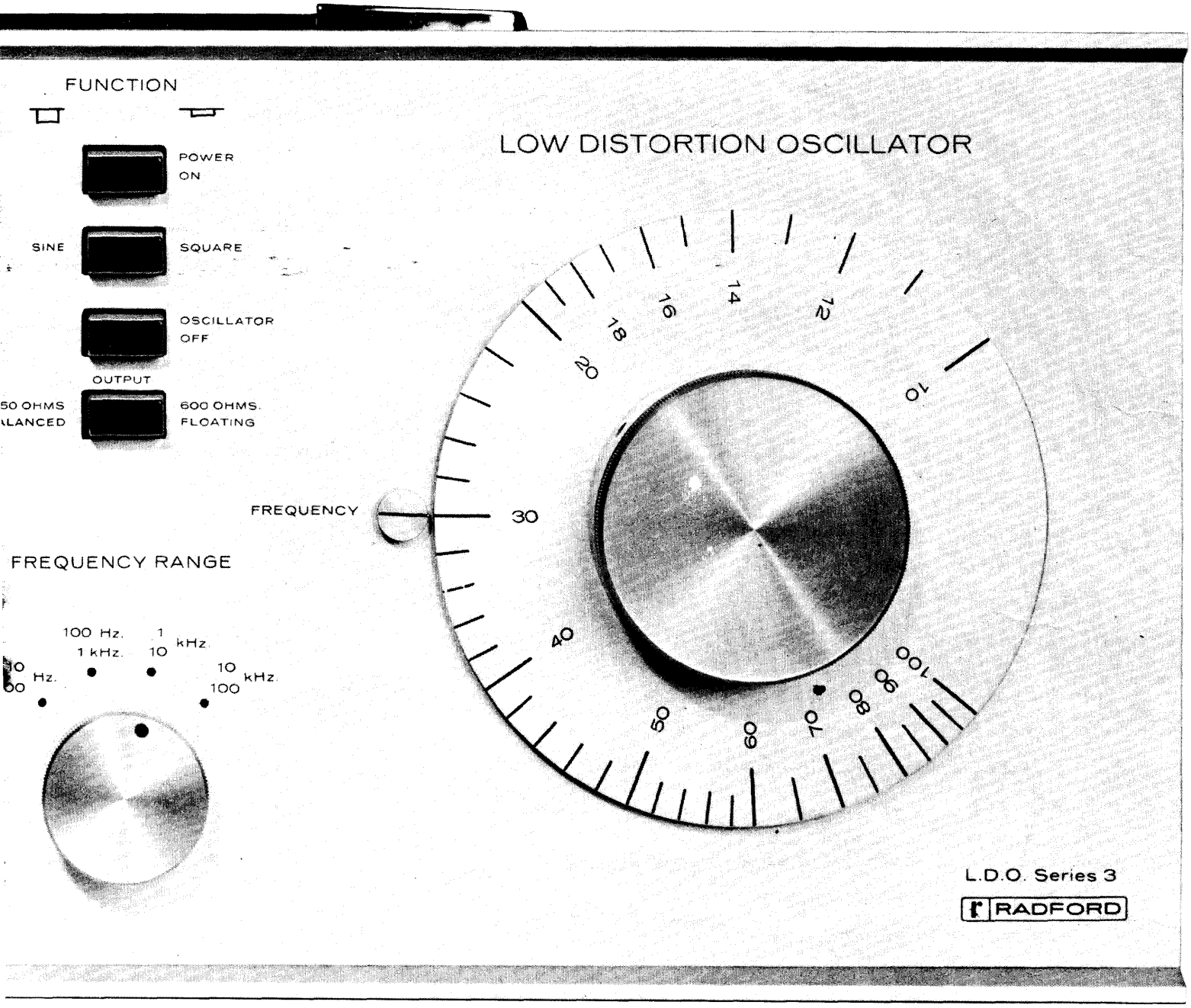
HR INSTRUMENTS

LEAFLET No A51 JAN 75

LOW DISTORTION OSCILLATOR

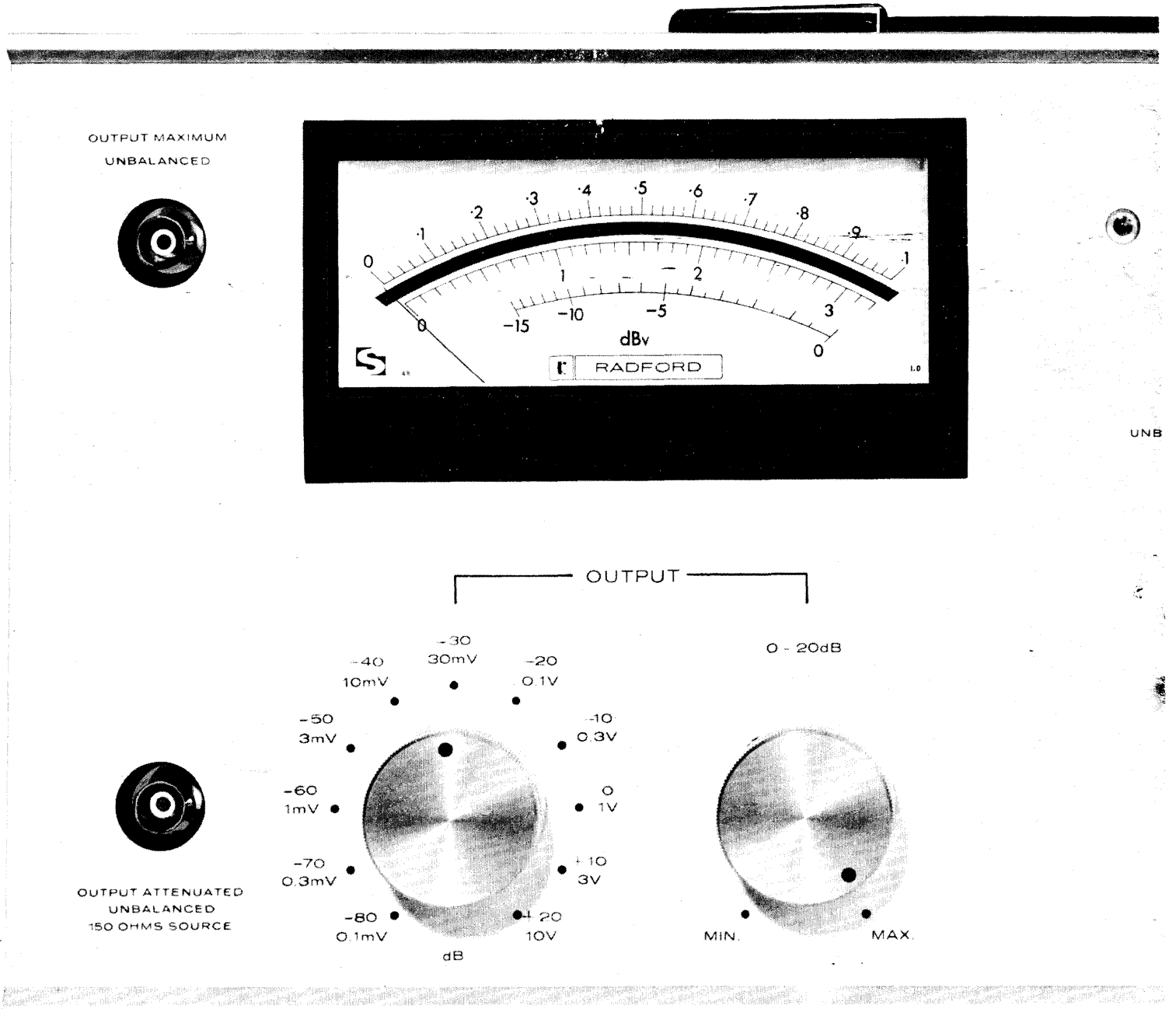
Series 3



Specification

Frequency range:	10Hz-100kHz (four bands).
Output voltage:	10V r.m.s. maximum.
Output waveform:	Sine and square.
Output attenuation:	0-25dB potentiometer and +20dBV to −80 in 10dB steps.
Output source resistance:	151 ohms constant from 0dBV to −80dBV, 147-154 ohms at +10dBV, and 100-177 ohms at +20dBV, with 25dB change of 0-25dB potentiometer.
Sine wave distortion:	0·002% mid. audio band. Typically 0·001% rising to 0·005% at 10Hz and 100kHz.
Square wave rise and fall time:	50 n.secs.
Output monitoring:	4" mirror scale meter engraved: 0-1, 0-3·2 and 0dBV to −15dBV (1V = 0dBV).
Calibration accuracy of meter:	1% f.s.d.
Power source:	110V, 120V, 130V, 220V, 230V, 240V. 40-60Hz. A.C. Mains supply.
Size overall:	17" wide x 7" high x 9" deep (43 x 17·8 x 23 cm).
Weight:	15¾ lb (7·2 kg) nett. 23 lb (10·4 kg) packed for transport.

HEDLEY RADFORD INSTRUMENTS LTD. BRISTOL BS3 2HZ ENGLAND



LOW DISTORTION OSCILLATOR

Series 3

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1. Introduction

The Low Distortion Oscillator Series 3 is a generator of nearly pure sine waves of continuously variable frequency from 10Hz to 100kHz. It supersedes the previous instruments (Series 1 and 2) first introduced in 1960.

The LDO3 is a laboratory instrument intended for use in the development of high quality audio equipment, but due to its versatility it is suitable for production testing and any situation where high quality audio equipment is maintained, tested and measured.

Low Distortion Oscillators, until the introduction of LDO3 have had a poor amplitude stability characteristic, with a very long settling time after frequency change at low frequencies. Due to a recently developed amplitude control circuit the LDO3 has excellent amplitude stability and a fast settling time.

With the complementary Distortion Measuring Set Series 3 it is possible to make measurements of total harmonic distortion below 0·002% at mid-band audio frequencies.

A description of the functions and facilities provided by the instrument and the basic design principles are descrbied below.

2. Functions, facilities and controls

2.1 Output terminations

The output of the oscillator is terminated by two BNC sockets, one side earthy.

2.2 Output attenuator

Two attenuators are fitted in the LDO3 – a potentiometer giving a continuously variable attenuation of 0-25dB and a switched ladder network providing attenuation from +20dBV to −80dBV in 10dB steps.

The 'attenuated' output is connected through a ladder attenuator, and the 'maximum' output is connected through a buffer resistor to the input of the 0-25dB continuously variable attenuator. The 'maximum' output is provided for oscilloscope waveform synchronisation.

2.3 Output monitoring

The output from the oscillator is monitored at the input of the ladder attenuator by a B.S. 1st grade meter having a 4" mirror scale. The meter is scaled 0-1. 0-3·2, and 0dBV to −15dBV. The continuously variable attenuator permits an adjustment of the voltage applied to the ladder attenuator which can be read on the meter, thus providing interpolation between the 10dB steps accurately measured in terms of voltage and dBV. A continuously variable output voltage is thus obtainable at the attenuated output socket from less than 10 μV to 10V r.m.s.

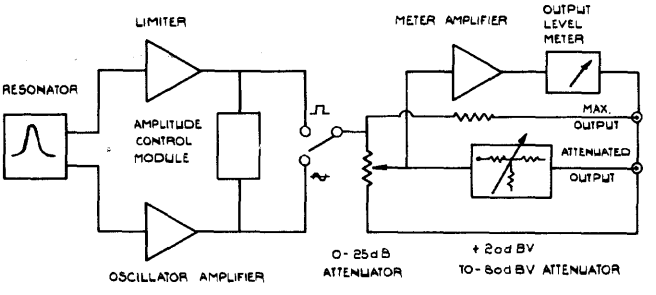
2.4 Frequency adjustment

The frequency range of the oscillator is 10Hz to 100kHz in four switched decade bands. Frequency adjustment within the bands is effected by a large 3-gang potentiometer controlled by a 4½" calibrated dial and 2" diameter knob.

2.5 Other controls

Push button switches enable the instrument to be switched ON/OFF, to select SINE or SQUARE output waveform, and to inhibit oscillations with the instrument still powered. This latter facility permits observation and measurement of background noise, hum-loops, or spurious signals in the measurement set up.

FIG. 1 BLOCK SCHEMATIC DIAGRAM



3. Design Details

3.1 Design considerations

The LDO1 and 2 instruments were valve operated. The specification claim for distortion was less than 0·005% and under suitable conditions of load a distortion level of 0·0025% was possible at mid-band audio frequencies. This kind of performance is generally considered adequate even by present day requirements, but certain inherent disadvantages indicated that further development was necessary.

The improvements looked for in the Series 3 instrument were in:

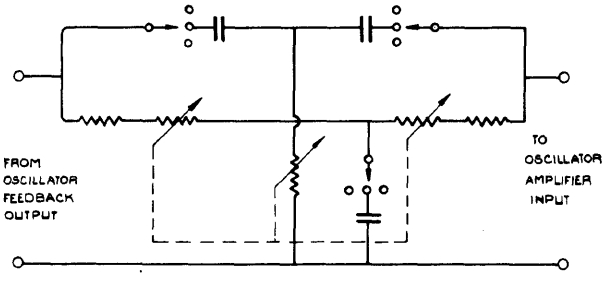
Amplitude stability and settling time after change of frequency.
Distortion levels, particularly at low and high frequencies.
Rise and fall time of square wave.
Accuracy of attenuator over complete oscillator frequency.
Temperature rise by replacement of valves by semiconductors.

The basic design of the LDO3 is shown in the schematic diagram Fig. 1. The design considerations of various sections of the instrument are outlined below.

3.2 Oscillatory circuit

The resonator in the LDO3 consists of a tunable 'Twin T' network, Fig. 2. The main advantage of the 'Twin T' network over other circuits is the very high attenuation at resonance which suppresses unwanted spurious frequencies and noise when used in a suitable feedback amplifier arrangement. Its high selectivity produces a rapid phase change at resonance ensuring excellent frequency stability as phase errors in the amplifier response are corrected by only a minute change of frequency.

FIG. 2 'TWIN T' CIRCUIT



3.3 Oscillator amplifier

The requirements for a suitable oscillator amplifier are:

- Very low distortion
- Absolute stability
- High input impedance
- High output capability
- Inverting gain controllable by the amplitude control module.

The amplifier circuit developed to meet these requirements, comprises a compound transistor pair as an impedance converter followed by a cascode amplifier which drives a complementary symmetry Class A output stage, as shown in the simplified circuit Fig. 3.

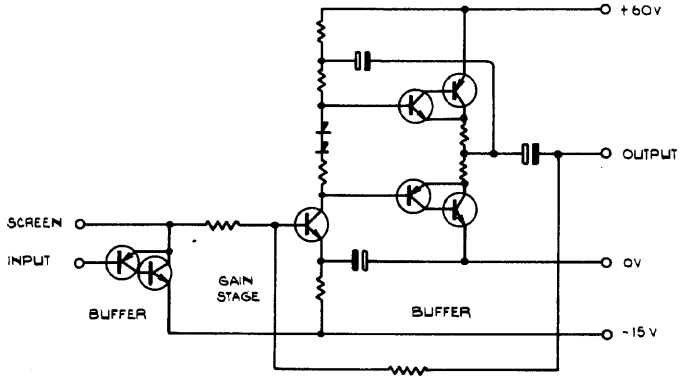
3.4 Limiter

The purpose of the limiter is to provide a square wave with very fast rise and fall times as an alternative to sine wave output and to provide a control signal for the amplitude control module. A simplified circuit is shown in Fig. 4.

3.5 Amplitude control module

In order to provide a stable output waveform amplitude it is necessary to vary the oscillator amplifier gain as a function of any change in output level. This is most commonly achieved by a thermistor or filament lamp. The disadvantages are: long settling time at low frequencies, distortion unless special compensation circuits are used, and output level variations with ambient temperature. Another method is to use the variable drain-source resistance of a field effect transistor for control. The FET provides fast settling time but the distortion introduced by its inherent non-linearity is unacceptable in a low distortion oscillator. The Series 2 LDO employed thermistor control in the 'low distortion' mode with its attendant disadvantages and FET control in the 'sweep' mode.

FIG. 3 OSCILLATOR AMPLIFIER: SIMPLIFIED CIRCUIT



It is known by engineers working on oscillator design that amplitude stability is a function of the non-linearity in the oscillator amplifier, and furthermore, that poor amplitude stability and slow settling time are concommitant with very low distortion. In the development of the Series 3 LDO this premise was accepted initially and distortion was deliberately introduced to provide a minimum acceptable stability. However, further research into the fundamental mechanism of oscillator stability and control has enabled the development of an entirely new technique which provides high stability and fast settling time with very low distortion. The amplitude control circuit is constructed as an epoxy resin encapsulated module mounted on the oscillator amplifier circuit board.

FIG. 4 LIMITER: SIMPLIFIED CIRCUIT

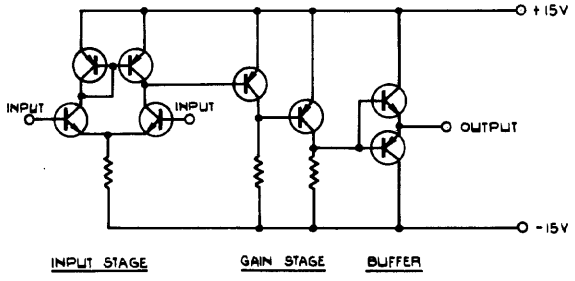
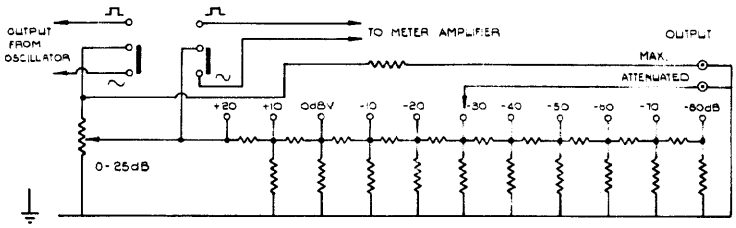


FIG. 5 ATTENUATOR CIRCUIT



3.6 Meter amplifier and rectifier module

The meter amplifier and rectifier module is constructed on a printed wiring board and is fitted to the meter terminals. It comprises a diode bridge driven by an operational amplifier. The meter time-constant and damping is adjusted to give a stable indication at 10Hz with a fast settling time. The frequency response of the meter/amplifier is flat over the range of the oscillator and is 0·5dB down at 0·5MHz. Two preset cermet potentiometers are fitted to the meter amplifier module to provide independent adjustment for accurate r.m.s. reading of sine and square waves.

3.7 Power supply

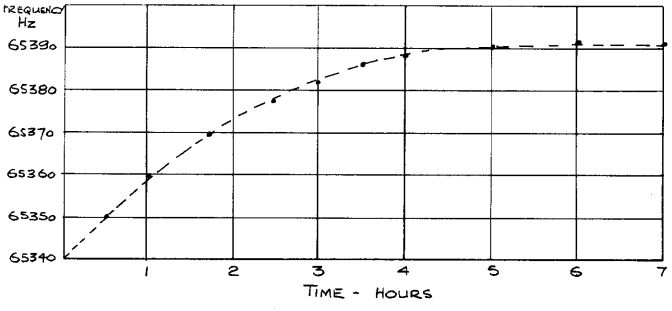
The power regulator module contains three separate voltage stabilised supplies energised from separate windings on the mains transformer. The supplies provide outputs of +60V, +15V and —15V, all of which have a fold back short circuit proof characteristic. The supplies are designed to protect the oscillator circuits against transients and differential ON/OFF time constants.

4. Construction

The Low Distortion Oscillator is constructed on an open chassis assembly. The chassis front and rear panels are secured together by spacer bars. The front facia comprises a screen printed anodised aluminium trim panel, affixed to an anodised aluminium extrusion fitted to the chassis front panel. The chassis assembly is enclosed by a baseplate and a wrap around cover with carrying handle. The chassis assembly is constructed from 18 swg. mild steel sheet and finished bright zinc plated. The cover is made from aluminium coated with texture finish matt black plastic. The knobs are lathe turned from solid aluminium bar and finished clear anodised. The frequency dial is aluminium sheet, deep etched, anodised, and screen printed.

The electronic circuits are constructed on glass epoxy printed wiring boards, screen printed with component identification and connecting wire numbers and colour. Connections to the boards are made with 'Amp' type connectors for easy service. All components are of the highest quality obtainable.

FIG. 6 FREQUENCY STABILITY



5. Guarantee

The instrument is guaranteed in the United Kingdom for a period of one year from the date of purchase. It covers the free replacement or repair of any defective component or part of the equipment during this period. It also covers the cost of labour in executing the repair or replacment if the instrument is returned to the factory service department, carriage paid, within the guarantee period.