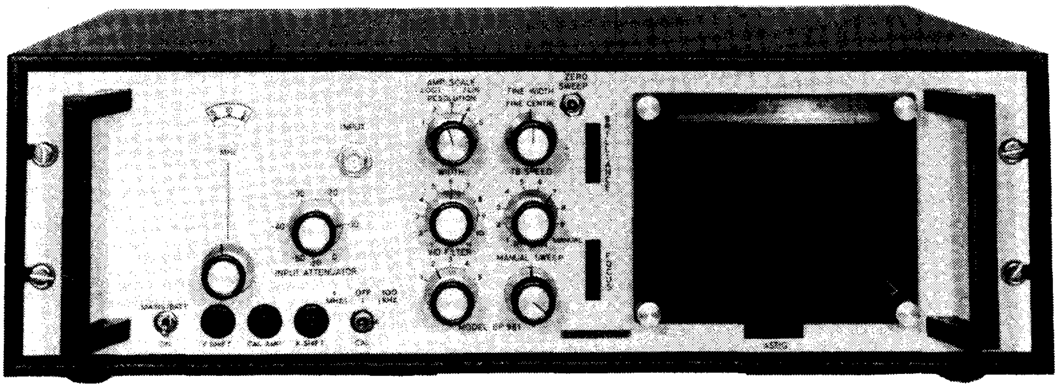
Eddystone

Panoramic Display Units

EP 961 MkII-A
EP 961 MkII-B



Manufactured in England by

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ISSUE NUMBER 1 JANUARY 1974

PRINTED IN ENGLAND

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NOTE : : AC MAINS CONNECTOR

The following information is issued in compliance with British Standard BS415:-

If the colours of the wires in the mains lead of this apparatus do not correspond with the coloured markings identifying the terminals in your mains connector (or plug) proceed as follows:-

1. The GREEN/YELLOW wire must be connected to the plug terminal marked "E" or " ⏚ " or coloured GREEN or GREEN/YELLOW.

2. The BLUE wire must be connected to the plug terminal marked "N" or coloured either BLUE or BLACK.

3. The BROWN wire must be connected to the plug terminal marked "L" or coloured either BROWN or RED.

4. If a 13 amp (BS1363) FUSED PLUG is used to facilitate connection to the supply outlet, the plug MUST be protected by a 3 AMP FUSE unless expressly declared otherwise (see para. 5 below). If another type of plug is used, a fuse of the appropriate rating must be fitted either in the plug, or the adaptor, OR AT THE DISTRIBUTION BOARD.

5. NOTE :

   A 3 AMP fuse rating is sufficient for most equipments, but in some instances, to allow for switching surges, it may be necessary to use a 5 AMP FUSE RATING. In all instances where the higher rating is applicable, specific notice will be given in the INSTALLATION SECTION of the handbook at the POWER SUPPLIES subsection.

AMENDMENT SHEET No: 1

Page B-5

Note that C139 is not fitted on Model EP961 MK11 - A.

C140 was 33pF, is now 540pF.

Page B-9

R5 ([illegible]20,000 ohms). This is a nominal value and may be adjusted on factory test.

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R5 now allocated : 8,200 ohms 5% 0.1W

R8 is 10,000 ohms nominal.

R13 is 10,000 ohms nominal.

R76 was 220 ohms, now 120 ohms 5% 0.1W

Circuit Diagram

Amend component valmes as given above.

Add R5 (RF Unit 'B') between base of TR2 and top of R9A.

Note that the polarity of C245 and C246 is incprrect and should be reversed.

The output at pin 16 of the Regulator Board should be 9V, not 10V as shown.

The supply to the Twist Coil should also be 9V.

Issued by;- EDDYSTONE RADIO LIMITED, ALVECHURCH ROAD, BIRMINGHAM B31 3PP, ENGLAND
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GENERAL DESCRIPTION AND TECHNICAL DATA

General Description The Mk.II variants of Model EP961 feature revised styling to match current equipment. The same basic chassis assembly is used for both variants which utilize many common sub-units.

Model EP961 Mk.II-A is tunable over the band 50kHz to 800kHz to match the range of intermediate frequencies commonly used in MF and HF communication receivers. Its performance specification is such that it can be used quite satisfactorily as a low-cost spectrum analyzer for monitoring local or distant transmitters: all normal modes of transmission can be accommodated including SSB.

The Mk.II-B version covers the wider frequency range of 500kHz to 36.5MHz and is an extremely versatile general-purpose equipment primarily intended for use with VHF and UHF receivers. Its usefulness extends into the laboratory field where its high sensitivity allows it to be used with direct aerial input in many applications. One task for which this version is ideally suited is monitoring FM broadcasts and communications transmissions in the VHF band.

Both display units employ a double-conversion circuit with fixed selectivity bandpass filters at the 1st IF and switched crystal/L-C filters at the 2nd IF. Five positions of selectivity are provided to give wide adjustment of resolution under all conditions of operation. Low-pass filters are included at the input to supress image and spurious responses to a minimum.

A rectangular c.r.t. with 10 x 6cm screen provides a selectable linear or logarithmic signal display with a linear frequency base which can be calibrated by reference to markers derived from an internal crystal standard. The tube has long persistence on the Mk.II-A version and medium persistence on Mk.II-B. A graticule is provided and vertical scaling is calibrated by combined use of the Input Attenuator and RF Gain.

The maximum available horizontal scan varies with the input frequency in use, lying within the limits 1kHz-200kHz and 10kHz-10MHz on the 'A' and 'B' versions respectively. Separate 'coarse' and 'fine' controls permit rapid selection of the required sweep width. The centre- frequency is controlled by adjustment of the Input Tuning but can be shifted within small limits by a separate 'fine' control to facilitate precise setting when operating the unit with narrow sweep width.

The time base is controlled by a panel switch to permit selection of the most appropriate speed for the scanning width in use: residual trace distortion can be minimised by suitable adjustment of a switched filter in the detector output circuit. A manual sweep facility is provided to allow accurate plots to be made of the X-Y values of any given display. DC sweep voltage is available to drive external oscillators for laboratory analysis of filters etc., and provision is made for connection to an external pen recorder. Fixing points are provided for a standard oscilloscope camera.

Both versions are similar in external appearance and in basic form are intended for installation in standard 483mm (19in) racking: a matching cabinet is available as an accessory when the unit is required for bench-mounting. Internal power units are provided for operation from all standard 40-60Hz AC supplies and 12V DC supplies with negative earth.

DATA SUMMARY

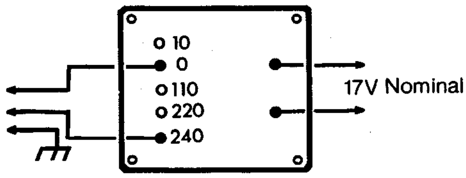
VERSION	Mk.II-A	Mk.II-B
Input Frequency	50kHz to 800kHz	500kHz to 36.5MHz
Intermediate Freqs.	1st IF : : 1.6MHz 2nd IF : : 70kHz	1st IF : : 45MHz 2nd IF : : 500kHz
Sensitivity TB Speed = 0.2Hz	10uV signal input produces 1cm trace deflection at 1kHz width setting (linear mode)	25uV signal input produces 1cm trace deflection at 10kHz width setting (linear mode)
Resolution	Signals differing by 40dB at 200Hz separation	Signals differing by 40dB at 6kHz separation
Sweep Width (dependent on Input Frequency)	1kHz-200kHz with direct input	10kHz-10MHz with direct input
Calibration Markers	100kHz and 10kHz	1MHz and 100kHz
Tube	10 x 6 cm, long persistence	10 x 6cm, medium persistence
Display	Vertical scaling: 20dB lin., 40dB log. Linear frequency base.	
Sweep Speed	Nine positions from 0.2Hz to 50Hz, plus manual sweep adjustment	
Centre Freq. Shift	Continuously variable	
Sweep Output	5V swing (–2V to –7V) from Hi-Z source of the order 5KΩ.	
Pen Recorder Output	100mV (positive swing) from Lo-Z source of the order 500Ω. Adjustable offset facility at rear.	
Input Impedance	50-100Ω unbalanced	
Power Supplies	AC : : 100/125V or 200/250V (40-60Hz). DC : : 12V (neg. earth)	
Consumption	Of the order 35-watts	
Dimensions	Rack-mounting: Panel : 483mm x 133mm (19in. x 5.25in.) Rack intrusion : 411mm (16.1875in.) Weight : 16.8kg (37 lb) Bench-mounting: Width : 502mm (19.75in.) Height : (including feet) : 165mm (6.5in.) Depth (overall) : 454mm (17.875in.) Weight : 22.2kg (49lb)	

INSTALLATION

A.C. Mains Operation

(a) Remove the cabinet and bottom cover plate. Check the settings of the Power Transformer tappings and adjust if necessary to suit local voltage. The tapping layout is as shown in Fig. 1.

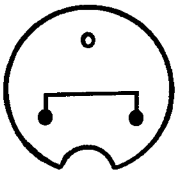
FIG. 1



N.B. Tappings are set for 240V operation when despatched from factory.

(b) Fit shorting plug, see Fig. 2 for wiring, into DC supply socket, located on the rear of Display Unit, to complete internal circuit.

FIG. 2



(c) Wire the Mains connector lead to suitable plug for connection to local supply. Three core lead coded as follows:-

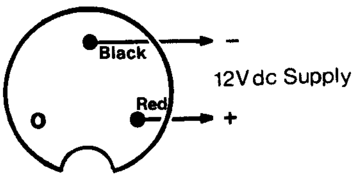
BROWN	: :	LIVE
BLUE	: :	NEUTRAL
GREEN & YELLOW	: :	EARTH

Note: A.C. Fuse 1A rating is fitted

D.C. Operation

(a) Remove shorting plug and modify wiring, see Fig. 3, and plug into socket at rear of Display Unit.

FIG. 3



View on wiring side

(b) Connect to 12V source capable of 2.5/3 amps continuous current.
Note 1: D.C. Fuse 5A rating is fitted
Note 2: If the supply is incorrectly connected the D.C. fuse will blow.
Note 3: The Display Unit operates to a negative earth and must not be connected to a 12V supply having a positive earth. If the supply is floating the Display Unit must not be connected to the same source that supplies other equipment having a positive earth.

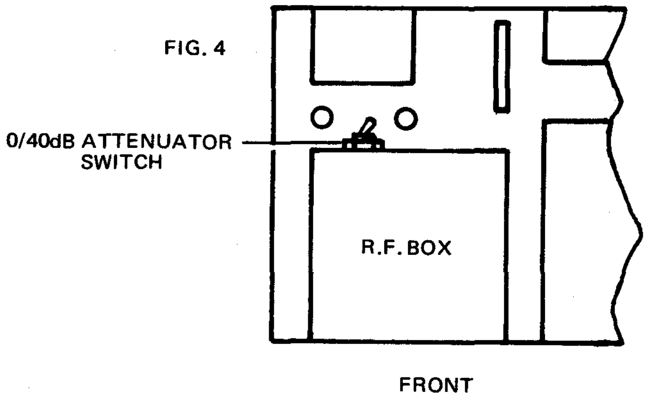
Signal Input

(a) The input sockets at the front and rear of the Display Unit are wired in parallel. [The signal input can be connected to either input convenient to the installation]. A standard BNC connector is supplied for this purpose, and should be wired to a suitable length of coaxial cable (50 or 75ohms). The free end may then be connected either to an aerial, coupling probe or a connector compatible with the associated equipment.

Note: The 961 Mk IIB version is supplied with a Low Pass Filter which should be connected between the BNC Connector and the chosen input.

(b) The optional 0/40dB Attenuator is operated by a switch located on the rear panel of the R.F. Tuner Box. (Operates rear input only). See Fig.4. The switch is **set** to the **OdB position** when despatched from the factory.

FIG. 4



Outputs

Rear Panel	–	Sweep Output	(Low Z)
		Pen Recorder Output	(Low Z)

OPERATION

CONTROL FUNCTIONS

TUNING CONTROL — Operates a two speed vernier scale, controlling the Input Frequencies.
MkII A – Calibrated 50kHz to 800kHz in 50kHz steps
MkII B – Calibrated 500kHz to 36.5MHz in 1MHz steps

INPUT ATTENUATOR — Controls the Input signal to the 1st Mixer stage. The scale settings 0 to 50dBs in 10dBs steps.

RESOLUTION (outer control) — Controls selectivity to enable optimum resolution to be obtained when used in conjunction with the "TB SPEED", "MANUAL SWEEP" & "WIDTH CONTROLS". Marked 1 to 5 switching positions.

AMP SCALE (inner control) — The control has two switching positions enabling a choice of "LOG" or "LIN" 'Y' display.

WIDTH — An eleven position switch controlling sweep frequency width. Examples of use:-
MkII A – with the 'TUNING CONTROL' at 400kHz a min. width of 1kHz and a max of 200kHz should be achieved.
MkII B – with the 'TUNING CONTROL' at 25MHz a min. width of 25kHz and a max of 10MHz should be achieved.

FINE WIDTH (inner control) — Enables fine width positions to be determined in the order of a 3:1 ratio over the "WIDTH CONTROL"

FINE CENTRE (outer control) — Used in conjunction with the 'TUNING CONTROL' it enables fine input frequencies to be set.

TB SPEED — Ten position switch allowing nine selections of speed from approx 5 sec's to 20 milli-sec's. The additional position marked "MANUAL" enables the "MANUAL SWEEP" control to function.

MANUAL SWEEP (outer control) — Potentiometer control giving full manual sweep facilities.

R.F. GAIN (inner control) — Enables manual gain control of the 2nd I.F. Stage.

VIDEO FILTER — A five position control. Varies the time constant of detector filtering.

CALIBRATOR SWITCH — A three position control which when used in conjunction with the "TUNING CONTROL" enables exact frequencies to be established.

Markings:- MkII A – Top position "100kHz"
centre position "OFF"
bottom position "10kHz"
MkII B – Top position "1MHz"
centre position "OFF"
bottom position "100kHz"

CAL AMP — Controls Amplitude of markers

ZERO SWEEP Push button control allowing recovery of correct frequency when changing speed or width.

SUPPLY SWITCH Operative for AC or DC working.

The following controls are as used for normal operation of an Oscilliscope 'BRILLIANCE'....'FOCUS'....'ASTIG'....'X SHIFT'....'Y SHIFT'....

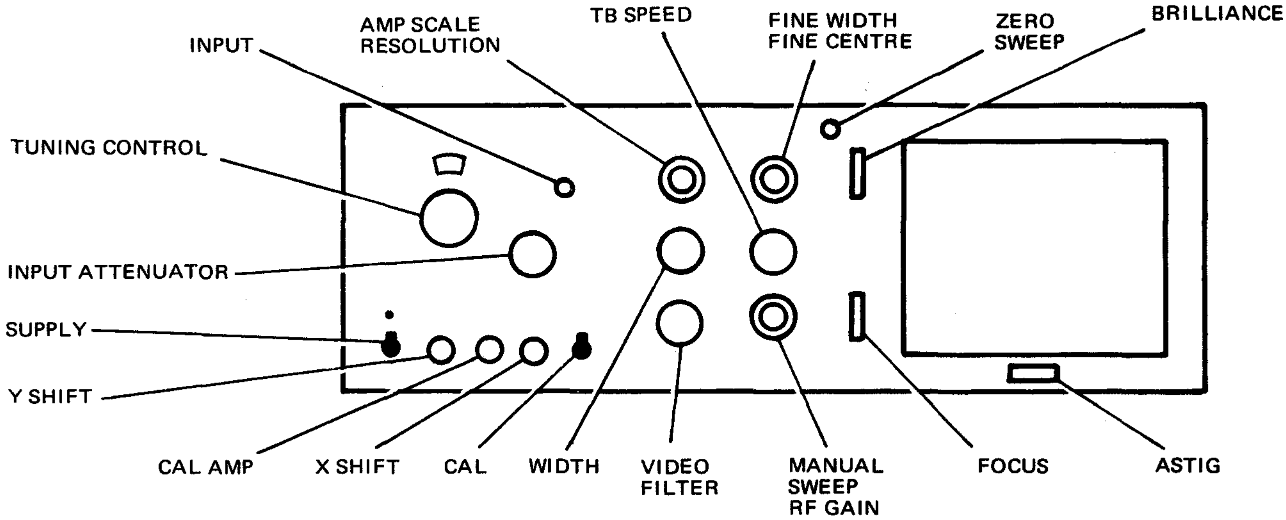


FIG. 5

SETTING UP/OPERATING PROCEDURE

1. Set 'SUPPLY' switch to 'ON', allow two minutes for CRT to warm up.
2. Adjust 'BRILLIANCE' to suit ambient light conditions.
3. Set 'TB SPEED' to 'MANUAL'.
4. Adjust 'MANUAL SWEEP' to centralize spot.
5. Adjust 'FOCUS' and 'ASTIG' for best possible spot definition.
6. Set 'TB SPEED' to position 5.
7. Adjust 'Y SHIFT' to position the trace 2cm above baseline.
8. Set 'FINE WIDTH' to minimum position (fully anticlockwise).
9. Adjust 'X SHIFT' to centralize the trace.
10. Re-adjust 'Y SHIFT' to position the trace on the baseline of the graticule.
11. Set 'R.F. GAIN' to maximum (fully clockwise).
12. Set 'INPUT ATTENUATOR' to OdB (fully clockwise).
13. Set 'AMP SCALE' for desired type of display.
14. Plug in associated receiver, either front or rear panel input sockets. (See 'INSTALLATION' Signal Input para (b) for optional 40dB feature).
15. Switch on associated receiver.
16. Adjust 'TUNING CONTROL' on Display Unit to the Receiver intermediate frequency.
17. Set 'FINE CENTRE' to mid-travel position.
18. Select appropriate setting on 'WIDTH' (widest display occurs at position 1).
19. Switch on the associated Receiver's calibrator and tune Receiver to convenient calibration marker, using headphones.
20. Adjust Receiver 'I.F. GAIN' control to give a suitable marker amplitude on CRT screen.

21. If the marker does not appear adjust 'TUNING CONTROL' and position the calibrator marker pip at the centre of the screen.

THE DISPLAY UNIT IS NOW TUNED EXACTLY TO THE I F OF THE ASSOCIATED RECEIVER

22. Verify the direction of frequency scale on CRT by tuning the associated Receiver higher in frequency. If the marker moves to the LEFT then lowest frequency occurs at left hand side of the screen.
23. Re-tune associated Receiver to place calibration marker back in the central position of CRT screen.
24. Switch on Display Unit 'CALIBRATOR' (MkII A . . . . 100kHz and 10kHz, MkII B . . . . 1MHz and 100kHz). Adjust marker height with 'CAL AMP' control.
    N.B. It should be noted that on the 1MHz (MkII B) and 100kHz (MkII A) setting, secondary pips will appear. These should be ignored.
25. Set 'WIDTH' and 'FINE WIDTH' controls to place Display Unit markers coincident with the vertical lines on the graticule.
26. Switch off **both** Calibrators.
27. Adjust 'INPUT ATTENUATOR' for suitable height of received spectrum using 'R.F.GAIN' for fine adjustment, if required.
    N.B. In normal operation it is advised to keep the 'R.F.GAIN' at it's MAXIMUM setting, reducing the gain with the 'INPUT ATTENUATOR'.
28. Set 'VIDEO FILTER' and 'RESOLUTION' for best display of received spectrum.
    N.B. 'VIDEO FILTER' introduces H.F.Cut (Maximum cut position 5) 'RESOLUTION' determines selectivity (Maximum selectivity position 5).
29. Re-adjust 'TB SPEED' etc. for optimum display.
    N.B. Use lowest possible 'TB SPEED' consistent with visual clarity.

MAINTENANCE

GENERAL

EP961 Mk.II Display Units have been designed for maximum reliability and should require very little maintenance. Spares for user-servicing can be supplied and advice will be given freely when required. Any enquiries relating to service matters should be directed to the "Sales and Service Dept." at our usual address. The Display Unit can be returned to us at any time should major servicing become necessary. The Ser. No. should be quoted in all communications and care should be taken to ensure that the Display Unit is well protected against possible damage during transit.

This Section gives information on replacement of fuses, lamps, etc. Instructions are also given for fitting major replacement items, such as modules. If a fault should occur the Circuit Description and associated information will provide a useful guide to servicing the equipment.

FUSE AND LAMP REPLACEMENT

Fuses

Two fuses are fitted in holders at the rear of the Display Unit, one being in series with the live pole of the a.c. supply and the other in the low-voltage d.c. circuit. Fuse ratings are as follows:-

A.C. Fuse	· · 100/125V supply	:	2A
	· · 200/250V supply	:	1A
D.C. Fuse	· · 5A		

Fuses are standard 20mm x 5mm glass cartridge type: spare fuses are supplied. (Part Nos. 1A:7173P; 2A:6704P; 5A:7814P).

Supply Indicator Lamp

If the lamp fails proceed as follows:-

1. Remove cabinet and/or dust cover.
2. Remove metal screen over the R.F. Unit (see Fig. 6) by unscrewing the four retaining screws on the left-hand side.
3. Unsolder the lamp connecting leads.
4. Remove lamp by pushing gently from the front.
   Fit replacement by inserting from the rear of the panel and pushing until lamp clicks home in collar.
5. Solder the lamp leads to the tag panel. Ensure that the longest lead (cathode) is connected to the resistor on the tag panel.

CATHODE-RAY TUBE REPLACEMENT

To replace the cathode-ray tube proceed as follows:-

1. Unscrew the four knurled nuts at the front and remove the tube escutcheon and graticule.
   Important: Do not polish the face of the new tube after removing protective covering.
2. Detach the connections at the side of the tube and the E.H.T. connector on the top.
3. Unscrew the small insulated panel from the top of the mu-metal screen and unsolder the leads to the Twist Coil.
4. Remove domed cover at rear. Unscrew small L-shaped bracket and detach base socket.
5. Push gently on base of tube and withdraw the tube from the front. The Twist Coil may slide off as the tube is withdrawn in which case it must be retrieved separately.
6. Transfer Twist Coil to neck of new tube and solder extension wires to leads.
7. Use extension wires to guide Twist Coil connections into required position when sliding tube into shield.
8. Replace graticule and tube escutcheon.

9. Fit base socket and secure L-shaped bracket.
10. Solder Twist Coil leads to pins on small insulated panel and replace the panel. Replace all other connections.

The following adjustments may be necessary when a new cathode-ray tube has been fitted:-

1. Adjust Twist Coil Potentiometer (RV24 on Regulator Board, see Fig. 6) to set baseline horizontal. If necessary, reverse Twist Coil leads to change field polarity.
2. Adjust Geometry Potentiometer (RV26 on Regulator Board) to correct any tendency for slight bowing of the base line.

REMOVAL OF UNITS, MODULES, ETC.

Refer to Fig. 6 for location of modules etc.

Standard Modules (X-Amplifier, Y-Amplifier, Timebase, Log/Lin. Amplifier, LV Rectifier)

1. Stand Display Unit chassis on left-hand side.
2. Disconnect leads from module pins.
3. Locate coaxial leads (Log/Lin. Amplifier) and inter-connectors (Y-Amplifier). Unplug connectors.
4. Remove the two retaining screws on underside of chassis, complete with shakeproof washers, taking care to note where earth tags are retained by these screws. The module should be supported as screws are removed.
5. Lift module free of chassis.
6. Replace module by reversing procedure detailed above, taking care to re-fit earth tags.

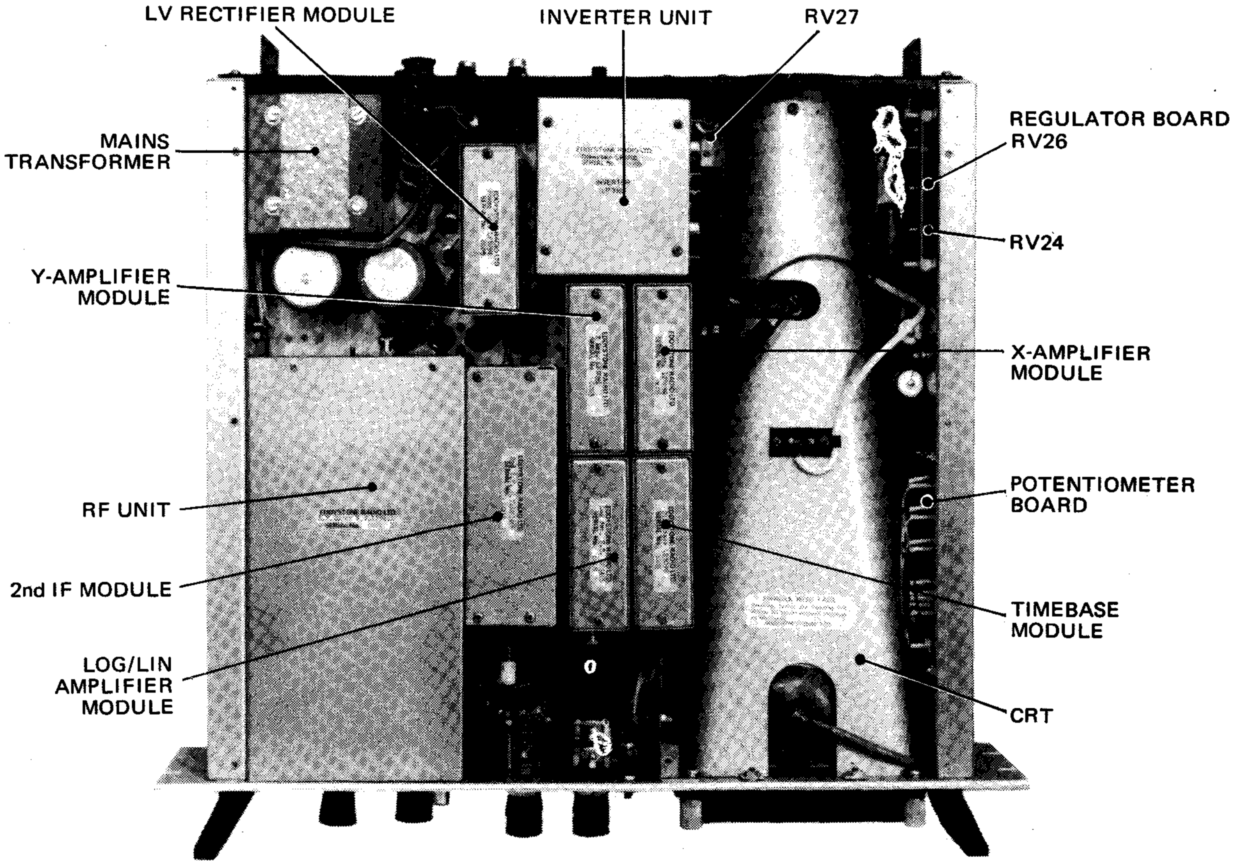


Fig. 6
Plan view of Display Unit with cover removed.

2ND IF Module

1. Remove all connections.
2. Set Resolution Switch to Position 1 and slacken screw in spindle coupler.
3. Remove four retaining screws on underside of chassis. (There are two groups of four screws associated with this module; the retaining screws are the outer group).
4. Slide module to the rear and lift clear of chassis.

Regulator Board

1. Disconnect leads from board pins.
2. Ease board off insulated pillars.

Calibrator Board

1. Remove two cover fixing screws.
2. Disconnect leads from board pins.
3. Ease board off insulated pillars.

Potentiometer Board

1. Remove four fixing screws.
2. Disconnect leads.

R.F. Unit

This contains four sub-units which may be removed in the following order:-

1st IF Unit; Sweep Oscillator Unit; RF Amplifier Unit; Attenuator Unit.

Proceed as follows:-

1. Remove four screws at left-hand side of outer metal screen and withdraw screen.
2. Remove four screws in top of inner metal screen and withdraw screen. The 1st IF Board is then exposed.
4. Slacken screws in spindle coupler of Sweep Oscillator Unit. Disconnect leads. Remove four retaining screws in base. Withdraw unit.
5. Disconnect coaxial leads and power supply plug at rear of RF Amplifier Unit. Remove two screws holding unit on support bracket. Access to these screws is facilitated by first detaching the Calibrator Board: it is not necessary to remove the leads to this board.
6. Set Attenuator Switch at 0dB position. Slacken screw at rear of spindle coupler. Detach connecting leads. Remove nut and washer on spindle bush.

Inverter Unit

1. Place chassis upside-down on bench.
2. Make a sketch of the soldered connections to the Inverter Unit.
3. Unsolder nine leads:-
   One orange; one red; three white (or yellow) P.T.F.E. sleeved (make particular note of connections); one chassis braid; one blue (bottom); two blue to pin on side of unit by power transistors.
4. Unclip EHT connector from cathode-ray tube.
5. Remove four screws securing unit to chassis.
6. Withdraw Inverter Unit. Fit replacement by reversing above procedure.
7. Check that tube heater voltage is 6.3V A.C. (pins 3 and 4 on tube base).
   If necessary adjust potentiometer RV27 located at top by rear of tube base.

Caution: heaters are 1.3KV above chassis potential.

CIRCUIT DESCRIPTION

A block diagram and a complete circuit diagram of the Display Unit are bound at the rear.

CIRCUITS CONTAINED IN RF UNIT

Except for frequency differences in the RF Units, the circuit function is the same for both models. Each of the RF Units take the basic form outlined in the Block Diagram. Appropriate frequencies etc. are indicated.

RF Input Amplifier

Input frequencies are fed at low-impedance, (50-100 Ω unbalanced), to a Wideband RF Amplifier. To prevent distortion, caused by large signals overloading the 1st Mixer, a 0-50dB attenuator is incorporated. Output from the Amplifier is taken, via the attenuator, to a Lowpass L/C Filter which determines the acceptance range of the particular unit fitted; the higher frequencies likely to produce undesired image responses are thus considerably attenuated. The signal is then applied to the 1st Mixer.

Sweep Oscillator

Oscillating on the higher side of the incoming signal, the sweep Oscillator is manually tuned over its appropriate frequency band. Two oscillator outputs are extracted via separate buffer stages. One output is taken to the Crystal Calibrator circuit; the other is applied to the 1st Mixer Stage where it heterodynes with the incoming RF Signal to produce the 1st IF.

1st IF

The 1st IF is the lower sideband of the mixer products which is selected by a filter and then amplified before being applied to the 2nd Mixer Stage. Bandwidth of the 1st IF is limited to some 10kHz in all versions and provides adequate selectivity to ensure that the signals applied to the 2nd Mixer are substantially free from spurious responses.

2nd Oscillator

The 2nd Oscillator is crystal controlled, oscillating on the higher side of the 1st IF frequency, its output is taken to the 2nd Mixer, where conversion to the 2nd IF takes place (70kHz or 500kHz). Output from the 2nd Mixer is fed via a co-axial lead to a 2nd IF Amplifier contained in the main chassis assembly.

CIRCUITS – MAIN CHASSIS ASSEMBLY

2nd IF Amplifier (70kHz or 500kHz)

Both IF Modules provide a high degree of amplification and feature variable selectivity, including crystal filter positions(s). Manual adjustment of the IF Gain is provided when operating the instrument with a linear display. When logarithmic display is used, the level of gain is pre-set to reduce noise clutter on the baseline.

Each IF Module includes a detector circuit which feeds a positive going output, via a switched video filter (5 positions), to the input of the Log/Lin. Amplifier.

Log/Lin. Amplifier

This module employs two integrated circuits and one dual transistor to provide linear or logarithmic amplification of the detector output. In the logarithmic mode of operation the dual transistor is used as a feedback element around the first operational amplifier. The feedback characteristic results in an output voltage which is proportional to the logarithm of the input voltage and presents up to 40dB of display amplitude. In the linear mode the dual transistor is by-passed and the circuit then becomes a DC coupled linear Amplifier presenting up to 20dB of display amplitude. Output from the Log/Lin. Amplifier is DC coupled to the input of the 'Y' Amplifier.

'Y' Amplifier

Output from the Log/Lin. Amplifier is fed via a source follower TR22 to the 'Y' Amplifier. This amplifier consists of a combination of cascaded feedback pairs and longtailed pairs.

Balanced outputs at the collectors of TR23 and TR24 are applied to TR27 and TR26 respectively.

RV5 ('Y' Gain) varies the amount of feedback.

RV6 and RV7 set the base voltage of TR24 via TR25.

TR26 and TR27 constitute a paraphase amplifier providing a balanced output drive waveform to the 'Y' Plates of the C.R.T.

Output from the Marker Amplifier is also applied to the base of TR24 via TR25.

An output taken from the collector of TR26 is fed to a source follower TR28 which provides direct drive for an external pen recorder.

Crystal Calibrator

Model EP961 Mk.II-A has a crystal fundamental frequency of 1MHz. For Model EP961 Mk.II-B the crystal fundamental is 10MHz. Both models utilise a 'divide-by-ten' circuit to provide calibration displays. The oscillator output is applied to a mixer circuit which also receives drive from the sweep oscillator. Audible beats occuring at harmonic intervals are amplified and applied to the 'Y' Amplifier deflector circuit. A control is provided to permit adjustment of the marker amplitude. Increased height of the marker display can be obtained when operating at advanced setting of the IF Gain.

Timebase

Nine time base speeds can be selected, ranging from 0.2Hz (very low sweeps of 5 seconds duration) to speeds of 50Hz. A tenth position of the switch permits direct manual control of the sweep by means of a panel control to cater for certain specialised applications.

Separate coarse and fine controls, are provided for adjustment of sweep widths, which range from 1kHz to 200kHz on the EP961 Mk.II-A model and from 10kHz to 10MHz on the EP961 Mk.II-B model. The basic timebase circuit makes use of a constant current bootstrap sweep generator, controlled by a bistable multivibrator which in turn is triggered from a free-running (astable) multivibrator. A further multi (monostable type) is employed to restrain the bistable multi during the flyback period and an associated clamp circuit provides automatic beam blanking. Sequential and revertive switching, over a delayed feedback loop, govern the action of the timebase circuit described as follows:-

The two stable states of the bistable multi may be considered as representing the forward sweep period (Sweep ON) and flyback period (Sweep OFF).

A pulse from the free running multi switches the bistable ON, removing the clamps from both the C.R.T. Blanking Circuit and the bootstrap sweep generator. The forward sweep commences at a speed determined by the selected R.C. time constant of the sweep generator. The charging sequence continues to a point where the sawtooth amplitude triggers the monostable multi into a quasi-stable state. The changed state of the monostable switches OFF the bistable via a pair of steering diodes in a feedback loop. This initiates the flyback period clamping both the electron beam of the C.R.T. and the sweep generator thus discharging the timebase capacitor.

The bistable is now ready to accept another input trigger pulse, but it is prevented from doing so by the action of the monostable. When the monostable returns to its stable state, in a time determined by the selected time constant, the 'hold-off' conditions are removed preparing the bistable for the next trigger pulse which reinitiates the whole action.

Reactor Drive

The sawtooth waveform from the timebase circuit is AC coupled to the Reactor Driver through a switched resistive potential divider. This determines the amount of current drive through the reactor coil and thus the amount of frequency deviation (Sweep Width) about the centre frequency of the sweep oscillator.

PERFORMANCE TESTING

Typical performance figures are given below. The Display Unit controls should be set initially as follows:-

LOG/LIN	: :	LIN
RESOLUTION	: :	2
WIDTH	: :	11
FINE WIDTH	: :	MINIMUM
TB SPEED	: :	1
INPUT ATTENTUATOR	: :	0dB

MODEL EP961 Mk.II-A

Sensitivity : 10μV input to give 1 cm. trace deflection.

Resolution : Signals differing by 40dB at 200Hz separation, (with RESOLUTION switch at position 1)

MODEL EP961 Mk.II-B

Sensitivity : 25μV input to give 1 cm. trace deflection

Resolution : Signals differing by 40dB at 6kHz separation, (with RESOLUTION switch at position 1)

VOLTAGE ANALYSIS

In the event of the Display Unit failing to operate normally initial voltage checks should be carried out at module and unit terminations in order to localise the fault. The majority of modules and units can be taken out and re-connected with covers removed to allow access for checking stage voltages. The Voltage Analysis Tables provided here give nominal values of module and stage voltages. A tolerance of 10% should be allowed on all readings, which were taken with a standard 20,000 ohm/volt multi-range testset using the lowest range applicable to the measurement being made. When making voltage measurements particular care should be taken to avoid accidental short circuits across the module pins.

Controls should be adjusted initially as indicated below:-

RF GAIN	: :	MAXIMUM
TB SPEED	: :	RANGE 7
WIDTH	: :	RANGE 1
FINE WIDTH	: :	MINIMUM
LOG/LIN	: :	LIN
RESOLUTION	: :	RANGE 1
CAL	: :	100kHz

TABLE 1

MODULE SUPPLIES ETC.

Voltages are positive with respect to circuit earth unless otherwise indicated.

MODULE/UNIT ETC.	PIN	VOLTAGE	NOTES
Inverter Unit	G	40V	Alternating
	F	80V	Alternating
	H	13V	Alternating
	J	0V	
	B	−1.3kV	
	C–D	9V	Alternating. Pins C and D are 1.3kV above chassis potential
		4.5kV	CRT final anode
LV Rectifier Module	1	0V	
	2	13V	Alternating
	3	40V	
	4	40V	
	5	40V	Alternating
	6	−40V	
	7	−80V	
	8	80V	
	9	80V	Alternating
	10	−13V	
	11	13V	
	12	13V	
	13	−13V	
	14	0V	
Regulator Board	15	0V	
	16	9V	Regulated
	16A	9V	Regulated
	17	9.8V	*
	17A	13.5V	*Unregulated
	18	13.5V	*Unregulated
	18A	40V	
	19	−40V	
	19A	20V	*
	20	2.2V	*
	21	0V	

* Voltage determined by power supply voltage.

Table 1 cont.

MODULE/UNIT ETC.	PIN	VOLTAGE	NOTES
Timebase Module	22	−0.75V	
	23	−10V	
	24	−40V	
	25	−80V	
	26	−17V	
	27	−3.3V	7–8V p–p waveform present
	28	13V	
	29	−0.3V	700mV p–p waveform present
	30	−13V	
	31	−1.5V	7V p–p waveform present
	32	0V	
	33	−1.5V	1V p–p waveform present
	34	−10V	
	35	−1.0V	1V p–p waveform present
	36	−2.3V	7V p–p waveform present
	37	−6.5V	7V p–p waveform present
	38	−4.0V	7V p–p waveform present
	39	0V	
X-Amplifier Module	40	13V	
	41	−0.25V	700mV p–p waveform present
	42	−10V	
	43	−13V	7V p–p waveform present
	44	− 4V	
	45	−4.1V	7V p–p waveform present
	46	−20V	
	47	−19V	
	48	0V	
	49	−13V	
	50	−25V	
	51	−24V	6–7V p–p waveform present
	52	51V	40V p–p waveform present
	53	38V	40V p–p waveform present
	54	80V	
	55	−40V	
	56	0V	

Table 1 cont.

MODULE/UNIT ETC.	PIN	VOLTAGE	NOTES
LOG/LIN Amplifier Module	57	−9.5V	
	58	0V	*
	59	−0.75V	
	60	−6.0V	
	61	0V	*
	62	0V	*
	63	0V	*
	64	−10.5V	
	65	−13V	
	66	−10V	
	67	−12.5V	
	68	−13V	
	69	−6.5V	
	70	−12.5V	
	71	−13V	
	72	13.5V	
	73	−13.5V	
	74	0V	
Y-Amplifier Module	75	0V	No signal
	76	40V	
	77	18V	
	78	3.3V	
	79	−40V	
	80	−10.5V	
	81	13V	
	82	32V	
	83	0V	
	84	0.85V	
	85	−4.7V	
	86	2.3V	
	87	2.1V	
	88	−12V	
	89	49V	
	90	80V	
	91	4V	
	92	4V	

* Voltages may be found if capacitors connected to these pins are still charged

Table 1 cont.

MODULE/UNIT ETC.	PIN	VOLTAGE	NOTES
			No signal
RF Tuner Unit	93	−1V	
EP961 Mk.II-A	99	0V	
	100	−13V	
	110	0V	
	111	10V	
	150	−10V	
	F	0V	
	G	0V	
			No signal
RF Tuner Unit	94	0V	
EP961 Mk.II-B	96	−10V	
	99	−1V	
	110	0V	
	111	10V	
	150	−10V	
	F	0V	
	G	0V	
			No signal
2nd IF Module	126	10V	
	127	0V	
	F	0V	
	I	0V	
Calibrator Board	112	10V	
	113	10V	
	129	1.4V	
	130	−0.5V	
	131	−10V	
	132	10V	
	133	10V	
	G	1.5—2V rms	Waveform from Sweep Oscillator

Table 1 cont.

MODULE/UNIT ETC.	PIN	VOLTAGE	NOTES
Cathode-ray Tube Base	1	–1240V	
	2	–1210V	
	3	–1400V	
	4	–1400V	
	5	–1020V	
	6	0V	
	7	0V	
	8	–	Blanking pulses during flyback
	9	–62V	
	10	0V	
	11	0V	
	12	0V	

TABLE 2
STAGE VOLTAGES

Voltages are positive with respect to circuit earth unless otherwise indicated.

REF	EMITTER/ SOURCE	BASE/GATE 1	COLLECTOR/ DRAIN	GATE 2	NOTES
TR 1	1.3V	0V	8.4V	0.4V	**These readings apply to Model EP961 Mk.II-A only**
TR 2	1.1V	1.7V	10.0V	–	
TR 3	0.4V	0V	9.8V	0.4V	
TR 4	3.6V	3.1V	9.6V	–	
TR 6	–9.4V	–8.7V	0V	–	
TR 7	–8.6V	–3.2V	0V	–	
TR 8	–9.2V	–3.2V	0V	–	
TR10	3.2V	3.8V	7.9V	–	
TR11	2.7V	2.8V	8.0V	–	
TR12	3.1V	3.4V	8.0V	–	
TR13	1.5V	0V	7.0V	–	
TR14	0.9V	1.5V	8.7V	–	
TR15	0.7V	1.4V	9.3V	–	
TR16	0.8V	1.3V	2.6V	–	
TR16A	1.3V	1.4V	4.4V	–	
TR17	1.5V	2.3V	3.0V	–	
TR17A	2.0V	0.8V	5.5V	0.25V	
TR18	3.1V	3.6V	4.6V	–	
TR18A	1.4V	1.9V	3.8V	–	
TR19	2.3V	2.9V	8.2V	–	
TR20	0.9V	1.6V	7.5V	–	

Table 2 cont.

REF	EMITTER/ SOURCE	BASE/GATE 1	COLLECTOR/ DRAIN	GATE 2	NOTES
TR 1	0.6V	0.2V	7.5V	0V	**These readings apply to Model EP961 Mk.II-B only**
TR 2	1.6V	2.3V	8.7V	–	
TR 3	1.8V	2.4V	8.9V	–	
TR 4	1.5V	0.4V	9.3V	0V	
TR 5	0.6V	1.2V	8.3V	–	
TR 7	–4.7V	–5.5V	0V	–	
TR 8	–7.6V	–1.8V	0V	–	
TR 9	–8.5V	–7.8V	–6.0V	–	
TR10	0.3V	0.9V	8.5V	–	
TR11	0.8V	1.5V	8.5V	–	
TR12	1.7V	2.4V	8.1V	–	
TR16	2.6V	2.9V	10.2V	–	
TR16A	1.4V	0.5V	3.5V	–	
TR17	1.4V	1.8V	3.9V	–	
TR17A	2.8V	2.7V	4.4V	0.25V	
TR18	2.9V	3.6V	4.8V	–	
TR18A	1.2V	1.7V	5.5V	–	
TR19	2.2V	2.8V	8.3V	–	
TR20	1.1V	2.1V	7.1V	–	
TR21(1)	0.1V	0V	0V		
TR22(2)	0.1V	0.4V	0.4V		
TR22	–1.5V	–1.2V	10.0V		
TR23	2.5V	2.1V	–5.0V		
TR24	2.7V	2.1V	–3.9V		
TR25	1.5V	1.1V	–5.3V		
TR26	–4.9V	–4.3V	–6.1V		
TR27	–6.0V	–5.4V	50.0V		
TR28	0.9V	0V	6.5V		
TR29	0V	–0.1V	–9.5V		
TR30	–8.9V	9.3V	–12.8V		
TR31	0.1V	–0.1V	–2.9V		
TR32	–2.2V	–2.9V	–12.5V		
TR33	–1.5V	–2.1V	–12.5V		
TR34	0V	–0.2V	–40.0V		
TR35	0V	–0.3V	–5.6V		

Table 2 cont.

REF	EMITTER/ SOURCE	BASE/GATE 1	COLLECTOR/ DRAIN	GATE 2	NOTES
TR36	0V	−0.2V	−5.8V		
TR37	0V	−0.2V	−2.8V		
TR38	−10.6V	−11.1V	−12.5V		
TR39	11.2V	12.5V	6.4V		
TR40	11.2V	12.5V	6.4V		
TR41	−0.7V	−1.3V	−9.9V		
TR42	−16.2V	−15.8V	22.5V		
TR43	−18.8V	−18.2V	59.0V		
TR44	−33.5V	−33.0V	−23.0V		
TR45	−18.6V	−17.8V	−12.6V		
TR46	10.3V	10.2V	−13.3V		
TR47	12.1V	13.0V	10.4V		
TR48	3.1V	3.6V	13.0V		
TR49	3.1V	3.6V	5.0V		
TR50	9.2V	9.9V	13.7V		
TR51	9.2V	9.9V	13.7V		
TR52	0V	−0.9V	8.9V		
TR53	0V	−1.0V	8.9V		

APPENDIX 'A'

SEMICONDUCTOR COMPLEMENT

REF	TYPE	MANUFACTURER	CIRCUIT FUNCTION	LOC
TR1*	40673	RCA	1st Mixer	B
TR2*	2N4254	Texas	1st IF Amplifier 1.6MHz	B
TR3*	40673	RCA	2nd Mixer	B
TR4*	2N4254	Texas	1670kHz Oscillator (Crystal)	B
TR5*	–	–	Not allocated	–
TR6*	2S512	Texas	Sweep Oscillator	C
TR7*	UC734B	Union Carbide	Sweep Oscillator Buffer (Mixer)	C
TR8*	UC734B	Union Carbide	Sweep Oscillator Buffer (Calibrator)	C
TR1**	40673	RCA	1st Mixer	B
TR2**	2N4254	Texas	1st IF Amplifier 45MHz	B
TR3**	2N4254	Texas	2nd IF Amplifier 45MHz	B
TR4**	40673	RCA	2nd Mixer	B
TR5**	BFX89	Mullard	45.5MHz Crystal Oscillator	B
TR6**	–	–	Not allocated	–
TR7**	BFX89	Mullard	Sweep Oscillator	C
TR8**	UC734B	Union Carbide	Sweep Oscillator Buffer (Mixer)	C
TR9**	2N4254	Texas.	Sweep Oscillator Buffer (Calibrator)	C
TR10*	2N4254	Texas	1st IF Amplifier 70kHz	D
TR11*	2N4254	Texas	Emitter Follower (Narrow)	D
TR12*	2N4254	Texas	Emitter Follower (Wide)	D
TR13*	UC734B	Union Carbide	2nd IF Amplifier	D
TR14*	2N4254	Texas	3rd IF Amplifier	D
TR15*	2N4254	Texas	4th IF Amplifier	D
TR10**	2N4254	Texas	1st IF Amplifier	D
TR11**	2N4254	Texas	2nd IF Amplifier	D
TR12**	2N4254	Texas	3rd IF Amplifier	D
TR16	2N4254	Texas	Cal Crystal Oscillator 10MHz (B), 1MHz (A)	E
TR16A	2N4254	Texas	Cal Oscillator Amplifier	E
TR17	2N4254	Texas	Cal Sweep Oscillator Amplifier	E
TR17A	40673	RCA	Cal Mixer	E
TR18	2N4254	Texas	2nd Marker Amplifier & Shaper	E
TR18A	2N4254	Texas	1st Marker Amplifier	E
TR19	2N4254	Texas	3rd Marker Amplifier & Shaper	E
TR20	2N4254	Texas	4th Marker Amplifier	E
TR21	BFY81	Texas	Log/Lin Amplifier	F
TR22	UC734B	Union Carbide	1st Y Amplifier	G
TR23	2N3702	Texas	2nd Y Amplifier	G
TR24	2N3702	Texas	2nd Y Amplifier	G
TR25	2N3702	Texas	Shift Control Stage	G
TR26	2N3712	Texas	Y Output Amplifier	G

* MODEL A ONLY ** MODEL B ONLY

REF	TYPE	MANUFACTURER	CIRCUIT FUNCTION	LOC
TR27	2N3712	Texas	Y Output Amplifier	G
TR28	UC734B	Union Carbide	Pen Recorder Output	E
TR29	2N3702	Texas	Monostable Multivibrator	H
TR30	2N3702	Texas	Monostable Multivibrator	H
TR31	2N3702	Texas	Monostable Multivibrator	H
TR32	2N3702	Texas	Bootstrap Amplifier	H
TR33	2N3702	Texas	Bootstrap Amplifier	H
TR34	2S325	Texas	Flyback Blanking Clamp	H
TR35	2N3702	Texas	Bistable Multivibrator	H
TR36	2N3702	Texas	Bistable Multivibrator	H
TR37	2N3702	Texas	Sweep Clamp	H
TR38	2N1132	Texas	Bootstrap Driver	I
TR39	2S302	Texas	Astable Multivibrator	I
TR40	2S302	Texas	Astable Multivibrator	I
TR41	BCY39 or 2S302	Mullard Texas	Sweep Oscillator Drive	H
TR42	2N3712	Texas	X Amplifier	I
TR43	2N3712	Texas	X Amplifier	I
TR44	2S512	Texas	Constant Current Source	I
TR45	2N3704	Texas	X Shift Control Stage	I
TR46	40372	RCA	Voltage Regulator Amplifier	K
TR47	2N3702	Texas	Voltage Regulator Amplifier	K
TR48	BFY51	Mullard	Voltage Regulator Balance	K
TR49	BFY51	Mullard	Voltage Regulator Balance	K
TR50	2N3055	RCA	High Current Regulator	N
TR51	2N3055	RCA	High Current Regulator	N
TR52	2N3055	RCA	Inverter Oscillator	L
TR53	2N3055	RCA	Inverter Oscillator	L
D1	BZY88/C5V1	Mullard	IC2 Voltage Regulator	E
D2	BZY88/C5V1	Mullard	IC3 Voltage Regulator	E
D3-D4	—	—	Not allocated	—
D5*	OA47	Mullard	Detector	D
D5**	OA47	Mullard	Detector	D
D6*	BZY88/C10	Mullard	Sweep Oscillator Voltage Stabilizer	C
D6**	BZY88/C8V2	Mullard	Sweep Oscillator Voltage Stabilizer	C
D7	BZY88/C6V2	Mullard	Y Amplifier Regulator	G
D8-D9	—	—	Not allocated	—
D10	OA47	Mullard	Coupling Diode	H
D11	OA47	Mullard	Clamp Diode	H
D12	OA47	Mullard	Clamp Diode	H
D13	OA91	Mullard	Coupling Diode	H
D14	OA47	Mullard	Coupling Diode	H
D15	OA91	Mullard	Coupling Diode	H
D16	OA91	Mullard	Clamp Diode	H
D17	OA47	Mullard	Clamp Diode	H
D18	OA47	Mullard	Clamp Diode	H
D19	OA47	Mullard	Clamp Diode	H
D20	OA47	Mullard	Clamp Diode	H
D21	BAX78	Mullard	Coupling Diode	I
D22	1N4004	Texas	Sweep Oscillator Linearity Diode	M

* MODEL A ONLY ** MODEL B ONLY

REF	TYPE	MANUFACTURER	CIRCUIT FUNCTION	LOC
D23	OA47	Mullard	Clamp Diode (Sweep Drive)	H
D24	OA202	Mullard	Control Diode X Amplifier	I
D25	BZY95/C15	Mullard	X Amplifier Coupling Diode	I
D26	OA202	Mullard	Clamp Diode X Amplifier	I
D27	OA202	Mullard	Control Diode X Amplifier	I
D28	OA202	Mullard	Clamp Diode X Amplifier	I
D29	BZY88/C3V6	Mullard	Voltage Regulator Reference	K
D30	1N4004	Texas	80 Volt Positive Rectifier	J
D31	1N4004	Texas	80 Volt Negative Rectifier	J
D32	1N4004	Texas	40 Volt Positive Rectifier	J
D33	1N4004	Texas	40 Volt Negative Rectifier	J
D34	1N4004	Texas	13 Volt Positive Rectifier	J
D35	1N4004	Texas	13 Volt Negative Rectifier	J
D36	LA60	International Rectifier	+4.5kV Voltage Doubler Rectifier	L
D37	LA60	International Rectifier	+4.5kV Voltage Doubler Rectifier	L
D38	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D39	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D40	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D41	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D42	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D43	1N4004	Texas	–1.3kV Voltage Doubler Rectifier	L
D44	BYX22/200	Mullard	Inverter Starting Diode	L
D45	1B40K05	Texas	Mains Supply Bridge Rectifier	O
D46	BYX38/300R	Mullard	Reverse Polarity Protection Diode	O
D47	OAZ228	Mullard	10 Volt Positive Regulator Diode	O
D48	OAZ228	Mullard	10 Volt Negative Regulator Diode	O
D49	–	–	Not allocated	–
D50	508214850	Hewlett Packard	Supply on Indicator	O
IC1*	CA3001	RCA	Input RF Amplifier	A
IC1**	SA20	Sylvania	Input RF Amplifier	A
IC2	SN7490	Fairchild	10MHz Divider (B Model) 1MHz Divider (A Model)	E
IC3	SN7490	Fairchild	1MHz Divider (B Model) 100kHz Divider (A Model)	E
IC4	7709C	Fairchild	Log/Lin Amplifier	F
IC5	7709C	Fairchild	Log/Lin Amplifier	F

* MODEL A ONLY ** MODEL B ONLY

APPENDIX 'B'

COMPONENT VALUES TOLERANCES AND RATINGS

Location Code

A RF Amplifier
B 1st IF Amplifier and Attenuator
C Sweep Oscillator LF
D 2nd IF
E Calibrator Marker Amp and Recorder Emitter Board
F Log/Lin Amplifier
G Y Amplifier
H Time Base
I X Amplifier
J L V Rectifier Module
K Regulator Board
L Inverter
M Pot Mounting Board
N Panel
O Main Chassis
P Side Plates
R Rear Panel

MODEL A ONLY

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C1	3900pF	Silvered Mica	5%	350V	B
C2	3900pF	Silvered Mica	5%	350V	B
C3	4700pF	Silvered Mica	5%	350V	B
C4	1800pF	Silvered Mica	5%	350V	B
C5	4700pF	Silvered Mica	5%	350V	B
C6	3900pF	Silvered Mica	5%	350V	B
C7	.047μF	Polycarbonate	20%	100V	B
C8	.047μF	Polycarbonate	20%	100V	B
C9	.047μF	Polycarbonate	20%	100V	B
C10	.1μF	Polycarbonate	20%	100V	B
C10A	.1μF	Polycarbonate	20%	100V	B
C11	100pF	Polystyrene	2%	125V	B
C12	1.5pF	Tubular Ceramic	.5pF	200V	B
C13	100pF	Polystyrene	2%	125V	B
C14	50pF	Silvered Mica	5%	350V	B
C15	140pF	Polystyrene	5%	125V	B
C16	12pF	Tubular Ceramic	10%	500V	B
C17	180pF	Polystyrene	2%	125V	B
C18	6.8pF	Tubular Ceramic	1%	200V	B
C19	180pF	Polystyrene	2%	125V	B
C20	6.8pF	Tubular Ceramic	1%	200V	B
C21	180pF	Polystyrene	2%	125V	B
C22	12pF	Tubular Ceramic	10%	500V	B
C23	140pF	Polystyrene	5%	125V	B
C24	60pF	Silvered Ceramic	10%	500V	B
C25	.1μF	Polycarbonate	20%	100V	B
C26	.1μF	Polycarbonate	20%	100V	B
C27	100pF	Polystyrene	2%	125V	B
C28	2pF	Tubular Ceramic	.25pF	500V	B
C29	100pF	Polystyrene	2%	125V	B
C30	.047μF	Polycarbonate	20%	100V	B
C30A	.1μF	Polycarbonate	20%	100V	B

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C31	10pF	Silvered Mica	10%	350V	B
C32	300pF	Silvered Mica	5%	350V	B
C33	300pF	Silvered Mica	5%	350V	B
C34	.1μF	Polycarbonate	20%	100V	B
C35	.1μF	Polycarbonate	20%	100V	B
C36	3200pF	Silvered Mica	5%	200V	B
C37	590pF	Polystyrene	5%	125V	B
C38	3200pF	Silvered Mica	5%	200V	B
C39	.1μF	Polycarbonate	20%	100V	B
C40	10μF	Electrolytic	+100% −10%	25V	B
C41-C49	—	Not allocated	—	—	—
C50	.1μF	Polycarbonate	20%	100V	A
C51	10μF	Electrolytic	+100% −10%	25V	A
C52	.1μF	Polycarbonate	20%	100V	A
C53	.1μF	Polycarbonate	20%	100V	A
C54	.1μF	Polycarbonate	20%	100V	A
C55	10μF	Electrolytic	+100% −10%	25V	A
C56	.1μF	Polycarbonate	20%	100V	A
C57	10μF	Electrolytic	+100% −10%	25V	A
C58-C69	—	Not allocated	—	—	—
C70	.1μF	Polycarbonate	20%	100V	C
C71	22μF	Tantalum	20%	16V	C
C72	.1μF	Polycarbonate	20%	100V	C
C73	12-360pF	Variable	—	—	C
C74	250pF	Silvered Mica	5%	350V	C
C75	970pF	Silvered Mica	5%	350V	C
C76	.001μF	Disk Ceramic	20%	500V	C
C77	.047μF	Polycarbonate	20%	100V	C
C78	10μF	Tantalum	20%	25V	C
C79	.001μF	Disk Ceramic	20%	500V	C
C80	.1μF	Polycarbonate	20%	100V	C
C81-C100	—	Not allocated	—	—	—
C101	390pF	Polystyrene	2%	125V	D
C102	—	Not allocated	—	—	—
C103	.047μF	Polycarbonate	20%	100V	D
C104	10μF	Electrolytic	+100% −10%	25V	D
C105	.002μF	Polystyrene	2%	125V	D
C106	150pF	Silvered Mica	5%	350V	D
C107	.002μF	Polystyrene	2%	125V	D
C108	.002μF	Polystyrene	2%	125V	D
C109	40pF	Silvered Mica	5%	350V	D
C110	.002μF	Polystyrene	2%	125V	D
C111	.047μF	Polycarbonate	20%	100V	D
C112	.047μF	Polycarbonate	20%	100V	D

MODEL A ONLY (Continued)

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C113	10μF	Electrolytic	+100% –10%	25V	D
C114	.047μF	Polycarbonate	20%	100V	D
C115	10μF	Electrolytic	+100% –10%	25V	D
C116	4.7μF	Electrolytic	+50% –10%	63V	D
C117	.047μF	Polycarbonate	20%	100V	D
C118	4.7μF	Electrolytic	+50% –10%	63V	D
C119	10μF	Electrolytic	+100% –10%	25V	D
C120	.001μF	Polystyrene	2%	125V	D
C121	.047μF	Polycarbonate	20%	100V	D
C122	4.7μF	Electrolytic	+50% –10%	63V	D
C123	.001μF	Polystyrene	2%	125V	D
C124	10μF	Electrolytic	+100% –10%	25V	D
C125	10μF	Electrolytic	+100% –10%	25V	D
C126	.001μF	Disk Ceramic	20%	500V	D
C127-C129	—	Not allocated	—	—	—

MODEL B ONLY

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C1	.01μF	Polycarbonate	20%	100V	B
C2	27pF	Tubular Ceramic	5%	200V	B
C3	60pF	Polystyrene	5%	125V	B
C4	150pF	Silvered Mica	5%	350V	B
C5	27pF	Tubular Ceramic	5%	200V	B
C6	25pF	Tubular Ceramic	5%	200V	B
C7	.001μF	Disk Ceramic	20%	500V	B
C8	.001μF	Disk Ceramic	20%	500V	B
C8A	.001μF	Disk Ceramic	20%	500V	B
C9	15pF	Tubular Ceramic	5%	200V	B
C10	.001μF	Disk Ceramic	20%	500V	B
C11	1.5pF	Tubular Ceramic	.25pF	200V	B
C12	15pF	Tubular Ceramic	5%	200V	B
C13	.001μF	Disk Ceramic	20%	500V	B
C14	.001μF	Disk Ceramic	20%	500V	B
C15	15pF	Tubular Ceramic	5%	200V	B
C16	1.5pF	Tubular Ceramic	.25pF	200V	B
C17	15pF	Tubular Ceramic	10%	200V	B
C18	.001μF	Disk Ceramic	20%	500V	B
C19	.001μF	Disk Ceramic	20%	500V	B
C20	.001μF	Disk Ceramic	20%	500V	B
C21	.011μF	Disk Ceramic	20%	500V	B
C22	15pF	Tubular Ceramic	10%	200V	B

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C23	1.5pF	Tubular Ceramic	.25pF	200V	B
C23A	.001μF	Disk Ceramic	20%	500V	B
C24	15pF	Tubular Ceramic	10%	200V	B
C25	.001μF	Polystyrene	2%	125V	B
C26	.1μF	Polycarbonate	20%	100V	B
C27	100pF	Polystyrene	5%	125V	B
C28	.001μF	Disk Ceramic	20%	500V	B
C29	56pF	Polystyrene	2%	125V	B
C30	.001μF	Disk Ceramic	20%	500V	B
C31	—	Not allocated	—	—	—
C32	390pF	Polystyrene	5%	125V	B
C33	22pF	Tubular Ceramic	5%	200V	B
C34	390pF	Polystyrene	5%	125V	B
C35	.1μF	Polycarbonate	20%	100V	B
C36-C49	—	Not allocated	—	—	—
C50	.1μF	Polycarbonate	20%	100V	A
C51	50pF	Tubular Ceramic	10%	500V	A
C52	100μF	Electrolytic	+50% −10%	16V	A
C53	.1μF	Polycarbonate	20%	100V	A
C54	3pF	Tubular Ceramic	.25pF	200V	A
C55	.1μF	Polycarbonate	20%	100V	A
C56	100μF	Electrolytic	+50% −10%	16V	A
C57	.1μF	Polycarbonate	20%	100V	A
C58	.1μF	Polycarbonate	20%	100V	A
C59	20pF	Tubular Ceramic	10%	500V	A
C60	.1μF	Polycarbonate	20%	100V	A
C61-C69	—	Not allocated	—	—	—
C70	.001μF	Disk Ceramic	20%	500V	C
C71	.1μF	Polycarbonate	20%	100V	C
C72	.1μF	Polycarbonate	20%	100V	C
C73	15pF	Tubular Ceramic	10%	200V	C
C74	5-90pF	Variable	—	—	C
C75	—	Not allocated	—	—	—
C76	25pF	Tubular Ceramic	5%	200V	C
C77	22pF	Tubular Ceramic	10%	200V	C
C78	.001μF	Disk Ceramic	20%	500V	C
C79	150μF	Electrolytic	+50% −10%	25V	C
C80	.001μF	Disk Ceramic	20%	500V	C
C81	.001μF	Disk Ceramic	20%	500V	C
C82	25pF	Tubular Ceramic	5%	200V	C
C83-C99	—	Not allocated	—	—	—
C100	.047μF	Polycarbonate	20%	100V	D
C101	.1μF	Polycarbonate	20%	100V	D
C102	390pF	Polystyrene	5%	125V	D

MODEL B ONLY (Continued)

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C103	.1μF	Polycarbonate	20%	100V	D
C104	800pF	Silvered Mica	2%	350V	D
C105	800pF	Silvered Mica	2%	350V	D
C106	1.5-6pF	Trimmer	—	—	D
C107	130pF	Silvered Mica	5%	350V	D
C108	180pF	Polystyrene	2%	125V	D
C109	130pF	Silvered Mica	5%	350V	D
C110	.1μF	Polycarbonate	20%	100V	D
C111	1500pF	Tubular Ceramic	10%	500V	D
C112	.1μF	Polycarbonate	20%	100V	D
C113	390pF	Polystyrene	5%	125V	D
C114	22pF	Tubular Ceramic	5%	200V	D
C115	390pF	Polystyrene	5%	125V	D
C116	390pF	Polystyrene	5%	125V	D
C116A	3pF	Tubular Ceramic	.5pF	200V	D
C117	390pF	Polystyrene	5%	125V	D
C118	390pF	Polystyrene	5%	125V	D
C119	390pF	Polystyrene	5%	125V	D
C120	150pF	Silvered Mica	5%	350V	D
C121	.1μF	Polycarbonate	20%	100V	D
C122	275pF	Silvered Mica	5%	350V	D
C123	.1μF	Polycarbonate	20%	100V	D
C124	130pF	Silvered Mica	5%	350V	D
C125-C129	—	Not allocated	—	—	—

BOTH MODELS

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C130	100pF	Tubular Ceramic	10%	500V	N
C131	.001μF	Tubular Ceramic	10%	500V	N
C132	.01μF	Polycarbonate	20%	100V	N
C133	.1μF	Polycarbonate	20%	100V	N
C134	.22μF	Polycarbonate	20%	100V	N
C135-C138	—	Not allocated	—	—	—
C139	33pF	Tubular Ceramic	5%	200V	E
C140	33pF	Tubular Ceramic	5%	200V	E
C141	7-35pF	Trimmer	—	—	E
C142	.001μF	Disk Ceramic	20%	500V	E
C143	.1μF	Polycarbonate	20%	100V	E
C144	.1μF	Polycarbonate	20%	100V	E
C145	.001μF	Disk Ceramic	20%	500V	E
C146	.1μF	Polycarbonate	20%	100V	E

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C147	.1μF	Polycarbonate	20%	100V	E
C148	.1μF	Polycarbonate	20%	100V	E
C149	.001μF	Disk Ceramic	20%	500V	E
C150	.1μF	Polycarbonate	20%	100V	E
C151	10μF	Tantalum	20%	25V	E
C152	33pF	Tubular Ceramic	5%	200V	E
C153	.001μF	Disk Ceramic	20%	500V	E
C154	.001μF	Disk Ceramic	20%	500V	E
C155	1μF	Tantalum	20%	35V	E
C156	10μF	Tantalum	20%	25V	E
C157	10μF	Tantalum	20%	25V	E
C158	.1μF	Polycarbonate	20%	100V	E
C159	.1μF	Polycarbonate	20%	100V	E
C160	10μF	Tantalum	20%	25V	E
C161	.1μF	Polycarbonate	20%	100V	E
C162	.1μF	Polycarbonate	20%	100V	E
C163	10μF	Tantalum	20%	25V	E
C164	.1μF	Polycarbonate	20%	100V	E
C165	10μF	Tantalum	20%	25V	E
C166	10μF	Tantalum	20%	25V	E
C167	10μF	Tantalum	20%	25V	E
C168	.1μF	Polycarbonate	20%	100V	E
C169	10μF	Tantalum	20%	25V	E
C170	10μF	Tantalum	20%	25V	E
C171	10μF	Tantalum	20%	25V	E
C172	22μF	Tantalum	20%	20V	E
C173	22μF	Tantalum	20%	20V	E
C174-C189	–	Not allocated	–	–	–
C190	.047μF	Polycarbonate	20%	100V	F
C191	640pF	Silvered Mica	1%	350V	F
C192	340pF	Silvered Mica	1%	350V	F
C193	22pF	Tubular Ceramic	10%	200V	F
C194	150μF	Electrolytic	+50% –10%	16V	F
C195	150μF	Electrolytic	+50% –10%	16V	F
C196-C209	–	Not allocated	–	–	–
C210	150μF	Electrolytic	+50% –10%	16V	G
C211	150μF	Electrolytic	+50% –10%	16V	G
C212	500μF	Tubular Paper	10%	600V	G
C213	22μF	Electrolytic	+50% –10%	63V	G
C214	.01μF	Polycarbonate	20%	100V	G
C215	150μF	Electrolytic	+50% –10%	16V	G
C216	50pF	Tubular Ceramic	10%	500V	G
C217	.01μF	Ceramic	–20% +80%	500V	G
C218	10μF	Electrolytic	+50% –10%	150V	G
C219	22μF	Electrolytic	+50% –10%	63V	G

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C220-C229	–	Not allocated	–	–	–
C230	22pF	Tubular Ceramic	10%	200V	H
C231	6.8μF	Electrolytic	+50% –10%	40V	F
C232	1.5μF	Electrolytic	+100% –10%	63V	F
C233	.22μF	Polycarbonate	20%	100V	F
C234	.1μF	Polycarbonate	20%	100V	H
C235	470μF	Electrolytic	+50% –10%	40V	O
C236	100pF	Tubular Ceramic	10%	500V	H
C237	30pF	Tubular Ceramic	10%	500V	H
C238	70pF	Tubular Ceramic	10%	500V	H
C239	3pF	Tubular Ceramic	10%	200V	H
C240	100μF	Electrolytic	+50% –10%	16V	F
C241	100μF	Electrolytic	+50% –10%	16V	F
C242	4.7μF	Electrolytic	+50% –10%	63V	F
C243	.68μF	Polycarbonate	20%	100V	F
C243A	22μF	Electrolytic	+50% –10%	63V	I
C244	.047μF	Polycarbonate	20%	100V	I
C245	1μF	Electrolytic	+100% –10%	63V	I
C246	1μF	Electrolytic	+100% –10%	63V	I
C247	10μF	Electrolytic	+100% –10%	25V	I
C248	150μF	Electrolytic	+50% –10%	16V	I
C249	180pF	Silvered Mica	5%	350V	I
C250	1000μF	Electrolytic	+50% –10%	16V	H
C251	500pF	Tubular Paper	10%	600V	I
C252	130pF	Silvered Mica	5%	350V	I
C252A	22μF	Electrolytic	+50% –10%	63V	I
C253	.1μF	Polycarbonate	20%	100V	I
C254-C259	–	Not allocated	–	–	I
C260	150μF	Electrolytic	+50% –10%	16V	K
C261	.1μF	Polycarbonate	20%	100V	K
C261A	150μF	Electrolytic	+50% –10%	16V	K
C262	10μF	Electrolytic	+100% –10%	25V	K
C263	–	Not allocated	–	–	–
C264	470μF	Electrolytic	+50% –10%	25V	K
C265-C269	–	Not allocated	–	–	–
C270	10μF	Electrolytic	+50% –10%	150V	J
C271	10μF	Electrolytic	+50% –10%	150V	J
C272	10μF	Electrolytic	+50% –10%	150V	J
C273	22μF	Electrolytic	+50% –10%	63V	J
C274	22μF	Electrolytic	+50% –10%	63V	J
C275	1000μF	Electrolytic	+50% –10%	25V	J
C276	1000μF	Electrolytic	+50% –10%	25V	J
C277	1000μF	Electrolytic	+50% –10%	25V	J
C278	1000μF	Electrolytic	+50% –10%	25V	J
C279	.002μF	Polystyrene	20%	10kV	L

BOTH MODELS

REF	VALUE	TYPE	TOLERANCE	WKG. V.	LOC
C280	.01μF	Ceramic	+80% −20%	2kV	L
C281	22μF	Electrolytic	+50% −10%	63V	L
C282-C289	–	Not allocated	–	–	–
C290	220μF	Electrolytic	+50% −10%	25V	P
C291	.1μF	Polycarbonate	20%	100V	P
C292	.1μF	Polycarbonate	20%	100V	P
C293	220μF	Electrolytic	+50% −10%	25V	P
C293A	7500μF	Electrolytic	+50% −10%	25V	O
C294	7500μF	Electrolytic	+50% −10%	25V	O
C294A	7500μF	Electrolytic	+50% −10%	25V	O
C295	7500μF	Electrolytic	+50% −10%	25V	O
C296	1000μF	Electrolytic	+50% −10%	16V	O
C297	1000μF	Electrolytic	+50% −10%	16V	O
C298	1000μF	Electrolytic	+50% −10%	16V	O
C299	.03μF	Ceramic	+80% −20%	1.5kV	L
C300	.002μF	Polystyrene	20%	10kV	L
C301	.01μF	Ceramic	+80% −20%	2kV	O
C302	.01μF	Ceramic	+80% −20%	2kV	O
C303	.03μF	Ceramic	+80% −20%	1.5kV	O

RESISTORS
MODEL A ONLY

REF	VALUE	TOL	RTG	LOC
R1	220Ω	5%	.1W	B
R1A	1MΩ	5%	.1W	B
R2	33 000Ω	5%	.1W	B
R3	.47MΩ	5%	.1W	B
R3A	680Ω	5%	.1W	B
R4	150Ω	5%	.1W	B
R4A	1000Ω	5%	.1W	B
R5	10 000Ω	5%	.1W	B
R6	2200Ω	5%	.1W	B
R7	1000Ω	5%	.1W	B
R8	100Ω	5%	.1W	B
R9	.47MΩ	5%	.1W	B
R10	1MΩ	5%	.1W	B
R11	33 000Ω	5%	.1W	B
R12	820Ω	5%	.1W	B
R13	2700Ω	5%	.1W	B
R14	100Ω	5%	.1W	B
R15	10 000Ω	5%	.1W	B
R16	4700Ω	5%	.1W	B
R17	3300Ω	5%	.1W	B
R18-29	Not allocated	—	—	—
R30	2700Ω	5%	.1W	A
R31	47Ω	5%	.1W	A
R32	2700Ω	5%	.1W	A
R33	1500Ω	5%	.1W	A
R34	100Ω	5%	.1W	A
R35	100Ω	5%	.1W	A
R36	10 000Ω	5%	.1W	A
R37-39	Not allocated	—	—	—
R40	68Ω	5%	.25W	B
R41	33Ω	5%	.25W	B
R42	100Ω	5%	.25W	B
R43	33Ω	5%	.25W	B
R44	100Ω	5%	.25W	B
R45	33Ω	5%	.25W	B
R46	100Ω	5%	.25W	B
R47	33Ω	5%	.25W	B
R48	100Ω	5%	.25W	B
R49	33Ω	5%	.25W	B
R50	68Ω	5%	.25W	B
R51	33Ω	5%	.25W	B
R52	100Ω	5%	.25W	B
R53	33Ω	5%	.25W	B
R54	100Ω	5%	.25W	B
R55	33Ω	5%	.25W	B
R56	100Ω	5%	.25W	B
R57	33Ω	5%	.25W	B
R58	100Ω	5%	.25W	B
R59	33Ω	5%	.25W	B

REF	VALUE	TOL	RTG	LOC
R60	200Ω	5%	.25W	B
R61-69	Not allocated	—	—	—
R70	6800Ω	5%	.1W	C
R71	680Ω	5%	.1W	C
R72	3300Ω	5%	.1W	C
R73	5600Ω	5%	.1W	C
R74	1MΩ	5%	.1W	C
R75	1000Ω	5%	.1W	C
R76	220Ω	5%	.1W	C
R77	1000Ω	5%	.1W	C
R78-99	Not allocated	—	—	—
R100	2200Ω	5%	.1W	D
R101	3300Ω	5%	.1W	D
R102	2200Ω	5%	.1W	D
R103	10 000Ω	5%	.1W	D
R104	10 000Ω	5%	.1W	D
R105	2700Ω	5%	.1W	D
R106	56 000Ω	5%	.1W	D
R107	22 000Ω	5%	.1W	D
R108	100Ω	5%	.1W	D
R109	.12MΩ	5%	.1W	D
R110	.12MΩ	5%	.1W	D
R111	4700Ω	5%	.1W	D
R112	47 000Ω	5%	.1W	D
R113	47 000Ω	5%	.1W	D
R114	4700Ω	5%	.1W	D
R115	33 000Ω	5%	.1W	D
R116	33 000Ω	5%	.1W	D
R117	33 000Ω	5%	.1W	D
R118	100Ω	5%	.1W	D
R119	1MΩ	5%	.1W	D
R120	100Ω	5%	.1W	D
R121	2200Ω	5%	.1W	D
R122	2700Ω	5%	.1W	D
R123	10 000Ω	5%	.1W	D
R124	2200Ω	5%	.1W	D
R125	1000Ω	5%	.1W	D
R126	100Ω	5%	.1W	D
R127	5600Ω	5%	.1W	D
R128	1000Ω	5%	.1W	D
R129	560Ω	5%	.1W	D
R130	100Ω	5%	.1W	D
R131	68 000Ω	5%	.1W	D
R132	22 000Ω	5%	.1W	D
R133	5600Ω	5%	.1W	D
R134-147	Not allocated	—	—	—

MODEL B ONLY

REF	VALUE	TOL	RTG	LOC
R1	1MΩ	5%	.1W	B
R2	.47MΩ	5%	.1W	B
R3	12 000Ω	5%	.1W	B
R4	680Ω	5%	.1W	B
R5	Not allocated	—	—	—
R6	47Ω	5%	.1W	B
R7	1000Ω	5%	.1W	B
R7A	100Ω	5%	.1W	B
R8	10 000Ω	5%	.1W	B
R9	2200Ω	5%	.1W	B
R9A	150Ω	5%	.1W	B
R10	1000Ω	5%	.1W	B
R11	1MΩ	5%	.1W	B
R12	100Ω	5%	.1W	B
R13	10 000Ω	5%	.1W	B
R14	2200Ω	5%	.1W	B
R15	1000Ω	5%	.1W	B
R16	1500Ω	5%	.1W	B
R17	100Ω	5%	.1W	B
R18	Not allocated	—	—	—
R19	33 000Ω	5%	.1W	B
R20	.47MΩ	5%	.1W	B
R21	47 000Ω	5%	.1W	B
R22	10 000Ω	5%	.1W	B
R23	100Ω	5%	.1W	B
R24	680Ω	5%	.1W	B
R25	1200Ω	5%	.1W	B
R26	100Ω	5%	.1W	B
R27-34	Not allocated	—	—	—
R35	100Ω	5%	.1W	A
R36	10 000Ω	5%	.1W	A
R37-39	Not allocated	—	—	—
R40	68Ω	5%	.25W	B
R41	33Ω	5%	.25W	B
R42	100Ω	5%	.25W	B
R43	33Ω	5%	.25W	B
R44	100Ω	5%	.25W	B
R45	33Ω	5%	.25W	B
R46	100Ω	5%	.25W	B
R47	33Ω	5%	.25W	B
R48	100Ω	5%	.25W	B
R49	33Ω	5%	.25W	B

REF	VALUE	TOL	RTG	LOC
R50	68Ω	5%	.25W	B
R51	33Ω	5%	.25W	B
R52	100Ω	5%	.25W	B
R53	33Ω	5%	.25W	B
R54	100Ω	5%	.25W	B
R55	33Ω	5%	.25W	B
R56	100Ω	5%	.25W	B
R57	33Ω	5%	.25W	B
R58	100Ω	5%	.25W	B
R59	33Ω	5%	.25W	B
R60	200Ω	5%	.25W	B
R61-69	Not allocated	—	—	—
R70	680Ω	5%	.1W	C
R71	1500Ω	5%	.1W	C
R72	680Ω	5%	.1W	C
R73	.47MΩ	5%	.1W	C
R74	1000Ω	5%	.1W	C
R75	2200Ω	5%	.1W	C
R76	220Ω	5%	.1W	C
R77	100Ω	5%	.1W	C
R78	5600Ω	5%	.1W	C
R79	470Ω	5%	.1W	C
R80-99	Not allocated	—	—	—
R100	12 000Ω	5%	.1W	D
R101	1500Ω	5%	.1W	D
R102	1000Ω	5%	.1W	D
R103	1000Ω	5%	.1W	D
R104	100Ω	5%	.1W	D
R105	12 000Ω	5%	.1W	D
R106	2700Ω	5%	.1W	D
R107	5600Ω	5%	.1W	D
R108	1000Ω	5%	.1W	D
R109	10 000Ω	5%	.1W	D
R110	100Ω	5%	.1W	D
R111	100Ω	5%	.1W	D
R112	5600Ω	5%	.1W	D
R113	2200Ω	5%	.1W	D
R114	180Ω	5%	.1W	D
R115	100Ω	5%	.1W	D
R116	100Ω	5%	.1W	D
R117	47 000Ω	5%	.1W	D
R118	15 000Ω	5%	.1W	D
R119	10 000Ω	5%	.1W	D
R120	82 000Ω	5%	.1W	D
R121-147	Not allocated	—	—	—

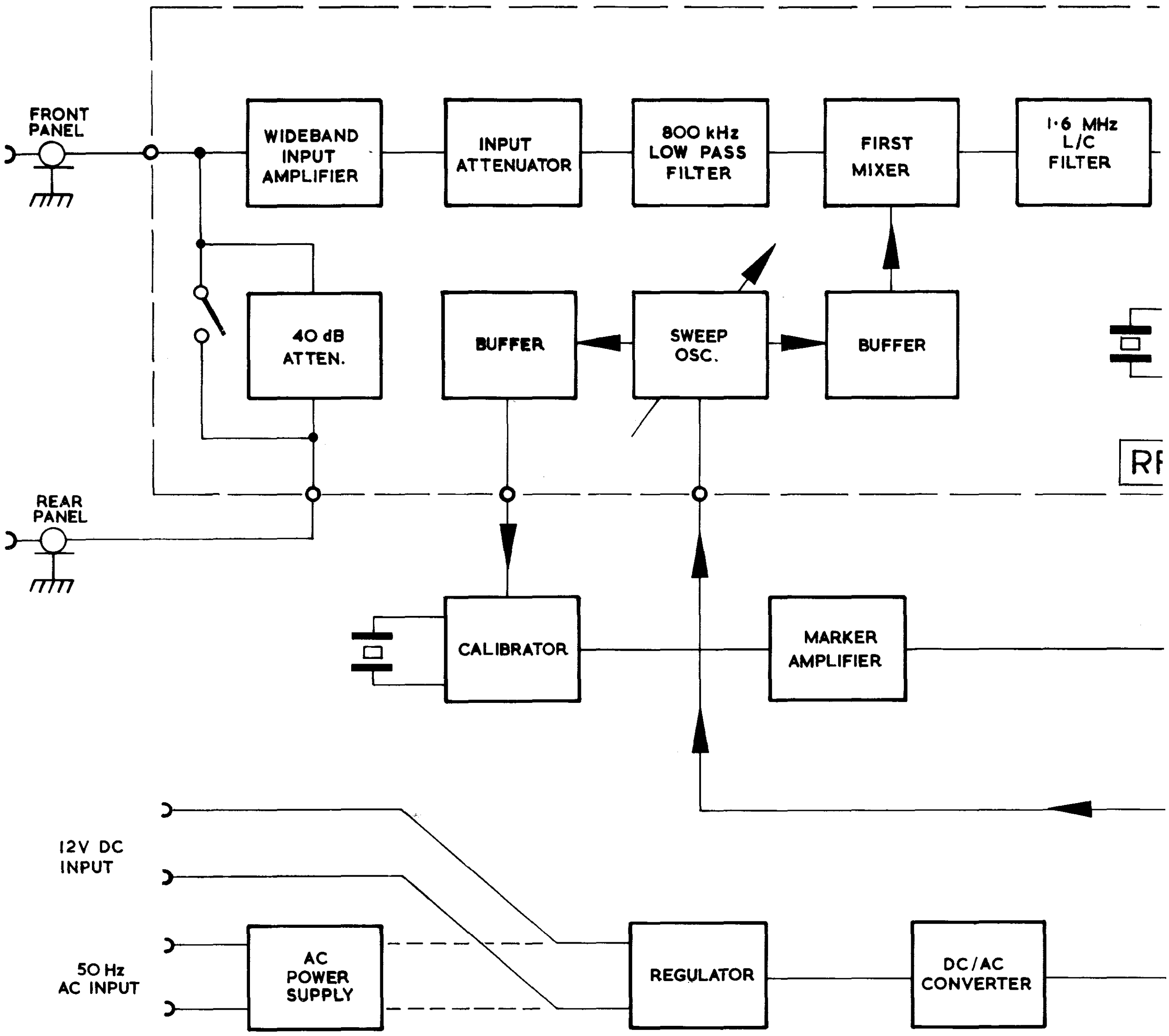
REF	VALUE	TOL	RTG	LOC
R148	330Ω	10%	.5W	N
R149	390Ω	5%	.1W	N
R150	15 000Ω	5%	.1W	E
R151	10 000Ω	5%	.1W	E
R152	470Ω	5%	.1W	E
R153	5600Ω	5%	.1W	E
R154	2200Ω	5%	.1W	E
R155	470Ω	5%	.1W	E
R156	100Ω	5%	.1W	E
R157	150Ω	5%	.1W	E
R158	150Ω	5%	.1W	E
R159	47 000Ω	5%	.1W	E
R160	5600Ω	5%	.1W	E
R161	2200Ω	5%	.1W	E
R162	470Ω	5%	.1W	E
R163	100Ω	5%	.1W	E
R164	.22MΩ	5%	.1W	E
R165	27 000Ω	5%	.1W	E
R166	.1MΩ	5%	.1W	E
R167	4700Ω	5%	.1W	E
R168	680Ω	5%	.1W	E
R169	5600Ω	5%	.1W	E
R170	2200Ω	5%	.1W	E
R171	470Ω	5%	.1W	E
R172	100Ω	5%	.1W	E
R173	15 000Ω	5%	.1W	E
R174	12 000Ω	5%	.1W	E
R175	6800Ω	5%	.1W	E
R176	5600Ω	5%	.1W	E
R176A	27 000Ω	5%	.1W	E
R177	15 000Ω	5%	.1W	E
R178	3900Ω	5%	.1W	E
R179	6800Ω	5%	.1W	E
R180	2700Ω	5%	.1W	E
R181	1000Ω	5%	.1W	E
R182	1000Ω	5%	.1W	E
R183	.68MΩ	5%	.1W	E
R184	10 000Ω	5%	.1W	E
R185	1800Ω	5%	.1W	E
R186	1000Ω	5%	.1W	E
R187	3300Ω	5%	.1W	E
R188-199	Not allocated	—	—	—
R200	10 000Ω	5%	.1W	F
R201	.47MΩ	5%	.1W	F
R202	10 000Ω	5%	.1W	F
R203	470Ω	5%	.1W	F
R204	1500Ω	5%	.1W	F
R205	.33MΩ	5%	.1W	F
R206	560Ω	5%	.1W	F
R207	1500Ω	5%	.1W	F
R208	18Ω	5%	.1W	F
R209	18Ω	5%	.1W	F
R210	10 000Ω	5%	.1W	F
R211	33 000Ω	5%	.1W	N
R212	3900Ω	5%	.1W	N
R213-229	Not allocated	—	—	—
R230	.15MΩ	5%	.1W	G
R231	.1MΩ	5%	.1W	G
R232	47Ω	10%	.5W	G
R233	18Ω	5%	.1W	G
R234	10 000Ω	5%	.1W	G
R235	2700Ω	5%	.1W	G
R236	47Ω	5%	.1W	G
R237	2200Ω	5%	.5W	G
R238	6200Ω	5%	.1W	G
R239	1000Ω	5%	.1W	G
R240	470Ω	5%	.1W	G
R241	4700Ω	5%	.1W	G
R242	1000Ω	5%	.1W	G
R243	470Ω	5%	.1W	G
R244	6800Ω	5%	.5W	G
R245	22Ω	5%	.1W	G
R246	8200Ω	5%	.1W	G
R247	6800Ω	5%	.1W	G
R248	.18MΩ	5%	.5W	G
R249	2200Ω	5%	.1W	G
R250	6800Ω	5%	.1W	G
R251	150Ω	5%	.1W	G
R252	4700Ω	10%	1W	G
R253	150Ω	10%	.5W	G
R254	4700Ω	10%	1W	G
R255	150Ω	10%	.5W	G
R256	470Ω	5%	.1W	G
R257	1000Ω	5%	.1W	G
R258-269	Not allocated	—	—	—
R270	47 000Ω	5%	.1W	H
R271	2200Ω	5%	.1W	H
R272	22 000Ω	5%	.1W	H
R273	220Ω	5%	.1W	H
R274	2200Ω	5%	.1W	H
R275	.15MΩ	5%	.1W	H
R276	2200Ω	5%	.1W	H
R277	47Ω	5%	.1W	H
R278	47 000Ω	5%	.1W	H
R279	820Ω	5%	.1W	H
R280	1200Ω	5%	.1W	H
R281	5600Ω	5%	.1W	N
R282	470Ω	5%	.1W	F
R283	470Ω	5%	.1W	F
R284	470Ω	5%	.1W	F
R285	4700Ω	5%	.1W	O
R286	1000Ω	5%	.1W	O
R287	33 000Ω	5%	1W	H
R288	22 000Ω	5%	.1W	H
R289	47 000Ω	5%	.1W	H

REF	VALUE	TOL	RTG	LOC
R290	1500Ω	5%	.1W	H
R291	22 000Ω	5%	.1W	H
R292	47 000Ω	5%	.1W	H
R293	47 000Ω	5%	.1W	H
R294	22 000Ω	5%	.1W	H
R295	1500Ω	5%	.1W	H
R296	68 000Ω	5%	.1W	H
R297	.18MΩ	5%	.1W	H
R298	470Ω	5%	.1W	H
R299	27 000Ω	5%	.1W	F
R300	47 000Ω	5%	.1W	F
R301	.1MΩ	5%	.1W	F
R302	2200Ω	5%	.1W	I
R303	2200Ω	5%	.1W	I
R304	1000Ω	5%	.1W	I
R305	8200Ω	5%	.1W	I
R306	8200Ω	5%	.1W	I
R307	1000Ω	5%	.1W	I
R308	100Ω	5%	.1W	I
R309	680Ω	5%	.1W	N
R310	22 000Ω	5%	.1W	N
R311	470Ω	5%	.1W	M
R312	47Ω	5%	.1W	O
R313	2200Ω	5%	.1W	N
R314	2700Ω	5%	.1W	N
R315	12 000Ω	5%	.1W	N
R316	15 000Ω	5%	.1W	N
R317	33 000Ω	5%	.1W	N
R318	.1MΩ	5%	.1W	N
R319	68 000Ω	5%	.1W	N
R320	.1MΩ	5%	.1W	N
R321	.39MΩ	5%	.1W	N
R322	1MΩ	5%	.1W	N
R323	5600Ω	5%	.1W	N
R324	3900Ω	5%	.1W	N
R325	1000Ω	5%	.1W	N
R326	10 000Ω	5%	.1W	N
R327	18 000Ω	5%	.1W	N
R328	47 000Ω	5%	.1W	N
R329	.1MΩ	5%	.1W	N
R330	.22MΩ	5%	.1W	N
R331	.27MΩ	5%	.1W	N
R332	.68MΩ	5%	.1W	N
R333	1MΩ	5%	.1W	N
R334	4700Ω	5%	.1W	H
R335	2700Ω	5%	.1W	H
R336	2200Ω	5%	.1W	H
R337	470Ω	5%	.1W	H
R338	68Ω	5%	.1W	H
R339	.1MΩ	10%	.5W	P

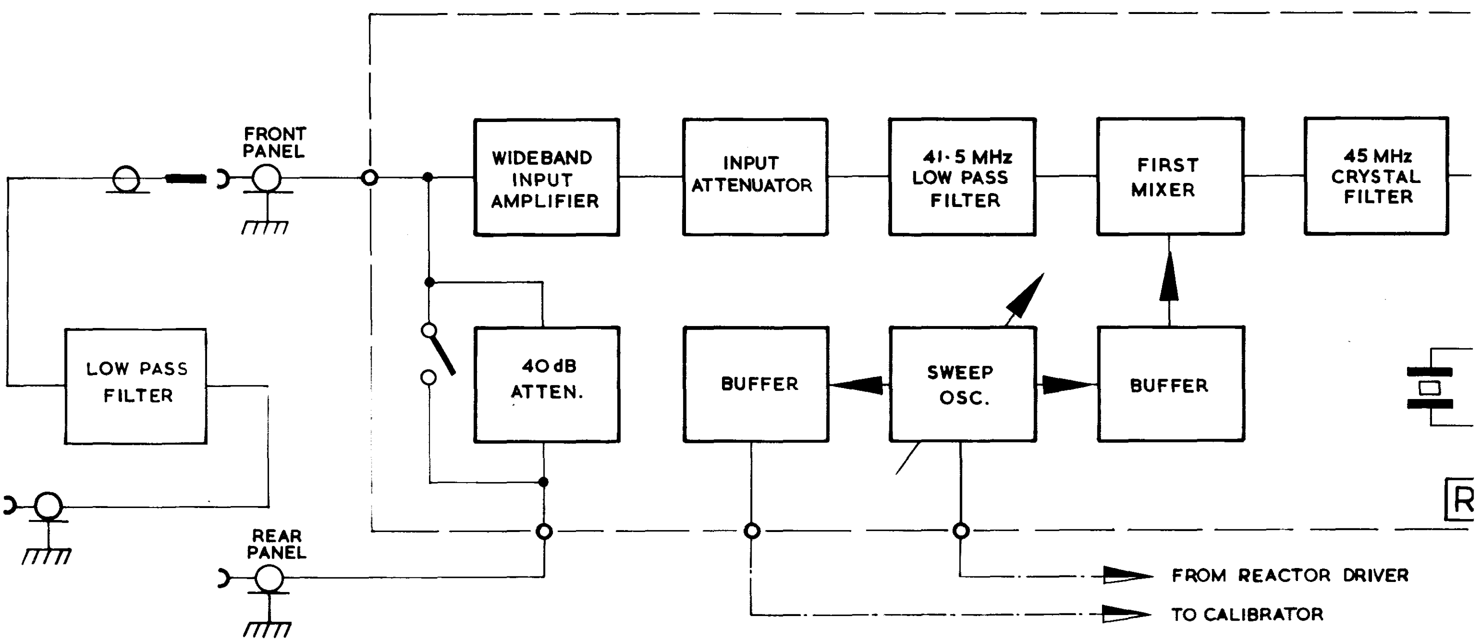
REF	VALUE	TOL	RTG	LOC
R340-349	Not allocated	—	—	—
R350	100Ω	5%	.1W	I
R351	6800Ω	10%	1W	I
R352	22 000Ω	5%	.1W	I
R353	680Ω	10%	.5W	I
R354	680Ω	10%	.5W	I
R355	390Ω	5%	.1W	I
R356	6800Ω	10%	1W	I
R357	220Ω	5%	.1W	I
R358	15 000Ω	5%	.1W	I
R359	4700Ω	5%	.1W	I
R360	22 000Ω	5%	.1W	I
R361	5600Ω	5%	.1W	I
R362	22Ω	5%	.1W	I
R363-378	Not allocated	—	—	—
R379	100Ω	5%	.5W	K
R380	100Ω	5%	.5W	K
R381	1200Ω	10%	.5W	K
R382	470Ω	5%	.5W	K
R383	150Ω	5%	.5W	K
R384	220Ω	5%	.5W	K
R385	33 000Ω	10%	.5W	K
R386	1000Ω	5%	.5W	K
R387	1000Ω	5%	.5W	K
R388	1000Ω	5%	.5W	K
R389	1000Ω	5%	.5W	K
R390	2200Ω	5%	.5W	K
R391-399	Not allocated	—	—	—
R400	270Ω	10%	.5W	J
R401	270Ω	10%	.5W	J
R402	10Ω	5%	3W	O
R403	10Ω	5%	3W	O
R404	10Ω	5%	3W	J
R405	10Ω	5%	3W	J
R406	390Ω	10%	.5W	J
R407	10 000Ω	5%	.5W	L
R408	2Ω	5%	25W	P
R409	Not allocated	—	—	—
R410	16Ω	10%	3W	L
R411	.05Ω			L
R412	.05Ω			L
R413	470Ω	10%	3W	L
R414	10Ω	10%	3W	L
R415-419	Not allocated	—	—	—
R420	1MΩ	10%	.5W	N
R421	1MΩ	10%	.5W	N
R422	1MΩ	10%	.5W	N
R423	.27MΩ	10%	.5W	N
R424	15 000Ω	10%	.5W	N
R425	680Ω	10%	.5W	O

POTENTIOMETERS

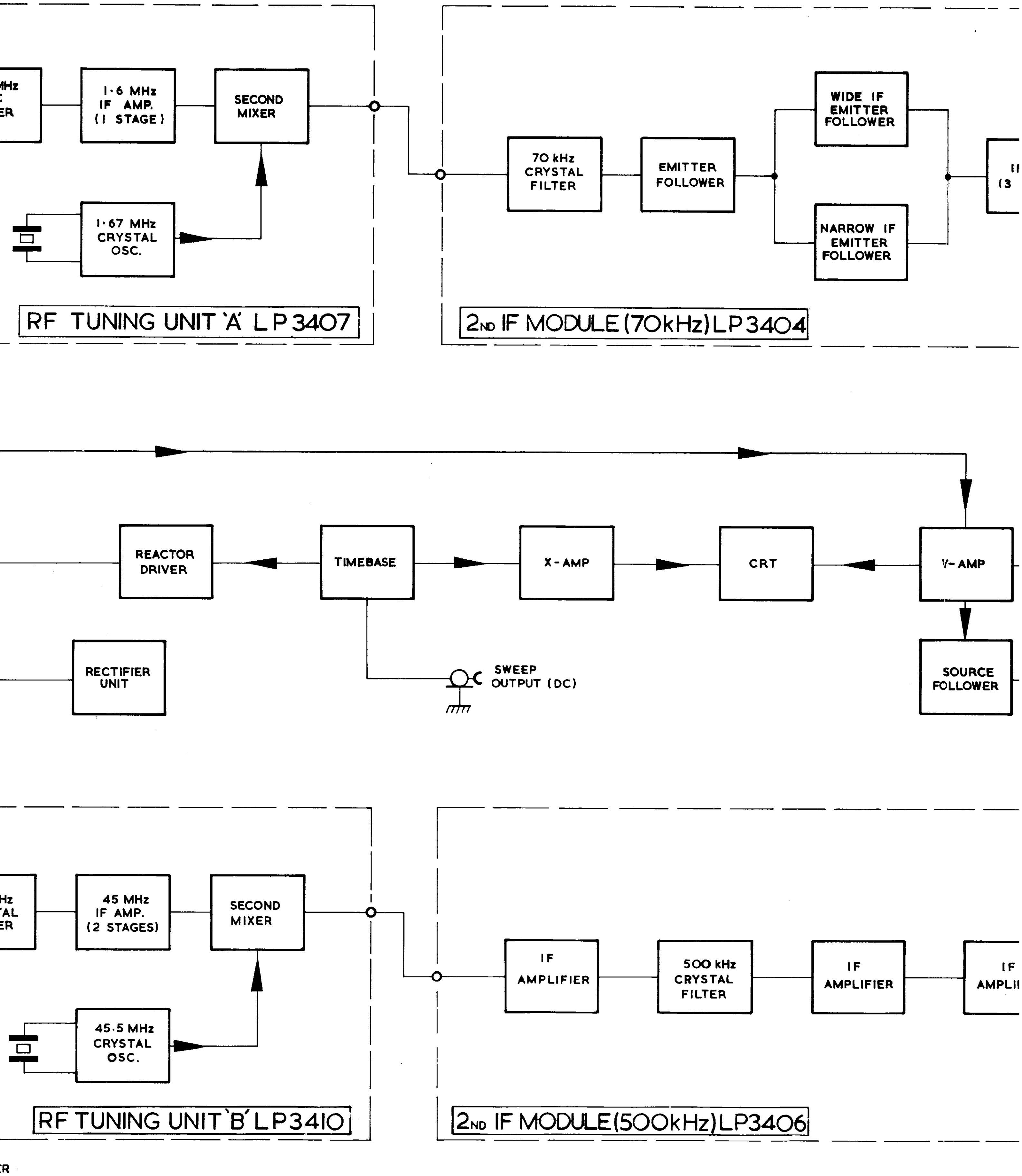
REF	VALUE	LAW	TYPE	FUNCTION	LOC
RV1	10 000Ω	Inverse Log	Wire-wound Dual	IF Gain	N
RV2	560Ω	Lin	Carbon Preset	Marker Amplitude	N
RV3	.1MΩ	Log	Carbon Preset	Log/Lin Gain	O
RV4	560Ω	Lin	Carbon Preset	Set Zero	R
RV5	1000Ω	Lin	Carbon Preset	Y Gain	O
RV6	47 000Ω	Lin	Carbon Preset	Y Shift	N
RV7	1000Ω	Lin	Carbon Preset	Y Balance	O
RV8	10 000Ω	Inverse Log	Wire-wound Dual	Manual Sweep Adjust	N
RV9	4700Ω	Lin	Carbon Preset	Linearity	M
RV10	10 000Ω	Inverse Log	Wire-wound Dual	Fine Centre	N
RV11	10 000Ω	Lin	Carbon Preset	Centre Width 1	M
RV12	10 000Ω	Lin	Carbon Preset	Centre Width 2	M
RV13	10 000Ω	Lin	Carbon Preset	Centre Width 3	M
RV14	560Ω	Lin	Carbon Preset	Fine Centre Width 4	M
RV15	560Ω	Lin	Carbon Preset	Fine Centre Width 5	M
RV16	560Ω	Lin	Carbon Preset	Fine Centre Width 6	M
RV17	560Ω	Lin	Carbon Preset	Fine Centre Width 7	M
RV18	560Ω	Lin	Carbon Preset	Fine Centre Width 8	M
RV19	560Ω	Lin	Carbon Preset	Fine Centre Widths 9-11	M
RV20	10 000Ω	Inverse Log	Wire-wound Dual	X Expansion	N
RV21	4700Ω	Lin	Carbon Preset	X Gain	O
RV22	4700Ω	Lin	Carbon Preset	X Shift	N
RV23	1000Ω	Lin	Carbon Preset	Set Volts	K
RV24	4700Ω	Lin	Carbon Preset	Twist	K
RV25	.1MΩ	Lin	Edge Pot Carbon	Astigmatism	N
RV26	.1MΩ	Lin	Carbon Preset	Geometry	K
RV27	5Ω	Lin	Wire-wound Preset	Set Heater Volts	R
RV28	1MΩ	Lin	Edge Pot Carbon	Focus	N
RV29	.47MΩ	Lin	Edge Pot Carbon	Brilliance	N
RV30	Not allocated	—	—	—	—
RV31	4700Ω	Lin	Carbon Preset	Centre Widths 4-11	M



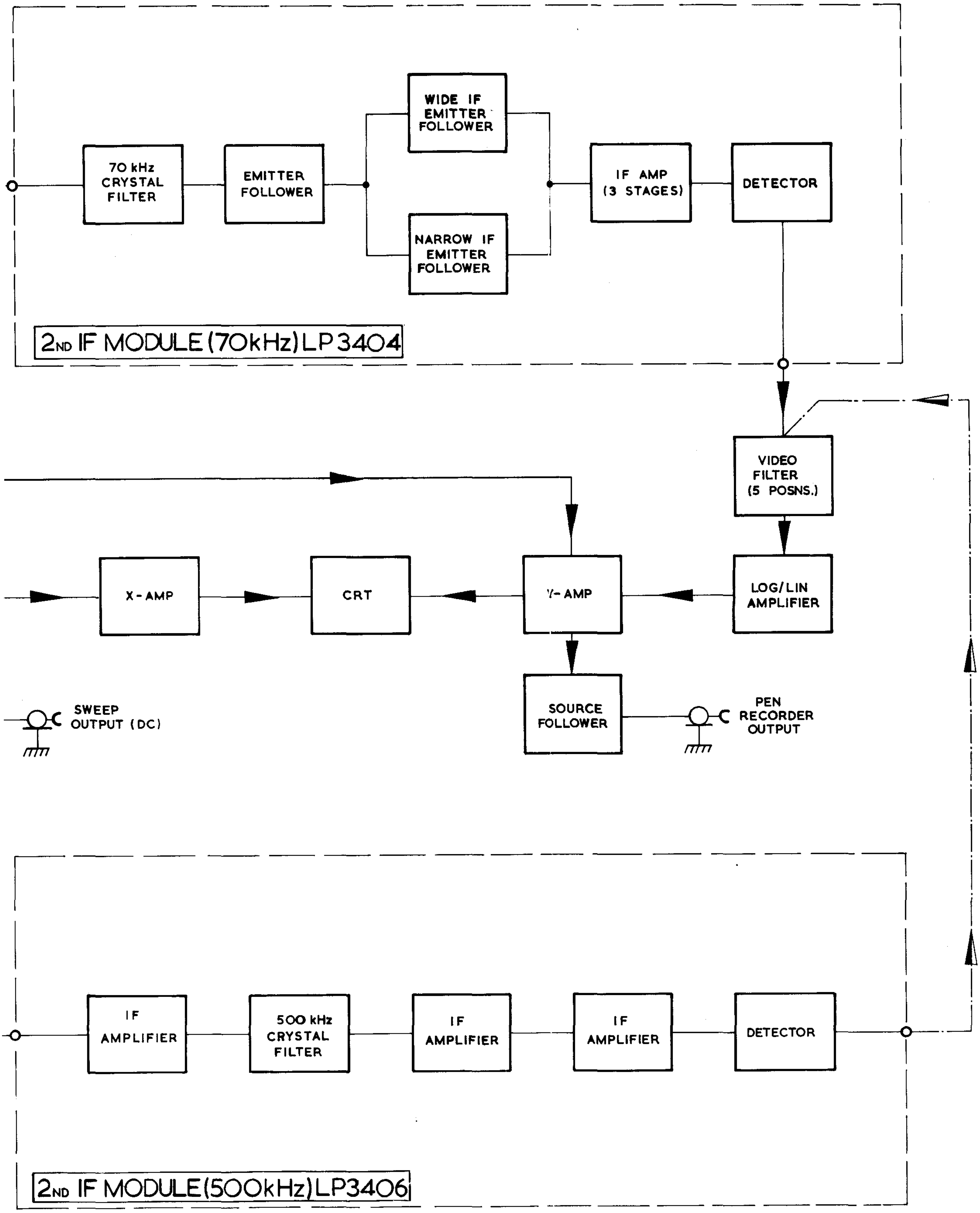
FRONT PANEL
WIDEBAND INPUT AMPLIFIER
INPUT ATTENUATOR
800 kHz LOW PASS FILTER
FIRST MIXER
1·6 MHz L/C FILTER
40 dB ATTEN.
BUFFER
SWEEP OSC.
BUFFER
REAR PANEL
CALIBRATOR
MARKER AMPLIFIER
12V DC INPUT
50 Hz AC INPUT
AC POWER SUPPLY
REGULATOR
DC/AC CONVERTER



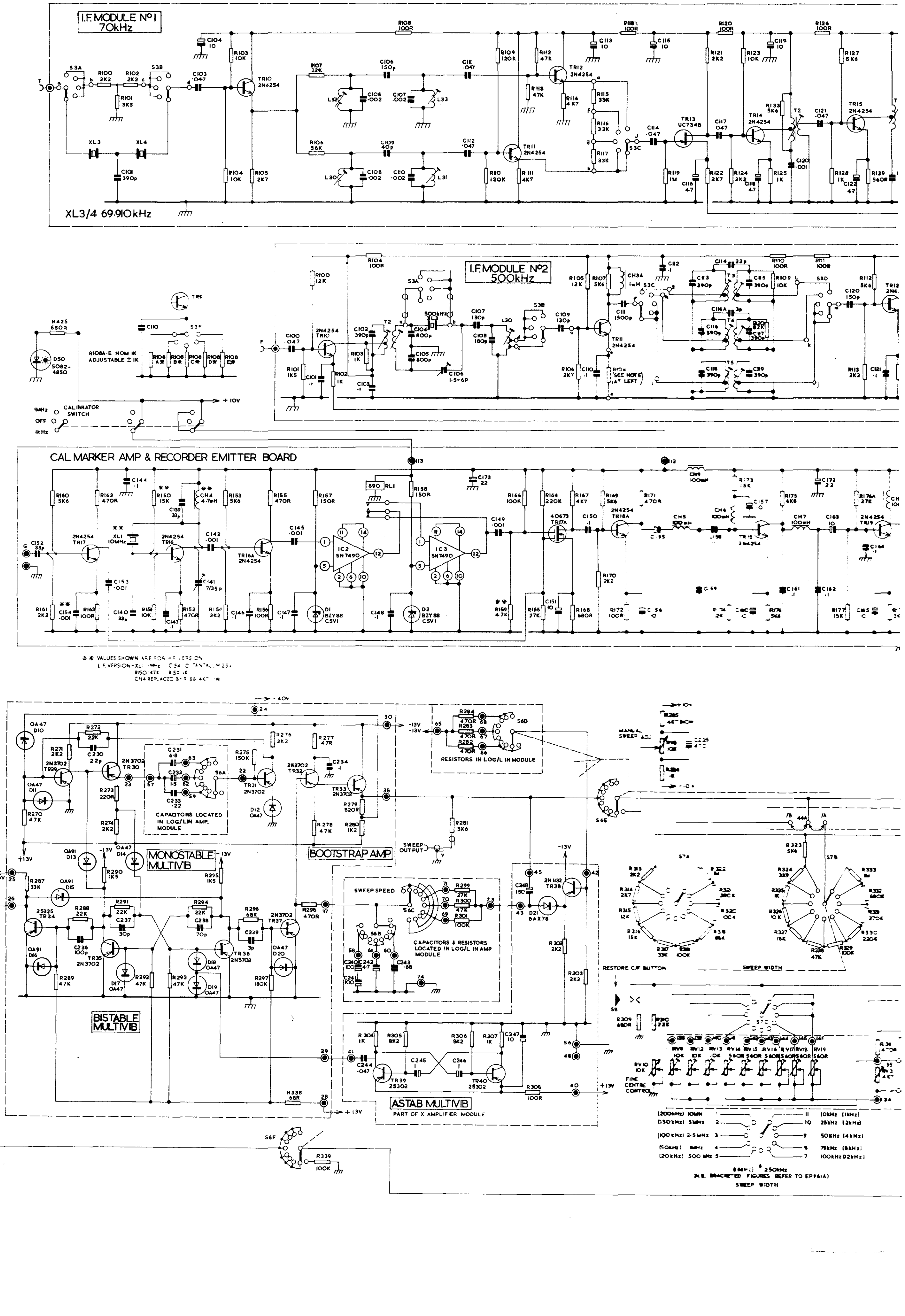
FRONT PANEL
WIDEBAND INPUT AMPLIFIER
INPUT ATTENUATOR
41·5 MHz LOW PASS FILTER
FIRST MIXER
45 MHz CRYSTAL FILTER
LOW PASS FILTER
40 dB ATTEN.
BUFFER
SWEEP OSC.
BUFFER
REAR PANEL
FROM REACTOR DRIVER
TO CALIBRATOR

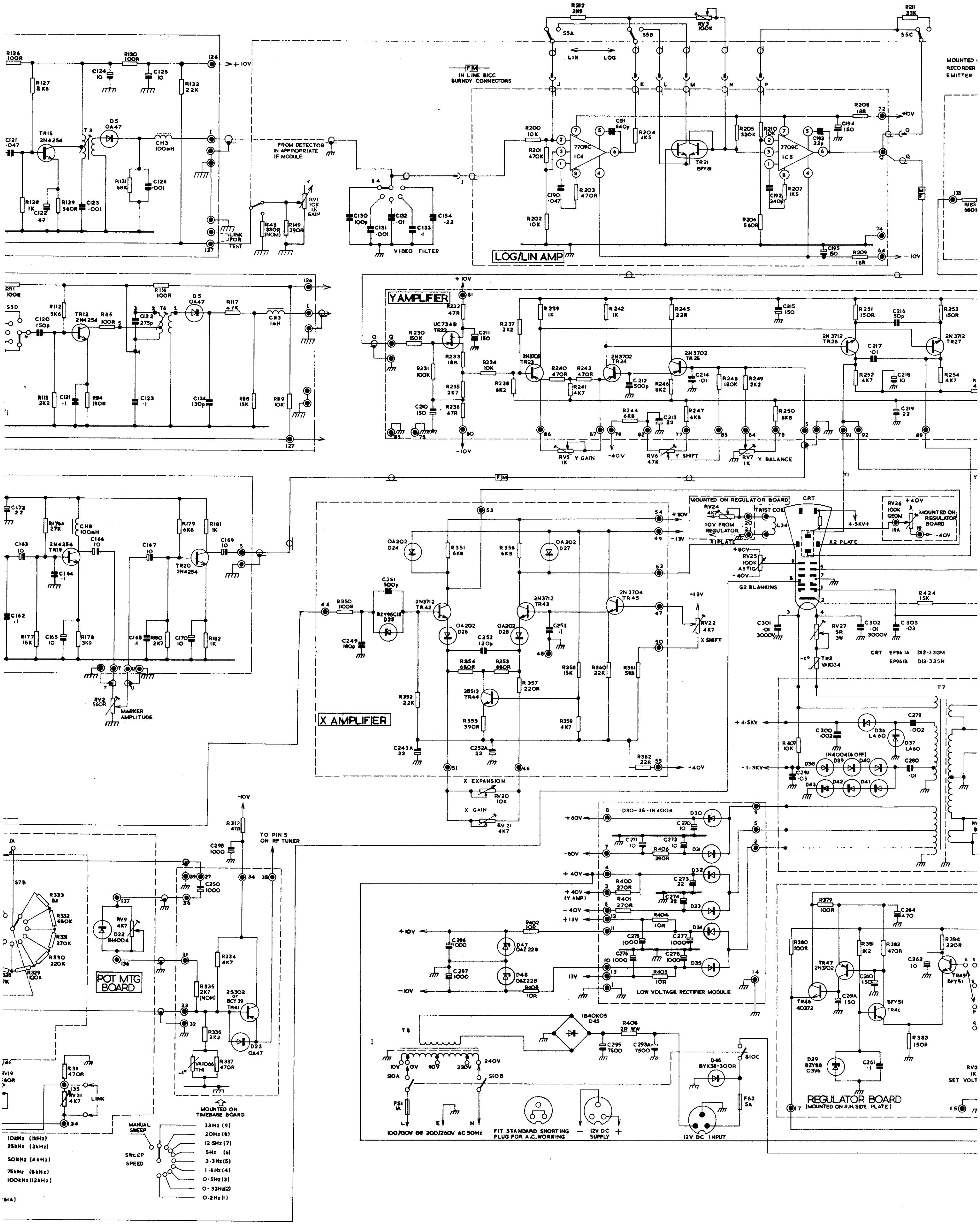


BLOCK DIAGRAM – MODELS EP961 Mk II-A & EP961 Mk II-B

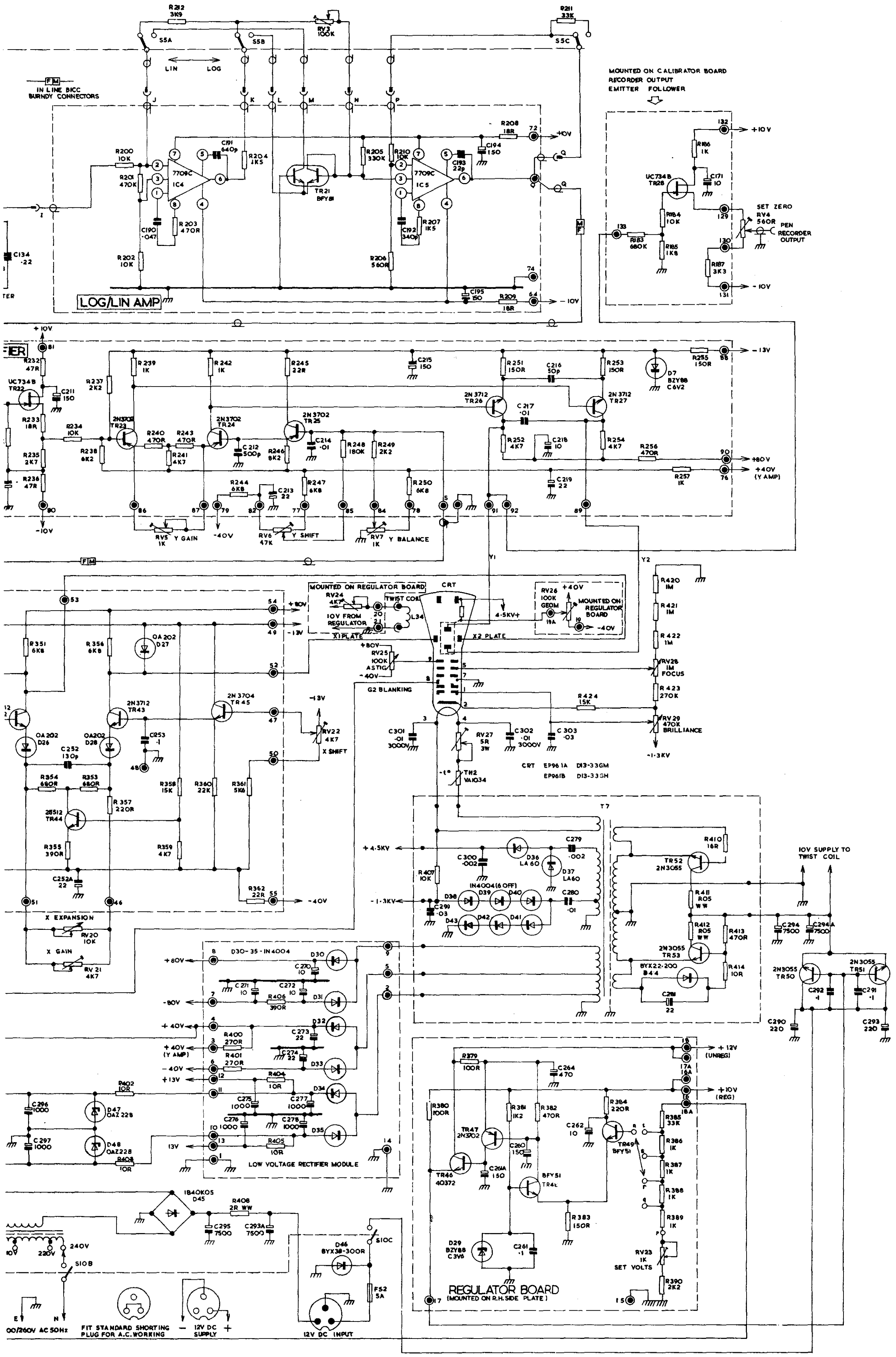

70 kHz CRYSTAL FILTER
EMITTER FOLLOWER
WIDE IF EMITTER FOLLOWER
NARROW IF EMITTER FOLLOWER
IF AMP (3 STAGES)
DETECTOR
2ND IF MODULE (70kHz) LP3404
VIDEO FILTER (5 POSNS.)
LOG/LIN AMPLIFIER
X-AMP
CRT
Y-AMP
SOURCE FOLLOWER
SWEEP OUTPUT (DC)
PEN RECORDER OUTPUT
IF AMPLIFIER
500 kHz CRYSTAL FILTER
IF AMPLIFIER
IF AMPLIFIER
DETECTOR
2ND IF MODULE (500kHz) LP3406

EP961 MK II-A SUPPLIED WITH 2nd IF MODULE (70kHz)
EP961 MK II B SUPPLIED WITH 2nd IF MODULE (500kHz)

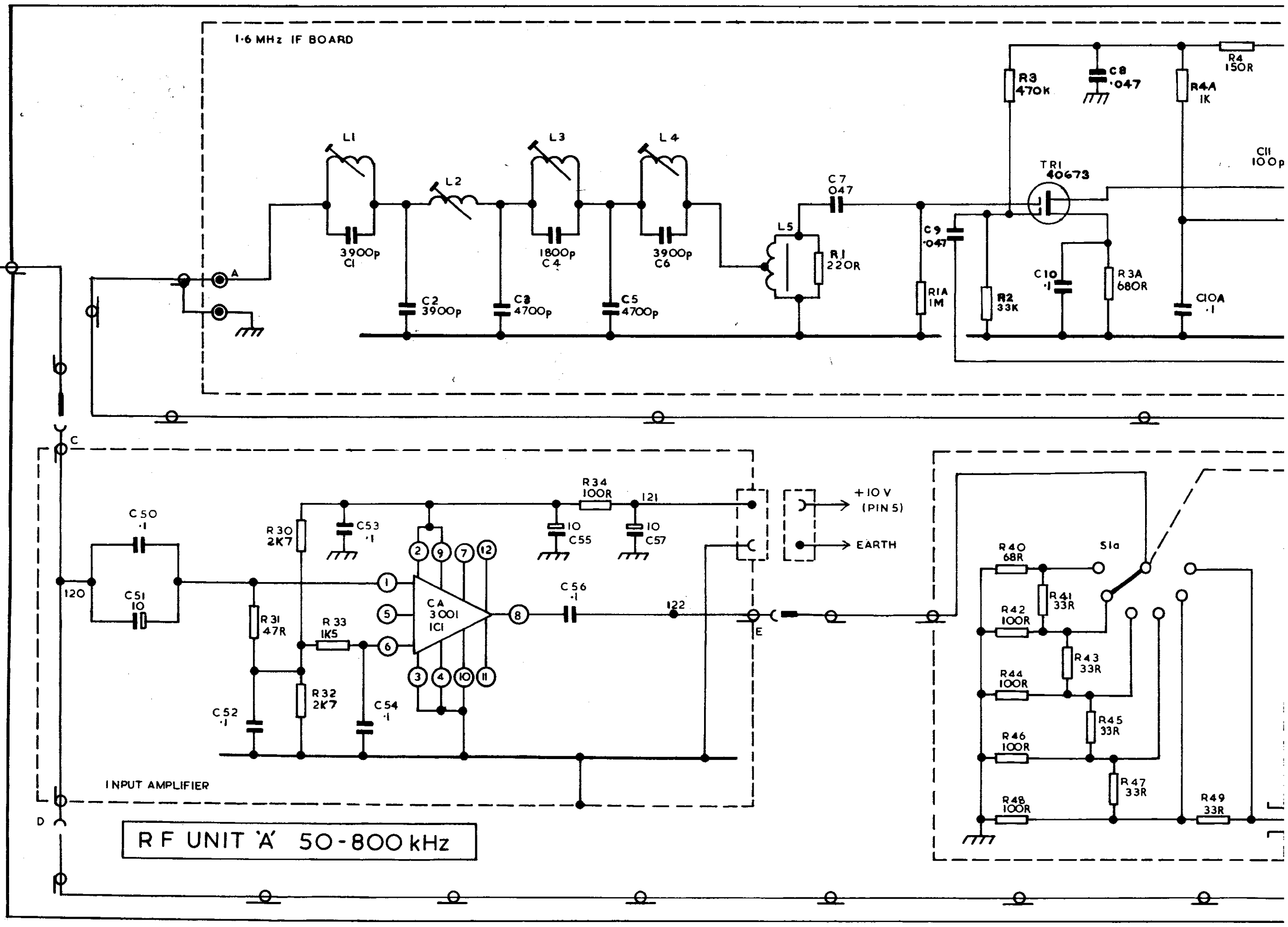


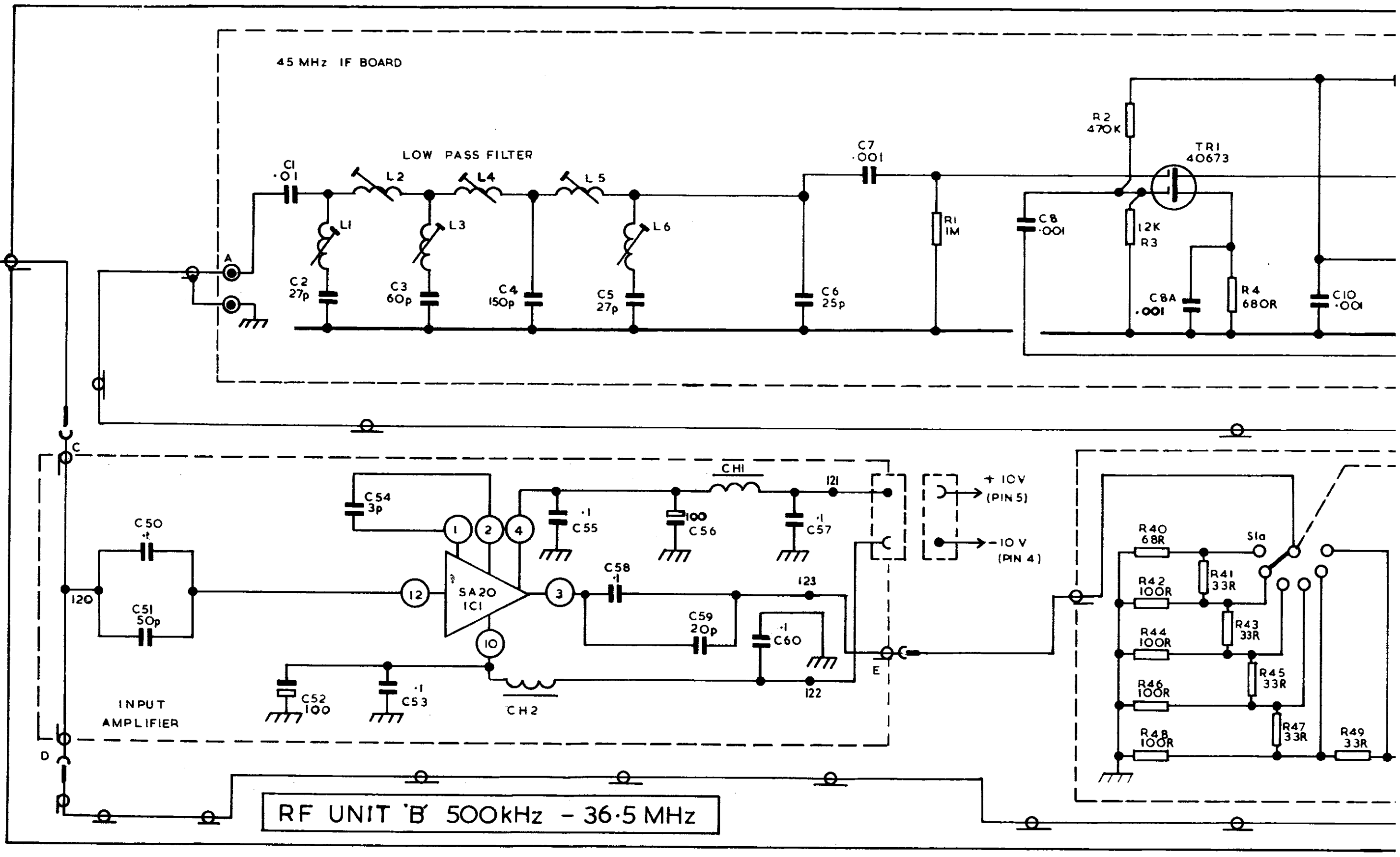


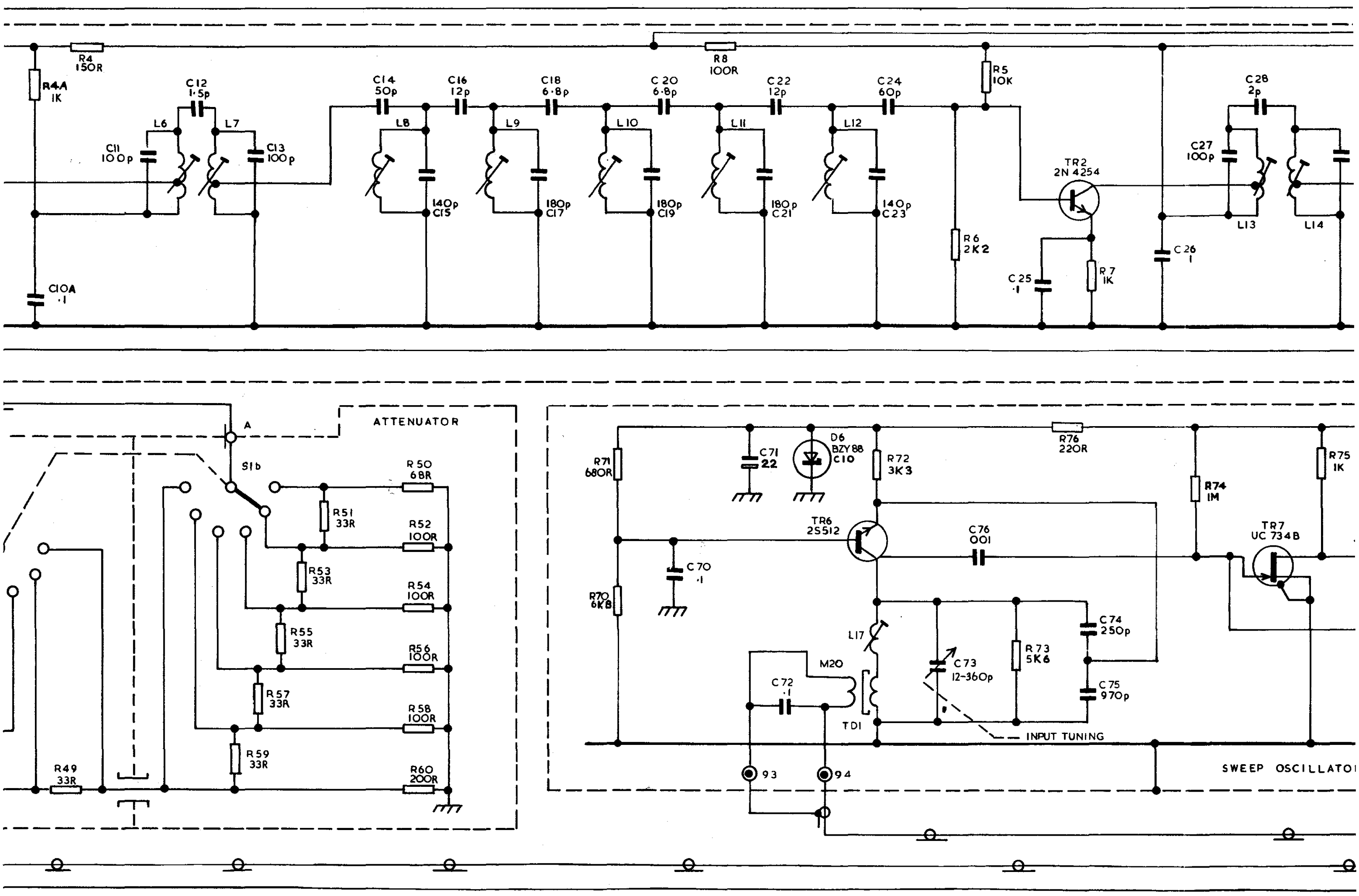
LIN
LOG
IN LINE BICC BURNDY CONNECTORS
FROM DETECTOR IN APPROPRIATE IF MODULE
LINK FOR TEST
VIDEO FILTER
LOG/LIN AMP
Y AMPLIFIER
Y GAIN
Y SHIFT
Y BALANCE
MARKER AMPLITUDE
MOUNTED ON REGULATOR BOARD
TWIST COIL
10V FROM REGULATOR
X1 PLATE
X2 PLATE
ASTIG
GEOM
G2 BLANKING
CRT EP961A D13-33GM
EP961B D13-33GH
X SHIFT
X AMPLIFIER
X EXPANSION
X GAIN
TO PIN 5 ON RF TUNER
POT MTG BOARD
MOUNTED ON TIMEBASE BOARD
D30-35-IN4004
LOW VOLTAGE RECTIFIER MODULE
100/130V OR 200/260V AC 50Hz
FIT STANDARD SHORTING PLUG FOR A.C. WORKING
12V DC SUPPLY
12V DC INPUT
REGULATOR BOARD (MOUNTED ON R.H.SIDE PLATE)
SET VOLT
MANUAL SWEEP
SWEEP SPEED
33Hz (9)
20Hz (8)
12·5Hz (7)
5Hz (6)
3·3Hz (5)
1·6Hz (4)
0·5Hz (3)
0·33Hz (2)
0·2Hz (1)
10kHz (1kHz)
25kHz (2kHz)
50kHz (4kHz)
75kHz (8kHz)
100kHz (12kHz)

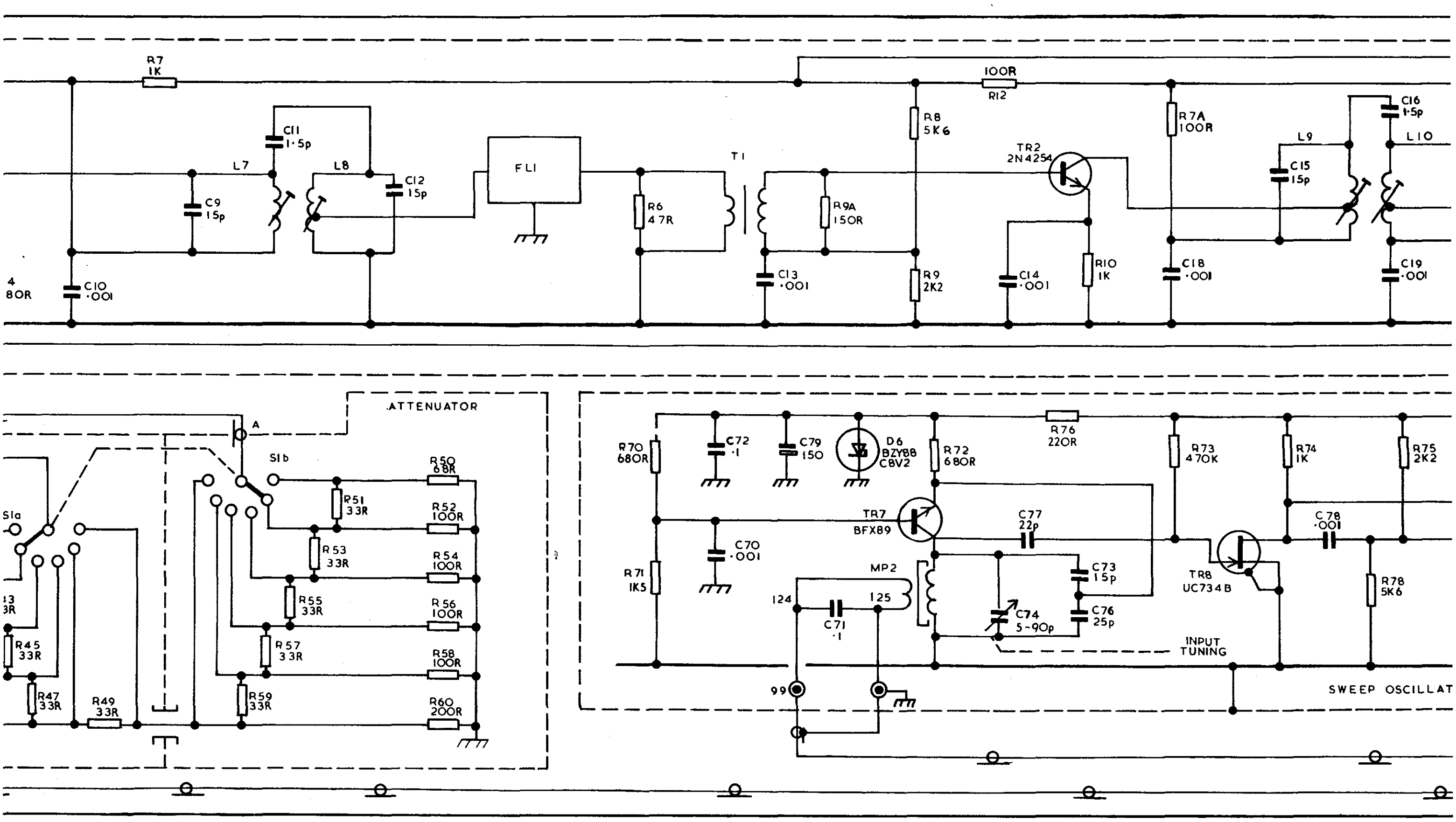


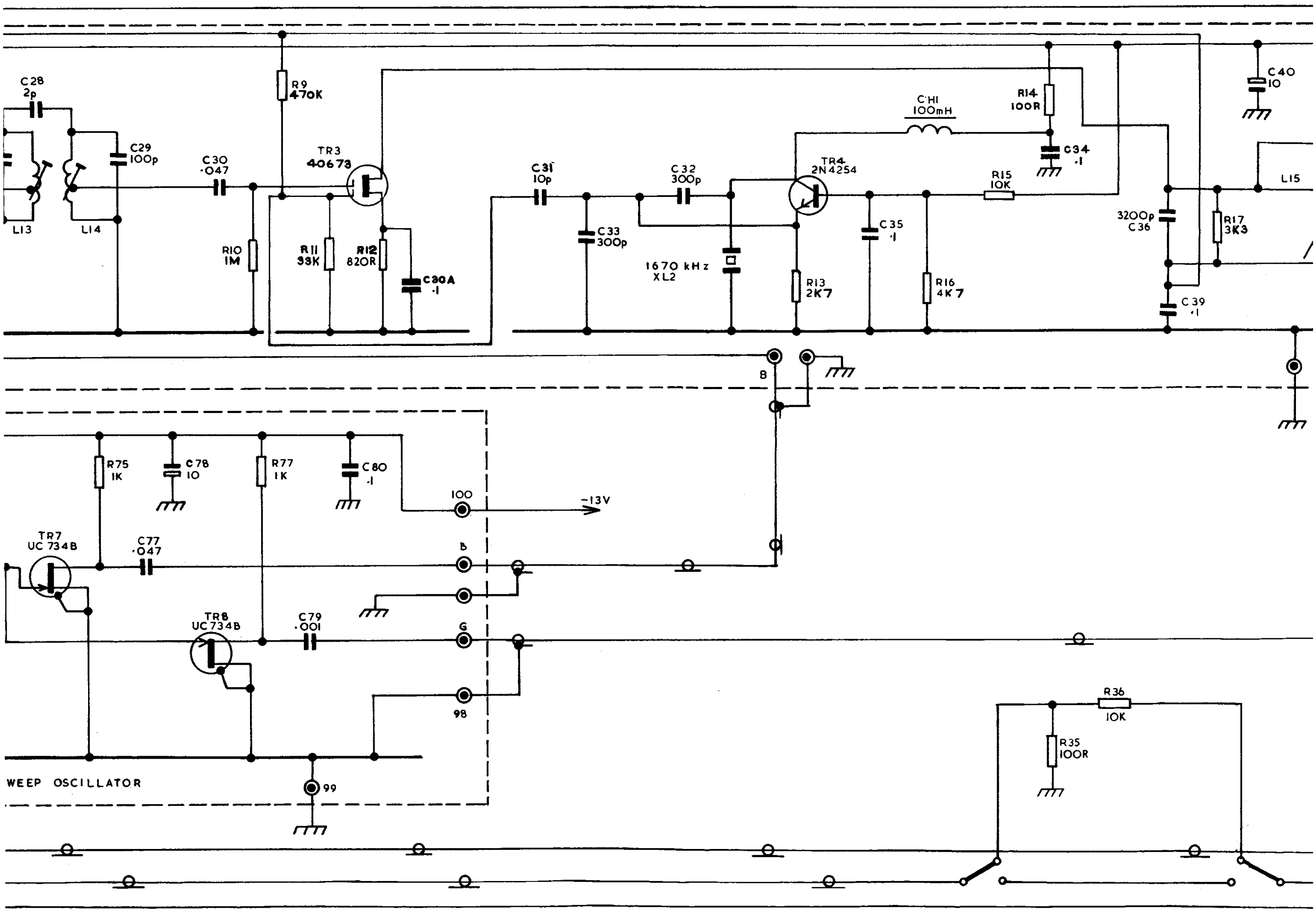
R212 3K9
S5A
S5B
RV3 100K
R211 33K
S5C
LIN
LOG
FM IN LINE BICC BURNDY CONNECTORS
R200 10K
R201 470K
C191 640p
R204 1K5
7709C IC4
C190 ·047
R203 470R
R202 10K
TR21 BFY81
R205 330K
R210 10K
7709C IC5
C193 22p
C192 340p
R207 1K5
R206 560R
R208 18R
C194 150
+10V
-10V
C195 150
R209 18R
LOG/LIN AMP
C134 ·22
MOUNTED ON CALIBRATOR BOARD RECORDER OUTPUT EMITTER FOLLOWER
R186 1K
UC734B TR28
C171 10
R184 10K
R183 680K
R185 1K8
SET ZERO RV4 560R
PEN RECORDER OUTPUT
R187 3K3
-13V
R232 47R
UC734B TR22
C211 150
R233 18R
R234 10K
R235 2K7
R236 47R
R237 2K2
R238 8K2
R239 1K
2N3702 TR23
R240 470R
R241 4K7
R242 1K
2N3702 TR24
R243 470R
C212 500p
R245 22R
2N3702 TR25
R246 8K2
C214 ·01
R248 180K
R249 2K2
C215 150
R250 6K8
R244 6K8
C213 22
R247 6K8
RV5 1K Y GAIN
-40V
RV6 47K Y SHIFT
RV7 1K Y BALANCE
R251 150R
C216 50p
R253 150R
D7 BZY88 C6V2
R255 150R
2N3712 TR26
C217 ·01
2N3712 TR27
R252 4K7
C218 10
R254 4K7
R256 470R
+80V
+40V (Y AMP)
R257 1K
C219 22
Y1
Y2
MOUNTED ON REGULATOR BOARD
RV24 4K7
TWIST COIL
L34
10V FROM REGULATOR
X1 PLATE
X2 PLATE
CRT
4·5KV+
RV26 100K GEOM
MOUNTED ON REGULATOR BOARD
R420 1M
R421 1M
R422 1M
RV28 1M FOCUS
R423 270K
R424 15K
RV29 470K BRILLIANCE
-1·3KV
RV25 100K ASTIG
G2 BLANKING
C301 ·01 3000V
RV27 5R 3W
C302 ·01 3000V
C303 ·03
CRT EP961A D13-33GM
EP961B D13-33GH
TH2 VA1034
R351 6K8
R356 6K8
OA202 D27
2N3712 TR43
2N3704 TR45
RV22 4K7 X SHIFT
OA202 D26
OA202 D28
C253 ·1
C252 130p
R354 680R
R353 680R
R357 220R
2S512 TR44
R355 390R
C252A 22
R358 15K
R360 22K
R361 5K6
R359 4K7
R362 22R
X EXPANSION
RV20 10K
X GAIN
RV21 4K7
T7
+4·5KV
-1·3KV
C300 ·002
D36 LA60
C279 ·002
D37 LA60
R407 10K
1N4004(6 OFF)
D38 D39 D40
C280 ·01
C291 ·03
D43 D42 D41
R410 16R
TR52 2N3055
R411 R05 WW
R412 R05 WW
R413 470R
2N3055 TR53
BYX22-200 D44
R414 10R
C281 22
10V SUPPLY TO TWIST COIL
C294 7500
C294A 7500
2N3055 TR50
2N3055 TR51
C292 ·1
C291 ·1
C290 220
C293 220
D30-35-1N4004
C270 10
D30
C271 10
C272 10
R406 390R
D31
-80V
+40V
R400 270R
C273 22
D32
+40V (Y AMP)
C274 22
R401 270R
D33
+13V
R404 10R
R402 10R
C275 1000
C277 1000
D34
C296 1000
D47 OAZ228
C276 1000
C278 1000
D35
C297 1000
D48 OAZ228
13V
R405 10R
R403 10R
LOW VOLTAGE RECTIFIER MODULE
+12V (UNREG)
R379 100R
C264 470
+10V (REG)
R380 100R
R381 1K2
R382 470R
R384 220R
C262 10
TR49 BFY51
R385 33K
TR47 2N3702
C260 150
R386 1K
TR46 40372
C261A 150
BFY51 TR48
R387 1K
R388 1K
R383 150R
R389 1K
D29 BZY88 C3V6
C261 ·1
RV23 1K SET VOLTS
R390 2K2
REGULATOR BOARD (MOUNTED ON R.H. SIDE PLATE)
1B40K05 D45
R408 2R WW
C295 7500
C293A 7500
240V
220V
S10B
S10C
D46 BYX38-300R
FS2 5A
E
N
00/260V AC 50Hz
FIT STANDARD SHORTING PLUG FOR A.C. WORKING
12V DC SUPPLY
12V DC INPUT


RF UNIT 'A' 50-800 kHz
1·6 MHz IF BOARD
INPUT
INPUT AMPLIFIER
L1
L2
L3
L4
L5
3900p C1
C2 3900p
1800p C4
C3 4700p
3900p C6
C5 4700p
C7 ·047
R1 220R
C9 ·047
R1A 1M
R2 33K
R3 470K
C8 ·047
R4 150R
R4A 1K
C11 100p
TR1 40673
C10 ·1
R3A 680R
C10A ·1
C50 ·1
C51 10
120
R30 2K7
C53 ·1
R31 47R
R33 1K5
R32 2K7
C52 ·1
C54 ·1
CA 3001 IC1
R34 100R
121
C55 10
C57 10
C56 ·1
122
+10 V (PIN 5)
EARTH
R40 68R
R41 33R
R42 100R
R43 33R
R44 100R
R45 33R
R46 100R
R47 33R
R48 100R
R49 33R
S1a
A
C
D
E

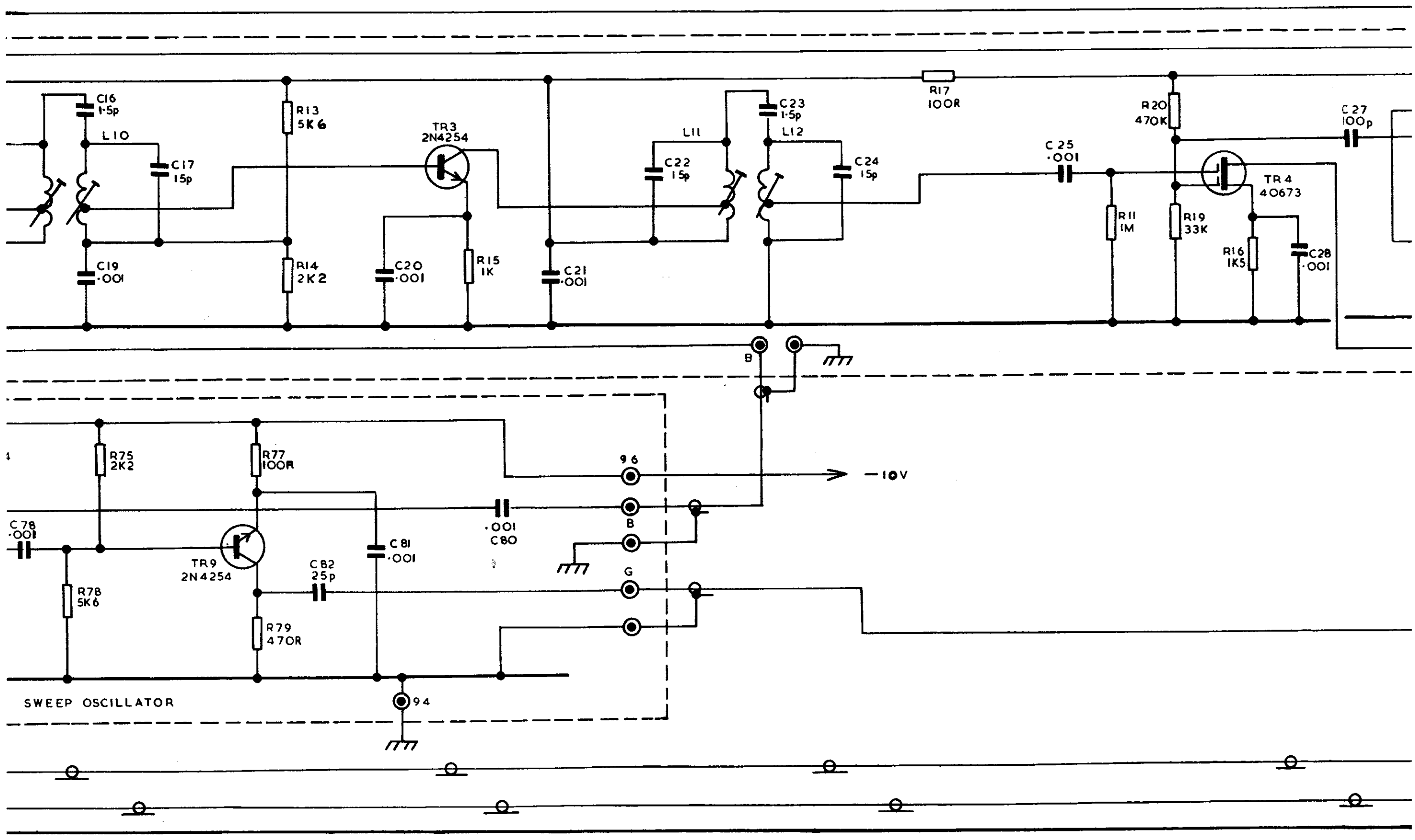

RF UNIT 'B' 500kHz - 36·5 MHz
45 MHz IF BOARD
LOW PASS FILTER
INPUT
INPUT AMPLIFIER
C1 ·01
L1
L2
L3
L4
L5
L6
C2 27p
C3 60p
C4 150p
C5 27p
C6 25p
C7 ·001
R1 1M
C8 ·001
R2 470K
TR1 40673
12K R3
C8A ·001
R4 680R
C10 ·001
C50 ·1
C51 50p
120
C54 3p
SA20 IC1
C55 ·1
C56 100
CH1
C57 ·1
121
C58 ·1
123
C59 20p
C60 ·1
C52 100
C53 ·1
CH2
122
+10V (PIN 5)
-10 V (PIN 4)
R40 68R
R41 33R
R42 100R
R43 33R
R44 100R
R45 33R
R46 100R
R47 33R
R48 100R
R49 33R
S1a
A
C
D
E


R4
150R
R4A
1K
C12
1·5p
L6
L7
C11
100p
C13
100p
C10A
·1
C14
50p
C16
12p
C18
6·8p
C20
6·8p
C22
12p
C24
60p
L8
L9
L10
L11
L12
140p
C15
180p
C17
180p
C19
180p
C21
140p
C23
R8
100R
R5
10K
R6
2K2
TR2
2N 4254
R7
1K
C25
·1
C26
1
C28
2p
C27
100p
L13
L14
ATTENUATOR
A
S1b
R50
68R
R51
33R
R52
100R
R53
33R
R54
100R
R55
33R
R56
100R
R57
33R
R58
100R
R59
33R
R60
200R
R49
33R
R71
680R
C71
22
D6
BZY88
C10
R72
3K3
R76
220R
R75
1K
R74
1M
TR6
2S512
C76
001
TR7
UC 734B
C70
·1
R70
6K8
L17
C73
12-360p
R73
5K6
C74
250p
M20
C72
·1
TD1
C75
970p
INPUT TUNING
93
94
SWEEP OSCILLATOI

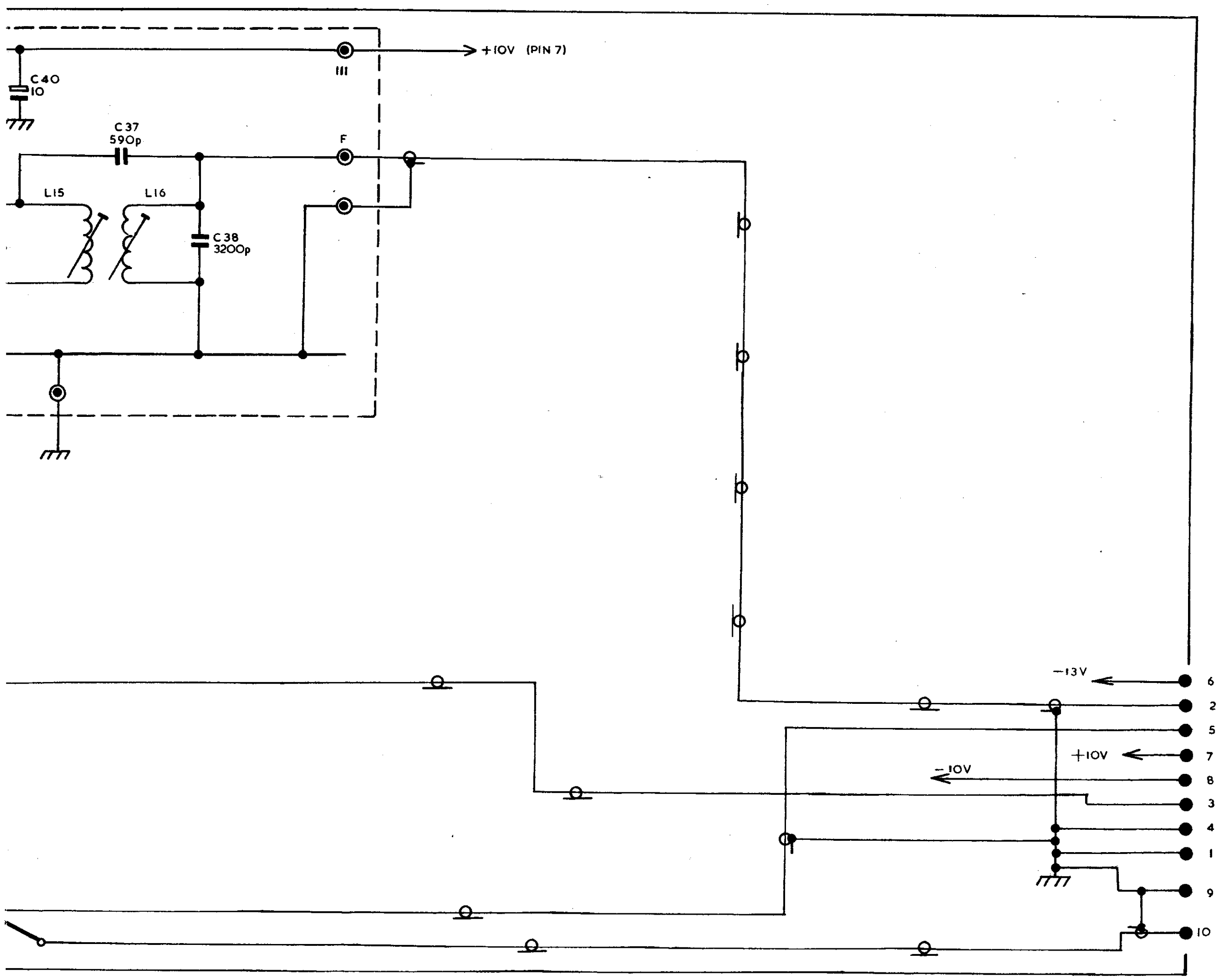

R7
1K
100R
R12
R8
5K6
R7A
100R
C16
1·5p
C11
1·5p
L7
L8
C12
15p
FL1
T1
TR2
2N4254
L9
L10
C15
15p
C9
15p
R6
47R
R9A
150R
4
80R
C10
·001
C13
·001
R9
2K2
C14
·001
R10
1K
C18
·001
C19
·001
ATTENUATOR
A
S1b
S1a
R50
68R
R51
33R
R52
100R
R53
33R
R54
100R
R55
33R
R56
100R
R57
33R
R58
100R
R59
33R
R60
200R
R45
33R
R47
33R
R49
33R
R70
680R
C72
·1
C79
150
D6
BZY88
C8V2
R72
680R
R76
220R
R73
470K
R74
1K
R75
2K2
TR7
BFX89
C77
22p
C78
·001
C70
·001
R71
1K5
MP2
124
125
C71
·1
C73
15p
C74
5-90p
C76
25p
TR8
UC734B
R78
5K6
INPUT
TUNING
99
SWEEP OSCILLAT

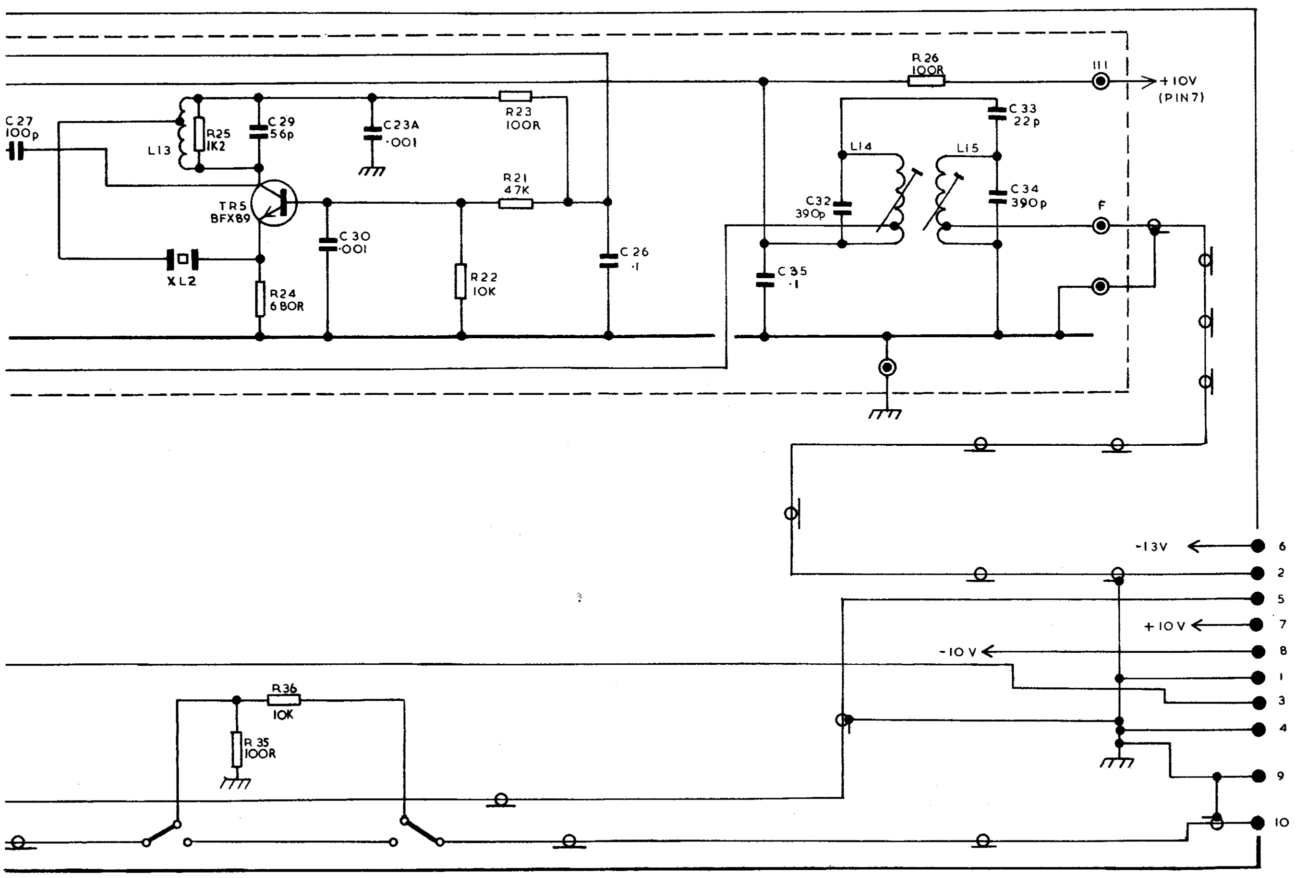


C28 2p
C29 100p
L13
L14
C30 ·047
R9 470K
TR3 40673
R10 1M
R11 33K
R12 820R
C30A ·1
C31 10p
C33 300p
C32 300p
1670 kHz XL2
CH1 100mH
TR4 2N4254
R13 2K7
R14 100R
C34 ·1
C35 ·1
R15 10K
R16 4K7
3200p C36
C39 ·1
R17 3K3
C40 10
L15
B
R75 1K
C78 10
R77 1K
C80 ·1
100
-13V
TR7 UC 734B
C77 ·047
B
TR8 UC 734B
C79 ·001
G
98
WEEP OSCILLATOR
99
R36 10K
R35 100R



C16 1·5p
L10
C17 15p
C19 ·001
R13 5K6
R14 2K2
TR3 2N4254
C20 ·001
R15 1K
C21 ·001
L11
L12
C22 15p
C23 1·5p
C24 15p
R17 100R
C25 ·001
R11 1M
R20 470K
R19 33K
TR4 40673
R16 1K5
C28 ·001
C27 100p
B
R75 2K2
R77 100R
96
-10V
C78 ·001
TR9 2N4254
R78 5K6
C81 ·001
·001 C80
B
C82 25p
G
R79 470R
SWEEP OSCILLATOR
94


C40
10
III
+10V (PIN 7)
C37
590p
F
L15
L16
C38
3200p
-13V
+10V
-10V
6
2
5
7
8
3
4
1
9
10


C27
100p
L13
R25
1K2
C29
56p
C23A
·001
R23
100R
R21
47K
TR5
BFX89
C30
·001
XL2
R24
680R
R22
10K
C26
·1
R26
100R
III
+10V
(PIN7)
C33
22p
L14
L15
C32
390p
C34
390p
F
C35
·1
-13V
+10 V
-10 V
6
2
5
7
8
1
3
4
9
10
R36
10K
R35
100R