Operating Instructions

H.F. SPECTRUM ANALYSER

Type OA 1094A Vol. 1

MARCONI INSTRUMENTS LIMITED, ENGLAND

OPERATING INSTRUCTIONS

No. EB 1094A-A/1

for

H.F. SPECTRUM ANALYSER

TYPES OA 1094A, OA 1094A/R
AND OA 1094A/S

Amendments, if any, are included at the end of the handbook.

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SCHEDULE OF PARTS SUPPLIED

1. One H. F. Spectrum Analyser Type OA 1094A **(Series),** complete with valves, etc., as follows :-

Valves:	Twelve:	Type 6AM6 (EF91), Pentodes.
	Three:	Type 12AU7 (ECC82), Double Triodes.
	Three:	Type 6BJ6, Pentodes.
	Two:	Type 6AS6, Pentodes.
	Two:	Type A2293, Triodes.
	Two:	Type 12AX7 (ECC83), Double Triodes.
	Two:	Type Q/U37, **Half-Wave Rectifiers.**
	One:	Type SC1/2000, Voltage Stabilizer.
	One:	Type 85A2, Voltage Stabilizer.
	One:	Type 0A2 (150C2), Voltage Stabilizer.
	One:	Type 0B2 (108C1), Voltage Stabilizer.
	One:	Type 5763 (QV03-12), Beam-Tetrode.
	One:	Type 6F33, Diode-Pentode.
	One:	Type 6AL5, Double Diode.
	One:	Type 6EP7, Cathode-Ray Tube.
Semi-conductors:	Eight:	Type 1N540, **Silicon Rectifiers.**
	Four:	Type **DD058, Silicon Rectifiers.**
	One:	Type SX631-VIP1, Silicon Rectifier Stack.
	One:	Type 2N456, Transistor.
	One:	Type GET 114, Transistor.
	One:	Type GET 115, Transistor.
	Two:	**Type Z20, 5%, Zener diodes.**
Crystals:	One:	12-Mc/s, Type QO1655H
	One:	15-Mc/s, Type QO1655H.
	One:	18-Mc/s, Type QO1655N.
Lamp:	One:	6.3-volt, 0.15-amp, M.C.C. (tubular).
Fuses:	Two:	3-amp, Cartridge.
	Two:	2-amp, Cartridge.
	One:	1-amp, Cartridge.
	One:	250-mA, Cartridge. **"Anti-surge"**
	One:	100-mA, Cartridge.

SCHEDULE OF PARTS SUPPLIED (continued)

2. Three Coaxial Free Plugs, Type BNC, for main r.f. fixed-frequency, and local oscillator inlets.

3. One Telephone Plug, Type P38; for phones jack.

4. One Mains Lead, Type TM 4726/183.

5. One Instruction Book No. EB 1094A -A/1.

The following optional accessories are supplied only if specially ordered :-

(a) Camera Mounting Hood, Type TM 5604.

(b) Trolley, Type TM 6612.

(c) Base-Plate Assembly, Type TM 6978.

(d) R.F. Fuse Unit, Type TM 6723.

(e) L. F. Extension Unit, Type TM 6448.

(f) Fixed Frequency Changer Unit, Type TM 6467 or Type TM 6467/1.

(g) External Local Oscillator, Type TM 7036A. (Supplied as part of OA 1094A/S.)

DATA SUMMARY

Input Frequency Range:	3 to 30 Mc/s in nine bands :- 3 to 6 Mc/s, 6 to 9 Mc/s, 9 to 12 Mc/s, 12 to 15 Mc/s, 15 to 18 Mc/s, 18 to 21 Mc/s, 21 to 24 Mc/s, 24 to 27 Mc/s, 27 to 30 Mc/s.
Input Level:	For full display, the input required is not greater than :- +50 dBμV (320 μV) between 3 and 6 Mc/s, +80 dBμV (10 mV) between 6 and 27 Mc/s, +90 dBμV (32 mV) between 27 and 30 Mc/s.
Amplitude Measurement Ranges:	0 to -30 dB, and -30 to -60 dB, where 0 dB represents reference level.
Selectivity:	Three values of 3-dB bandwidth can be selected, viz., 6, 30, and 150 c/s; frequencies outside bandwidths of 120, 600, and 3,000 c/s respectively are rejected by more than 60 dB.
Spectrum Width:	0 to 3 kc/s and 0 to 30 kc/s in two ranges.
Sweep Duration:	0.1, 0.3, 1, 3, 10, and 30 sec.
Power Supply:	200 to 250 volts, or 100 to 150 volts after adjusting links, 40 to 100 c/s, 185 watts. Models supplied ready for immediate 100- to 150-volt use if specified at time of ordering.

DATA SUMMARY (continued)

Dimensions (in case):	Height 31 in (79 cm)	Width 25 in (64 cm)	Depth 27 in (69 cm)

(Type CA 1094A/R, for 19-inch rack mounting, occupies 26 1/4 inches panel height including the Power Unit.)

Weight (in case): 278 lb (126 kg).

L.F. Extension Unit Type TM 6448

Input Frequency Range: Up to 3 Mc/s in five bands as follows :-

Range 1: 0.8 to 3 Mc/s,
Range 2: 0.3 to 0.8 Mc/s,
Range 3: 0.16 to 0.3 Mc/s,
Range 4: 0 to 0.16 Mc/s,
Range 5: 0 to 3 Mc/s.

The practical lower limit of the last two bands is approximately 100 c/s.

Input Attenuator: 0 to 50 dB, switched in 10 dB steps.

Input Level: For full display on the H.F. Spectrum Analyser, the input required is not greater than +92 dBμV (40 mV).

Bandwidth: On the tuned ranges, the 3-dB bandwidths at the centre frequencies are approximately:-

Range 1: 500 kc/s,
Range 2: 80 kc/s,
Range 3: 50 kc/s.

DATA SUMMARY (continued)

Fixed Frequency Changer Unit Type TM 6467

Input Frequency:	300 kc/s.
Input Level:	For full display on the H. F. Spectrum Analyser, the input required is not greater than +118 dBμV (800 mV).

Fixed Frequency Changer Unit Type TM 6467/1

Input Frequency:	3.1 Mc/s.
Input Level:	For full display on the H. F. Spectrum Analyser, the input required is not greater than +118 dBμV (800 mV).

External Local Oscillator Type TM 7036A

Frequency Range :	2.3 to 5.3 Mc/s in eleven steps with overlap and continuous adjustment.
Output Level :	Sufficient to drive the mixer stage of the Spectrum Analyser. Approximately 500 mV.
Hum :	50 c/s side bands down by at least 45 dB.
Drift :	Not more than .02% per 10 minutes after 10 minutes warm up.

1 INTRODUCTION

1.1 GENERAL

H.F. Spectrum Analyser OA 1094A gives a panoramic presentation of the frequency spectra of signals in the 3- to 30-Mc/s band. The spectrum of the signal under test is displayed on a cathode-ray tube screen in the form of a series of vertical peaks whose heights and separations give the relative amplitudes and frequencies of the signal components. The Analyser comprises a triple superhet receiver, whose third local oscillator is frequency-swept by a valve reactor under the control of the cathode-ray tube time-base generator.

The width of spectrum displayed is continuously variable up to 30 kc/s, which allows the observation of the whole bandwidth of a broadcast transmission; at the other extreme, the display can be narrowed to a few cycles to facilitate the separation of closely-spaced components.

Relative levels of signal amplitude can be measured over a range of 30 dB or, in two steps, 60 dB. A high order of selectivity ensures adequate discrimination between signals of widely differing amplitudes but as little as 50 c/s apart; alternative lower values of selectivity are available, primarily to facilitate tuning and also for making rapid measurements on the more widely-spaced components.

The time taken to scan the spectrum may be varied in steps from 0.1 to 30 sec., the slower speeds ensuring absence of ringing effects when using high selectivity. Continuity of display is provided by the long-persistence cathode-ray tube.

The nature of the display makes the Spectrum Analyser particularly suitable for the identification and quantitative assessment of inter-modulation products or hum components in the output of single-sideband transmitters and drive units, for making dynamic distortion tests during the transmitter setting-up procedure, or for studying the effective bandwidth of on/off or frequency-shift keyed transmissions. With f.m. signals, it facilitates the accurate determination of modulation index by the Bessel zero or disappearing carrier method.

1.1 (continued)

The Analyser is provided with a flat-faced cathode-ray tube which improves the readability of the display.

The OA 1094A/1 is a version of the H. F. Spectrum Analyser that is designed for mounting in a 19-inch rack.

1.2 OPTIONAL ACCESSORIES

Special care has been taken to provide a rugged mechanical design and to minimize microphony. Where arduous conditions of vibration are encountered, microphony can be further reduced by bolting the OA 1094A case to anti-vibration mountings; a base-plate, with six anti-vibration mountings fitted, can be supplied if specially ordered.

The OA 1094A case or the base-plate can be bolted either to a trolley, which can be supplied if specially ordered, or to a bench. A runner on each side of the OA 1094A case enables the instrument to be pulled forward, so allowing access to all units.

When required, the Analyser's cathode-ray tube surround can be removed and replaced by a Camera Mounting Hood. The Camera Mounting Hood, which can be supplied to order, is intended to accommodate an AC 2/25 Oscillograph Recording Camera (D. Shackman and Sons); a viewing aperture allows the trace to be viewed and photographed simultaneously.

A plug-in L. F. Extension Unit, which can be supplied as an accessory, widens the range of the Analyser to cover frequencies down to 100 c/s. The front panel of the L. F. Extension Unit, when fitted, replaces a blank panel immediately below the Analyser's input connectors.

A Fixed Frequency Changer can be fitted inside the Analyser for the benefit of users who wish to display a signal of one particular frequency. It allows the Spectrum Analyser to accept a fixed-frequency signal at a separate inlet without the necessity of adjusting the tuning controls. Frequency Changers are at present available for inputs of 3.1 Mc/s - to suit the standard drive-unit output for h.f. communication transmitters - and 300 kc/s for a specific radio-navigation aid.

1.2 (continued)

To prevent the possibility of damage due to overloading of the Analyser's input attenuators, an R. F. Fuse Unit is available as an optional accessory. This comprises a 1/16-amp fuse in a 75-ohm coaxial assembly, designed to be connected between the input source and any one of the front-panel input connectors.

2 OPERATION

2.1 INSTALLATION

2.1.1 Plastic Cover

Unpack the instrument and completely remove the protective plastic cover (if fitted). When supplied, this cover is for protection during transit and storage; the instrument should on no account be operated with the cover in position as serious overheating could result.

2.1.2 Valves

The instrument is normally dispatched with all valves, including the cathode-ray tube, and quartz crystals in their holders.

2.1.3 Mounting

Fourteen 3/8-inch diameter holes are provided in the base of the OA 1094A case to enable it to be secured. Six of the holes are through the six feet and coincide with the six anti-vibration mountings on the optional Base Plate, TM 6978. The other eight holes are for use in mounting the case directly to a Trolley, TM 6612, which is fitted with corresponding 5/16-inch BSF studs and captive nuts. The Base Plate has eight similarly placed holes, and can therefore be used between case and Trolley. Any of the holes in the case can be used when securing it to a bench. If the six feet are removed from the case, 5/8-inch screws or bolts can be used in the holes vacated.

2.2 SWITCHING ON AND ALIGNING TRACE

(1) Be sure that the instrument is correctly adjusted for the voltage of the a.c. power supply. Normally dispatched ready for use with 240-volt supplies, the instrument can be adjusted for other voltages as described in Section 5.3.

2.2 (continued)

(2) Connect the mains lead between the a. c. supply and the MAINS INPUT connector on the Power Unit.

(3) Switch ON by means of the SUPPLY switch on the Power Unit. The pilot lamp on the Power Unit should glow.

(4) After a few seconds, turn the TIME BASE switch to 10 sec, and adjust the BRILLIANCE and FOCUS, X SHIFT and Y SHIFT controls for a clear trace on the cathode-ray tube screen.

(5) When the equipment is throughly warmed up, adjust the Y SHIFT control to align the trace with the lower edge of the cathode-ray tube mask; then adjust the X SHIFT control to bring the right-hand end of the trace to a point about 1/8 inch to the right of the extreme right-hand vertical calibration line.

2.3 APPLYING INPUT SIGNAL

Signals within the range 3 to 30 Mc/s are applied via the R. F. INPUT connector. Where an L. F. Extension Unit, type TM 6448, has been supplied as an optional accessory and is in use for the presentation of signals in the 0- to 3-Mc/s range, the input signal is applied via the INPUT connector on the front panel of the L. F. Extension Unit; in this case, the L. F. Extension Unit OUTPUT connector is connected to the R. F. INPUT connector of the main instrument by means of the Coaxial Cable Link TM 4726/164. Where a Fixed Frequency Changer Unit - type TM 6467 (300 kc/s) or type TM 6467/1 (3.1 Mc/s) - has been supplied as an optional accessory and is in use for the presentation of signals at the particular fixed frequency, the input signal is applied via the FIXED INPUT connector.

The R. F. INPUT and FIXED INPUT connectors on the main instrument, and the INPUT connector on the L. F. Extension Unit, are 75-ohm BNC type coaxial sockets which mate with 75-ohm BNC type free coaxial plugs as supplied with the instrument. Uniradio 70 is a suitable type of coaxial cable for use with these plugs. The input impedance at each of the three signal inlets is nominally 75 ohms.

2.3 (continued)

The minimum signal level necessary for a full display, having a 60-dB signal-to-noise ratio (with the SELECT FILTER switch set to 30 c/s), varies with frequency and is as shown in Data Summary.

The maximum signal level permissible at the R.F. INPUT or FIXED INPUT connectors on the Analyser, or at the INPUT connector on the L.F. Extension Unit, is 4.5 volts. An R.F. Fuse Unit type TM 6723, which can be supplied as an optional accessory, can be plugged in series with the input to the Analyser or L.F. Extension Unit to protect the input attenuators from damage through accidental application of high r.f. or h.t. voltages.

2.4 TUNING

The following tuning-in procedure is applicable when the L.F. Extension Unit and Fixed Frequency Changer Units are not in use; for the tuning-in procedure when these optional Accessories are connected to the Analyser, see Sections 2.7.1 and 2.7.2 respectively. Where environmental conditions of vibration dictate the use of an external local oscillator, a special tuning-in procedure is required as detailed in Section 2.8.

(1) Connect a pair of headphones into the PHONES jack, using the 2-pole telephone plug supplied.

(2) Set the LOCAL OSC. switch to INT.

(3) Set the RANGE switch to the position appropriate to the frequency of the signal under examination. If the signal is within 15 kc/s of 6 Mc/s, use Range A and not Range B; if the signal is within 15 kc/s of 18 Mc/s, use Range F and not Range E. See Section 2.5.4.

(4) Set the R.F. TUNE control approximately to the frequency of the signal under examination; with the SOUND switch held at ON, rotate the MAIN TUNE control for zero beat in the headphones. Then, with the SOUND switch released, rotate the R.F. TUNE control for maximum signal amplitude on the cathode-ray tube screen. During these tuning adjustments, adjust the overall

2.4 (continued)

gain as required by means of the R. F. ATTENUATOR and SET GAIN controls (clockwise for maximum sensitivity). When the signal frequency is unknown, set the R. F. TUNE control to the middle of the probable band, the R. F. ATTENUATOR and SET GAIN controls fully clockwise, and adjust the MAIN TUNE control for an audio response.

(5) Set the SWEEP WIDTH RANGE switch to x1.0 and the SWEEP WIDTH control to 30 kc/s.

(6) Set the SELECT FILTER switch to 150 c/s - 0 dB and the TIME BASE switch to 0.1 sec or 0.3 sec.

(7) Set the FINE TRIM control to 0.

(8) There should now be on the screen a response or group of responses which may be centred by means of the MAIN TUNE control. Do not use the FINE TRIM control for centring at this stage; this must only be used at the smaller sweep widths, otherwise sideband clipping may occur.

(9) With the R. F. TUNE control adjusted for maximum amplitude of display, use the R. F. ATTENUATOR, SET GAIN, and I. F. ATTENUATOR controls to bring the peak of the major response (normally the carrier) against the 0-dB calibration line on the screen.
To avoid the risk of overloading the r.f. stages, it is advisable to keep the I. F. ATTENUATOR and SET GAIN controls towards their maximum clockwise limits. The most likely condition for overloading occurs when measuring signals whose peak envelope level is considerably greater than the level of the major component: deep amplitude modulation, or two-tone testing on suppressed-carrier systems, for example, produce this effect. Freedom from overloading can readily be proved by reducing the signal input by 10 dB with the R. F. ATTENUATOR and checking that all component peaks on the c. r. t. display drop by a full 10 dB.

2.5 MAKING A MEASUREMENT

2.5.1 Choice of Sweep Width, Filter, and Time-Base Speed - Avoidance of Ringing

The choice of sweep width, filter and time-base speed for any particular measurement depends primarily on the width of the spectrum under observation and the frequency separation of components.

The SWEEP WIDTH controls should preferably be adjusted so that the part of the spectrum under investigation occupies about two-thirds of the width of the graticule. The sweep width between the outer graticule lines is given by the reading on the SWEEP WIDTH dial multiplie by the factor indicated by the setting of the SWEEP WIDTH RANGE switch.

The 150-c/s position of the SELECT FILTER switch allows the use of the fastest time-base speeds and is primarily intended for searching and tuning-in; it may also be used for rapid analysis of a wide spectrum where high resolution is not essential. It is not satisfactory with sweep widths less than about 5 kc/s.

The 30-c/s filter is suitable for the majority of measurements; its resolution is adequate with sweep widths down to about 1.5 kc/s, but its use is limited to the slower time-base speeds (see Table 1).

The 6-c/s filter is recommended for measurements at sweep widths below 2 kc/s, or when the highest resolution is necessary. The 30-sec time base is normally required for this filter, except at the lowest sweep widths, when the 10-sec time base may be used (see Table 1).

The maximum permissible time-base speed is strictly limited in accordance with the sweep width and filter in use, a slow speed being essential for a wide sweep and/or a narrow filter bandwidth. The use of too fast a time base gives rise to 'ringing' of the selective circuits; this effect shows itself by distortion of a displayed response in the following respects :-

(a) A reduction in peak amplitude,
(b) An increase in width of response,
(c) Displacement to the right,
(d) The appearance of a damped oscillation on the trailing edge.

Fig. 6 on the Typical Oscillosgrams diagram, at the end of this handbook (Vol I), illustrates these effects by depicting two responses

2.5.1 (continued)

to the same signal, the one on the left having been obtained at a slow time-base speed, and the other using too fast a speed.

The extent of the distortion due to ringing can be estimated from the value of the sweep bandwidth factor, F, which is defined in terms of the sweep width, filter bandwidth, and time-base duration by the expression

$$F = w/tB^2 \quad \text{.........................} \quad (1)$$

where w = sweep width in c/s
t = time-base duration in seconds
B = 3-dB bandwidth of filter in c/s

Distortion is negligible when F is less than 0.5, and can be considered tolerable for most applications up to a value of F = 2, which represents a rate of sweep (w/t) of 72 c/s/sec when using the 6-c/s filter. At F = 2 the most obvious effect of ringing is a decrease of some 2.5 dB in response amplitude, together with a slight increase in response width.

As F is increased beyond a value of 2, the distortion becomes rapidly worse; the ringing response on the diagram referred to above illustrates typical distortion at F = 7.4.

Table 1 relates sweep width, time-base duration and filter bandwidth for F = 0.5 and F = 2 in accordance with expression (1). The first column shows the filter 3-dB bandwidth; the second column lists the time-base durations that are practical for each filter; the third column indicates the maximum sweep width that may be used if distortion is to be negligible, (F = 0.5); the fourth column shows the increased sweep width that may be used if a small amount of distortion is tolerable, (F = 2).

2.5.1 (continued)

TABLE 1

FILTER	TIME BASE	MAX. PERMISSIBLE SWEEP WIDTH Negligible Distortion (F = 0.5)	Moderate Distortion (F = 2)
150 c/s	3 sec	>30 kc/s	>30 kc/s
	1 sec	11.25 kc/s	>30 kc/s
	0.3 sec	-	13.5 kc/s
	0.1 sec	-	4.5 kc/s
30 c/s	30 sec	13.5 kc/s	>30 kc/s
	10 sec	4.5 kc/s	18 kc/s
	3 sec	-	5.4 kc/s
	1 sec	-	1.8 kc/s
6 c/s	30 sec	540 c/s	2.16 kc/s
	10 sec	-	720 c/s

'-' implies that the maximum permissible sweep width is less than the useful minimum as imposed by the width of the filter skirt; the 60-dB bandwidth of each filter is approximately 20 times its 3-dB bandwidth.

Example :- To investigate an a.m. spectrum as shown in Fig. 1 of the Typical Oscillograms diagram, and in which the modulation frequency, f_m, is 1 kc/s.

A convenient width of display is obtained with a sweep width of about 3 kc/s, and adequate resolution is given by the 30-c/s filter.

It can be seen from column 3 of Table 1, that, if negligible distortion is required, a time-base duration of 10 sec is sufficient, since this allows a maximum sweepwidth of 4.5 kc/s; if slight distortion is permissible (column 4), the 3-sec time base can be used.

The following procedure provides a quick check to determine whether ringing is present :

Decrease the SWEEP WIDTH and, if ringing is present, there will be an increase in signal amplitude as depicted by the cathode-ray tube display; to eliminate the ringing, if present, either decrease the SWEEP WIDTH setting or reduce the TIME BASE speed.

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2.5.2 Itemized Procedure

The sequence of steps in making a measurement is as follows :-

(1) Set the SWEEP WIDTH RANGE, SWEEP WIDTH, SELECT FILTER (0-dB positions only) and TIME BASE controls for a suitable display, in accordance with the recommendations discussed in Sect. 2.5.1.

(2) Centralize the display by means of the MAIN TUNE control. For final centring, or with small sweep widths, the FINE TRIM control may be used.

It is advisable at this stage to recheck the gain and shift control settings as follows :-

(3) Remove the r.f. input plug and check the setting of the X SHIFT and Y SHIFT controls as detailed in Section 2.2(5). The X SHIFT setting may vary slightly with time-base speed.

(4) Turn the SELECT FILTER switch to its associated +30 dB position and adjust either the SET GAIN control or the I.F. ATTENUATOR so that the 'grass' due to noise is below the bottom red calibration line.

(5) Restore the SELECT FILTER switch to its original 0 dB setting and reconnect the input. Bring the reference component to within 5 dB of the 0 dB graticule line by means of the R.F. ATTENUATOR, then to within 0.5 dB by means of the I.F. ATTENUATOR, and exactly to the line by means of the SET GAIN control. Recentralize, if necessary, with the FINE TRIM control.

Relative amplitudes of components in the displayed spectrum can now be measured against the red calibration lines. At the 0 dB positions of the SELECT FILTER switch, measurement can be made in a range of 0 to -30 dB relative to the carrier or other reference component. The I.F. ATTENUATOR may be used to interpolate between the graticule lines but must be restored to its original setting after being used in this way.

2.5.2 (continued)

Relative frequencies can be determined by reference to the vertical graticule lines and the value of sweep width in use. The indicated sweep width refers to the number of kc/s swept while the spot travels between the outer graticule lines. The full inter-line spacing, as used between each of the five inner lines, represents one-fifth of the total indicated sweep width; the half-spacing between the outer pairs of lines represents one-tenth.

Reliance should not be placed on responses appearing on the part of the trace outside the left-hand graticule line; during this part of the trace the equipment is recovering from the muting effect which takes place during the c.r.t. flyback period.

To examine components whose level is lower than -30 dB relative to the reference component, turn the SELECT FILTER switch to the associated +30 dB position. The horizontal graticule lines, reading from top to bottom, now indicate -30, -40, -50 and -60 dB respectively; the peaks of the components previously shown on the 0- to 30-dB display are now compressed near the top of the screen.

2.5.3 Direction of Frequency Increase

The direction of frequency increase on the screen may be from left to right or vice-versa, depending on the setting of the RANGE switch - see TABLE 2. This information is also shown on the dial of the MAIN TUNE control.

TABLE 2

RANGE		DIRECTION OF FREQUENCY INCREASE
A	3 - 6 Mc/s	right to left
B	6 - 9 Mc/s	left to right
C	9 - 12 Mc/s	left to right
D	12 - 15 Mc/s	left to right
E	15 - 18 Mc/s	right to left
F	18 - 21 Mc/s	right to left
G	21 - 24 Mc/s	right to left
H	24 - 27 Mc/s	left to right
J	27 - 30 Mc/s	right to left

2.5.4 Spurious Responses

The combination of high stability and high resolution in the Spectrum Analyser has been accomplished by the use of a crystal-controlled first local oscillator and i.f. crystal filters in a triple superhet circuit. This type of receiver inevitably gives rise to the possibility of spurious responses appearing at various frequencies. While most of these have been eliminated by the design of the r.f. and i.f. stages, spurious responses may still be present under certain circumstances at the following frequencies :-

(a) 6 Mc/s on Range B. Due to the fact that the first frequency-changer will have a 6-Mc/s output at this point, input signal breakthrough can cause a spurious response. This can be avoided by using Range A and not Range B for measurements at 6 Mc/s.

(b) 18 Mc/s on Range E. A spurious response may occur at this point as a result of interaction between the applied signal and the second harmonic of the first local oscillator. This can be avoided by using Range F and not Range E for measurements at 18 Mc/s.

(c) 30 Mc/s. Allowance should be made for the fact that a spurious response may occur at 30 Mc/s by interaction between the applied signal and the third harmonic (36 Mc/s) of the first local oscillator.

2.6 INTERPRETATION OF DISPLAY

The following sections are included to assist in interpreting the spectral display obtained with various types of modulation. To illustrate the examples quoted, a selection of typical displays is given on Drawing No. TLC 27991, at the end of this handbook (Vol I).

2.6.1 Amplitude Modulation

A pure sine-wave a.m. signal has a spectrum of the form shown in Fig. 1; this consists of a central carrier component (f_c) with an upper and a lower side-frequency component separated from the carrier by spacing equal to the modulation frequency.

2.6.1 (continued)

The depth of modulation can be calculated from the relative amplitudes of carrier and side-frequency components, as follows :-

Having aligned the carrier peak with the 0-dB line, read off the decibel level, -n dB, of one of the side-frequency components. Convert -n dB to a voltage ratio, v, by referring to the Decible Conversion Table (columns 1 and 3) at the end of this volume of the handbook. The percentage modulation m, is given by

$$m = 2v \times 100\%$$

Distortion in the modulating waveform gives rise to further side-frequencies, since each frequency component in the modulating waveform, as shown by Fourier analysis, contributes a pair of side frequencies, one on each side of the carrier and separated from it by spacing equal to the frequency of the distortion component.

2.6.2 Frequency Modulation

The spectrum of an f.m. signal consists of a central carrier component and a series of side-frequency components separated by spacing equal to the modulating frequency.

Fig. 2 illustrates the spectrum of an f.m. signal with a modulation frequency, f_m, of 5 kc/s and a deviation, δf, of 4 kc/s; the modulation index ($\delta f/f_m$) is, therefore, 0.8. In Fig. 3, δf has been increased to 12 kc/s, giving a modulation index of 2.4.

The absence of the carrier component is a fundamental feature of an f.m. signal at a mod. index of 2.4; carrier disappearance also occurs at certain other values of mod. index, and each pair of side frequencies exhibits a similar effect. The values of mod. index at which these disappearances take place are given in Table 3.

2.6.2 (continued)

TABLE 3

Order of disappearance	Modulation Index			
		Side Frequencies		
	Carrier	1st pair	2nd pair	3rd pair
1	2.405	3.832	5.136	6.380
2	5.520	7.016	8.417	9.761
3	8.654	10.173	11.620	13.015
4	11.792	13.324	14.796	16.223
5	14.931	16.471	17.960	19.409

Advantage can be taken of this knowledge of modulation index to measure deviation by the Bessel zero method, as follows :-

If the deviation is kept constant and the modulation frequency slowly increased from zero, the successive disappearances can be clearly seen. Since the mod. index is accurately known at each disappearance, and assuming the modulating frequency (f_m) is also known, the deviation (δf) can easily be calculated from the expression

$$\delta f = \text{mod. index} \times f_m$$

The presence of a.m. on f.m. is shown by an asymmetrical spectrum in which the upper sideband contains a greater range of significant components. This effect can be seen in Fig. 3.

2.6.3 On-Off and Frequency Shift Keying

On-off keying is, in effect, a particular form of amplitude modulation employing a complex modulating waveform. The spectrum consists of a central carrier component with a series of side-frequency components spread over a band whose width increases with keying speed and with the squareness of the keying waveform; spacing between the components is equal to the fundamental keying frequency. This display can be used to assess the significant bandwidth of a keyed signal.

2.6.3 (continued)

In the example illustrated in Fig. 4, a mark/space ratio of 2:1 was used, resulting in the attenuation of every third component.

Frequency shift keying is a form of frequency modulation and produces a similar spectrum. The spectrum width depends on keying speed, shift, and keying waveform; spacing between components, as with on-off keying, is equal to the fundamental keying frequency. The display shows the significant bandwidth of the keyed signal; the amount of shift can be measured by employing the Bessel zero technique described under Frequency Modulation.

2.6.4 Single Sideband Modulation

The Spectrum Analyser is particularly suitable for the measurement of distortion or hum in suppressed-carrier or pilot-carrier systems, eliminating many of the difficulties of making such measurements by other methods.

Fig. 5 shows the spectrum of an s.s.b. two-tone-test drive signal having a pilot carrier frequency of 3.1 Mc/s. The two modulation components have frequencies of 1,100 c/s (f_1) and 1,775 c/s (f_2) above that of the carrier, and 3rd-order intermodulation products can be seen at 425 c/s ($2f_1 - f_2$) and 2,450 c/s ($2f_2 - f_1$) above the carrier. 5th-order products and hum components would probably be revealed by switching to the high-sensitivity position of the filter switch.

Intermodulation distortion, normally expressed as the amplitude ratio between one 3rd-order product and one of the two fundamental tones, can be read off against the graticule lines.

Other features of s.s.b. transmissions that can be assessed with the Spectrum Analyser include pilot carrier compression and cross-talk. Carrier compression, which is apt to take place in the presence of a strong sideband signal, can be observed as a change in amplitude of the carrier component as the sideband signal is applied. Cross-talk from one sideband to the other can be assessed from the relative amplitudes of the wanted signals in one sideband to the unwanted signals which appear as an attenuated mirror image on the other side of the carrier.

2.6.5 Miscellaneous Applications

Adjustment of Balanced Modulators. The modulator can be set up by tuning the Spectrum Analyser to the carrier frequency and adjusting the modulator balance controls for minimum amplitude of carrier response.

Frequency Comparison. The Spectrum Analyser can be used as an accurate indicator, for example when tuning an r.f. oscillator to the frequency of a standard reference oscillator. Each oscillator should be coupled to the R.F. INPUT plug via a pad to avoid interaction. It is merely necessary to adjust the variable oscillator until its response on the c.r.t. screen coincides with that of the reference oscillator.

2.7 OPERATION WITH OPTIONAL FREQUENCY-CHANGING UNITS

The procedure for switching on and aligning the trace, detailed in Section 2.2, should be carried out before commencing to operate the instrument under the conditions of Sections 2.7.1 or 2.7.2.

2.7.1 L.F. Extension Unit, Type TM 6448

Normally, when an H.F. Spectrum Analyser and L.F. Extension Unit are supplied together, the Extension Unit is installed before dispatch. To install a TM 6448 Extension Unit that has not been supplied with the Spectrum Analyser, first check that the Analyser has been disconnected from the mains supply, then

(a) remove, by slackening the two Dzus fasteners, the Blank Panel Unit (TM 6659) immediately below the Analyser's input connectors,

(b) carefully insert the L.F. Extension Unit in place of the Blank Panel Unit, ensuring that the 8-way McMurdo plug mates correctly with the corresponding socket in the Analyser,

(c) tighten the two Dzus fasteners in the L.F. Extension Unit.

2.7.1 (continued)

The following tuning instructions, for signals in the range 0 to 3 Mc/s, are intended to be read in conjunction with Section 2.4:-

(1) Set the H.F. Spectrum Analyser's RANGE switch to A.

(2) Connect the OUTPUT socket on the Extension Unit to the R.F. INPUT socket on the Spectrum Analyser by means of the Coaxial Cable Link, Type TM 4726/164, supplied with the Extension Unit.

(3) Apply the signal under test to the INPUT socket on the Extension Unit using a BNC-type plug as supplied with the Spectrum Analyser. The input impedance of the Extension Unit is 75 ohms.

(4) To avoid overloading the L.F. Extension Unit, initially set the Analyser's R.F. ATTENUATOR and I.F. ATTENUATOR switches to 0 dB, set the LF. Extension Unit's R.F. ATTENUATOR to 50 dB, and turn the SET GAIN control fully clockwise; the initial adjustments to input signal level should then be made by means of the L.F. Extension Unit's R.F. ATTENUATOR.

(5) Set the H.T. switch to the ON position.

(6) Set the Extension Unit's RANGE switch to 1, 2, 3, or 4, according to the input signal frequency.

<u>Note</u>: When the frequency of the signal input to the L.F. Extension Unit is not known, set the Extension Unit's RANGE switch initially to 5, set the R.F. TUNE control to between 3 and 6 Mc/s, and adjust the MAIN TUNE control for an audio beat in headphones plugged into the PHONES jack with the SOUND switch held at ON. The input frequency is then found by means of the tuning-in procedure detailed in (6), (7), (8), and (9).

2.7.1 (continued)

(7) When the Extension Unit is switched to RANGE 1, 2, or 3, set the TUNE INPUT control approximately to the input signal frequency. The bandwidth of each input filter is large compared with the maximum spectrum width (30 kc/s) that can be displayed on the Analyser, so that there is no risk of attenuating part of the signal under test unless the TUNE INPUT control is badly mistuned. When the Extension Unit is switched to RANGE 4, the TUNE INPUT control is inoperative.

(8) Set the R.F. TUNE control approximately to a frequency which is the difference between 6 Mc/s and the frequency of the signal under test,

e.g., if the signal frequency is 2.4 Mc/s, set the R.F. TUNE control to (6 - 2.4) Mc/s, i.e., 3.6 Mc/s.

The Extension Unit may be used with input signal frequencies down to about 100 c/s.

(9) With a pair of headphones connected into the PHONES jack and with the SOUND switch held at ON, rotate the MAIN TUNE control for zero beat in the headphones; then, with the SOUND switch released, rotate the R.F. TUNE control and the TUNE INPUT control for maximum signal amplitude on the cathode-ray tube screen.

(10) Adjust the Spectrum Analyser controls for a suitable display, setting the R.F. ATTENUATOR control on the Extension Unit as required.

The measurement technique detailed in 2.5.1 and 2.5.2 should be followed when using the L.F. Extension Unit, care being taken to avoid ringing.

(11) On completion of measurements using the L.F. Extension Unit, turn the H.T. switch to the OFF position. This prevents the possibility of interference from the Extension Unit when the Spectrum Analyser is used alone.

2.7.1 (continued)

Note:

(a) When using the L.F. Extension Unit, the direction of frequency increase on the Spectrum Analyser cathode-ray tube screen will be from left to right.

(b) For maximum suppression of the 6-Mc/s local oscillator signal in the Extension Unit, it is advisable to retain 10 or more dB in the Extension Unit's R.F. ATTENUATOR.

When applying an input signal whose frequency is so low that the i.f. output from the L.F. Extension Unit approaches 6 Mc/s, local oscillator breakthrough from the L.F. Extension Unit may be apparent on the cathode-ray tube. In this condition, it is advisable to adjust the preset BRIDGE BALANCE control as follows :-

(i) Set the H.T. switch to the ON position.

(ii) Set the Extension Unit's R.F. ATTENUATOR to 10 dB or to a higher attenuation setting.

(iii) Turn the RANGE selector switch on the L.F. Extension Unit to the appropriate position for the signal to be measured, but do not connect the input signal to the INPUT socket.

(iv) With the R.F. INPUT socket on the Spectrum Analyser connected to the OUTPUT socket on the Extension Unit by means of the Coaxial Cable Link supplied, tune the Spectrum Analyser to 6 Mc/s and adjust the attenuator and gain controls to show a convenient response on the cathode-ray tube screen.

(v) Adjust the preset BRIDGE BALANCE control to reduce the response amplitude to a minimum.

OR, as an alternative to steps (iv) and (v),

(vi) Connect a sensitive valve voltmeter, instead of the Coaxial Cable Link, to the OUTPUT socket and adjust the preset BRIDGE BALANCE control for minimum valve voltmeter reading.

2.7.2 300-kc/s and 3.1-Mc/s Fixed Frequency Changer Units, Types TM 6467 and TM 6467/1

The 3.1-Mc/s Fixed Frequency Changer is intended primarily to facilitate measurements on the output of conventional h.f. transmitter drive units. It enables measurements - of distortion, for example - to be made alternatively on transmitter and drive unit without the necessity of retuning the Spectrum Analyser. The 300-kc/s Fixed Frequency Changer was designed to facilitate measurements on a specific radio-navigation aid.

Either the 300-kc/s Fixed Frequency Changer (Type TM 6467) or the 3.1-Mc/s Fixed Frequency Changer (Type TM 6467/1) may be fitted to the Spectrum Analyser. Normally, when a Spectrum Analyser and Fixed Frequency Changer Unit are supplied together, the Fixed Frequency Changer Unit is installed before dispatch from the Works. To install a 300-kc/s or 3.1-Mc/s Fixed Frequency Changer Unit, first check that the Spectrum Analyser has been disconnected from the mains supply and that it is securely bolted to trolley or bench (if the Spectrum Analyser is the OA 1094A version), then :-

(a) Remove the upper assembly; see Section 5.5.1. (a) to (e) (if the instrument is the rack-mounting OA 1094A/1 version, remove the dust cover).

(b) Bolt the Fixed Frequency Changer Unit to the Spectrum Analyser's main frame in the space provided for it adjacent to 700 kc/s Filter Unit, type TM 6493; two countersunk 4-BA clearance holes are provided for this purpose in the central main frame member and two countersunk 2-BA clearance holes in the lower main frame member; the hole diameters in the frame correspond to the width of fixing slots in brackets attached to the Fixed Frequency Changer Unit.

(c) Remove the free 8-way Painton socket from its stowing slots in the Scanning Unit and connect it to the corresponding Painton plug in the Fixed Frequency Changer Unit.

(d) Connect the free end of the Fixed Frequency Changer Unit's coaxial input lead (TM 4726/125) to SKT A on the back of the Spectrum Analyser's main frame.

(e) Connect the free end of the Fixed Frequency Changer Unit's coaxial output lead (TM 4726/124) to SKT A on Frequency Changer II (TM 6447).

2.7.2 (continued)

To examine a 300-kc/s signal (with Fixed Frequency Changer Unit TM 6467 installed) or a 3.1-Mc/s signal (with Fixed Frequency Changer Unit TM 6467/1 installed), proceed as follows :-

(1) Apply the fixed frequency input signal to the front-panel FIXED INPUT socket, using a BNC-type plug as supplied with the Spectrum Analyser. The input impedance of either Fixed Frequency Changer Unit is 75 ohms.

(2) Set the LOCAL OSC. switch to INT.

(3) Turn the RANGE switch to the FIXED INPUT position.

The R.F. ATTENUATOR, MAIN TUNE, and R.F. TUNE controls have no effect when the RANGE switch is in the FIXED INPUT position and all gain adjustment must then be made with the I.F. ATTENUATOR and SET GAIN controls; the display can be centralized only by means of the FINE TRIM control. Apart from these differences, the general method of making a measurement is similar to that given in Section 2.5 for r.f. inputs.

Note that, when using the 300-kc/s and 3.1-Mc/s Fixed Frequency Changer Units, the direction of frequency increase on the Spectrum Analyser cathode-ray tube screen will be from left to right and from right to left respectively.

2.8 OPERATION WITH EXTERNAL LOCAL OSCILLATOR

Where arduous conditions of vibration necessitate the use of an external local oscillator, the oscillator (having a frequency range of from 2.3 to 5.3 Mc/s) should be plugged into the EXT LOCAL OSC. connector; this connector is a BNC-type coaxial socket which mates with a BNC-type free coaxial plug as supplied with the instrument (Uniradio 70 is a suitable type of coaxial cable for use with this plug). The minimum local oscillator signal input level required at the EXT LOCAL OSC. socket is about 0.5 volt.

The procedure for switching on and aligning the trace, detailed in Section 2.2, should be carried out before commencing to operate the Spectrum Analyser with an external local oscillator connected.

2.8 (continued)

To operate the Spectrum Analyser when an external local oscillator is connected, proceed as follows :-

(1) With the LOCAL OSC. switch initially set to INT., follow the tuning-in procedure detailed in Section 2.4.

(2) With the LOCAL OSC. switch set to EXT., set the external local oscillator frequency to approximately the frequency to which the MAIN TUNE control is set, as indicated on its red EXT OSC. scale.

(3) Centre the response, or group of responses, on the cathode-ray tube screen by adjusting the external local oscillator frequency.

(4) Measurements may now be made in accordance with the procedure recommended in Section 2.5; instead, however, of centralizing the display by means of the MAIN TUNE control where recommended in Section 2.5.2(2), the display should be centralized by adjusting the external local oscillator frequency.

A specially designed external local oscillator, Type TM 7036A, is supplied with the Services version of the Spectrum Analyser, Type OA 1094A/S.

3 OPERATION SUMMARY

When you are familiar with the principles and techniques of operation as detailed in Section 2, the following abridged instructions may be found a convenient guide for quick reference.

ALIGNING TRACE (See Sect. 2.2 for details)

Adjust Y SHIFT to align trace with lower edge of c.r.t. mask.
Adjust X SHIFT to bring right-hand end of trace to a point about 1/8 inch to the right of extreme right-hand vertical calibration line.

TUNING (See Sect. 2.4 for details)

Switch to required range and adjust MAIN TUNE for zero beat in headphones; adjust R.F. TUNE for maximum response on c.r.t.
Set SWEEP WIDTH controls to 30 kc/s - x1, SELECT FILTER to 150 kc/s - 0 dB, and TIME BASE to 0.1 sec or 0.3 sec. Set FINE TRIM to 0.
Adjust R.F. TUNE for maximum display amplitude. Adjust R.F. ATTENUATOR, I.F. ATTENUATOR, and SET GAIN for 0 dB display. Centralize by adjusting MAIN TUNE.

MAKING A MEASUREMENT (See Sect. 2.5 for details)

Set SWEEP WIDTH controls, SELECT FILTER (0 dB positions only), and TIME BASE for suitable display. Re-centralize by MAIN TUNE and FINE TRIM.
Disconnect input, re-check X SHIFT and Y SHIFT settings, and adjust SET GAIN or I.F. ATTENUATOR for low 'grass' level with SELECT FILTER at +30 dB.
Reconnect input, return SELECT FILTER to 0 dB, and adjust R.F. ATTENUATOR, I.F. ATTENUATOR, and SET GAIN for 0 dB display.
Measure relative amplitudes from 0 to -30 dB against horizontal graticule lines with SELECT FILTER in 0 dB position, and from -30 to -60 in +30 dB position.
Measure relative frequencies against vertical lines. Setting of SWEEP WIDTH controls indicates frequency sweep between outer lines.

4 TECHNICAL DESCRIPTION

4.1 CIRCUIT ARRANGEMENT

The main units included in the H. F. Spectrum Analyser are shown enclosed by dotted lines in Circuit Interconnection Diagram XD 33948 at the end of Vol. II of the handbook; this diagram also shows the inter-unit signal leads and connectors. Block Schematic Diagram TLC 38195, at the end of this volume of the handbook, shows in schematic form the portions of the circuit to which the front-panel controls are connected. Drawing XD 33949, in Vol. II of the handbook shows h.t. and l.t. connections from the Power Supply Unit (TM 6580) to the other units of the Spectrum Analyser. It should be noted that each one of the three inter-unit diagrams referred to here contains the optional L. F. Extension Unit (TM 6448) and also an optional Fixed Frequency Changer Unit (TM 6467 or TM 6467/1). Reference to the Circuit Interconnection and Block Diagrams will assist in an understanding of the circuit summary that follows.

When an L. F. Extension Unit is fitted to the Spectrum Analyser, input signals in the range 100 c/s to 3 Mc/s are applied to the INPUT socket on the Extension Unit; the Extension Unit produces an i.f. signal in the range 3 to 6 Mc/s.

Input signals in the range 3 to 30 Mc/s, including the 3 to 6 Mc/s output from the L. F. Extension Unit, are applied via the front-panel R. F. INPUT socket, SKT A, to Frequency Changer I. Frequency Changer I, which has a crystal-controlled local oscillator, produces an i.f. in the range 3 to 6 Mc/s. However, when the RANGE switch on the Analyser is in the 3 - 6 Mc/s position, Frequency Changer I serves as an amplifier to input signal frequencies in this range.

Frequency Changer II, which has a variable-frequency local oscillator, produces a 700-kc/s i.f. signal from the 3- to 6-Mc/s input to the unit. When one of the optional Fixed Frequency Changer Units is fitted to the Spectrum Analyser, its 700-kc/s i.f. output is fed to the cathode-follower following the mixer stage in Frequency Changer II. The EXT. LOCAL OSC. socket provides for connecting an external local oscillator to Frequency Changer II when severe vibration is encountered, the internal local oscillator in Frequency Changer II then being switched off.

4.1 (continued)

The 700-kc/s signal is fed from Frequency Changer II via the SET GAIN control to a 700-kc/s band-pass filter and thence to a ladder attenuator which can be switched by the front-panel I. F. ATTENUATOR control. A second signal path from the 700-kc/s Filter goes to the Sound Channel where the signal is amplified and mixed with the output of a 700-kc/s local oscillator; any difference between the two frequencies is audible in headphones plugged into the front-panel PHONES jack, and the Spectrum Analyser can be tuned for zero beat in the phones - a visual signal should then be apparent on the cathode-ray tube screen.

From the I. F. Attenuator, the 700-kc/s signal is fed to the Scanning Unit where it is mixed with a nominal 760-kc/s local-oscillator signal to produce a 60-kc/s i.f. The local-oscillator frequency is swept by the sawtooth generator that drives the c.r.t. X-plates. One control (TIME BASE - SECONDS) thus serves to set both time base speed and local oscillator sweep rate; the sweep width is variable between a few c/s and ±15 kc/s.

The 60-kc/s i.f. signal is applied to one of three band-pass filter configurations chosen by means of the SELECT FILTER switch; pairs of positions of the SELECT FILTER switch enable each filter configuration to be terminated by a 30-dB attenuator pad or not, as required. The filter configurations are such that the bandwidth of the signal viewed at any instant is either 6 c/s, 30 c/s or 150 c/s.

After being passed by one of the three filter configurations, the signal returns to the Scanning Unit where it is amplified and detected before driving the c.r.t. Y-plates.

As a result of the c.r.t. X-plates being driven by the same sawtooth generator as that which sweeps the 760-kc/s local oscillator the displayed frequency of the input to the H. F. Spectrum Analyser is synchronized with the c.r.t. time base.

4.2 CIRCUIT DESCRIPTIONS

The following circuit descriptions of the units in the Spectrum Analyser are intended to be read in conjunction with the associated circuit diagrams given beside the headings :-

4.2.1 Frequency Changer I Circuit Diagram : XD 33961

The incoming signal enters via socket SKT A and passes through a ladder-type attenuator, which gives an attenuation of up to 50 dB in five equal steps. Some preselection of the signal is provided by tuning the input circuit with the R.F. TUNE control, C10; this gives 30-dB image rejection at all but the highest frequencies and reduces the risk of overloading the frequency-changer stage, V2, by stray unwanted signals.

The full frequency range is covered in nine steps by the RANGE switch, SA, which selects (i) the tuned r.f. input transformer and (ii) the appropriate crystal in the local-oscillator stage, V1.

The signal frequency is changed to the band 3 to 6 Mc/s; if, however, the signal frequency itself is in the band 3 to 6 Mc/s, Frequency Changer I acts merely as an r.f. amplifier. By operating the local oscillator above or below the signal frequency, and by selecting the second harmonic of the oscillator on the two highest frequency ranges, it is possible to obtain a full coverage without serious spurious responses using only three crystals. The range of the tuned r.f. input transformer and the local-oscillator frequency appropriate to each setting of the RANGE switch are shown in Table 3.

TABLE 3

RANGE (Mc/s)		R.F. TUNE Range (Mc/s)	Local-Oscillator Frequency (Mc/s)
A	3-6	3-6	-
B	6-9)	6-12	12
C	9-12)		15
D	12-15)	12-21	18
E	15-18)		12
F	18-21)		15
G	21-24)	21-30	18
H	24-27)		30 (2nd harmonic)
J	27-30)		24 (2nd harmonic)

4.2.1 (continued)

On ranges B, C, and D, trap circuits are included in series with the primaries of input transformers T2 and T3. These circuits are tuned to reject the 2nd harmonic of input frequencies of 8, 10, and 12 Mc/s respectively, which might otherwise cause a spurious image-frequency response.

The 3- to 6-Mc/s i.f. output from V2 is fed to the cathode-follower V3 and thence via a coaxial lead to Frequency Changer II.

4.2.2 <u>Frequency Changer II</u> Circuit Diagram: XD 33849

The 3- to 6-Mc/s input from Frequency Changer I is applied to SKT B.

The MAIN TUNE control operates the ganged capacitors C5, C9 and C19. C5 and C9 tune a band-pass filter, T1 to T2, over the range 3 to 6 Mc/s; C19 controls the local oscillator, V2, and tunes it over the range 2.3 to 5.3 Mc/s.

The 700-kc/s i.f. output from the mixer, V1, passes through cathode-follower V3 and is taken via the front-panel SET GAIN control, RV2, to output socket SKT C. RV2 has a range of about 20 dB and enables the sensitivity of the Analyser to be set so that noise generated in the frequency-changer does not cause an excessive display of 'grass' on the cathode-ray tube.

At the 10th position, FIXED INPUT, of the RANGE switch, the local oscillator, one half of double triode V2, is switched off. On this range, a fixed-frequency input from a 300-kc/s or 3.1-Mc/s Fixed Frequency Changer Unit - if one of these units has been supplied as an optional accessory - is fed into Frequency Changer II via socket SKT A.

When conditions dictate the use of an external local oscillator, the external local oscillator signal is applied to Frequency Changer II via SKT D; turning the LOCAL OSC. switch to EXT. switches h.t. from pin 1 to pin 6 of V2 so that the other half of V2 serves as an amplifier to the external local oscillator input.

4.2.3 I.F. Units Circuit Diagram: XC 33953, XC 33957

The signal passes from the front-panel SET GAIN control to the 700 kc/s Filter Unit via SKT C and PL A on the rear of the Analyser's main frame. The Filter Unit has a bandpass characteristic with peak attenuation frequencies of 640, 760, and 820 kc/s (see Drawing No. TLC 26183, at the end of this volume of the handbook, for characteristic curves); by this means, spurious 60-kc/s components are prevented from appearing in the output of the third frequency changer.

The signal then passes to the I.F. Attenuator Unit, which has 11 steps of 1 dB. It thus bridges the steps in the r.f. attenuator, and may also be used to assist interpolation between the 10-dB calibration lines on the tube screen.

4.2.4 Scanning Unit and Filter Units Circuit Diagrams: XD 33951 and XD 33954-5-6

Third Frequency Changer. The 700-kc/s i.f. signal enters the Scanning Unit via socket SKT A and passes to a frequency-changer stage; this consists of a 6-dB pad, R1 to R3, mixer V2, local oscillator V1, and bandpass filters T1 and T2. The components of the signal are changed to a band centred on 60 kc/s by means of the local oscillator, V1, whose frequency is swept through a band centred on 760 kc/s and up to 30 kc/s in width by the reactance-modulator valve, V3, under the control of the time-base stage, V6.

The width of the band swept out by the oscillator may be varied between 0 and 30 kc/s by means of the SWEEP WIDTH-RANGE switch, SA, and the SWEEP WIDTH control, RV3. The control varies the band symmetrically about a point near the middle of the trace, so that a response located at this point remains substantially fixed. As the sweep width is reduced it becomes increasingly difficult to make small adjustments to the position of the display on the trace with the MAIN TUNE capacitor, and the FINE TRIM control, C6, is then used. This has a range of ±10 kc/s and its vanes are shaped to give a very open scale near the mean position.

The signal passes out of the Scanning Unit via socket SKT B to a group of 60-kc/s crystal filters.

4.2.4 (continued)

Filter Units. It is not possible to choose one final i.f. bandwidth to give a good performance throughout the whole range of sweep width. A filter which is narrow enough to give good resolution at low sweep-widths would require an excessively long time base to avoid severe ringing at high sweepwidths. If ringing is allowed to occur in the i.f. filter, the resolving power of the Analyser rapidly deteriorates and its sensitivity to individual signal components decreases. The sensitivity to a continuous noise spectrum remains unchanged, however, so that the signal/noise ratio deteriorates and the shape of complex transmissions will be distorted. The effect of ringing on a displayed response is illustrated in fig. 6 on the Typical Oscillograms diagram, No. TLC 27991, at the end of this volume of the handbook.

A choice of three final bandwidths and six time-base speeds is provided. The bandwidth is determined by combinations of the three crystal filters, which have nominal bandwidths of 6, 30, and 150 c/s respectively at 3 dB discrimination (see Drawing No. TLD 26189 for characteristic curves). They are selected by the SELECT FILTER switch which connects them as follows :

In the two '150 c/s' positions, the 150-c/s Filter is used on its own, the skirts of its response curve being improved by the response of the i.f. amplifier stages, V4 and V5, in the Scanning Unit.

In the two '30 c/s' positions, the 30-c/s and 150-c/s Filters are used in cascade, with a 60-kc/s Amplifier (see Circuit Diagram XC 33958) between them to prevent mismatching and to equalize the pass-band loss. The combined characteristic has a considerably improved discrimination and steeper skirts than the curve for the 30-c/s filter alone.

In the two '6 c/s' positions, the 6-c/s and 30-c/s Filters are similarly cascaded with the 60-kc/s Amplifier and a pad.

The SELECT FILTER switch has a '0' and '+30 dB' position for each filter bandwidth. In the '0' position, a 30-dB pad is switched in to terminate the filter configuration; in the '+30 dB' position, the 30-dB pad is not connected. The 30-dB pad provides for an accurate 0- or 30-dB two-position gain variation.

4.2.4 (continued)

<u>I.F. Amplifier</u> The i.f. amplifier in the Scanning Unit receives the signal from the filters via socket SKT C. It consists of the two variable-mu valves, V4 and V5, connected in cascade. To prevent positive feedback, the two i.f. amplifier stages are screened from one another.

<u>Detector and Logarithmic Amplifier.</u> The signal is passed through the detector stage, V7, and thence to the logarithmic amplifier, V8 and V9. V8 is a variable-mu stage whose characteristic can be varied by the potentiometer RV4. The signal then passes through the Y-deflection amplifier, V10 and V12. Y-shift is obtained by means of RV5 which controls the effective d.c. level. MR2 and MR3 serve to limit the output to the cathode-ray tube from V12 and V10 respectively, the biasing of the diodes being preset by RV8 and RV9 respectively.

The variable-mu stage, V8, gives an approximately logarithmic characterisic over a range of 30 dB; this range can be accommodated on the cathode-ray tube screen and relative levels measured against the graticule lines, which are marked 0, -10, -20, and -30 dB. The discrimination of the filters, and the linearity of the r.f. and i.f. circuits, however, are adequate to handle signals in a range of 60 dB; measurements covering the full 60-dB range are made in two steps. In the high-gain position, the c.r.t. graticule lines indicate -30, -40, -50, and -60 dB; signal components, which were previously accommodated between 0 and -30 dB, are now compressed at the top of the screen but the lesser components are magnified and their levels may now be evaluated.

<u>Time Base.</u> The sawtooth waveform, which provides the horizontal deflection on the cathode-ray tube and also frequency-modulates the third local oscillator, is derived from the time-base generator, V6. The time constants of the generator feedback circuits are controlled by the TIME BASE switch, SB, which provides a choice of six durations varying from 0.1 to 30 seconds.

V6 is connected to the push-pull X-deflection amplifier, V11 and V13. The gain of this amplifier is adjustable by means of RV6 and the horizontal position of the display is controlled by the X SHIFT potentiometer, RV7. The time-base sawtooth passes to the X-plates of the c.r.t. via sockets SKT D and SKT E.

4.2.4 (continued)

The use of a push-pull horizontal deflection amplifier, and the linear relationship between the control voltage applied to the reactance modulator valve and the change in oscillator frequency, results in a high degree of linearity in the horizontal frequency scale on the c.r.t. screen.

4.2.5 Sound Channel — Circuit Diagram : XC 33937

This unit converts the 700-kc/s i.f. signal from the 700-kc/s Filter Unit to an audio output for initial tuning or signal-identification purposes. It comprises a two-stage i.f. amplifier, V1 and V2, followed by an oscillator/mixer, V3. The anode circuit of V1 is shunted by semiconductor diode MR1 to obtain a limiting action so that a gain control is unnecessary.

The local oscillator, which is a tuned-anode oscillator with transformer-coupled feedback, is pretuned to 700 kc/s. The audio output is taken from the cathode of the mixer portion of V3 via C7 to the front-panel PHONES jack.

H.T. is connected to the Sound Channel only when the spring-loaded front-panel SOUND switch is held in the ON position; the possibility of Sound Channel local-oscillator breakthrough affecting visual measurements is thus avoided.

4.2.6 C.R.T. Network — Circuit Diagram : XC 33960

Focus and brilliance of the c.r.t. are adjusted by means of potentiometers RV2 and RV3 respectively. RV1 allows adjustment of the mean potentials of the c.r.t. deflection plates relative to that of anodes 1 and 3 in order to minimize astigmatism.

The e.h.t. is divided between the final anode and control grid of the cathode-ray tube, +2.4 kV being applied to the final anode and -2.25 kV to the control grid. A voltage stabilizer, V1, serves to hold the main part of the negative e.h.t. supply potential steady, as adjustments to the BRILLIANCE control setting are responsible for variations in the load on this supply.

4.2.7 Power Unit   Circuit Diagram : XD 33947

Two 100-watt mains transformers, T1 and T2, are employed in the Power Unit.

One secondary winding, LT3, on T1 provides the heater supply to the cathode-ray tube, and another l.t. winding, LT1, provides heater supplies to the other units of the Spectrum Analyser. A third l.t. winding, LT2, on T1 feeds a full-wave silicon rectifier circuit, incorporating the rectifier stack MR1, followed by a transistorized series regulator which provides a stabilized l.t. supply for certain valves in Frequency Changer I, Frequency Changer II, and the Scanning Unit; the reference voltage is taken from the 250-volt h.t. line via RV2 to a d.c. amplifier, VT1, which feeds the series element, VT3, via an emitter-follower, VT2.

The '200 V H.T.' winding on T1 feeds a bridge rectifier circuit, MR2 to MR5, which is followed by a conventional filter circuit, L1, C2, and C8, and a neon stabilizer V1. The stabilized 150-volt output from this circuit is added in series with the output of a 250-volt series regulator supplied from the '350 V H.T.' winding on T2 to form a 400-volt stabilized supply.

The '350 V H.T.' winding on T2 feeds a bridge rectifier circuit, MR6 to MR9, followed by a conventional filter circuit, L2, C5 and C6. The output of the filter is applied to parallel-connected V2 and V3 which form the series element of a series regulator circuit. The reference voltage for the regulator circuit is supplied by the neon stabilizer, V5, to a cathode-coupled pair, V7; an amplifier, V4b, and cathode-follower, V4a, complete the feedback loop. The 250-volt stabilized supply is taken from the cathodes of V2 and V3 to pin 5 of socket SKT B. The l.t. secondary winding, on T2, supplies the heaters of V2, V3, and V4 in the Power Unit.

The cathode-ray tube e.h.t. supply is derived from an oscillator, V6, which works at a frequency approximating to 100 kc/s - but sufficiently distant from 100 kc/s to prevent close harmonic relationship with the 700-kc/s i.f. output of Frequency Changer II. The e.h.t. transformer, T3, steps up the oscillatory voltage and applies it to the anode of V8 and cathode of V9. V8 and V9 are connected as half-wave rectifiers to produce the positive and negative e.h.t. supplies referred to in Section 4.2.6. Identical low-pass R-C filter circuits provide smoothing for the positive e.h.t. voltage at the cathode of V8 and for the negative e.h.t. voltage at the anode of V9; R36, R37, R38, and R39 form identical bleeder networks across the two e.h.t. supplies.

4.2.8 L.F. Extension Unit Circuit Diagram : XD 33950

The L.F. Extension Unit (Type TM 6448), which is an optional accessory, extends the range of the Analyser to cover frequencies from 3 Mc/s down to about 100 c/s. The unit is a heterodyne device, employing a crystal-controlled local oscillator and a ring bridge balanced modulator.

The input attenuator, which is variable in 10-dB steps from 0 dB to 50 dB, is used to adjust the input signal to a suitable level for mixing with the 6-Mc/s signal derived from the local oscillator. As the output voltage from the ring bridge is proportional to the input signal amplitude, the attenuator also acts as an output level control.

The three-section, five-position, RANGE switch at the output of the attenuator is used to connect any one of four filter networks into the circuit, or, in its fifth position, to feed the signal from the attenuator directly to the ring bridge circuit.

The first three RANGE switch positions introduce L-C acceptor filters using preset inductors L2, L3, and L4; a variable capacitor, C9, common to each circuit, acts as a tuning control so that the filters on Ranges 1, 2 and 3 may be tuned to any frequency within their range. These three filters jointly cover the frequency range 0.16 Mc/s to 3 Mc/s.

At the fourth switch position a low-pass filter using inductors L1, L5 and L6 is connected into circuit; this filter has a cut-off frequency of approximately 190 kc/s and is not tunable.

The frequencies covered by the five ranges are :-

Range 1	0.8 Mc/s	-	3 Mc/s
Range 2	0.3 Mc/s	-	0.8 Mc/s
Range 3	0.16 Mc/s	-	0.3 Mc/s
Range 4	0	-	0.16 Mc/s
Range 5	0	-	3 Mc/s

The electron-coupled crystal-controlled local oscillator operates at a frequency of 6 Mc/s. The primary of T1 and the preset capacitor C11 form a tuned anode load whose resonant frequency is preset to obtain the required output voltage from the oscillator.

4.2.8 (continued)

The secondary of T1 is coupled to the ring bridge circuit via a T-type attenuator. This attenuator reduces the output voltage from the oscillator to a suitable level for the bridge circuit and also makes the output of the oscillator and the input to the ring bridge more resistive. An h.t. switch, SB, renders the oscillator inoperative when the Extension Unit is not being used.

Particular attention has been given in the design of the ring bridge modulator circuit to obtaining minimum harmonic distortion of the desired signal and good suppression of the local-oscillator carrier. Matched pairs of crystal diodes are used in each arm of the bridge to give good balance.

It should be noted that the signal generated at the output of the bridge is the difference frequency of the input signal and the 6-Mc/s carrier from the local oscillator, so that, as the input frequency increase from 0 to 3 Mc/s, the output frequency decreases from 6 to 3 Mc/s.

4.2.9 Fixed Frequency Changer Units Types TM 6467 and TM 6467/1 Circuit Diagram : XC 33952 -/1

Either a 300-kc/s Fixed Frequency Changer Unit (type TM 6467) or a 3.1-Mc/s Fixed Frequency Changer Unit (type TM 6467/1), both of which are optional accessories, can be fitted to the Spectrum Analyser. Circuit Diagram XC 33952 -/1, near the end of Vol. II of the handbook, shows the circuit of the 300-kc/s Fixed Frequency Changer Unit; R7, T1, C3, and XL1 have different values in the 3.1-Mc/s Fixed Frequency Changer Unit, as shown on Component List XC 33952/1.

The local oscillator, which operates at 1 Mc/s in the 300-kc/s version of the Fixed Frequency Changer and at 2.4 Mc/s in the 3.1-Mc/s version, is a modified form of Colpitts oscillator.

The input to the Fixed Frequency Changer Unit is fed via the front-panel FIXED INPUT socket, a 40-dB attenuator pad (R1, R2, and R3), and a tuned transformer (T1) to the mixer stage (V1). The 700-kc/s i.f. signal output of the mixer is taken via a transformer having critical coupling between its two windings, T2, to the mixer

4.2.9 (continued)

output section of Frequency Changer II. With a Fixed Frequency Changer Unit in use, the front-panel RANGE switch is at FIXED INPUT; this position of the RANGE switch disconnects the 250-volt h.t. supply from the local oscillator in Frequency Changer II and connects the supply instead to the Fixed Frequency Changer Unit.

4.2.10 R.F. Fuse Unit

The function of the R.F. Fuse Unit, which can be supplied as an optional accessory, is the protection of the Analyser's input attenuators from damage due to the accidental application of high r.f. or h.t. voltages; the Unit can be plugged in series with the Analyser's R.F. INPUT or FIXED INPUT sockets or with the INPUT socket on the optional L.F. Extension Unit.

The Unit consists essentially of a 1/16-amp fuse connected between a BNC plug and a BNC socket in a 75-ohm coaxial assembly. The fuse, which is a 1/16-amp Littelfuse (Type 361 8AG), burns out with an input of 90 mA, i.e. 6.75 volts; ten spare fuses are supplied with the R.F. Fuse Unit.

4.2.11 External Local Oscillator TM 7036A Circuit Diagram XD 38129/1

This is a small box which may be fixed to the front panel of the power unit, from which it draws its supply voltage. It is very stable, non-microphonic and hum-free in operation, and provides ample power between 2.3 and 5.3 Mc/s to drive the mixer stage of the Spectrum Analyser.

Two oscillators are used to cover the range, both transistorized, tuned by variable capacity diodes and fixed inductances. Reverse bias voltage is applied via a switched resistor ladder and potentiometer, the controls for which are on the upper surface of the box. The output is taken to the main instrument by a short length of cable.

5 MAINTENANCE

5.1 GENERAL

Section 4, TECHNICAL DESCRIPTION, of this handbook deals with the internal circuits of the Spectrum Analyser and is intended to be read in conjunction with the Block Schematic, Circuit Interconnection, and Circuit Diagrams; the Block Schematic is located at the end of this volume of the handbook and the Circuit Interconnection Diagram and Circuit Diagrams are in Vol. II. It is recommended that, before commencing the adjustment or replacement of component parts of the instrument, you should be familiar with the principles described in Section 4 and illustrated in the Diagrams.

WARNING - HIGH VOLTAGES, UP TO SEVERAL KV, ARE EMPLOYED IN THIS INSTRUMENT. IT IS DANGEROUS TO OPERATE THE INSTRUMENT WITH PARTS CARRYING THESE VOLTAGES EXPOSED.

5.2 FUSES

The circuits of the Spectrum Analyser are protected by seven fuses as follows :-

Two 2-amp fuses (FS1 and FS2) in series with the input connections to the mains transformer in the Power Supply Unit.

Two 3-amp fuses (FS3 and FS4) in series with the two ends of secondary winding LT2 of Transformer T1 in the Power Supply Unit.

A 250-mA fuse (FS6) in series with one end of the '350 V H.T.' winding of Transformer T2 in the Power Supply Unit.

A 100-mA fuse (FS5) in series with one end of the '200 V H.T.' winding of Transformer T1 in the Power Supply Unit.

5.2 (continued)

A 1-amp fuse (FS1) in series with the stabilized heater supply to V1, V2, and V3 in the Scanning Unit.

All fuse-holders, except that for the lamp fuse, are located on the front panel of the Power Unit; the 1-amp fuse and fuse-holder are contained within the Scanning Unit, and it is necessary to remove the top cover that shields V1, V2 and V3 in the Scanning Unit in order to replace this fuse.

5.3 SUPPLY VOLTAGE - TRANSFORMER CONNECTIONS

The Analyser can be adjusted to operate from any supply in the ranges 100 to 150 volts and 200 to 250 volts, 40 to 100 c/s. For this purpose, each of the two mains transformers has two tapped primary windings. For the higher voltage range, the two primary windings on each transformer are linked in series; for the lower voltage range, the four main 100-volt sections of the two transformers are all connected in parallel. When the primaries are correctly linked, the supply input is connected to taps selected according to the particular voltage of the supply.

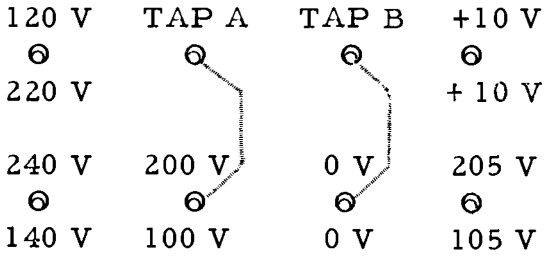
Connections to the transformers are made at a mains tapping panel situated beneath a transparent cover on the front panel of the Power Unit. The mains tapping panel layout is as shown in the following two diagrams. The diagrams show :

(1) tags linked for the range 100 to 150 volts, i.e. a link between tags marked '0 V' and 'TAP B', and another link between tags marked 'TAP A' and '100 V/200 V'.

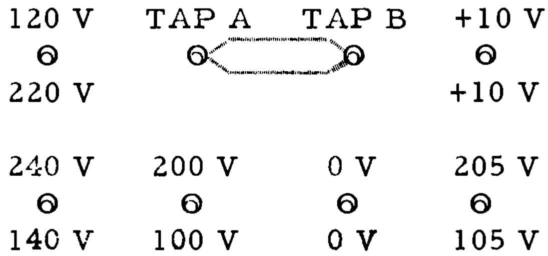
(2) tags linked for the range 200 to 250 volts, i.e. both links between tags marked 'TAP A' and 'TAP B'.

The mains input, via the SUPPLY switch and the 2-amp fuses, should be applied to the tags whose voltage markings (reading only those appropriate to the linking of the primaries), when added, match the supply voltage.

5.3 (continued)



Links for 100 to 150 volts
on tapping panel



Links for 200 to 250 volts
on tapping panel

Example: If the supply is 230 volts, 'TAP A' should be linked to 'TAP B' and the leads from the SUPPLY switch and fuses should be connected to tags marked '+10 V' and '120 V/220 V'.

Before altering the position of the leads from the SUPPLY switch and fuses, or the position of the links, first DISCONNECT THE SUPPLY.

5.4 WITHDRAWING INSTRUMENT FROM CASE

WARNING - Before withdrawing the OA 1094A H.F. Spectrum Analyser from its case, it is important to ensure that the case is securely mounted, either on Trolley TM 6612 or on a bench.

When the OA 1094A is in use on a bench, at least two bolts are necessary to secure the Analyser to the bench; and, if only two bolts are employed for this purpose, they must fix the OA 1094A case via two holes at the bottom rear of the case.

When a Base Plate Assembly, Type TM 6978, has been supplied as an accessory and is in use, it is essential that the Base Plate be secured to the case and to either trolley or bench before withdrawing the OA 1094A H.F. Spectrum Analyser from its case.

5.4 (continued)

Access to the interior of the OA 1094A H.F. Spectrum Analyser is gained by removing the eight 1/4-inch BSF screws and washers from the two strips at the sides of the Analyser's front panel. This releases the internal assemblies, so that they can be pulled out on runners by grasping two of the panel rails. Catches on the runners lock them in the fully extended position and must be pressed to be released.

Do not remove the two 1/4-inch UNF hexagon-head screws exposed when the strips are removed, near the top of the Power Unit front panel, as these two screws secure the internal assemblies to the cabinet runners.

To remove the dust cover from the OA 1094A/R rack-mounting version of the H.F. Spectrum Analyser, it is only necessary to unscrew the four captive 2-BA screws in the rear of the dust cover.

5.5 ACCESS TO INDIVIDUAL UNITS

General tests or some peculiarity in the performance of the Spectrum Analyser may suggest the desirability of inspecting the interior of one of the individual units. The mechanical design of the Spectrum Analyser is such that covers can be removed from units without removing the units from the Analyser frame; individual units can therefore be largely tested in situ. As the Power Unit (TM 6580) and the optional L.F. Extension Unit (TM 6448) are units separate from the main assembl having their own front panels, these two units can be removed from the Analyser for servicing. In addition, the following units can be easily removed from the Analyser when required :-

Sound Channel, TM 6469
700-kc/s Filter, TM 6493
60-kc/s Amplifier, TM 6508
6-c/s Filter Unit, TM 6568
30-c/s Filter Unit, TM 6568/1
150-c/s Filter Unit, TM 6568/2
Fixed Frequency Changer Unit,
  if fitted, TM 6467 or TM 6467/1

5.5.1 Access to OA 1094A Power Unit

In order to gain access to the Power Unit of the OA 1094A H.F. Spectrum Analyser, it is necessary either to remove the upper assembly, so leaving the Power Unit still bolted to the runners of the OA 1094A case, or to remove the complete instrument from the case - it is then a comparatively simple matter to detach the Power Unit.

To remove the upper assembly from the OA 1094A case, proceed as follows :-

(a) Remove the eight 1/4-inch BSF screws and washers from the sides of the OA 1094A front panel, and pull the internal assemblies forward on the runners; see Section 5.4.

(b) Disconnect from the Power Unit the two Plessey Mk. 4 plugs, one from each of the two chassis of the Power Unit, by reaching up through the gap between the two chassis.

(c) If the Spectrum Analyser is mounted on Trolley TM 6612, grip the centre pair of handles on the front panel; this prevents the Analyser sliding backwards when the screws which hold it to the Power Unit are removed.

(d) Withdraw the ten 2-BA socket-head screws which bolt the frame of the upper assembly to the Power Unit.

(e) Remove the upper assembly by a forward and upward movement, leaving the Power Unit mounted on the runners of the OA 1094A case.

To gain access to the Power Unit by removing the upper assembly and Power Unit together from the OA 1094A case, proceed as follows :-

(1) Remove the eight 1/4-inch BSF screws and washers from the sides of the OA 1094A front panel, and pull the internal assemblies forward on the case runners; see Section 5.4.

(2) Remove the two 1/4-inch UNF hexagon-head screws from the front panel of the Power Unit.

5.5.1 (continued)

(3) Remove the instrument from the runners and case by a forward and upward movement.

(4) Remove the ten 2-BA socket-head screws which bolt the upper assembly to the Power Unit.

(5) Lay the upper assembly on the right side, as viewed from the front panel, on a bench.

(6) Disconnect from the Power Unit the two Plessey Mk. 4 plugs, one from each of the two chassis of the Power Unit.

Note :At least two people are needed to lift the OA 1094A H.F. Spectrum Analyser from its case.

5.5.2 Access to L.F. Extension Unit

To remove the L.F. Extension Unit, when fitted, from the H.F. Spectrum Analyser, turn and release the two Dzus fasteners in the front panel of the L.F. Extension Unit, and then withdraw the L.F. Extension Unit.

5.5.3 Removal of Cathode-Ray Tube

The c.r.t. can be removed from the Analyser by carrying out the following procedure :-

(1) Remove the B14A valve-holder from the c.r.t.

(2) Unsolder the earthing lead from the earthing tag on the c.r.t. shield.

(3) Unscrew the wing nut and lift the clamp at the neck of the c.r.t.

(4) Slacken the clamp at the front-panel end of the c.r.t.

(5) Withdraw the c.r.t. with its shield from the Analyser; the c.r.t. shield may subsequently be slid from the c.r.t. by slackening the screw through the fixing lug.

5.6 WORKING VOLTAGES

The following voltages are representative of those to be expected on an H.F. Spectrum Analyser if measurements are made with a meter having a d.c. sensitivity of 20,000 ohms per volt (e.g. an Avometer 8), except where otherwise stated. Variation in voltages on individual instruments must be anticipated owing to normal tolerances of valve and transistor performance and component values.

5.6.1 Supply Voltages

The supply voltages in Table 4 are those to be expected in the Power Unit when it is connected to the rest of the instrument in the normal manner.

TABLE 4

Supply	Measured between	Voltage
200 V H.T. a.c.	Tags on T1	200 V a.c.
350 V H.T. a.c.	Tags on T2	350 V a.c.
L.T. 1	Tags on T1	6.3 V a.c.
L.T. 2	Tags on T1	15.5 + 15.5 V a.c.
L.T. 3	Tags on T1	6.3 V a.c.
L.T.	Tags on T2	6.3 V a.c.
250 V H.T. rectified	Junction MR7/MR9 and chassis	400 V d.c.
400 V H.T. rectified	Junction MR3/MR5 and chassis	500 V d.c.
250 V H.T. regulated	Across C19	250 V d.c.*
* Set by control RV3		

5.6.2 Valve and Transistor Electrode Voltages

The following table shows valve and transistor electrode d.c. voltages with respect to chassis on each of the sub-units in turn.

TABLE 5

Frequency Changer I

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	245	1.6	165	-	1.6
V2	90	-	122	-	1.1
V3	225	20	225	10	20

Frequency Changer II

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	122	-	110	-	1.4
V2a	75	-	-	-0.4	0
V2b*	95	-	-	-	2.9
V3	195	20	195	10	20

* For V2b measurements, set the LOCAL OSC. switch to EXT. For all other valve electrode voltage measurements in Frequency Changer II, set the LOCAL OSC. switch to INT.

5.6.2 (continued)

Scanning Unit

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1b	235	-	-	147	186
V2*	245	-2.3	224	-1	0.85
V3	235	18	237	10	18
V4	220	-	118	-	2.4
V5	220	-	118	-	2.4
V6	165	-0.4	200	-3	-
V8	110	6	108	-	6
V9	108	-	-	-	-
V10*	275	14	215	10	14
V11*	175	17	180	13	17
V12	150	15	215	12	15
V13	230	15	180	12	15

* The figure given for V2 anode volts is that to be expected at pin 5. V10 and V11 electrode voltages are respectively dependent upon the X SHIFT and Y SHIFT settings.

60-kc/s Amplifier

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	220	2.1	250	-	2.1

Sound Channel

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	250	3.2	250	-	3.2
V2	250	3.0	250	-	3.0
V3a	250	-	-	80	108
V3b	230	-	-	-	11.5

5.6.2 (continued)

Power Unit

Valve No.	Anode Volts	Screen Volts	Grid Volts	Cathode Volts
V1	400	-	-	250
V2	365	-	232	250
V3	365	-	232	250
V4a	370	-	198	230
V4b	198	-	158	160
V5	85	-	-	-
V6	250	215	-46	2.2
V7a	207	-	80	85
V7b	160	-	84	85
V8	-	-	-	2400
V9	-2250	-	-	-

Transistor VT1 collector	-0.75	volt
Transistor VT1 base	5.9	volts
Transistor VT1 emitter	6.1	volts
Transistor VT2 collector	-6.1	volts
Transistor VT2 base	-0.75	volt
Transistor VT2 emitter	-0.5	volt
Transistor VT3 collector	-6.1	volts
Transistor VT3 base	-0.5	volt
Transistor VT3 emitter	-	

L. F. Extension Unit (optional accessory)

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	195	1.2	185	2.6*	1.2

* This is the r.f. voltage at the grid of V1, measured with a valve voltmeter.

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5.6.2 (continued)

300-kc/s Fixed Frequency Changer Unit (optional accessory)

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	155	-1*	125	-	1.75
V2	220	7.25	100	-	7.25

* The r.f. voltage at the suppressor of V1, measured with a valve voltmeter, is 7.5 volts.

3.1-Mc/s Fixed Frequency Changer Unit (optional accessory)

Valve No.	Anode Volts	Suppressor Volts	Screen Volts	Grid Volts	Cathode Volts
V1	190	-1*	140	-	1.8
V2	190	16	210	-	16

* The r.f. voltage at the suppressor V1, measured with a valve voltmeter, is 12.5 volts.

External Local Oscillator Type TM 7036A (optional accessory)
With an input of 250 V, and the range switch in the appropriate position for working conditions.

Pin 1 of SA4B	12 V	Point 1	92 V
Emitter of VT1	10.7 V	Point 2	124 V
Base of VT1	10.5 V	Point 4	7.9 V
Emitter of VT2	9.8 V	Point 5	1.4 V
Base of VT2	9.7 V		

HANDBOOK CHANGE

H.F. SPECTRUM ANALYSER

Types OA 1094A, -A/R and -A/S

At the higher sweep speeds, full amplitude of display may not be reached immediately at the beginning of each sweep. This is due to the flyback circuit time constant determined by C10 in the input circuit of V2 in the Scanning Unit. Because the time constant must be long enough to prevent ringing it delays the re-opening of V2 which is cut off during the flyback period. This effect will not be noticeable with sweeps of 10 or 30 seconds.

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TYPICAL OSCILLOGRAMS

MARCONI INSTRUMENTS LIMITED

DRN	M.C	DATE	25.2.58	CHKD	J.R.H	ISSUE	2

STOCK LIST	OA1094 & A	DRG No.	TLC 27991

Fig. 1 Amplitude Modulation

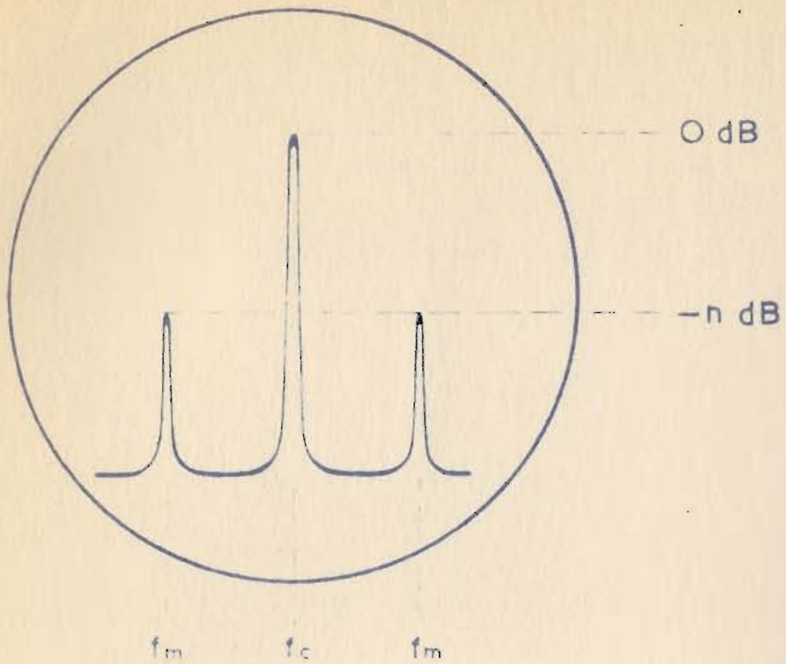


Fig. 2 Frequency Modulation Mod Index 0.8

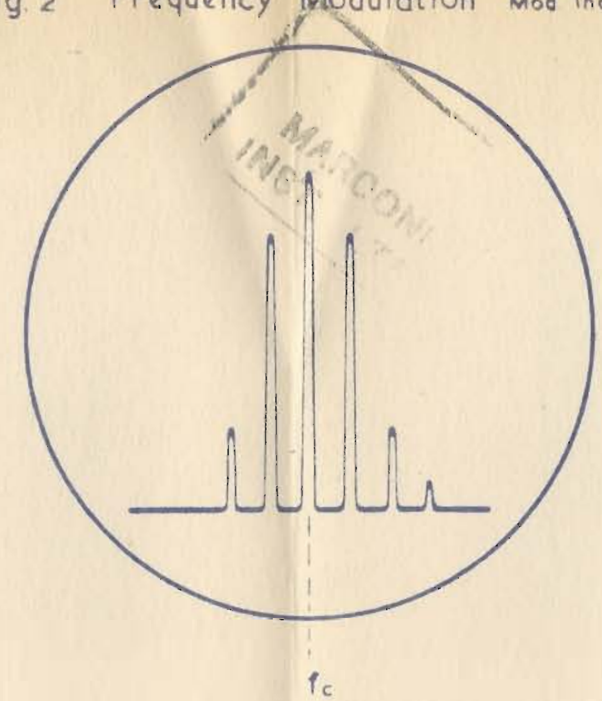


Fig. 3 Frequency Modulation Mod Index 2.4

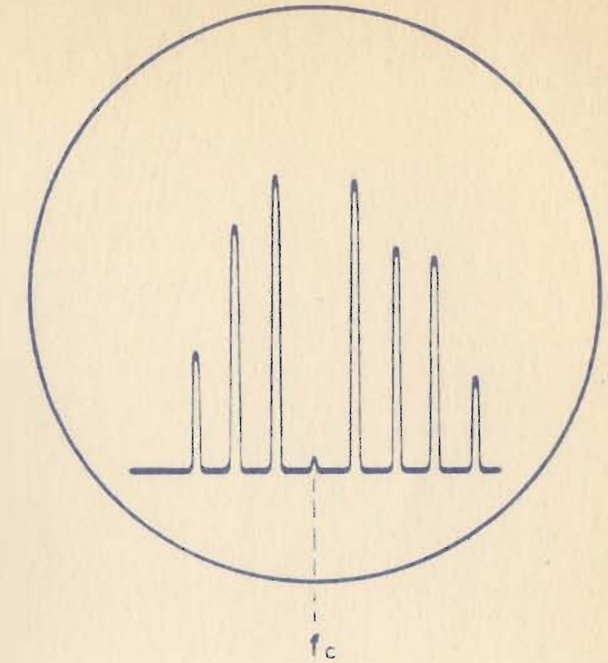


Fig 4 On-Off Keying

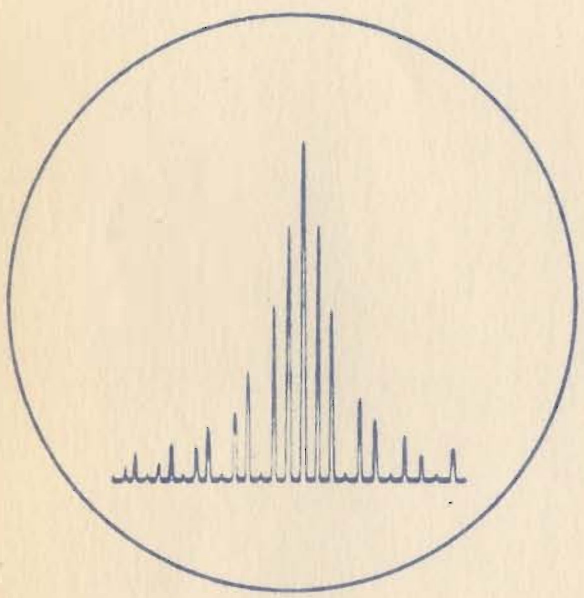


Fig 5 S.S.B. Two-Tone Test

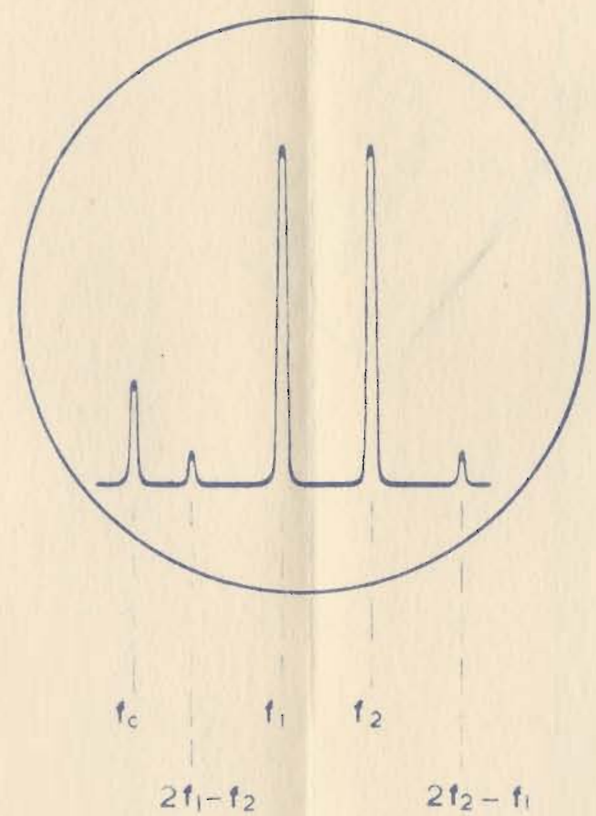
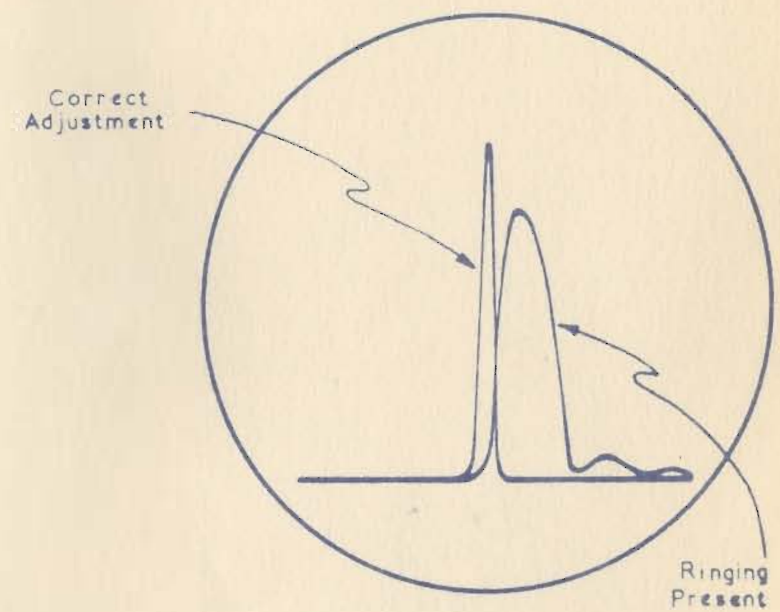


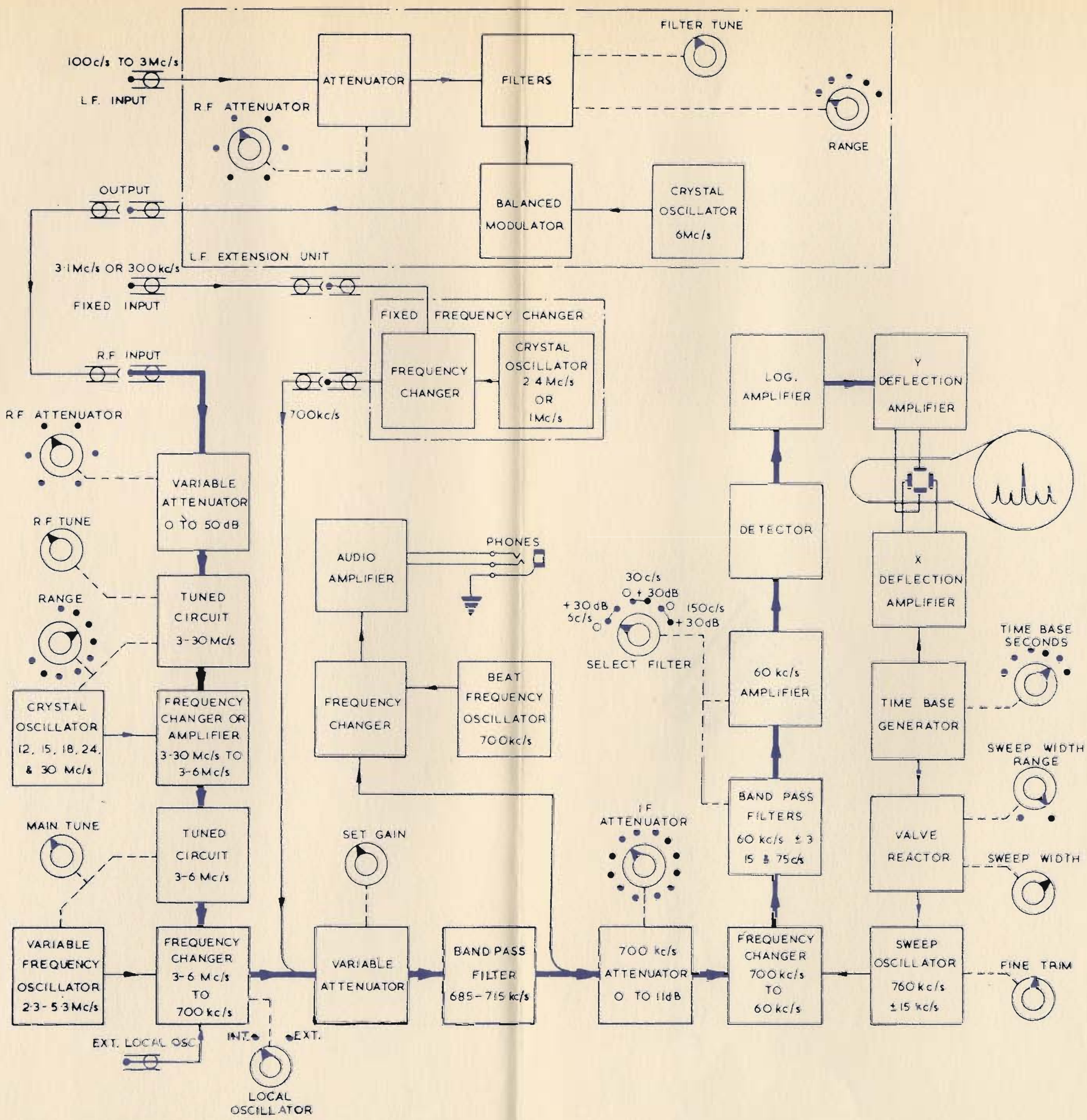
Fig. 6 Effect of Ringing



TYPICAL OSCILLOGRAMS

TLC 27991

TITLE BLOCK SCHEMATIC DIAGRAM OF H.F. SPECTRUM ANALYSER OA1094A AND OA1094A/1	DRG. No. TLC38195
MARCONI INSTRUMENTS LIMITED	SHEET ..... OF ..... SHEETS



BLOCK SCHEMATIC DIAGRAM OF H.F. SPECTRUM ANALYSER OA1094A AND OA1094A/1

DRG. No.	ISS.
TLC38195	1

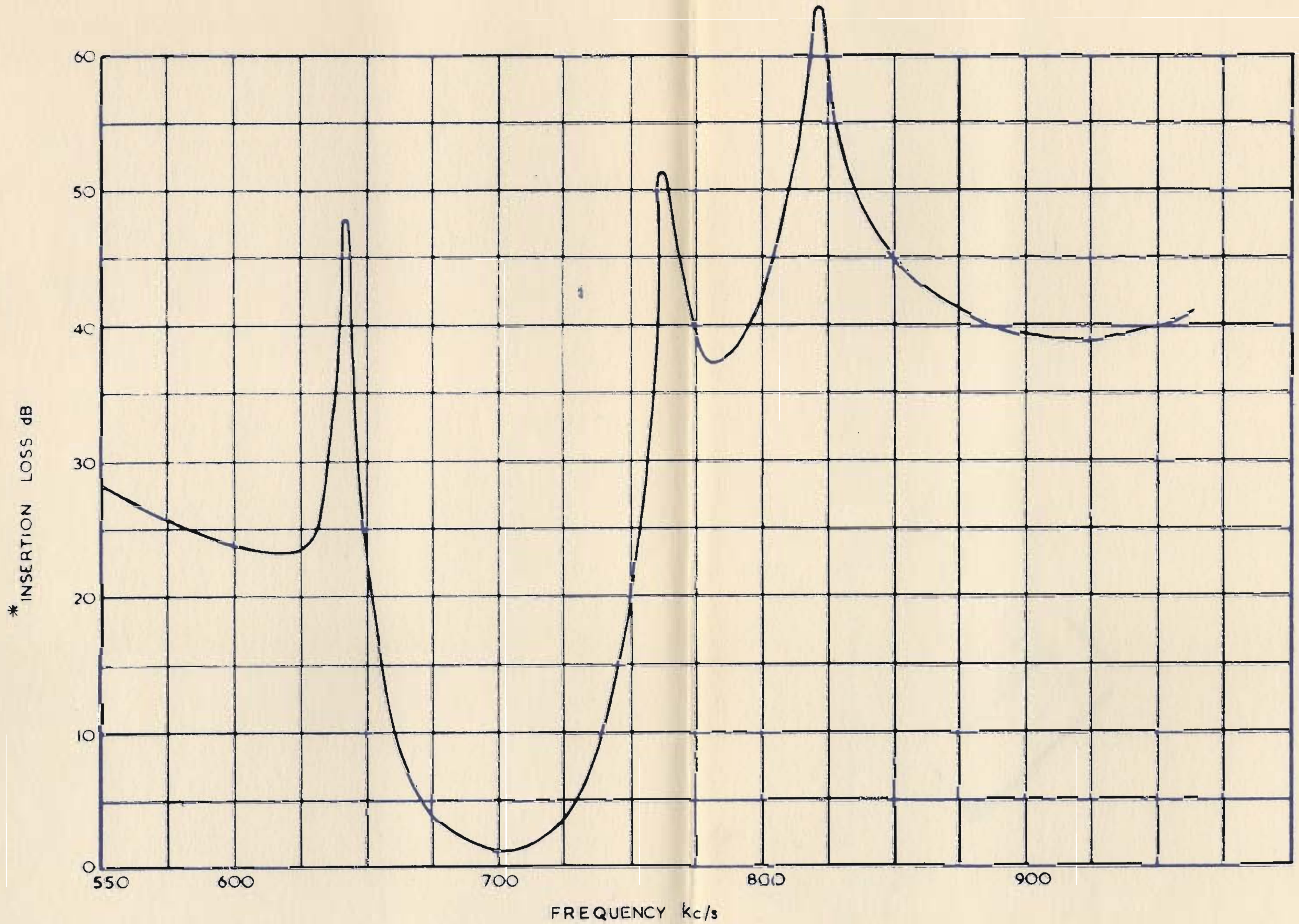
RESPONSE CURVE

FOR

700 kc/s FILTER

MARCONI INSTRUMENTS LIMITED

DRN	M.C.	DATE	8 · 4 · 58	CHKD	[illegible]	ISSUE 2	
STOCK LIST	OA 1094 &A	DRG No.	TLC 26183				



* MEASURED BETWEEN 75-OHM TERMINATIONS

RESPONSE CURVE FOR 700 kc/s FILTER

TRACED FROM G.P.O. DRAWING

TLC 2618 3

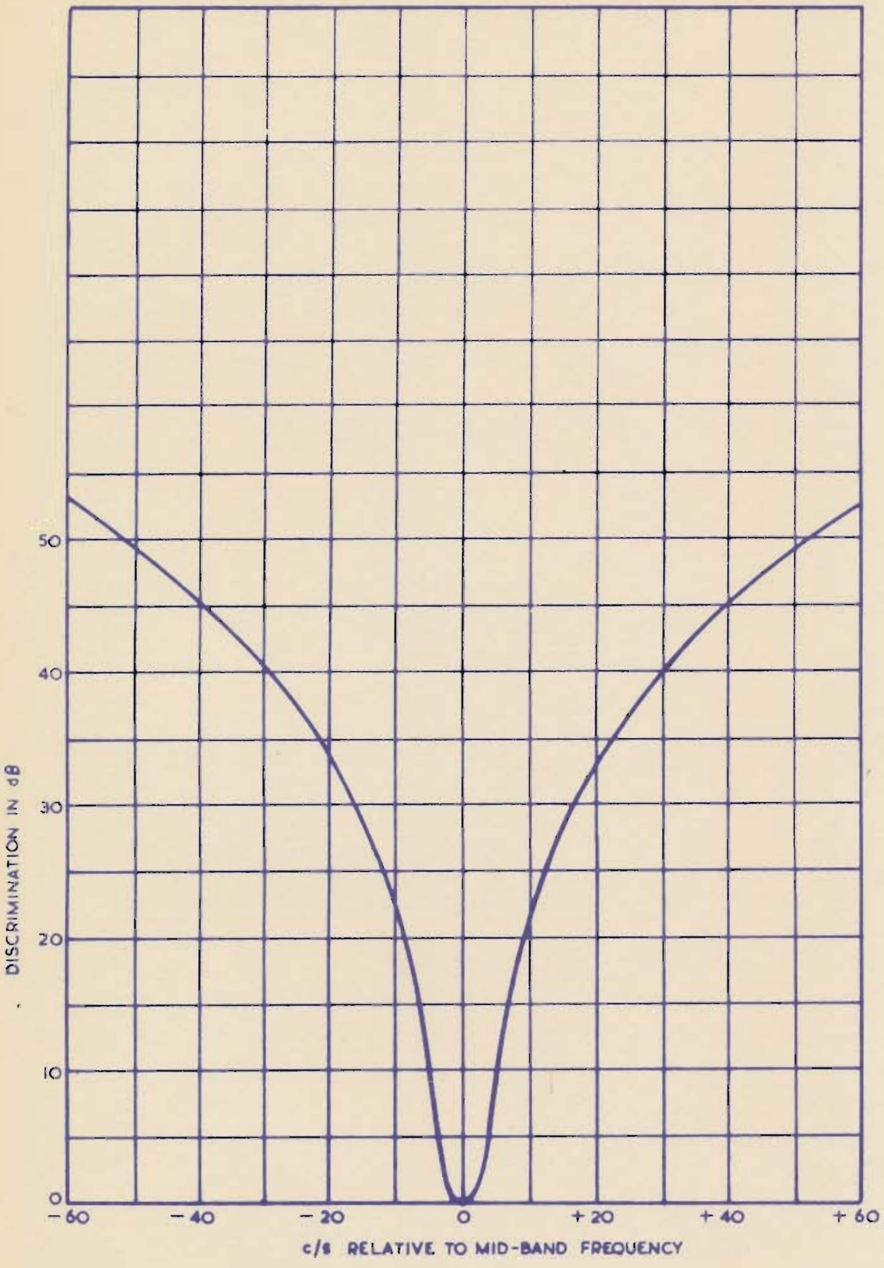
RESPONSE CURVES

FOR

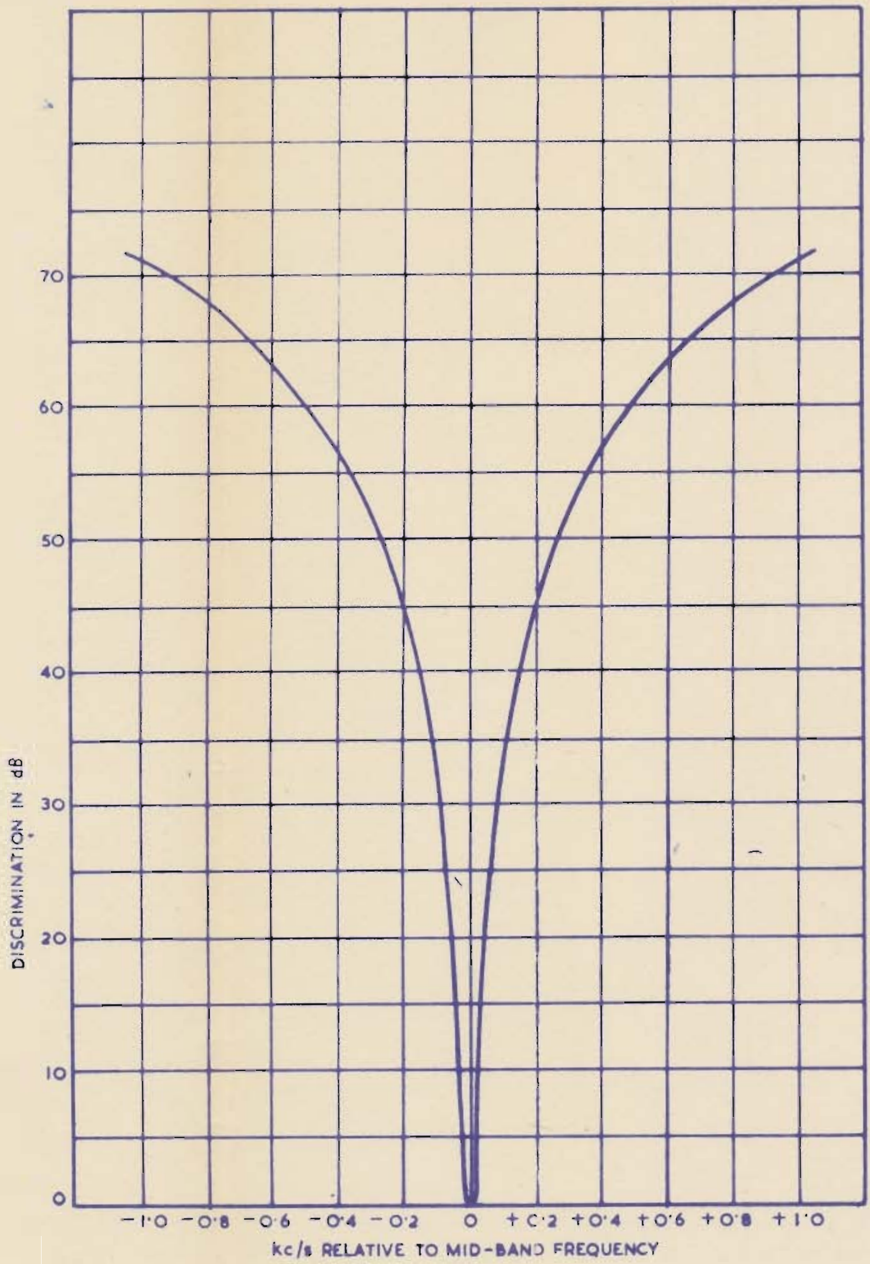
6 c/s, 30c/s & 150 c/s FILTERS

MARCONI INSTRUMENTS LIMITED							
DRN.	M.C.	DATE	8-4-58	CHKD	JH.	ISSUE	2
STOCK LIST	OA 1094 & A		DRG. No.		TLD26189		

6c/s FILTER

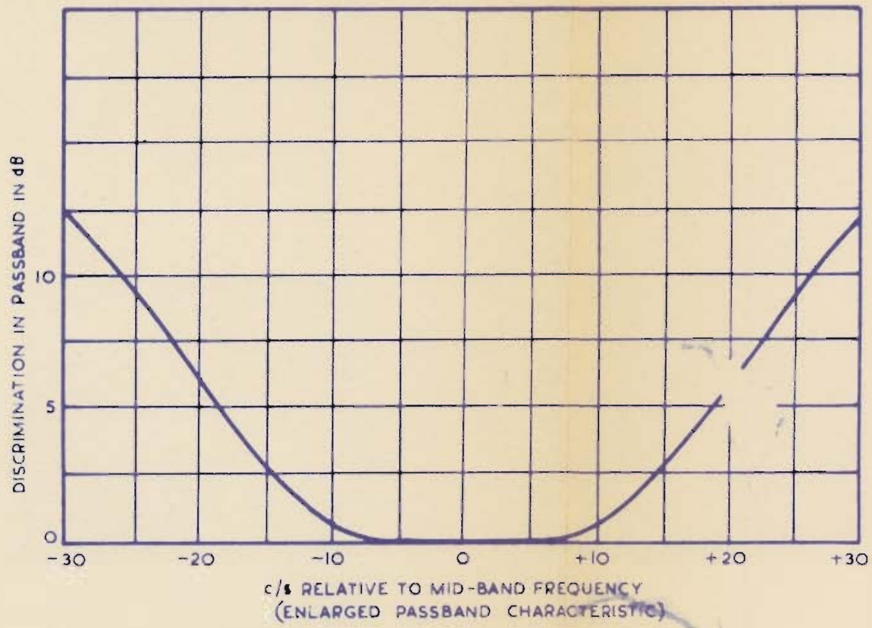

DISCRIMINATION IN dB
50
40
30
20
10
0
− 60
− 40
− 20
0
+ 20
+ 40
+ 60
c/s RELATIVE TO MID-BAND FREQUENCY

30c/s FILTER (CURVE A)

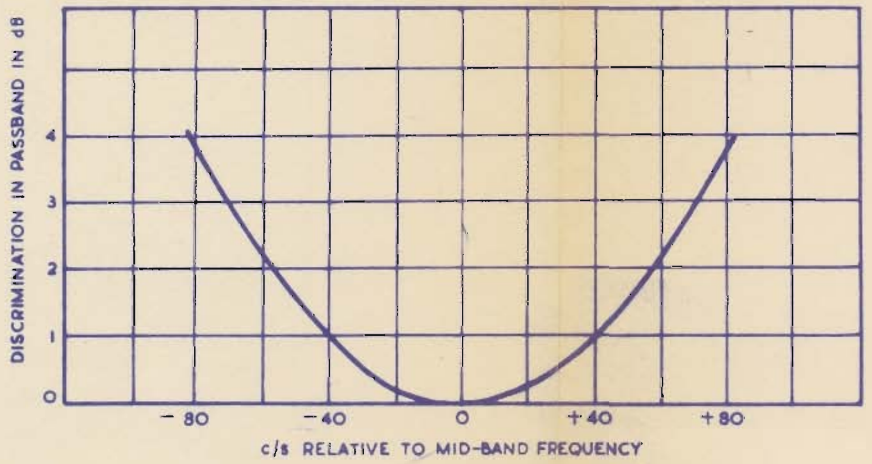


RESPONSE CURVES FOR

30 c/s FILTER (CURVE B)

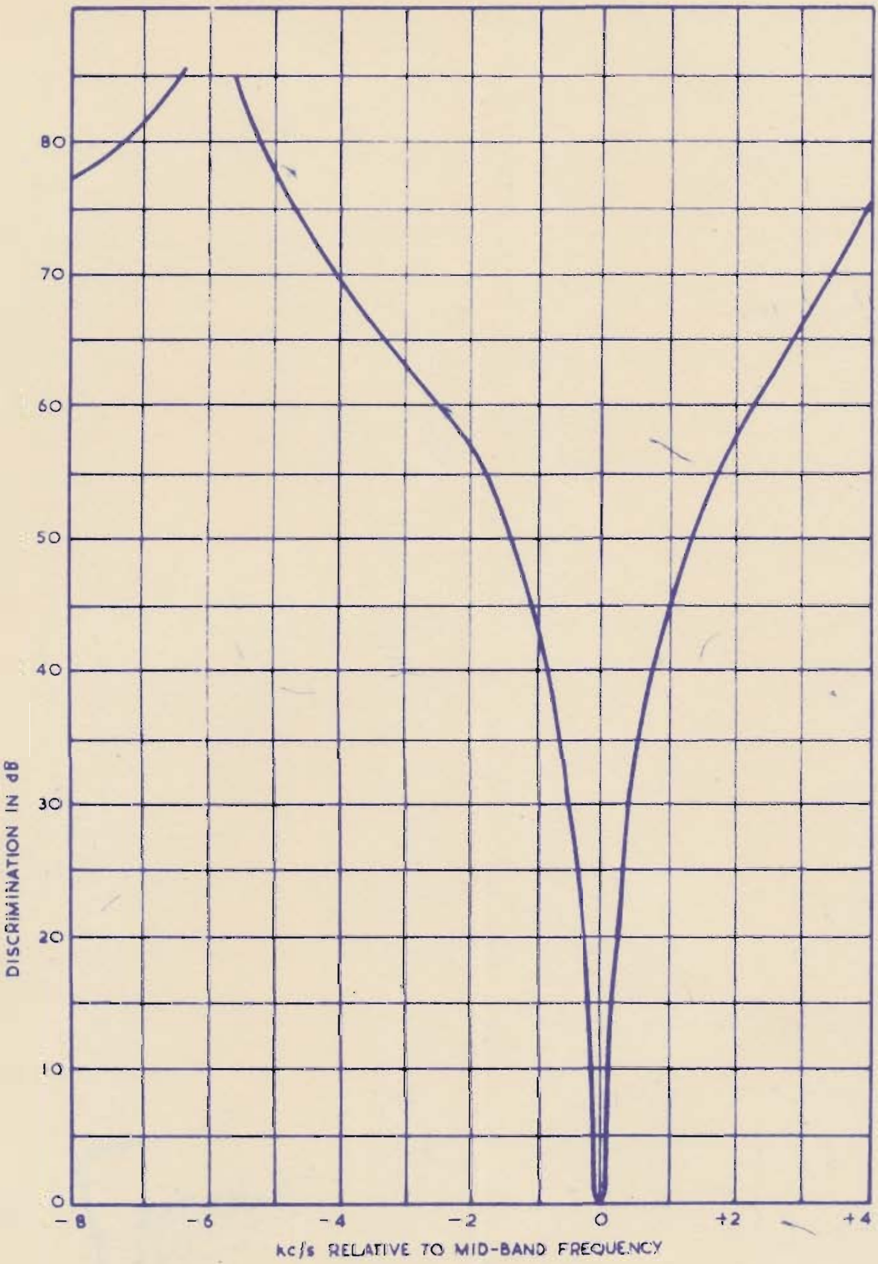


150 c/s FILTER (CURVE B)



FOR 6c/s, 30c/s & 150c/s FILTERS

150c/s FILTER (CURVE A)



TRACED FROM G.P.O. DRAWING

TLD 26189

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62

DECIBEL CONVERSION TABLE

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	·006310	**22**	12·59	158·5
·06310	·003981	**24**	15·85	251·2
·05012	·002512	**26**	19·95	398·1
·03981	·001585	**28**	25·12	631·0
·03162	·001000	**30**	31·62	1,000
·02512	·0006310	**32**	39·81	1,585
·01995	·0003981	**34**	50·12	2,512
·01585	·0002512	**36**	63·10	3,981
·01259	·0001585	**38**	79·43	6,310
·01000	·0001000	**40**	100·00	10,000
·007943	·00006310	**42**	125·9	15,850
·006310	·00003981	**44**	158·5	25,120
·005012	·00002512	**46**	199·5	39,810
·003981	·00001585	**48**	251·2	63,100
·003162	·00001000	**50**	316·2	100,000
·002512	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	158,500
·001995	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	251,200
·001585	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	398,100
·001259	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	631,000
·001000	10^{-6}	**60**	1,000	10^{6}
·0005623	$3{\cdot}162 \times 10^{-7}$	**65**	1,778	$3{\cdot}162 \times 10^{6}$
·0003162	10^{-7}	**70**	3,162	10^{7}
·0001778	$3{\cdot}162 \times 10^{-8}$	**75**	5,623	$3{\cdot}162 \times 10^{7}$
·0001000	10^{-8}	**80**	10,000	10^{8}
·00005623	$3{\cdot}162 \times 10^{-9}$	**85**	17,780	$3{\cdot}162 \times 10^{8}$
·00003162	10^{-9}	**90**	31,620	10^{9}
·00001000	10^{-10}	**100**	100,000	10^{10}
$3{\cdot}162 \times 10^{-6}$	10^{-11}	**110**	316,200	10^{11}
10^{-6}	10^{-12}	**120**	10^{6}	10^{12}
$3{\cdot}162 \times 10^{-7}$	10^{-13}	**130**	$3{\cdot}162 \times 10^{6}$	10^{13}
10^{-7}	10^{-14}	**140**	10^{7}	10^{14}

MARCONI INSTRUMENTS LIMITED
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