COSSOR

EQUIPMENT MANUAL

COSSOR RADAR AND ELECTRONICS LTD.

COSSOR

C.R.D. 23

RADAR DISPLAY HANDBOOK

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COSSOR RADAR AND ELECTRONICS LIMITED

A Subsidiary of A. C. COSSOR, LTD. and of RAYTHEON COMPANY, U.S.A.

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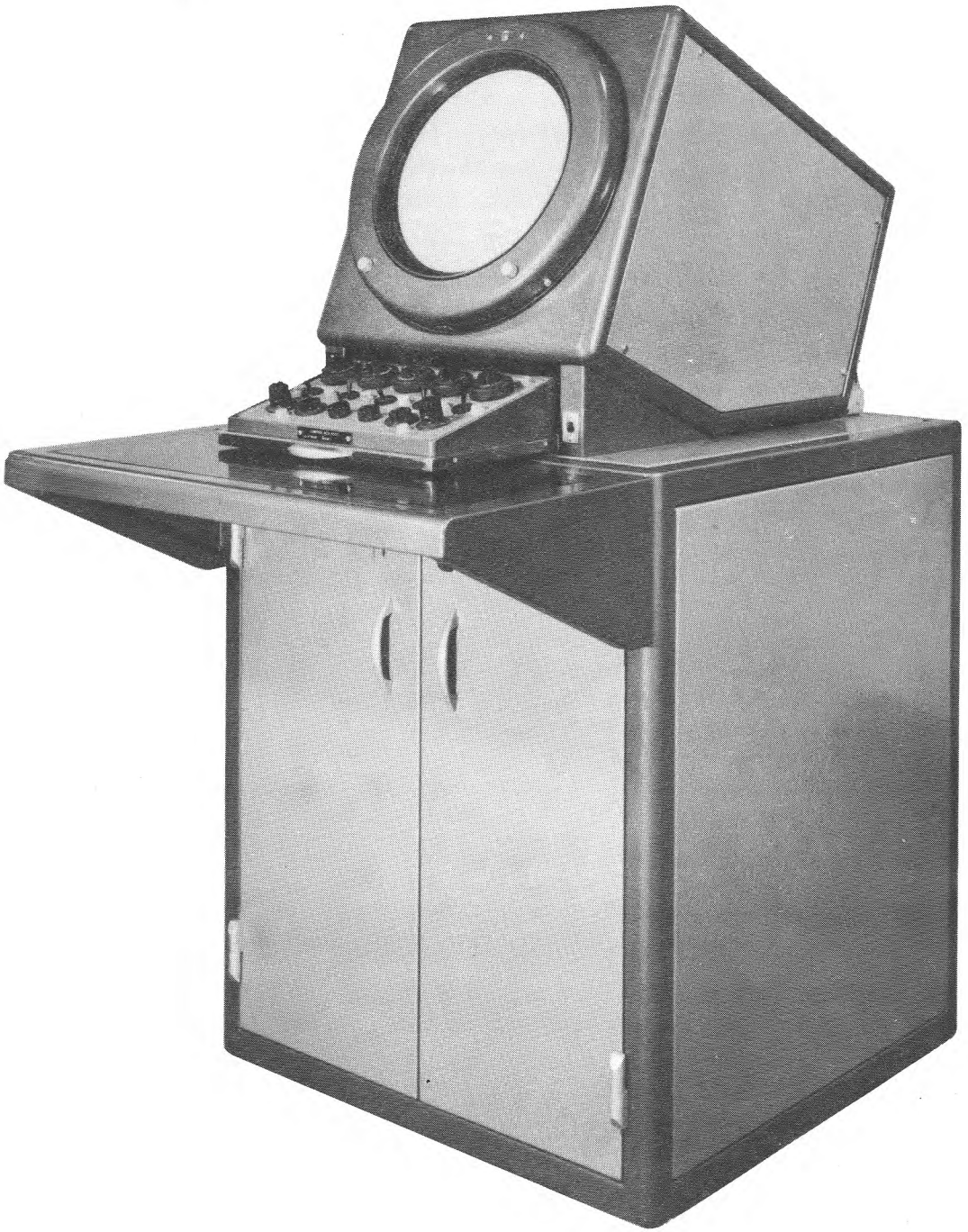

PLATE I

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1. Cossor Radar Display 23 is a sophisticated p.p.i. system designed to provide up to ten different forms of signal information simultaneously. It can be considered as a flexible unit which may be used with almost any type of radar installation, whether simple or complex. The basic equipment consists of the viewing unit, containing a 12-inch c.r.t. together with its fixed coil d.c. coupled deflection system; and a base assembly, on which the viewing unit may be mounted, which contains the waveform generation circuit and the positive and negative power units.

FACILITIES PROVIDED

Ranges

2. Four ranges are available. These may extend to any distance required by the parent equipment, provided the ratio of the-maximum to minimum scale does not exceed 10 to 1.

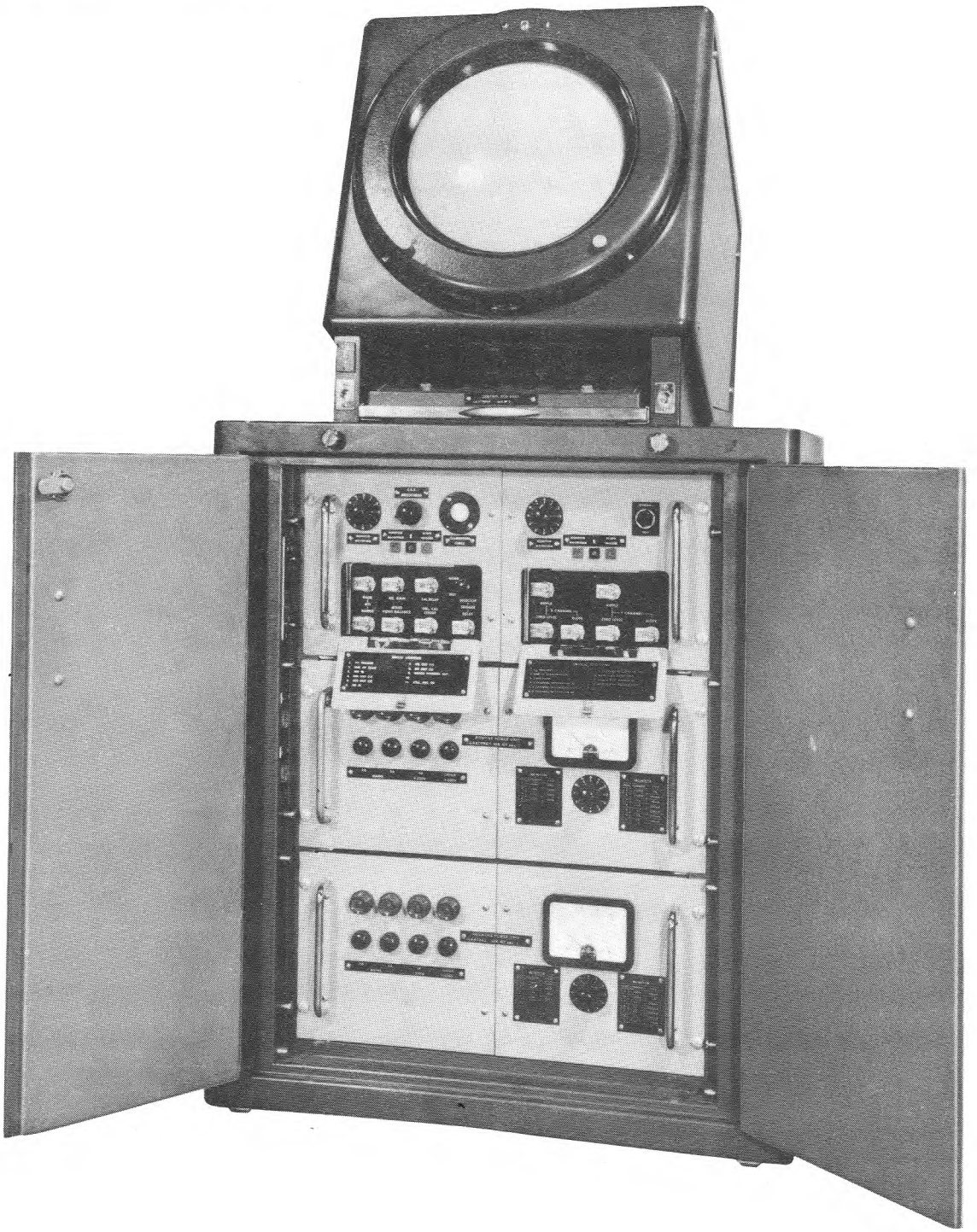

PLATE 2

SHOWING FRONT PANELS OF SUB-UNITS

PART ONE

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GENERAL DESCRIPTION

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Illustration

INTRODUCTION

1. Cossor Radar Display 23 is a sophisticated p.p.i. system designed to provide up to ten different forms of signal information simultaneously. It can be considered as a flexible unit which may be used with almost any type of radar installation, whether simple or complex. The basic equipment consists of the viewing unit, containing a 12-inch c.r.t. together with its fixed coil d.c. coupled deflection system; and a base assembly, on which the viewing unit may be mounted, which contains the waveform generation circuit and the positive and negative power units.

FACILITIES PROVIDED

Ranges

2. Four ranges are available. These may extend to any distance required by the parent equipment, provided the ratio of the-maximum to minimum scale does not exceed 10 to 1.

Range markers

3. Range markers are provided at intervals of 1, 5, 10 and 20 nautical miles and are arranged to have successive degrees of brilliance. This enables the operator to cause the markers to appear in succession, the 20 mile markers first, by operating the marker gain control.

Video channels

4. Six video channels are available and may be controlled independently. Two of these are normally used to display M. T. I. and normal radar signals. This permits the operator, while looking at a cancelled picture at full gain, to display as a background an uncancelled picture at reduced gain. Other channels may be used for secondary radar, video mapping, etc.

Bearing markers

5. Bearing markers, such as a north marker or 10° markers, may be provided by brightening one radial trace at the required intervals.

Secondary radar and CRDF

6. The output from IFF or civil secondary radar may be displayed together with the primary display, another of the video channels being employed for this purpose. Arrangements can also be made to present the output of standard CRDF equipment on the p.p.i.

Video mapping

7. A twin video map unit may be employed which provides for long and short range. As the equipment is switched from one range to another, the appropriate map is automatically displayed.

Interscan markers

8. Additional information, such as numbers or symbols, may be displayed during the interscan periods. These may be positioned by the operator and used either for his own reference or as a means of communicating information to other operators.

MECHANICAL FEATURES

General design

9. The base units are designed so that several of them may be stacked, one on top of another, for use with a complex display system. Access to the sub-

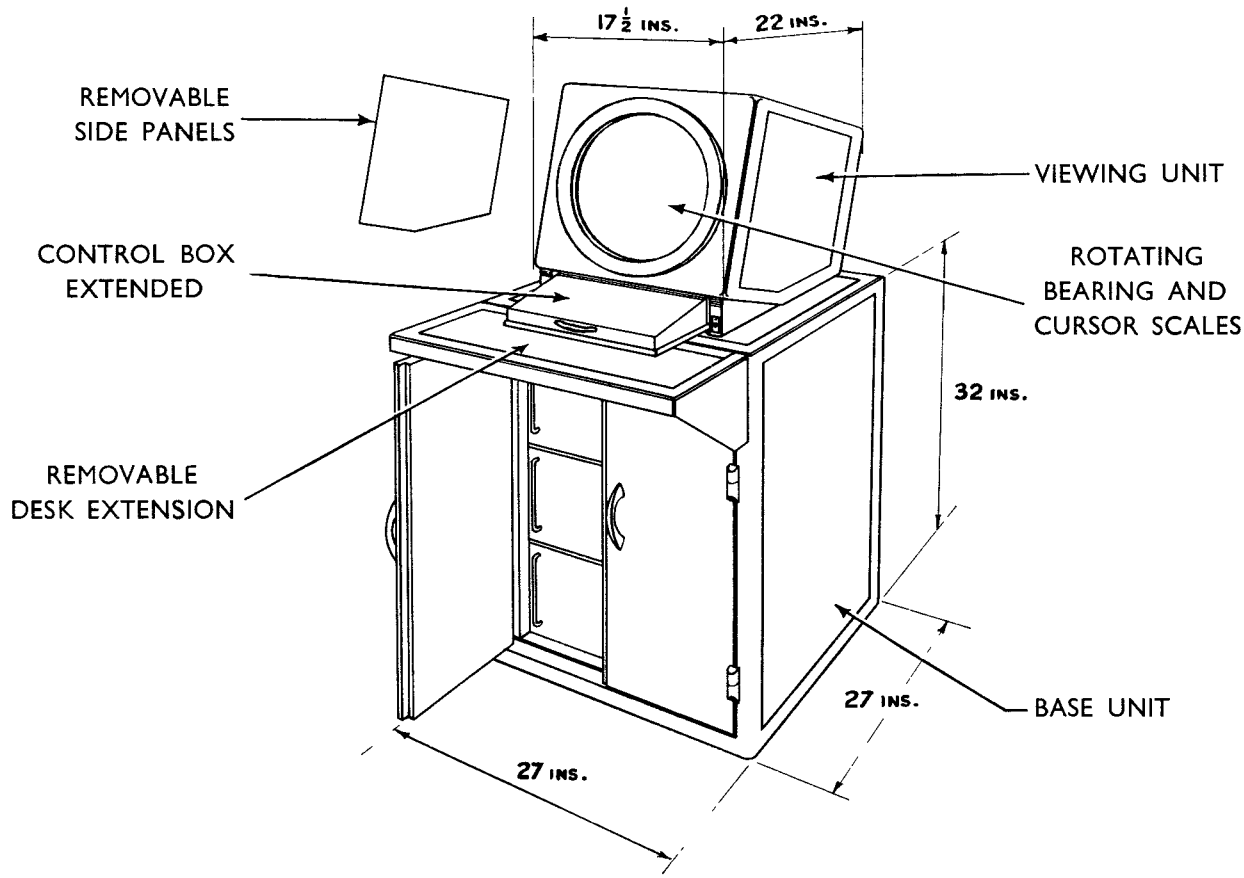

FIG. 1.1.1
CONSTRUCTIONAL DETAILS & DIMENSIONS

assemblies is obtained by means of two hinged doors. Each chassis, except for the lower one, can be withdrawn on to a service tray, which may be readily attached to the base unit. The viewing unit has been so designed that all components are accessible when side panels are removed and the hinged chassis opened outwards. All the operator's controls are assembled on a panel, which is withdrawn from under the viewing unit and then moved back again after the controls have been adjusted. Ball catches are employed to lock the panel in either position. A desk extension is also provided for the convenience of the operator, this being fitted to the front of the base unit. Outlines and dimensions are shown in Fig. 1.1.1.

POWER SUPPLIES

Stabilized supply and switching

10. CRD.23 must be operated from a stabilized 230V 50c/s supply, this being obtained from an existing source or from a Servomex voltage regulator which may be fitted, if required. The power is normally switched to the display units through the mains distribution box of the parent equipment.

Emergency switch

11. For the purpose of safeguarding the equipment, power is normally applied in sequence to the individual circuits by means of switching units. In an emergency, though, the operation of these may be by-passed by using the emergency mains switch inside the base unit.

COOLING AND ANTI-CONDENSATION

Cooling

12. The base units and viewing units each have their separate system. The former has an air intake fan, capable of supplying 300 cubic feet per minute, which draws air through a polythene filter at the rear. This is directed upwards inside the unit. Holes in the ducting are provided at convenient points so that air is directed across the three electronic units at the most advantageous points. The system is capable of supplying another base unit standing on top of the original, this being arranged by removing an end cover and connecting the ducting of the two units. The viewing units have an extraction fan mounted at the rear which draws air through a polythene filter above the control panel recess and directs it across the electronic components.

Anti-condensation

13. Anti-condensation heaters are fitted in both units. Both heaters and blower motors are supplied from the unstabilized mains, which are switched by a

changeover relay. When the equipment is off, the heaters are operative; when the equipment is on, the heaters are switched off and the cooling system is in operation.

REMOTING FACILITIES

14. With additional equipment, the display system may be remoted up to 4000 yards. A description of the remoting units is given in the handbook associated with the main equipment.

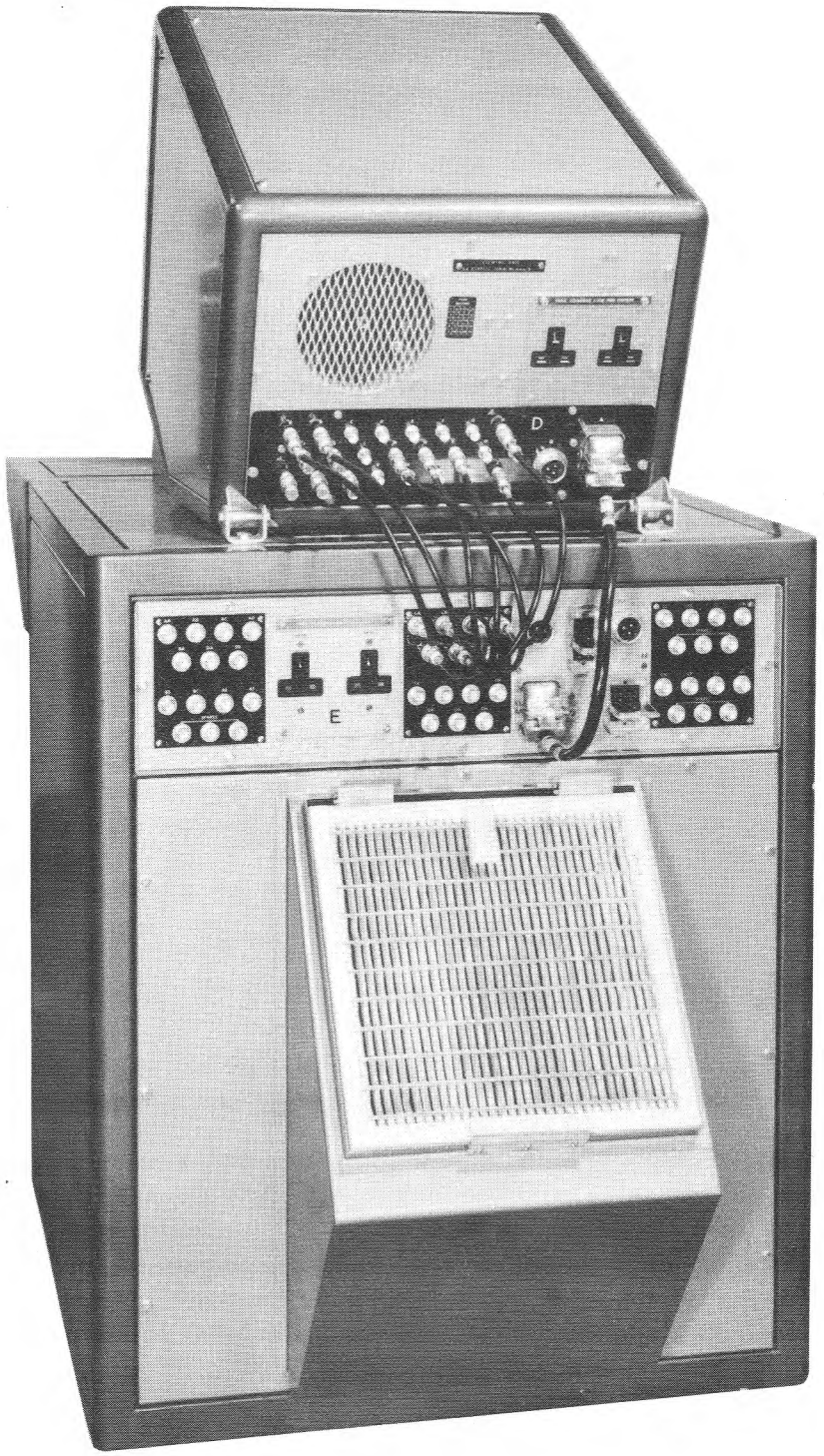

PLATE 3

SHOWING REAR PANELS OF BASE & VIEWING UNITS

CHAPTER 2

FUNCTIONAL DESCRIPTION

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General

1. While the basic operation of the display system is conventional, there are certain subsidiary circuits which also need description. The facilities provided by these may or may not be required, depending upon the type of equipment with which the display system is used. The operation is initiated in the waveform generator, which is supplied with information from the parent equipment. Various output signals and waveforms from this unit are then supplied to the viewing unit. This contains the deflection amplifiers, the video mixer and the c.r.t. To obtain a logical sequence, however, the functional description is dealt with by systems, rather than by units.

Deflection system

2. Since a p.p.i. display is required, the timebase waveforms are arranged to create a radial timebase which rotates with the aerial. A sine/cosine potentiometer at the aerial provides d.c. voltages, the sense and amplitude of which are determined by the bearing angle. These two voltages are used to operate two integrator circuits which produce voltage waveforms corresponding to the sine and cosine inputs. The start of the timebase is determined by a triggering input from the transmitter unit of the main equipment. This initiates a gating circuit which controls the integrators so that the sweep voltage is produced within the gate. The duration of the gate is greater than the sweep time of the maximum range of the equipment.

3. The sawtooth voltage waveforms produced by the integrators are supplied to the deflection amplifiers. These provide suitable current waveforms for

supplying the deflection coils of the c.r.t. and producing the radial timebase. Switching is employed in this circuit to provide the four timebase ranges. Offset facilities are obtained by using controls which vary the standing current through the deflection coils.

M.T.I. and normal radar signal mixing

4. Normal radar signals are received from the head i.g. amplifier in the transmitter-receiver and amplifier by the normal radar amplifier in the waveform generator. They are then passed to two circuits, either or both of which may be used; these being the normal radar output stage and the M.T.I./normal radar signal mixing stages. The M.T.I. signals are obtained from the M.T.I. receiver in the main equipment and amplified in the waveform generator. These are then also passed to the M.T.I./normal radar signal mixing stage.

5. The M.T.I. and normal radar signals are mixed in such a way that, during the first part of the trace, only M.T.I. signals are displayed. Then, for the remainder, normal radar signals appear. This enables clutter round the centre of the p.p.i. to be removed and still allows the operator to obtain the benefit of the normal radar signals over the greater part of the range. The changeover point along the trace from M.T.I. to normal radar signals may be varied at the operator's convenience. The output is taken to the video mixer stages and applied to the cathode of the c.r.t. If it is not required to display M.T.I. signals, the normal radar output alone is taken to the video mixer.

Iso-echo facility

6. The iso-echo unit is substituted for the normal radar amplifier when the equipment is used for weather observation. The receiver in the parent equipment provides a video signal which is supplied to the iso-echo strip. This is simply a two-stage amplifier followed by a switching device. When echoes received from storm areas reach a pre-determined strength, the switch operates and reduces the output to zero. This produces a blacked-out 'hole' in the display picture which represents the storm centre. The point at which the switch operates may be varied to enable the extent of the storm area to be observed more accurately.

North marker

7. When the north marker is required, the aerial is arranged to operate a switch at 0^{o}. This initiates the action of a circuit in the waveform generator which produces a positive-going pulse. The pulse is applied to the brightener mixer and serves to brighten one trace each time the aerial passes through true north.

Range markers

8. The range marker circuit in the waveform generator consists of a master oscillator and a series of divider stages. At the start of each timebase the oscillator is allowed to operate and the divider stages produce positive-going

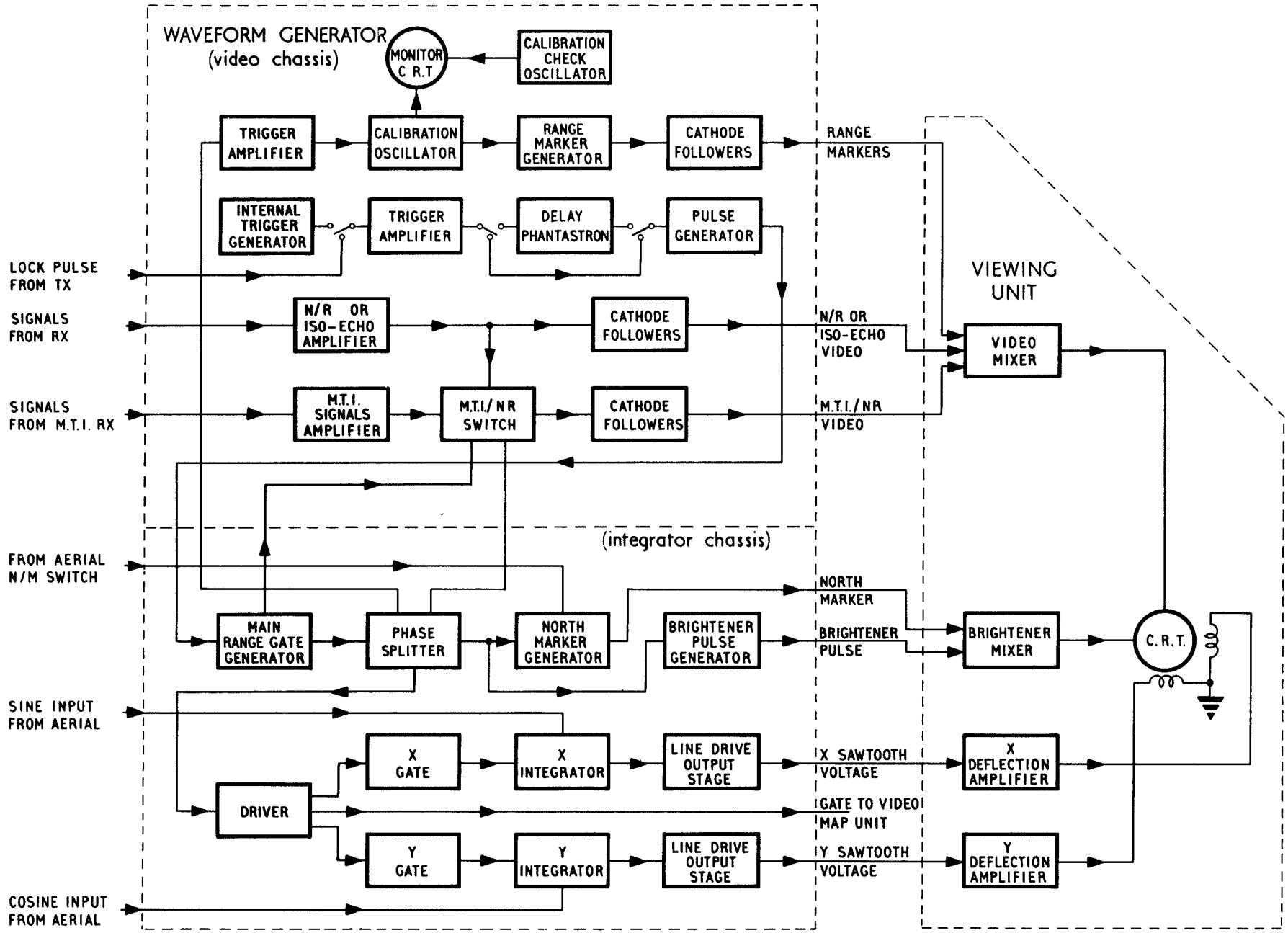

FIG. 1.2.1. BLOCK DIAGRAM OF CRD 23

pulses at intervals which represent the required ranges. These are accepted by one channel of the video mixer and, after amplification, applied as negative-going pulses to the cathode of the c.r.t. Range rings are thereby produced on the p.p.i. The accuracy of these markers may be checked by using the calibration check oscillator in conjunction with the monitor c.r.t.

Video mixer

9. The video signals are mixed, amplified and applied as negative pulses to the cathode of the c.r.t. The video mixer has six independently controlled input channels, which allow several types of information to be displayed.

Brightener mixer

10. The main scan brightener waveform is obtained from the gating circuit in the waveform generator. It is a positive-going output which lasts for the duration of the range gate and is supplied to the brightener mixer. This is a similar circuit to the video mixer and provides five independently controlled chanels, one of which is used by the main scan brightener. After amplification, it is applied as a positive-going pulse to the grid of the c.r.t. to brighten the trace during the sweep time.

E.h.t. supply

11. The e.h.t. voltage is obtained from an oscillator circuit which supplies a voltage doubler. The output voltage level is controlled by using a sample of the secondary voltage of the oscillator transformer to provide bias for the oscillator valve. This arrangement provides a stable output of 15kV for the c.r.t.

Video mapping

12. A positive-going pulse is supplied from the gating circuit in the waveform generator and used to trigger the video mapping unit, when fitted. The output from this equipment is accepted by one or two channels of the video mixer and displayed on the p.p.i.

PART TWO

CHAPTER 1

THE WAVEFORM GENERATOR

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Illustration

INTRODUCTION

1. The waveform generator unit has two chassis which are designated the integrator and the video units. The former is mainly concerned with the preparation of the timebase waveforms from the information obtained from the sine/cosine potentiometer at the aerial. The video chassis is responsible for the signals and markers which are to be displayed on the c.r.t. The chassis are dependent upon each other for certain functions, these being shown in Table 1.

TABLE 1

Interconnections between integrator and video chassis

Video chassis	Function	Integrator chassis
Socket A	Negative trigger	Socket A
Socket C	End-of-scan trigger	Socket C
Socket X	NR/MTI gate	Socket X
Socket D	CAL gate	Flying lead

INTEGRATOR CHASSIS

General

2. Included on this chassis are the main range gate generator, the X and Y integrators, the north and 10^{o} marker generators and the brightener generator. Miscellaneous trigger outputs are provided and monitoring facilities enable the operation of all parts of the circuit to be checked. The stages are condisered in turn.

Main range gate generator

3. The main range gate generator is a phantastron circuit incorporating V1, V2 and MR2. The input is obtained from the T_o generator and consists of a negative-going pulse. This is applied through V2B to prevent back-coupling and initiates the run-down action of the phantastron. The point at which the anode voltage bottoms represents the end of the gate, so this is adjusted by RV1, the TIMEBASE DURATION control, to correspond with the maximum scan time required by the equipment.

4. The positive-going square wave at the suppressor of V1 is applied to phase-splitter V3B. The negative-going output at the anode is used to cut off V4, the driver for the two main gate phase splitters V5 and V6. These are normally cut off but are switched on by the output from the anode of V4, which is d.c. coupled to the grids. Inverse square waves are obtained from

the cathode and anode of each valve, V5 output being used to gate the Y integrator, V6 being used for the X circuit.

Input to the integrators

5. The inputs to the X and Y integrators are derived from a sine/cosine potentiometer which rotates with the aerial and produces voltages proportional to the sine and cosine of the aerial bearing. D.c. voltages of equal amplitude, but of opposite polarity, are applied across the windings of the potentiometer. The two wipers are spaced 90^{o} apart and are aligned so that when the aerial is at a position corresponding to 0^{o}, the wiper producing the sine output is at 0 volts and the wiper producing the cosine output is at +50 volts d.c. maximum. As the aerial rotates the voltages will vary between 0 and +50 volts d.c. but will be 90^{o} out of phase. These voltages are then fed to the integrator circuits to produce sawtooth voltages. These are used by the deflection amplifiers to control the c.r.t. deflection coils so that a rotating radial trace is displayed with an angular position corresponding to that of the aerial bearing.

The integrators

6. The Y integrator, which employs valves V8 to V14, and the X integrator, which includes valves V16 to V21, are identical circuits, the former being concerned with the cosine input from the sine/cosine potentiometer, and the latter dealing with the sine input. As the operation is the same in both cases, only that of the X integrator is given here.

7. V15 is the main integrator valve and C33 the integrator capacitor. In between traces, clamping diodes V16A and B and V17A and B are conducting and so short-circuit C33. The d.c. sine input is applied through a resistance network to the grid of V15 and to one plate of C33. This voltage varies in polarity and amplitude as the aerial rotates but can have no effect upon the grid voltage while the clamp circuit is operating.

8. At T_o, when the range gate begins, the diodes are cut off by the output from V6, consisting of a positive pulse at the cathodes of V17 and a negative pulse at the anodes of V16. This allows integration to commence, the charging current in C33 being determined by the instantaneous sine voltage and therefore the rate of run up or down of the voltage at V15 anode. This anode voltage varies positively or negatively about +240V, according to the polarity of the sine input and appears as a sawtooth waveform with a maximum amplitude of 150V. At the end of the gate, the diodes conduct and discharge C33, causing the flyback.

9. This voltage is passed to a double cathode follower stage from which the feedback is taken. The first cathode follower V18A enables the slant level of the sawtooth waveform to be changed from +240V to 0V without varying the amplitude of the sawtooth, by the constant current triode V10A in its cathode circuit. The input to the grid of V18A produces a similar waveform at the

cathode. A similar waveform is also obtained at V19A anode but the sitting level is approximately 0V. This is fed to the grid of V18B. The cathode voltage of this stage is then applied to the other plate of C33 and so completes the feedback loop. V19B is a constant current triode which provides a high dynamic load for the cathode follower and so improves linearity. R59 is included to provide a measure of negative feedback.

10. The output from V18B cathode, which is the true integrator output, is applied to line drive stage V20. This is a cathode follower output stage which employs V21 as a load to improve linearity. The output is taken from SKTE and SKTF to the X channel deflection amplifiers in the viewing units.

Integrator pre-set controls

11. The operation of the X integrator controls is the same as that of their counterparts in the Y integrator. Switch C is used to disconnect the input and return the grid circuit of V15 to earth. RV16 'SLOPE' may then be adjusted so that, with zero input, the current through C33 is zero and therefore the rate of change of the integrator is zero. RV18 (RIPPLE) is a humdinger control to minimise ripple. It is held at a positive potential to avoid the possibility of emission occuring from the heater to the cathode and creating noise. RV20 'ZERO LEVEL' is adjusted so that the output from V20 varies about zero.

12. C31 is used to balance out any stray capacity which could cause steps on the gate waveform. C11 is employed to equalise the edges of the gate output waveform from V6 and so minimise spikes. Since stray capacitance has a greater effect on the higher impedance anode circuit, extra capacitance is added to the cathode circuit to create a balance.

13. The north marker circuit obtains its input from a micro-switch on the aerial which is adjusted to close when the aerial is facing north. V22 is normally held cut off at the suppressor as well as the control grid. When the microswitch closes, R177 is short-circuited and the grid voltage is raised to 0V, but has no effect on the anode current since the valve is still cut off at the suppressor. At T_o the positive-going range gate from the screen of V4 lifts the bias on the suppressor of V22. During the gate, therefore, the north marker will appear as a negative-going pulse at the anode of V22. This is applied to the flip-flop formed by V24A and B, the natural period of which is much longer than the time equivalent of the maximum range of the equipment. The pulse cuts off V24B and the change-over produces a positive-going pulse at the cathode of V24A. This represents the north marker output and is taken to the brightener mixer via SKTK.

14. To ensure that only one trace is brightened, a negative end-of-scan trigger pulse from V3 is supplied through C44 and d.c. restorer V23B to the grid of V24, and returns the flip-flop to its stable state. The lagging edge of the anode waveform of V24B is fed to the grid of V22 to cut off this valve in

case the microswitch is still closed. Without this, the pulse at V22 grid could continue until the next range gate appeared at V22 suppressor. V23A restores this waveform negatively.

Facility for 10^{o} markers

15. When 10^{o} markers are required, the aerial switching is arranged to energise RLA at these intervals and short-circuit R204. The 10^{o} output pulses are therefore of a lower amplitude than the north marker and do not show up as brightly on the display. In this way the north marker is easily distinguished.

Production of the main scan brighteners

16. The negative-going pulse at the anode of V3B is negatively restored and applied to the grids of V7A and B. The pulse cuts off the valves during the range gate and produces positive-going pulses at the anodes which are used as main scan brightener waveforms. These are supplied from SKTB and SKTL and taken to the brightener mixer circuits in the video unit.

End-of-scan trigger output

17. The negative-going output from V3B is also differentiated by C5 and R20 and applied to the grid of V3A. This valve is normally cut off, so the negative spike at the start of the range gate has no effect. However, the positive spike at the end of the gate causes V3A to conduct and produce a negative-going pulse at the anode. This may be used as an end-of-scan trigger for auxiliary equipment and is obtained from SKTC and SKTZ.

M. T. I. range gate output

18. The sawtooth at the anode of V1 is fed out to the video half of the waveform generator where it switches over the mixed video output from M. T. I. to normal radar at a time determined by the M. T. I. range control. This output is at SKTX.

Range ring gating pulse output

19. The voltage at the cathode of V3B is a positive-going pulse occurring with the range gate. This is used as a gating pulse for the range ring circuit and is supplied from PLD.

Video map gating pulse output

20. A fraction of the positive-going pulse at the screen of V4 is used as a gating pulse for the C. R. D. 23 video map circuitry and supplied from SKTN. This video map unit forms part of the auxiliary equipment for the display system.

Monitoring

21. Monitoring facilities are provided by switch B and its associated test points. With an oscilloscope connected to TP1, the main waveforms may be observed at each position of the switch. TP2 is an earthing point. TP3 is connected to SKTA at which the T_o pulse is received and this may be used as a sync pulse for the oscilloscope.

VIDEO CHASSIS

General

22. This chassis contains the circuitry associated with the range marker generator, the M.T.I./normal radar gate, and either the normal radar amplifier or the iso-echo video strip. Trigger pulses required by circuits in the integrator chassis, and by the video map unit, are also provided. A monitor c.r.t. is incorporated for calibration purposes.

External triggering

23. Facilities are provided to enable both positive and negative external triggering pulses to be accepted. A delay circuit may also be employed for use when a trigger pulse well in advance of T_o is provided by the transmitter, such as with 787 equipment. The pulse is supplied to SKTW and developed across potentiometer RV34. The output from the slider is taken through links A or B and switch SA to one side of the primary of T8. By changing over the links, the connections to the transformer are reversed, to allow either polarity of input to be used. RV34 controls the trigger sensitivity.

24. V50 amplifies the trigger pulse before it is applied to either the blocking oscillator V51B or the phantastron delay circuit V34 and V44, depending upon the position of the link associated with these stages. Whether the delay circuit is employed or not, the input to V51B is a negative-going pulse applied to the anode which cuts the valve on at the grid. The output from the cathode is a positive pulse of 25V amplitude and 4μs width. This may be used to trigger the auxiliary video mapping equipment from SKTY. A similar pulse, but of negative polarity, is obtained from the anode circuit and taken to the integrator chassis on SKTA.

Internal triggering

25. An internal trigger pulse is provided for test purposes by a free-running multivibrator formed by V49A and B. This may be switched into circuit by SA and its output taken from across R387 and applied to the primary of T8. The setting of RV32 determines the p.r.f., which is variable over the range 300 to 700 c/s.

Range calibration generator

26. The range calibration generator is responsible for providing range marker rings on the p.p.i. display at 1, 5, 10 and 20 mile intervals. The operation of the circuit is initiated by the calibration oscillator V26. A positive-going gating pulse is obtained from the integrator chassis on SKTD and is amplified and inverted by V51A. The leading edge of this waveform is made variable by the action of RV31 and C84. V52B restores the voltage negatively before it is applied to the suppressor of V26 to allow the oscillator to operate for the duration of the sweep gate.

27. Normally, anode current is flowing through V26 but the circuit does not oscillate, since the anode circuit does not permit feedback to the grid in correct phase. When the gate pulse occurs, however, the anode current is cut off and the circuit oscillates as a triode stage, the screen serving as an anode. The frequency is made variable between 80 and 89kc/s by the adjustable tuning slug in T1. The output is squared by V27A and, after differentiation, used to trigger the 1 mile blocking oscillator stage of V27B.

28. The output from V27B is used to trigger a divide-by-5 phantastron stage formed by V28 and V29, the division ratio being controlled by RV25. This triggers the blocking oscillator stage of V30, which is responsible for the 5 mile markers. This, in turn, is used to trigger the divide-by-2 blocking oscillator stage of V31A, which provides the 10 mile markers. Similarly, the 20 mile markers are provided by a further divide-by-2 stage, employing V31. The marker voltages are applied to the grids of cathode follower output valves V33A and B and taken to the video mixer on SKTAB or SKTP.

29. The amplitude of the 1 mile markers is not variable but that of the 5, 10 and 20 mile outputs may be controlled by RV36, RV37 and RV38. Taking 1V as a typical value of the 1 mile markers, the 5 mile output would be adjusted to 1.3V, the 10 mile output to 1.6V and the 20 mile markers levelled at 2.0V. These settings provide corresponding graduation in the brilliance of the range marker rings displayed on the p.p.i.

30. Since the start of the 150V sawtooth timebase voltage is delayed 2 or 3μs with respect to the trigger at SKTA, RV31 is adjusted to provide a similar delay. This ensures that the calibration oscillator begins to operate at the same time as the sweep.

Calibration check oscillator

31. On position 11 of switch SC, the crystal oscillator stage of V47A may be used for checking the frequency of the calibration oscillator. The sine wave output voltages of both stages are applied to the deflection plates of the monitor c.r.t. so that, when both are operating at the same frequency, a single Lissajou figure is produced. Due to the fact that the calibration oscillator is gated, however, it is necessary to ensure that both outputs are maintained in correct

phase relationship so that a steady figure is displayed. For this reason, a sample of the crystal oscillator output is taken through MR6 to the internal trigger multivibrator for synchronization. The brilliance of the c.r.t. is controlled by RV33.

Normal radar and iso-echo amplifiers

32. Provision has been made for the accommodation of a normal radar amplifier or an iso-echo video strip, as required by the major equipment. These are interchangeable and are plugged into SKTE. H.t. for these amplifiers is provided by the stabilizer circuit formed by V37 and V47B. This is supplied from the +330B line and provides a stabilized output of 200V. RV26 is connected between the -330V and earth and is used to control the gain of the amplifier in use. The normal radar output is obtained from PLF and applied through C96 to the grids of the twin cathode follower output stages formed by V46 A and B. Outputs are taken to the video mixers from SKTR and SKTU. Reference should be made to Appendix 1 for further information on the normal radar and iso-echo amplifiers.

M. T. I. / normal radar gate

33. Facilities are provided for accepting M. T. I. and normal radar signals and producing a composite display which obtains the maximum advantage from each type of signal. During the initial part of the trace, M. T. I. signals are displayed to avoid clutter round the centre of the screen caused by nearby permanent echoes. But at a point along the trace past which these are not a nuisance, normal radar signals are displayed. The switching action is initiated by a sweep waveform input from the integrator chassis and the point at which the switchover occurs may be controlled for the convenience of the operator.

34. M. T. I. signals are supplied from the major equipment to SKTQ and are amplified by the video amplifier formed by V36 and V42. Gain is controlled by RV27. The output is taken to V39B, the M. T. I. gate. Signals from the normal radar amplifier are applied to the grid of V39A, which serves as the normal radar gate. Both gates are controlled by the action of V41 and the d.c. levels at the grids are balanced by RV29.

35. At the start of a sweep, V41B is conducting and enables the M. T. I. gate valve to operate as a cathode follower. M. T. I. signals are applied through isolating diode V40B to the grids of twin cathode follower stages V45A and B. V34 is a monostable stage, V34B being cut off by the potential at the slider of R28. A negative-going sweep waveform is obtained from the integrator chassis and applied via SKTX to the grid of V34A. As the input increases negatively, a point is reached when the state of the circuit is reversed and a negative-going pulse is obtained from the anode of V34B.

36. V35 is connected as a bi-stable stage. At the begining of the sweep, V35B is conducting. When the negative-going output arrives from V34B, the

state of this circuit is reversed and the positive-going pulse at the anode of V35B is applied to the grid of V41A. The state of this stage is now reversed so that the normal radar gate valve V39A is able to conduct and the M. T. I. is closed. The output from V39A is now applied through isolating diode V40A to the grids of the cathode follower stages V45A and B, so that normal radar signals appear at the output for the latter portion of the trace. The mixed M. T. I. / normal radar outputs are taken to the video mixers on SKTS and SKTT. The point along the sweep when the changeover occurs may be controlled by adjustment of R28.

37. Since V35 is a bi-stable stage, it is necessary for it to be triggered again so that it will revert to its original state in readiness for the next sweep. A negative-going end-of-scan trigger pulse is obtained from the integrator chassis for this purpose and is applied to the grid of V35A via SKTC.

Monitoring

38. With the aid of an oscilloscope and monitoring switch C, waveforms may be observed, as shown in Fig. 2. 1. 1.

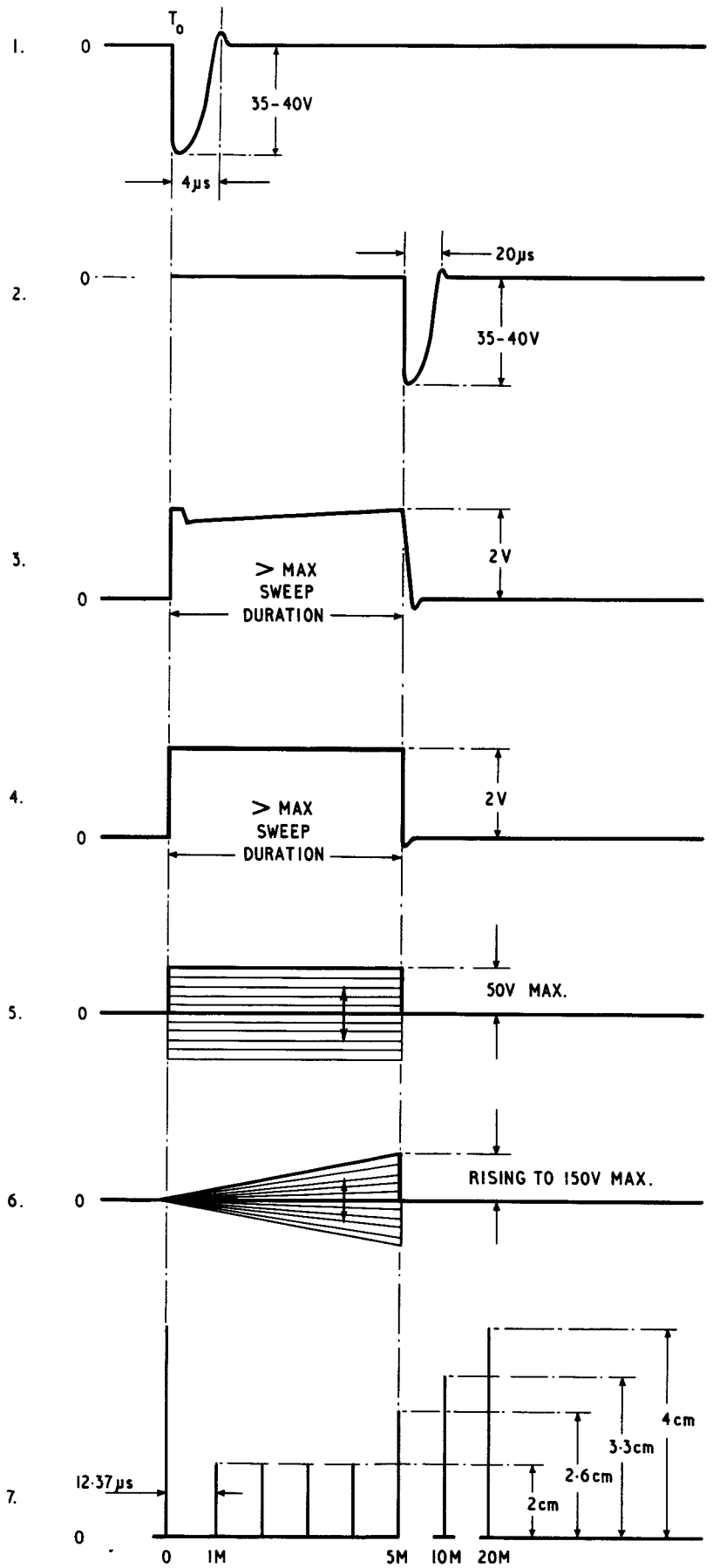

FIG. 2.1.1. MONITOR POSITIONS OF THE WAVEFORM GENERATOR

CHAPTER 2

THE VIEWING UNIT

List of contents — Para.

Tables — No.

Illustration — Fig.

INTRODUCTION

1. The electronic components associated with the viewing unit are assembled on two chassis, one on either side of the c.r.t. and coil assembly. On one chassis, components associated with the X and Y deflection amplifiers are assembled. The other contains the video mixer, the brightener mixer and the e.h.t. circuits. Power supplies for these are obtained through one of the switching units in the negative power unit. Both these chassis may be removed easily for servicing purposes and safety devices are incorporated so that the removal of either side panel cuts off the power supplies to that chassis.

DEFLECTION AMPLIFIERS

General

2. The deflection amplifiers convert the sawtooth input voltages from the integrators to sweep current for the deflection coils. D.C. coupling is employed and the use of high gain amplifiers plus a large amount of negative feedback, ensures good frequency response and an accurate coil-current copy of the input waveform. Provision is made for offsetting the display to allow more detailed observation of a selected area. Since the circuits of the X channel and Y channel amplifiers are identical, the following description of the 'X' channel amplifier is also applicable to the other. The circuit is considered in two parts, dealing with the master and slave amplifiers.

Master amplifier

3. The master amplifier includes V1, V2b, V3 and V4 and controls the c.r.t. coil current in one direction to produce the positive-going excursions of the trace. The output voltage from the 'X' channel of the integrator circuit arrives on BPLA-19, varying about earth potential. This is fed to the grid of V1 through phase advancing network R50, C10 to obtain a more linear rise of coil current. The cathode of V1 is held at a positive potential, obtained from divider R3, R4 and RV1 (SET ZERO) across the +330 volt supply. As the stages are d.c. coupled, adjustment of RV1 varies the initial level of current through the deflection coil and so determines the origin of the trace.

4. After amplification in V1, the voltage is applied through phase correction network R5, C11 to the grid of V2b. The coupling circuit is referenced to the -500 volt rail to obtain correct bias conditions. This stage provides sufficient amplification to drive the master amplifier output valves V3 and V4. Coupling network R9, R10, R11 and C12 provides phase correction and is also part of the limiting circuit of V2a.

Slave amplifier

5. The slave amplifier employs valves V5, V6, V7 and V8a and controls the deflector coil current to produce the negative-going excursions of the trace.

The deflection coil is connected between BSKTA and BSKTB. The anodes of V3 and V4 are returned to earth through the coil in series with R28 and RV3, so that increasing current through this stage produces the sweep in the positive direction. Slave output valves V5 and V6 are connected so that current is drawn in the opposite direction. As this stage operates as a cathode follower, a greater drive is required than can be obtained from any point in the circuit of V2b. Amplifiers V7 and V8a are therefore used for this purpose. The voltage across series resistors R28 and RV3 are used to provide the input to V8a. This is supplied to the grid through network R32, R33, C14 and is referenced to the -500 volts rail through R40 and RV5. The amplified voltage is applied through phase correction network R34, C15 to the grid of V7. The anode voltage of this stage is used to drive output valves V5 and V6.

Operation of master and slave amplifiers

6. With a positive-going input, increasing current through V3 and V4 causes a negative voltage to develop across R28 and RV3. This voltage is amplified by V8a and V7 and causes the current through V5 and V6 to decrease. As this current is in opposition to that flowing through V3 and V4, the slave valves assist the action of the master valves, and vice versa.

Limiting sweep amplitude

7. Valves V2a and V8b operate as limiters to restrict the extent of the current swing in each direction. V2a is biased off by a negative potential from RV2 (MAIN AMP LIMIT) which is adjusted to produce the required length of trace in the positive direction. When the sweep current through R28 and RV3 increases sufficiently to overcome the bias, V2a conducts and prevents further rise of voltage at the grids of V3 and V4. Limiter V8b is connected as a diode. During the positive excursion of the sweep, it is biased off by a positive potential at the cathode obtained from RV4 (SLAVE AMP LIMIT). During the negative excursion, the reverse current through the coil produces an increasing positive voltage across R28 and RV3. Depending on the setting of RV4, V8b eventually conducts and limits any further rise of voltage at the grid of V8a.

Negative feedback

8. Negative current feedback is provided by feeding the voltage developed across R28 and RV3 through an attenuator network to the grid of V1. Sections of this network, which consists of R45 to R48 and C1 to C4, are switched by RLA and RLB for each range. The amount of feedback, and therefore the gain of the amplifier, is controlled by RV3 (GAIN). This control is used in conjunction with the corresponding control in the 'Y' channel circuit to balance the output of the two amplifiers. A measure of voltage feedback is also obtained from the junction of R26 and R27 through a phase correcting network, R49 and C5, to the grid of V1. Current negative feedback for the slave amplifier is obtained from the voltage developed across the sampling resistor R23. This voltage is supplied through R24 and C13 to the grid of V8a.

Limiting overswing

9. The diodes V9a and V9b are connected in series to limit the coil voltage overswing at the limiter reference potential of +330 volts. The heaters of the diodes are referenced to +165 volts at the junction of R43 and R44 to reduce heater-to-cathode potential.

10. The X offset is obtained from RV13 (X OFFSET) on the control panel via BPLA-21. Due to the d.c. coupling, this voltage varies the initial level of the coil current so that the origin of the trace may be displaced in any direction to a maximum of one radius of the tube on the 200-mile range. As the range is altered, the centre of the display remains stationary, irrespective of the offset, so that the display expands about the centre. This is ensured by the resistive network associated with RV6 (X RE-CENTRE) which is switched for each range by RLE.

C.R.D.F. facilities

11. When CRD23 is used in conjunction with CRDF equipment, the origin of the trace is offset by an amount corresponding to the distance between the radar head and the CRDF station. The shift voltage required to obtain this offset is supplied via BPLA-23.

Use of the inter-trace markers

12. When inter-trace markers are required, the character voltages are supplied to BPLA-11 and fed through network R51 to R54 and C6 to C9 to the grid of V1. This network is switched for different ranges by RLA and RLB so that the size and relative positions of the characters remain constant on all ranges. If desired, a reference voltage may be supplied to both amplifiers on BPLA-22 to re-set the point of origin at the beginning of each trace.

Provision of test points

13. Test points are provided to enable the following to be monitored:

TP2 - current through the deflection coil

TP1 - voltage across the deflection coil

TP3 - slave output current (voltage across R23)

VIDEO MIXER

General

14. The video mixer circuit has been designed to accept up to six positive-going video input signals and supplies a negative output to the cathode of the

c.r.t. Three double triodes are employed, the grid circuits of which are controlled independently by potentiometers on the control panel.

Input channels available

15. All six input sockets are d.c. coupled to their amplifiers through CR networks. These provide a high input impedance together with h.f. compensation. The grids are decoupled to earth and returned to their appropriate controls in the control unit via APLB-13 and -21 to -25. The following table shows the facility provided by each channel and the socket, valve and control associated with each circuit.

TABLE 1

Input channels

Socket	Channel	Valve	Control unit p/mtr.
ASKT-Z	Range rings	V1a	RV2
ASKT-Y	Secondary radar	V1b	RV3
ASKT-Q	Video map 1	V2a	RV4
ASKT-R	Video map 2	V2b	RV5
ASKT-P	Normal radar	V3b/V7a	RV7
ASKT-M	M.T.I. and normal radar	V3a/V7b	RV6

Short time constant facility

16. The input circuits to V3a and V3b can also be switched through short time constant circuits to reduce clutter. When RLA and RLB are energized from the +330V line through S2, the S.T.C. switch in the control panel, the input voltages are differentiated by C5, R7 and C15, R42. Diodes V7a and V7b clip the negative excursions of the differentiated waveforms.

17. Voltage stabilizer V17 provides h.t. at +70V for V1, V2 and V3 and also for the corresponding circuits of the brightener mixer. The h.t. for the stabilizer is obtained from the +330V supply on APLA-2. V17b operates as a series valve which is controlled by the output from V17a, the shunt.valve.

Amplification of video signals

18. A negative output is developed across the common anode load R23 in series with r.f. compensator L1. The voltage is fed through C11 and R28 to the grid of V4. This valve is unbaised and conducting at saturation, so the input voltage is restored negatively by the action of the grid. The amplified output from this stage is applied through R68 and h.f. compensator C16 to the grid of V5.

Application of video to c.r.t.

19. Output valve V5 is almost cut off by a potential obtained from the cathode of V6b. This valve is normally conducting and draws current through part of potential divider R105, R106 across the -330V supply. V6a is connected as a diode and restores the input positively. The screen of V5 is connected directly to the +330V line to obtain a large output swing. The negative pulses at the anode are supplied to the cathode of the c.r.t. via ASKT-T. RV2 and C14 are included to provide compensation for h.f. losses caused by inter-unit cabling.

Limiting video output level

20. Diode MR1 operates as a limiter to restrict the output to a level within the 10V to 30V grid base of the c.r.t. One side of MR1 is connected to a potential divider between the +500V and -330V rails, consisting of R15, R93, V12a and R94/95. The setting of RV1 (VIDEO LIMIT) determines the voltage drop across V12a and hence the reference voltage of MR1. If the anode voltage of V5 tends to fall below this level, MR1 conducts and limits the negative-going pulse by applying negative feedback to the grid of V5.

Prevention of unwanted brightening

21. Switching power to other units in the equipment may momentarily upset the outputs from the stabilized supplies and cause brightening of the display. This is prevented by the following methods. The grid of the control valve V17a is returned to the -330V rail. If the rail voltage were to rise, the +70V output would fall and this would be amplified as a brightener input to V4. To avoid this, the grid of V17b is returned to the -330V rail through a long CR network, R109 and C44. Switching may also affect the +330V rail and cause the +70V output to dip. This would also be amplified by V4 and appear as a rise at the grid of V5. To avoid this, the +330V rail is connected through C47 to the grid of V6b. If the +330V rail should fall, the grid of V5 is taken below cut-off, due to the cathode follower action of V6b, and counteracts the rise at the grid. MR3 negatively restores the grid of V6b.

BRIGHTENER MIXER

General

22. The brightener mixer has been designed to accept up to five positive-going brightener waveforms and supplies a positive output to the grid of the c.r.t. As with the video mixer, each channel is controlled independently from the control unit.

Input channels available

23. Valves V12b, V13 and V14 provide amplification for each of the five channels. The input sockets are d.c. coupled to the grid through CR network to

provide a high input impedance and compensation for h.f. The grid circuits are decoupled to earth but obtain their bias from their respective control potentiometers. When CRD23 is used with CR353, only two of the brightener channels are required. These are provided by V14 which handles the main scan and north marker brightener pulses. The grids of V12b and V13 are returned through 1.8M resistors to the -330V line. As no external connections are made, these valves remain cut off.

Amplification of pulses

24. When the north marker pulse is required, this is arranged to arrive on ASKT-H and is amplified by V14a. This circuit is controlled by RV9 (BEARING MARKS) on the control panel, connected through APLA-24. The brightener input is supplied from the waveform generator on ASKT-N and is amplified by V14b. This circuit is controlled by RV5 (BRIGHTENER AMP), which is part of a divider across the -330V supply, and is adjusted to produce pulses of 40V amplitude at the anode of V15.

Application of brightener pulses to c.r.t.

25. Amplifier V15 is conducting at saturation and restores the input negatively. The screen potential is preset by RV4 (BRIGHTENER LEVEL) to compensate for variations in the characteristics of different c.r.ts. The anode is connected directly to the grid of the tube through ASKT-D and also through R86 and APLA-17 to RV10 (BRIGHTNESS) on the control panel. This varies the c.r.t. grid voltage about the level set by RV4 to give smooth control over brightness.

Operation of focus valve

26. V16 is a d.c. power amplifier which controls the current through the focus coil. The coil is connected between ASKT-U and ASKT-S, which is returned to the +330V rail. The grid potential is obtained from RV1 (FOCUS) on the control panel and varies the current through the focusing coil. R91 provides current negative feedback.

E.h.t. power supply

27. The e.h.t. supply consists of a regulated 33kc/s oscillator circuit which produces 15kV at 100μA. A voltage doubler is used to keep down the p.i.v. across the rectifiers, and the voltage across the coil, and all high voltage components are enclosed in a selastomer-filled container.

E.h.t. oscillator and regulator circuit

28. Oscillator valve V9 is connected as a Hartley circuit using the primary of T1 as the tank coil. The secondary circuit of T1 provides the e.h.t. To

prevent variation of the output voltage, the oscillator is regulated at the grid by the circuit of V8. V8a rectifies the voltage from across secondary a.b. and charges reservoir capacitor C18 in proportion to the output voltage. V8b is a d.c. amplifier and is coupled to the grid of V9 so that an increase of output is counteracted by an increase of bias, which reduces the output to normal. The grid of V8b is referenced to a potential determined by RV3 (SET EHT). Adjustment of this control varies the regulator output level which alters the amplitude of oscillation and so adjusts the level of e.h.t.

Operation of voltage doubler

29. The output from the e.h.t. secondary is applied to the voltage doubler circuit, which consists of rectifiers V10 and V11 and reservoir capacitors C23 and C24. The filaments of the rectifiers are supplied from the two low voltage windings. With this circuit, C24 is charged through V10 to the secondary voltage during one half-cycle. During the following half-cycle, the voltage across C24 is in series with the secondary voltage so that C23 is charged to 15kV through V11. The negative side of C23 is earthed and the e.h.t. is developed across R60 and R61 in series with the +500V supply. The +800V potential required for the first anode is obtained from the junction of R60 and R61, smoothing being provided by R59 and C22. The +15kV output is supplied to the final anode through the CR filter formed by C23, R62 and C1. Capacitor C1 is mounted on the frame of the viewing unit above the c.r.t.

Pre-centering system

30. Any mis-alignment of the electron gun would cause distortion of the scan and give rise to bearing errors. To avoid this, the electron beam is directed along the axis of the tube by the fields of a pair of pre-centering coils L2. These are supplied with d.c. in either direction from potentiometers RV11 (X PRE-CENTRE) and RV12 (Y PRE-CENTRE) in the control unit.

CONTROL PANEL

General

31. The operational control and switches associated with the viewing unit are assembled on the control panel. The function of these will vary, depending upon the type of installation with which the display system is used. Table 2 shows the different panels associated with the three major equipments in use at present.

TABLE 2

Variations of control panel

Control panel	Installation	Variation
GA87998	CR353 (WINDFINDER)	Range scale 25-50-100-200 and Iso-echo.
GA87998/1	CR787A	Range scale 10-25-50-100 and C.R.D.F.
GA87998/2	CR353 (CAIRNS)	Range scale 30-60-120-240 and Iso-echo

32. All the controls used with each type of installation are grouped in Table 3. Differences in some types of control will apparent, since these will have the same circuit reference.

TABLE 3

Function of controls

Type of control	Circuit ref.	Function	Remarks
4 position rotary switch	S1	RANGE SWITCH	This switch provides 4 ranges, the variants of which are shown in Table 2.
Toggle switch	S2	S.T.C.	When switched to the ON position, relays in the video mixer circuit are energized from the +330V supply. Two of the input circuits to the mixer then present a short time constant (S.T.C.) to the input pulse and so reduce clutter.
Toggle switch	S3	CENTRE/OFFSET	Brings into operation the 'X' and 'Y' offset controls.
Toggle switch	S4	DISPLAY ON/OFF	This initiates the switching sequence providing stabilized mains and h.t. supplies to the viewing unit.
Toggle switch	S5	ISO-ECHO ON/OFF	Used with CR353. Brings into operation the Iso-echo contour control RV8.

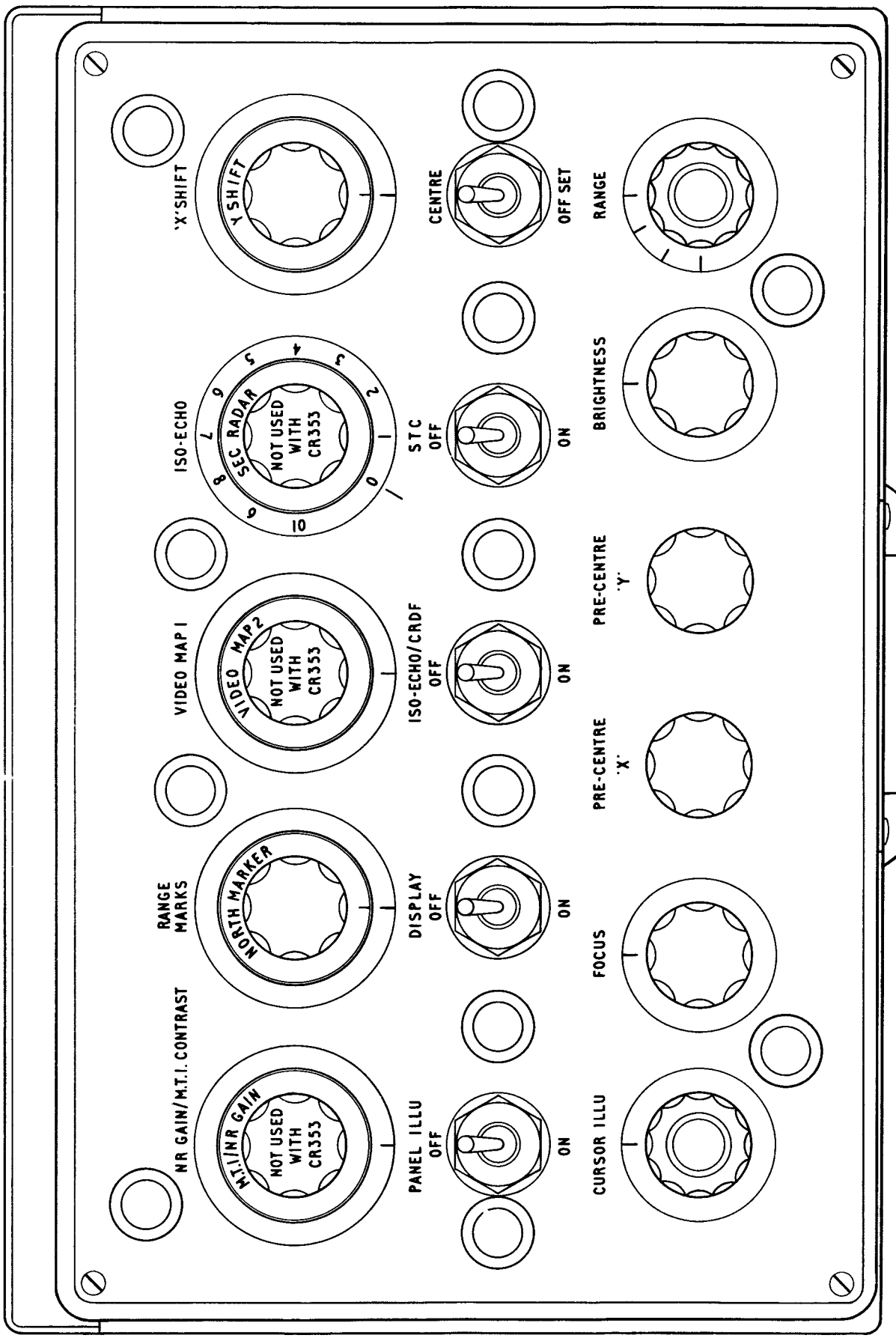

FIG. 2.2.1. PANEL CONTROLS

Table 3 contd.

Type of control	Circuit ref.	Function	Remarks
Toggle switch	S5	C.R.D.F.	Brings into operation the C.R.D.F. control RV8.
Toggle switch	S6	PANEL ILLUM ON/OFF	Is used to complete the 28V a.c. circuit from T2 to the twelve panel lights.
Potentiometer	RV1	FOCUS	Adjusts the grid potential of focusing valve V16 on the mixer chassis, thereby controlling the current through the c.r.t. focusing coil.
Potentiometer	RV2	RANGE RINGS	Adjustment of this control enables the range rings to be displayed.
Potentiometer	RV3	SECONDARY RADAR	Controls the secondary radar display.
Potentiometer	RV4	VIDEO MAP 1	Controls the 1st video map display.
Potentiometer	RV5	VIDEO MAP 2	Controls the 2nd video map display.
Potentiometer	RV6	M.T.I./N.R. GAIN	Controls the mixed M.T.I. and normal radar signals.
Potentiometer	RV7	M.T.I. CONTRAST	Enables permanent echoes to be displayed as a background to moving targets.
Potentiometer	RV7	NORMAL RADAR	Controls the normal radar gain.
Potentiometer	RV8	ISO-ECHO	Enables the turn-over point of the iso-echo circuit to be controlled and is routed to the base unit for this purpose.
Potentiometer	RV8	C.R.D.F.	Controls the C.R.D.F. display.
Potentiometer	RV9	BEARING MARKS	Controls the north marker and 10^{o} marker display.

Table 3 contd.

Type of control	Circuit ref.	Function	Remarks
Potentiometer	RV10	BRIGHTNESS	Controls the general brightness level of the display.
Potentiometer	RV11	PRE-CENTRE'X'	RV11 varies the current through the X pre-centering coils.
Potentiometer	RV12	PRE-CENTRE 'Y'	RV12 varies the Y pre-centering coil current.
Potentiometer	RV13	'X' SHIFT	Self explanatory.
Potentiometer	RV14	'Y' SHIFT	Self explanatory.
Potentiometer	RV15	CURSOR ILLUM.	This potentiometer adjusts the illumination level of the nine lamps surrounding the cursor.

AUXILIARY CIRCUITS

Cooling system

33. The extractor fan is mounted on the rear panel and draws air through the polythene filter over the control panel recess. The motor is supplied from the unstabilized mains plug DPLB through the contacts of RLA. This relay is energized from the 28V d.c. supply when the viewing unit is switched on.

Anti-condensation heaters

34. Two 30W anti-condensation heaters are fitted below the c.r.t. The unstabilized mains supply is switched to the heaters by RLA when the equipment is switched off and the relay de-energized.

Interlocks

35. Microswitches SA and SB are wired in series with the 28V line to the DISPLAY ON/OFF switch and are operated by the removal of either side panel. When desired, they can be rendered inoperative for servicing purposes.

APPENDIX 1

NORMAL RADAR AMPLIFIER AND ISO-ECHO VIDEO UNIT

INTRODUCTION

1. The normal radar amplifier and the iso-echo video strip are interchangeable units, either of which may be used as a sub-assembly of the waveform generator. The normal radar amplifier is a conventional circuit which supplies signals to the video mixer to provide the p.p.i. display. The gain is pre-set by a potentiometer on the front panel of the main chassis. When the equipment is used for weather observation, the iso-echo video unit is employed instead of the conventional amplifier. This provides a display which shows the contours of storm areas, the centres of these being represented by blacked-out 'holes' on the screen. The turnover point from the normal display to 'hole' is varied by a potentiometer on the control panel.

NORMAL RADAR AMPLIFIER

General

2. Signals at 30Mc/s i.f. are provided by the head amplifier in the parent equipment and supplied to the normal radar amplifier on SKTG. After amplification in the four i.f. stages, signals are detected by X1 and applied to the grids of V5A and B, which are connected in parallel as a cathode follower stage. The output is then taken from PLF to the main chassis. The maximum gain of the amplifier is 85dB and is controlled by a voltage obtained from RV26. This amplifier is a standard unit which is used in several equipments and some of the facilities provided by it are not required in this case. RLA remains unenergized and the junctions between R14 and R24 and R17 and R20 are earthed.

ISO-ECHO VIDEO UNIT

General

3. Basically, the iso-echo video unit is a wide-band two-stage amplifier followed by a switching device. The switch is actuated when the input signals exceed a pre-determined level and the output falls to zero, producing a blacked-out 'hole' in the display picture. The same gain control that is used for the normal radar amplifier is also used for this unit.

4. Video signals from the receiver in the main equipment arrive on PLG and are applied to the grid of amplifier V1. The bias voltage of this stage is obtained from RV26, the pre-set gain control on the main chassis. After amplification in this and the following stage, the output is d.c. restored and applied to the grid of V3A. This is a cathode follower stage from which the output is applied to the junction of R15 and R18.

5. When the iso-echo condition is inoperative, that is when RLA is energized, the signal amplitude is reduced by the divider formed by R15 and R16 and applied to the grid of cathode follower V3B. A normal radar signal of about 6V amplitude is obtained from SKT F and taken to the main chassis. When the ISO-ECHO switch on the control panel is switched on, RLA is de-energized and contacts 1 and 2 close. The ISO-ECHO control may now be adjusted to set the level at which the signal at the base of VT1 will cause saturation. When this occurs, the collector and emitter are at virtually the same potential so that no voltage appears across R16 and, because there is no output at SKT F, a blacked-out 'hole' is produced on the display which represents the storm-centre.

CHAPTER 3

POWER SUPPLIES

List of contents

TABLES

GENERAL

1. CRD23 is operated from a stabilized mains supply. This may be obtained from the major equipment or, if that is not possible, from a Servomex voltage regulator which would then be fitted in one of the base units. Two power packs are used to provide the positive and negative d.c. voltages and the output from these are stabilized independently to provide suitable supplies fro the d.c. coupled circuits employed. Switching units are provided for the waveform generator and each viewing unit so that the a.c. and d.c. supplies may be switched through in correct sequence. These are plug-in assemblies which are contained in the negative power unit.

UNSTABILIZED SUPPLIES

2. The production of the original, as yet unstabilized supplies, is achieved by similar circuits in the positive and negative power units. These are conventional circuits employing bridge rectifiers and LC filters, the lower h.t. voltage circuit

in each power unit being used as an internal reference supply. Each circuit is fused and a lamp is employed to indicate the presence of the output voltages. The unstabilized h.t. is then supplied to the corresponding stabilized chassis.

NEGATIVE STABILIZED SUPPLIES

3. There are four main circuits included on the negative stabilizer chassis. Two of these are the -330V and -500V supplies, one is the internal reference circuit and the last is a 24 d.c. supply for relay operation.

Stabilized -330V supply

4. The unstabilized voltage is brought in on PLA-13(+140V) and PLA-22(-330V). V3, V5, V6 and V7 operate as a series stabilizer which is controlled by the circuit of V1 and V2. The screens of the series valves are held at a steady potential of +170V by the output from the internal reference circuit. The grid of V1 is returned to a potential determined by the setting of RV3, which is pre-set to obtain the required output level. Variations of the -330V line affect the cathode potential of V1. The amplified ripple is then applied to the grid of V2A. Due to the common cathode load R14, the ripple is applied to V2B so that the anode voltage is in correct phase to control the grids of the series valves. RV1, RV2 and RV4 are used to balance the current through V3, V6 and V7 with that through V5. Meter M1 is switched across each of the anode resistors in turn for the purpose.

5. An output is taken from the -330V line through R35 to relay RLA in the unstabilized chassis. Before the stabilized voltages appear, this relay is un-energised and the reservoir capacitor in the -500V supply charges through R19, which limits the charging rate. When the stabilized output reaches its proper level, though, RLA is energised and R19 switched out of circuit.

Stabilized -500V supply

6. The unstabilized voltage is brought in on PLA-12 (+150V) and PLA-23 (-500V). The screen of series stabilizer V8 is held steady at +75V by neon V10 and is controlled at the grid by the circuit of V4. The anode voltage of V4 is obtained from the +330V stabilized input on PLA-2. V12 is employed to hold the cathode at a potential of -415V. The input voltage to the control circuit is obtained from the junction of R63 and R64, which are part of the potential divider across the output.

Internal reference voltage circuit

7. Normally the +330V output from the positive stabilized power unit is used to provide the h.t. for the control circuit of V1 and V2; but to allow the negative supply to be checked independently, an internal reference voltage is provided by the circuit of V9. Under normal conditions, the anode voltage of V9 is obtained from the stabilized +330V input on PLA-2 and the +170V reference voltage at the

cathode of V9 is used as the screen supply for the four series stabilizers in the -330V supply. When SB is switched to TEST, though, the unstabilized +330V input from the negative chassis is used as the anode voltage of V9. The +170V reference voltage is also switched to V1 and V2, to replace the stabilized +330V, and R15 is switched into circuit. By increasing the cathode load in this way, the lower h.t. is compensated for and normal conditions are simulated.

28V d.c. supply

8. The mains input on PLA-16 and -25 is applied to T_1 which provides the heater supplies for the valves on this chassis. One of the secondaries provides 28V which is applied across a bridge rectifier. The output is then used as the d.c. supply for the relays.

Monitoring

9. Monitoring is provided by M1 on the front panel, which is switched by SA, located beneath it. The following table shows the functions at each position of the switch.

TABLE 1

Functions of negative power unit monitoring switch

Position	Function	F.S.D.
1	-500V supply voltage	500V
2	-300V supply voltage	500V
3	+170V reference voltage	500V
4	+330V supply voltage	500V
5	-500V line current	100mA
6	-300V line current	1A
7	V9 anode current	100mA
8	V5 anode current	500mA
9	V6 anode current	500mA
10	V7 anode current	500mA
11	V3 anode current	500mA

POSITIVE STABILIZED SUPPLIES

10. The positive stabilized chassis provides the +500V and +330V supplies. As with the negative unit, an internal reference voltage supply is included for test purposes.

Stabilized +500V supply

11. The input from the unstabilized chassis is brought in on PLA-7 and -15. V5 and V10 are series stabilizers which are controlled by V4 in a conventional manner. The anode voltage of V4 is obtained from the unstabilized +650V supply through decoupling components C4 and R18. The setting of RV5 determines the output voltage level.

Stabilized +330V supply

12. The input from the unstabilized chassis is brought in on PLA-8 and earth. V6, V7, V8 and V9 operate as series stabilizers and are controlled by the circuit of V1 and V2. This is similar to the control circuit employed with the stabilized -330V supply, except that the ripple is applied to the grid of V1 instead of to the cathode. The output voltage level is determined by the setting of RV5.

13. An output is taken through R60 to RLA on the unstabilized chassis. Before the stabilized output appears, the reservoir capacitor charges at a reduced rate through limiting resistor R19. When the stabilized output reaches its correct level, RLA energises and short-circuits R19, allowing the capacitor to charge at the normal rate.

Internal reference voltage circuit

14. Normally, the grids of V1, V2 and V4 are returned to the stabilized -500V line on PLA-5. To enable the unit to be tested independently of the negative supply, though, an internal reference voltage is provided. This is obtained from the -160V input from the unstabilized chassis, which is stabilized at -85V by the circuit of V3. When SB is switched to TEST, the grids of V1, V2 and V4 are returned to the reference voltage line through alternative resistive networks, the values of which are chosen so that normal conditions are simulated.

Monitoring

15. Monitoring facilities are provided by meter M1 in conjunction with switch SA, both of which are located on the front panel. The following table shows the function at each position of the switch.

TABLE 2

Functions of positive power unit monitoring switch

Position		F.S.D.
1	-500V supply voltage	500V
2	-85V reference voltage	100V
3	+330V supply voltage	500V
4	+500V supply voltage	500V
5	+330V line current	1A
6	+500V line current	200mA
7	V3 anode current	10mA
8	V6 anode current	500mA
9	V7 anode current	500mA
10	V8 anode current	500mA
11	V9 anode current	500mA

SWITCHING UNITS

General

16. The switching units are identical and up to three of these are plugged in to the chassis of the negative power unit switch power through to the waveform generator and viewing units in correct sequence. Their operation is initiated at any time after the main equipment has been switched on by closing the ON/OFF switch on the viewing unit, which completes the +24V line. In the case of the waveform generator, this is completed by a permanent link.

Operation

17. When the equipment is switched on, a stabilized +330V input is taken to each switching unit on PLA-13. RLB is energized through R1 and contact B1 completes the earth line to RLA. When the ON/OFF switch is closed, the +24V line is switched through and this relay is energized. RLA has four sets of contacts; one set switches 6.3V a.c. from T1 in the negative power unit to the heater of V1, the thermal delay switch; two sets switch the mains through to the unit concerned to provide the heater supplies, and another set connects one side of RLD through MR1 to the thermal delay switch. RLD cannot energize yet, though, since the potential at the V1 side of MR1 is more positive than the +28V line at PLA-19 and current cannot flow in the reverse direction through MR1.

18. After approximately 30 seconds, the contact of V1 closes. Current is now able to flow from earth, through the contact of V1 and through MR1 in the forward direction to energize RLD. As this relay energizes, it locks on through D5, which by-passes V1 and MR1. Two double sets of contacts are employed to reduce sparking and switch the -330V and -500V lines through to the unit being controlled. A further set short-circuits the contacts of V1.

19. As D5 closes, RLC becomes energized. Two further sets of contacts are now connected across those carrying the mains to reduce the loading, as a double set of contacts also completes the +330V line and provides h.t. A further contact completes the +24V line to RLE. This relay switches the +500 line and is the final phase of the switching action, since this supply is responsible for the production of the e.h.t. in the viewing units. When the ON/OFF switch is opened again, all the relays except RLB are de-energized and all supplies cut off.

CHAPTER 4

CABLING INFORMATION

GENERAL

1. Since CRD 23 is used with various types of equipment, there will necessarily be differences between one installation and another. The information given here has therefore been designed to show the cabling of a basic display and yet to indicate all the routes which would be required in a complex system. Fig. 2.4.1 shows this arrangement and the details of each cable are given below. Reference to this should be made in conjunction with the cabling schedule of the parent equipment. Wiring and interconnection details of the base and viewing units are given in Figs. 2.4.2 and 2.4.3.

DETAILS OF INTER- UNIT CABLING

No.	From	Colour	Pin	Function	To	Remarks
1	Mains supply	Red	A	Unstab. mains (L)	B.U.+	(3-way 19A
		Black	B	Unstab. mains (N)		(Plessey plug
		Green	C	Earth		
1	Stabilized supply	Red	A	Stab. mains (L)	B.U.	(4-way 19A
		Black	B	Stab. mains (N)		(Plessey plug
		Green	C	Earth		
3	Aerial	Green	4	Sine/cos. pot (E)	B.U.	18-way Unitor
		Braid	5	Screen		
		Braid	8	Screen		
		Yellow	9	Az. mkr. trig. return		
		Blue	10	Az. mkr. trigger		
		Braid	12	Screen		
		White	13	Sine/cos. pot (2)		
		Braid	14	Screen		
		Red	15	Sine/cos. pot (1)		
		Black	16	+ve to sine/cos. pot.		
		Braid	17	Screen		
		Brown	18	-ve to sine/cos. pot.		
4	Tx/rx.	-	-	Lock pulse	B.U.	Min. Pye plug
5	Tx/rx.			Normal radar sigs.	B.U.	Min. Pye plug
6	Tx/rx.			M.T.I. video sigs.	B.U.	Min. Pye plug
7	B.U.			Azimuth mkr.	V.U.+	UR70
8	B.U.			M.T.I. & NR sigs.	V.U.	UR70
9	B.U.			Brightener pulse	V.U.	UR70
10	B.U.			Normal radar sigs.	V.U.	UR70
11	B.U.			Range rings	V.U.	UR70
12	B.U.			X Sawtooth	V.U.	UR70
13	B.U.			Y Sawtooth	V.U.	UR70

DETAILS OF INTER-UNIT CABLING (cont.)

14	B.U.	Red	1	+500V stab.		
		Blue	2	+330V stab.		
		Green	3	Earth		
		Yellow	4	-330V stab.		
		White	5	-500V stab.		
		Black	7	+330V to def.amps.		
		Red/brown	9	-330V to def.amps.		
		Brown	11	+28V		
		Violet	12	+28V switched		
		Orange	14	iso-echo ON/OFF		
		Grey	20	CRDF switch		
		Red/blue	21	CRDF switch		
		Red/white	24	Stab.mains (L)		
		Red/black	25	Stab.mains (N)		
15	Mains supply	Red	A	unstab.mains (L)	V.U.	3-way 19A Plessey plug
		Black	B	unstab.mains (N)		
		Green	C	Earth		

+ Note: B.U. - base unit

V.U. - viewing unit

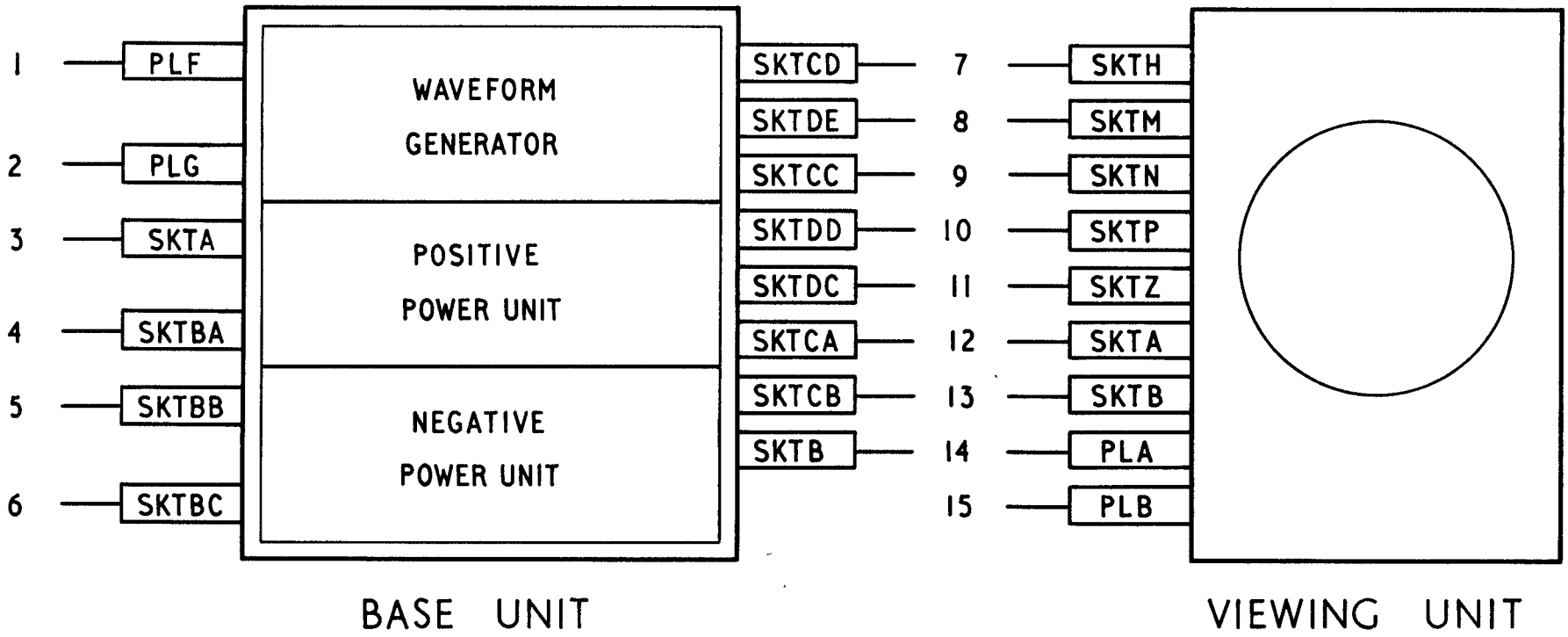

FIG.2.4.1. DIAGRAM OF INTER-UNIT CABLING

PLUG PANEL				RELAY	NEGATIVE POWER PACK			POSITIVE POWER PACK		WAVEFORM GENERATOR		FUNCTION	
E.SKT A	E SKT. B	E.SKT C	E.PL G.	RLB	UNSTAB. C.SKT. A	STAB. D.SKT. A	STAB. D.PL. D	UNSTAB. A.SKT. A	STAB. B.SKT.A	INTEGRATOR F.SKT.A	VIDEO G.SKT.A		
							1			1	1	+500V STAB.	
							2			2	2	+330V STAB.	
7							3			3	3	EARTH	
							4			4	4	-330 V STAB.	
							5			5	5	-500 V STAB.	
							21			24	24	A.C. MAINS STAB. L	FROM SWITCH UNIT DX1
							22			25	25	A C. MAINS STAB. N	
	11	11					17					+28 V OUT	
							16					+28 V IN SWITCHED	
	1						6					+500V STAB.	
	2&7						7					+330V STAB.	
	3						8					EARTH	
	4&9						9					-330 V STAB.	
	5						10					-500 V STAB.	
	24						18					A.C. MAINS STAB. L	FROM SWITCH UNIT DX2
	25						23					A.C. MAINS STAB. N	
	12						19					+28V IN SWITCHED	
		1					11					+500V STAB.	
		2&7					12					+330V STAB.	
		3					13					EARTH	
		4&9					14					-330V STAB.	
		5					15					-500V STAB	
		24					24					A.C. MAINS STAB. L	FROM SWITCH UNIT DX3
		25					25					A.C. MAINS STAB. N	
		12					20					+28V IN SWITCHED	
								3	7			+650V TO STABILISER	
								2	8			+470V TO STABILISER	
								23	19			EARTH	
								25	20			EARTH	
								14	14			RELAY SUPPLY RLA/2	IN POSITIVE POWER UNIT
								15	13			RELAY SUPPLY RLA/2	
								5	10			-150V TO INT. REFERENCE	
								21	21			EARTH	
						1			1			+500V STAB.	
						2			2			+330V STAB.	
						3			3			EARTH	
						4			4			-330V STAB.	
						5			5			-500V STAB.	
					23	23						-500V STAB.	
					3	12						+150V TO STABILISER	
					22	22						-330V STAB.	
					2	13						+140V TO STABILISER	
					4	11						+330V UNSTAB. SUPPLY	
					1	21						EARTH	
					14	19						RELAY SUPPLY RLA/2	IN NEGATIVE POWER UNIT
					15	20						RELAY SUPPLY RLA/2	
				a	6	25		6	25			A.C. MAINS STAB	
				b	16	16		16	16			A.C. MAINS STAB	
			c		13	6		13	15			EARTH	
16									22			+50V SIN/COS POT SUPPLY	
18									23			-50V SIN/COS POT SUPPLY	
17									17			BRAID OF+50V SUPPLY	
12									18			BRAID OF-50V SUPPLY	
13										21		SIN X CHANNEL	
14										22		BRAID "	
15										16		COS. S CHANNEL	
8										17		BRAID "	
4										12		SIN/COS POT COMMON EARTH	
10										13		AZ MKR. TRIGGER	
9										14		BRAID OF AZ MKR. TRIGGER	
2										11		NORTH MARKER RELAY OUT	
	17	17										ISO-ECHO LEVEL	
	14	14										ISO- ECHO ON / OFF	

FIG. 2. 4. 2. BASE ASSEMBLY SCHEDULE OF CONNECTIONS

VIDEO MIXER			DEFLECTION AMP	CONTROL PANEL		BACK PANEL	BEZEL ASSY.	T1	T2	SA	SB	C.R.T.	SOCKET R.P.	FUNCTION
ASKTA	ASKTB	APL-C	BSKT-A	CSKT-A	CPL-B	DPL-A	ESKT-A							
1						1 ✓								+500V STAB.
2				2		2 ✓								+330V STAB.
3				3		3 ✓								EARTH
4				4		4 ✓								-330V STAB.
6									f					FILS
16									g					FILS
7				21										+330V SWITCHED
9				15										X PRECENTRE
10				20										Y PRECENTRE
11				13										Y PRECENTRE
12				12										X PRECENTRE
15				11										S.T.C RELAY
17					25									M.S. BRIGHTENER
21					23									C.R.D.F. GAIN
22						22 X								RR & BM GAIN
23						23 X								I.T. GAIN
24					24									B.M. GAIN
	1				1									X PRECENTRE
	2				2									Y PRECENTRE
	6		9						j					FILS
	16		10						k					FILS
	8				3									FOCUSING
	13				21									MTI/NR GAIN
	15											10		+800V
	21				22									N.R GAIN
	22				20									V. MAP 2 GAIN
	23				19									V. MAP 1 GAIN
	24				18									RANGE RING GAIN
	25				17									S.S.R. GAIN
			1		7									RANGE SWITCH
			2			7 ✓								+330V TO DEF. AMP.
			3		6	3 ✓								EARTH
			4			9 ✓								-330V TO DEF. AMP.
			5			5 ✓								-500V STAB.
19			6						d					FILS
20			16						e					FILS
			7						p					FILS
			8						q					FILS
			12		4									Y OFFSET
			18		8									RANGE SWITCH
			21		5									X OFFSET
			24						l					FILS
			25						m					FILS
				1			1							CURSOR ILLUM.
				6			2		n				a	PANEL LIGHTS
				16					o				b	PANEL LIGHTS
				7		20								C.R.D.F. SWITCH
				8		21								C.R.D.F. SWITCH
				9		11								28V TO/ON OFF SWITCH
				10						2				INTERLOCK
						12					1			INTERLOCK
						24			a					STAB. MAINS
						25			b or c					STAB. MAINS
		1						c						
		5						a						
		8 & 9												LINK
		15						d & g						
		17						e						
		19						h						
		25						b						
			14						h					FILS
			15						i					FILS
									r			1		FILS
									s			12		FILS

FIG. 2.4.3. VIEWING UNIT SCHEDULE OF CONNECTIONS

PART THREE

CHAPTER 1

SETTING UP PROCEDURE

List of contents

INTRODUCTION

1. The following instructions are given to enable the basic display units to be set up in readiness for operation. It is assumed that the equipment is fully serviceable and that the required supplies and signals are available from the parent equipment. Reference should also be made to the corresponding instructions in the handbook relating to the main installation.

TEST EQUIPMENT

2. The test equipment for setting up is shown below:

(a) Avometer model 8

(b) Oscilloscope capable of displaying waveforms between 1V and 150V in amplitude and between 3μs and 3ms duration and which also provides the sawtooth voltage referred to in para. 9.2 of this chapter.

(c) Signal generator capable of providing a modulated pulse output at 30Mc/s.

(d) Engineer's rule

(e) Tuning tool (non-magnetic)

POWER SUPPLIES

3. Negative power unit

(a) Withdraw the negative power unit on to the service tray and pull out the plunger on the microswitch safety interlock.

(b) Ensure that the EMERGENCY switch on the base unit is on.

(c) Depress the DISPLAY ON button on the parent radar distribution panel and verify that the four indicator lamps on both power units are illuminated.

(d) Allow the time delay of 30 seconds to elapse.

(e) Set the monitor switch on the front panel of the negative power unit to position 2. Unlock RV3 and adjust the control so that the voltage registered on the meter is -330 $\pm$ 3.3V. Lock the control.

(f) Switch to position 1 and check that the voltage registered by the meter is -500V $\pm$ 5V.

(g) Switch to position 8 and note the current flowing through the meter. The current flow through the valve V5 is not adjustable, so this is used as the standard to balance the current through the other valves V3, V6, V7.

(h) Set the monitor switch to positions 9, 10 and 11 in turn and balance each current to the value at position 8 by means of potentiometers RV1, RV2, RV4 respectively. It will be necessary to unlock each control in turn, then re-lock after adjustment.

(i) Return the negative power supply unit to the home position in the base unit.

4. Positive power unit

(a) Withdraw the positive power supply unit on to the service tray and set the microswitch safety interlock to the service position by pulling out its plunger.

(b) Set the monitor switch on the positive power unit to position 3, and adjust the voltage by means of RV4 to give a meter reading of +330V + 3.3V. The control must be unlocked initially and then locked again after the adjustment.

(c) Unlock RV5. Switch to position 4 and adjust the control to give a meter reading of +500V $\pm$ 5V. Lock RV5.

(d) Switch to position 8 and note the current registered by the meter on the front panel of the unit. Use this value of current as a standard to balance the current at the monitor positions given below.

(e) Unlock the controls RV1, RV2 and RV3. Set the monitor switch to positions 9, 10 and 11 in turn and balance each current to the value obtained at position 8 by means of RV1, RV2 and RV3 respectively. Lock the controls.

(f) Return the positive power supply unit to its home position in the base unit.

WAVEFORM GENERATOR

5. Setting the calibration oscillator trigger

(a) Withdraw the waveform generator from the base unit on to the service tray and turn it on its side so that the video half of the chassis is uppermost.

(b) Pull out the plunger on the microswitch safety interlock so that the power supply to the waveform generator remains on.

(c) Unlock RV34, the TRIGGER SENSITIVITY control.

(d) Adjust the monitor c.r.t. BRIGHTNESS control so that a spot appears in the centre of the screen. The spot should be stationary, indicating that the calibration oscillator is not being triggered.

(e) Rotate the TRIGGER SENSITIVITY control until a trace appears on the monitor screen, thus showing that the oscillator is being triggered. Increase the rotation of the control slightly to provide a margin of safety, then lock it.

6. Tuning the calibration oscillator

(a) Set the TEST/NORMAL switch on the video chassis of the waveform generator to TEST.

(b) Set the monitor switch to position 11. As the output from the check oscillator appears, a moving Lissajou figure is produced.

(c) Tune the iron dust core of T1 with a non-magnetic tuning tool until the trace is a loop, indicating that the two oscillators are operating at the same frequency.

(d) Rotate the BRIGHTNESS control ant-clockwise to reduce the monitor c.r.t. brilliance.

(e) Set the monitor to position O.

(f) Set the TEST/NORMAL switch to NORMAL.

7. Setting the amplitude of the markers

(a) The calibration marker voltages are set to specific values so that the rings appear on the display in the correct order when the RANGE MARKS control on the viewing unit is rotated clockwise. The adjustments required to produce this proportional effect are detailed below.

(b) Monitor the output of the video half of the waveform generator with the monitor switch set to position 9 so that the calibration markers are displayed on the screen of an oscilloscope.

(c) Check the amplitude of the 1 mile markers. Note the value, which should be between 0.8V and 1.5V. The spacing between the 1 mile markers should be 12.4μs.

(d) Check the amplitude of the 5 mile markers and adjust RV36, the 5M MARKER AMP control, so that the value is 1.3 times that of the 1 mile markers. The spacing between the 5 mile markers should be 62 s.

(e) Check the amplitude of the 10 mile markers and adjust RV37, the 10M MARKER AMP control, so that the value is 1.6 times that of the 1 mile markers. The spacing between the 10 mile markers should be 124 s.

(f) Check the amplitude of the 20 mile markers and adjust RV38, the 20M MARKER AMP control, so that the value is twice that of the 1 mile markers. The spacing between the 20 mile markers should be 247 s.

(g) Return the waveform generator to the home position within the base unit.

GAIN CONTROL ADJUSTMENTS

8. General

The GAIN control RV26 must be adjusted to provide the correct gain of the iso-echo strip or the normal radar i.f. amplifier, depending upon which of these sub-assemblies is fitted to the chassis of the video half of the waveform generator. Instructions for carrying out the adjustment are given below.

9. Iso-echo strip

(a) Set the ISO-ECHO ON/OFF switch on the viewing unit control panel to OFF.

(b) With an oscilloscope capable of providing a sawtooth output, feed a positive-going sawtooth of 12.5 s duration and 1.5V peak into ESKT BB, the NR input.

(c) By means of the oscilloscope, observe the output from the monitor socket on the video half of the waveform generator with the monitor switch set to position 7.

(d) Unlock RV26 and adjust it so that the amplitude of the output sawtooth does not exceed 1.5V peak. The duration of the sawtooth should be identical to the input.

(e) Lock the control RV26

(f) Set the ISO-ECHO ON/OFF switch to ON.

(g) With the ISO-ECHO control on the viewing unit control panel fully anti-clockwise, the sawtooth displayed on the oscilloscope should not be affected.

(h) Rotate the ISO-ECHO control clockwise and observe that the duration of the sawtooth decreases linearly.

10. Normal radar i.f. strip

(a) Unlock the control RV26.

(b) Connect into ESKT BB the output from a signal generator, which is set to provide a pulse modulated 30Mc/s signal, 1mV peak.

(c) Monitor the output with an oscilloscope, the monitor switch on the video half of the waveform generator being set to position 7.

(d) Adjust the amplitude by means of RV26 to 1.5V.

(e) Lock the control RV26.

VIEWING UNIT

11. General

Adjustments to the viewing unit are made with the side panels removed to allow access to the deflection amplifiers. Set the plungers on the safety interlock microswitches so that the power supplies to the viewing unit remain on.

WARNING

LETHAL VOLTAGES ARE PRESENT IN THE E.H.T. SECTION OF THE VIEWING UNIT. CARE MUST BE TAKEN NOT TO TOUGH ACCIDENTALLY THOSE POINTS AT WHICH HIGH VOLTAGES ARE PRESENT.

12. Balancing the slave current

(a) The outputs of the X and Y slave amplifiers must be adjusted so that they are identical and of the correct value. The following procedure should be carried out as an initial check and then repeated on subsequent occasions when either of the power units in the base console are replaced or serviced. Adjustments to other controls on the deflection amplifier chassis is not within the scope of this volume, since these are preset at the factory and should not require adjustment.

(b) Unlock RV5, the X SLAVE CURRENT ADJ control.

(c) Connect an Avometer across R23. Adjust RV5 control to produce a meter reading of 7.2V. Lock the control.

(d) Unlock RV105, the Y SLAVE CURRENT ADJUST control.

(e) Connect an Avometer across R123. Adjust RV105 to produce a meter reading of 7.2V. Lock the control.

13. Adjusting the range ring spacing

(a) Stop the aerial turning so that the trace lies at 0^{o} on the display c.r.t.

(b) Adjust C110 on the 'Y' channel of the deflection amplifier chassis so that the spacing between the 1 and 2 mile markers is the same as between

the 4 and 5 mile markers. The distances may be measured by means of an engineers rule.

(c) Rotate the aerial so that the trace lies at 90°.

(d) Repeat the adjustment described above by means of C10 on the 'X' channel of the deflection amplifier chassis.

14. Setting the bearing scale

(a) Set the TEST/NORMAL switch on the integrator half of the waveform generator to TEST so that a spot and not a trace is displayed.

(b) Set the CENTRE/OFFSET switch on the control panel of the viewing unit to OFFSET. Unlock the bearing scale.

(c) Adjust the 'X' and 'Y' shift controls until the spot lies under the intersection of the axis lines on the cursor.

(d) Vary the 'Y' SHIFT control between its extremes of travel and align the centre line of the cursor with the trace drawn by the spot on the c.r.t.

(e) Reset the spot to the intersection of the axis lines.

(f) Adjust the bearing scale on the bezel until the 0° and 180° points are coincident with the centre line of the cursor.

(g) Lock the bearing scale.

(h) Reset the TEST/NORMAL switch to NORMAL.

CHAPTER 2

OPERATING INSTRUCTIONS

List of contents

INTRODUCTION

1. The instructions in this chapter are for bringing into operation a CRD.23 display in conjunction with a CR.353 radar installation that is in full adjustment and providing the necessary signals. It is assumed that the mains supply to the base unit has provided power to initiate the switching sequence.

PROCEDURE

2. Switching on

(a) Withdraw the control box from the viewing unit and ensure that the BRIGHTNESS, NR GAIN and ISO-ECHO controls are rotated fully anti-clockwise. The CENTRE/OFFSET toggle switch should be set to the CENTRE position. The other toggle switches on the control box should be set to their respective OFF positions.

(b) Commence by setting the DISPLAY ON/OFF switch to ON.

(c) Switch the PANEL ILLUM ON/OFF switch to ON.

(d) Advance the BRIGHTNESS control in a clockwise direction until a trace appears on the c.r.t., then adjust the FOCUS control for optimum focus of the trace. Normally the trace is substantially straight, rotating in a clockwise direction with the point of origin in the centre of the c.r.t. screen.

(e) Rotate the RANGE RING control until the rings are visible.

(f) Advance the NR GAIN control until signals are displayed at a suitable level.

3. Optional controls

(a) Certain controls may be used at the operator's discretion and do not have to be operated in any particular sequence. These controls are the RANGE

switch, ISO-ECHO, OFFSET, 'X' and 'Y' shift, CURSOR illumination and NORTH MARKER.

(b) Rotate the CURSOR ILLUM control until the bearing scale is provided with a suitable level of illumination.

(c) Rotate the NORTH MARKER control so that the trace brightens up.

DETAILED EXAMINATION OF SIGNALS

4. Iso-echo control

Set the ISO-ECHO ON/OFF switch to ON and advance the ISO-ECHO contour control until strong signals disappear, leaving blacked out portions of the display.

5. Offset facility

(a) If it is desired to examine in more detail a storm area or weather front, the procedure is as follows:-

(b) Set the RANGE switch to the maximum range.

(c) Set the CENTRE/OFFSET switch to OFFSET.

(d) Use the 'X' and 'Y' shift controls to bring the desired signal into the centre of the display.

(e) Reducing the range by operation of the RANGE switch will amplify the signal area and this will remain in the centre of the display due to the offset facility.

SWITCHING OFF

6.

(a) Switch off the viewing unit by the appropriate ON/OFF toggle switch.

(b) Switch off the stabilized mains supply by depressing the DISPLAY OFF button on the mains distribution box.

VARIANTS

7. The operating instructions for CRD.23 displays used in conjunction with other radar installations follow a similar sequence to that given for CR.353. The essential control differences may be deduced from Tables 1 and 2, Part 2, Chap. 2.

PARTS LISTS

The inter-services numbers given in the parts lists are in an abbreviated form, only the significant figures referring to the individual components are shown. The category prefixes are given below:-

Resistors, fixed	5905-99-
Resistors, variable	5905-99-
Capacitors, fixed	5910-99-
Capacitors, variable	5910-99-
Plugs	5935-99-
Sockets	5935-99-
Relays	5945-99-
Switches	5930-99-
Lamps, midget	6240-99-
Fuse links	5920-99-

Where there are no inter-services numbers, a manufacturer's part number is given. Those prefixed by the letter K refer to components manufactured by Cossor Radar and Electronics Ltd.

1.

POSITIVE POWER UNIT (UNSTABILIZED CHASSIS) 87993/1

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	220k	10	1/2	-	022-3081
R2	220k	10	1/2	-	022-3081
R3	220k	10	1/2	-	022-3081
R4	220k	10	1/2	-	022-3081
R5	220k	10	1/2	-	022-3081
R6	220k	10	1/2	-	022-3081
R7	220k	10	1/2	-	022-3081
R8	220k	10	1/2	-	022-3081
R9	220k	10	1/2	-	022-3081
R10	220k	10	1/2	-	022-3081
R11	220k	10	1/2	-	022-3081
R12	220k	10	1/2	-	022-3081
R13	220k	10	1/2	-	022-3081
R14	220k	10	1/2	-	022-3081
R15	220k	10	1/2	-	022-3081
R16	220k	10	1/2	-	022-3081
R17	470k	10	1/4	-	022-3121
R18	470k	10	1/4	-	022-3121
R19	1k	10	1/2	-	022-2006
R20	1k	10	1/2	-	022-2006
R21	1M	10	1/2	-	022-3165
R22	1.3M	10	1/2	-	022-3180
R23	12k	10	1/2	-	022-2144
Capacitors					
C1	8 μF	20	800V	-	011-2629
C2	8 μF	20	800V	-	011-2629
C2	8 μF	20	800V	-	011-2629
C3	8 μF	20	800V	-	011-2629
C4	8 μF	20	800V	-	011-2629
C5	8 μF	20	800V	-	011-2629
C6	0.005 μF	+80 -20	3KV	A97069/2	
C7	0.005 μF	+80 -20	3KV	A97069/2	
C8	0.005 μF	+80 -20	3KV	A97069/2	
C9	0.001 μF	10	2KV	A92938/3	

POSITIVE POWER UNIT (UNSTABILIZED CHASSIS) 87993/1 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Capacitors (cont.)					
C10	0.001 μF	10	2KV	A92938/3	
C11	0.001 μF	10	2KV	A92938/3	
C12	0.001 μF	10	2KV	A92938/3	
C13	0.001 μF	10	2KV	A92938/3	
C14	0.001 μF	10	2KV	A92938/3	
C15	0.001 μF	10	2KV	A92938/3	
C16	0.001 μF	10	2KV	A92938/3	
Rectifiers					
MR1	Silicon rectifier, Mullard 0A211				10 CV 7114
MR2	Silicon rectifier, Mullard 0A211				
MR3	Silicon rectifier, Mullard 0A211				
MR4	Silicon rectifier, Mullard 0A211				
MR5	Silicon rectifier, Mullard 0A211				
MR6	Silicon rectifier, Mullard 0A211				
MR7	Silicon rectifier, Mullard 0A211				
MR8	Silicon rectifier, Mullard 0A211				
MR9	Silicon rectifier, Mullard 0A211				
MR10	Silicon rectifier, Mullard 0A211				
MR11	Silicon rectifier, Mullard 0A211				
MR12	Silicon rectifier, Mullard 0A211				
MR13	Silicon rectifier, Mullard 0A211				
MR14	Silicon rectifier, Mullard 0A211				
MR15	Silicon rectifier, Mullard 0A211				
MR16	Silicon rectifier, Mullard 0A211				
MR17	Silicon rectifier, Mullard 0A211				
MR18	Silicon rectifier, Mullard 0A211				
MR19	Silicon rectifier, Mullard 0A211				
MR20	Silicon rectifier, Mullard 0A211				
Misc.					
L1	Choke 3H		950mA	KA30768	
L2	Choke 3H		950mA	KA30768	
L3	Choke 10H		170mA	KA30769	
T1	Transformer			KA30771	
RLA	Relay 6,800 ohms				011-9098
ILP1	Neon indicator lamp			KS9342	
ILP2	Neon indicator lamp			KS9342	
ILP3	Neon indicator lamp			KS9342	
ILP4	Neon indicator lamp			KS9342	

POSITIVE POWER UNIT (UNSTABILIZED CHASSIS) 87993/1 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Misc. (cont.)					
FS1	Fuse link		5A		059-0112
FS2	Fuse link		5A		059-0112
FS3	Fuse link		1A		059-0109
FS4	Fuse link		0.5A		059-0108
FS5	Fuse link		0.5A		059-0108
FS6	Fuse link		1A		059-0109
FS7	Fuse link		250mA		059-0107
PLA	Plug Unitor 25-way (Patt.B)				056-2007

NEGATIVE UNSTABILIZED POWER UNIT 87993

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	220k	10	1/2	-	022-3081
R2	220k	10	1/2	-	022-3081
R3	220k	10	1/2	-	022-3081
R4	220k	10	1/2	-	022-3081
R5	220k	10	1/2	-	022-3081
R6	220k	10	1/2	-	022-3081
R7	220k	10	1/2	-	022-3081
R8	220k	10	1/2	-	022-3081
R9	220k	10	1/2	-	022-3081
R11	220k	10	1/2	-	022-3081
R12	220k	10	1/2	-	022-3081
R13	220k	10	1/2	-	022-3081
R14	220k	10	1/2	-	022-3081
R15	220k	10	1/2	-	022-3081
R16	220k	10	1/2	-	022-3081
R17	470k	10	1/2	-	022-3121
R18	470k	10	1/2	-	022-3121
R19	1k	10	1/2	-	022-2006
R20	1k	10	1/2	-	022-2006
R21	1M	10	1/2	-	022-3165
R22	1.3M	5	1/2	-	022-3180
R24	330k	10	1/2	-	022-3102
R15	470k	10	1/2	-	022-3123
R26	470k	10	1/2	-	022-3123
Capacitors					
C1	8 μF	20	800 (V)	-	011-2629
C2	8 μF	20	800	-	011-2629
C3	8 μF	20	800	-	011-2629
C4	8 μF	20	800	-	011-2629
C5	8 μF	20	800	-	011-2629
C6	0.005 μF	+80 -20	3k	A97069/2	
C7	0.005 μF	+80 -20	3k	A97069/2	
C8	0.005 μF	+80 -20	3k	A97069/2	
C9	0.001 μF	10	2k	A92938/3	
C10	0.001 μF	10	2k	A92938/3	
C11	0.001 μF	10	2k	A92938/3	
C12	0.001 μF	10	2k	A92938/3	
C13	0.001 μF	10	2k	A92938/3	
C14	0.001 μF	10	2k	A92938/3	
C15	0.001 μF	10	2k	A92938/3	
C16	0.001 μF	10	2k	A92938/3	

NEGATIVE UNSTABILIZED POWER UNIT 87993 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Misc.					
MR1	Silicon rectifier, Mullard 0A211				
MR2	"				
MR3	"				
MR4	"				
MR5	"				
MR6	"				
MR7	"				
MR8	"				
MR9	"				
MR10	"				
MR11	"				
MR12	"				
MR13	"				
MR14	"				
MR15	"				
MR16	"				
MR17	"				
MR18	"				
MR19	"				
MR20	"				
L1	Choke 3H		850mA	KA30768	
L2	Choke 3H		850mA	KA30768	
L3	Choke 24H		50mA	KA30463	
T1	Transformer			KA30767	
PLA	Relay 6800 ohms				011-9098
ILP1	Neon indicator lamp			KS9342	
ILP2	Neon indicator lamp			KS9342	
ILP3	Neon indicator lamp			KS9342	
ILP4	Neon indicator lamp			KS9342	
FS1	Fuse link 5A				059-0112
FS2	Fuse link 5A				059-0112
FS3	Fuse link 1A				059-0109
FS4	Fuse link 0.5A				059-0108
FS5	Fuse link 0.5A				059-0108
FS6	Fuse link 1A				059-0109
FS7	Fuse link 100mA				059-0131
FS8	Fuse link 250mA				059-0107
PLA	Plug 25-way Unitor (Patt B)				056-2007

POSITIVE STABILIZED POWER UNIT 87997/1

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	330k	5	3/4	-	021-6731
R2	68k	5	3/4	-	021-6103
R3	100	10	1/4	-	022-1110
R4	330k	5	3/4	-	021-6731
R5	1.5M	1	3/4	-	021-6776
R6	390k	1	3/4	-	021-6575
R7	1.8M	1	3/4	-	021-6782
R8	470	10	1/4	-	022-1194
R9	330k	5	3/4	-	021-6731
R10	2.7k	5	3/4	-	021-5293
R11	15k	10	1/2	-	022-2153
R12	470	10	1/4	-	022-1194
R13	55.5		10mA	KA88172/14	
R14	22k	5	3/4	-	021-6043
R15	22k	5	3/4	-	021-6043
R16	330k	5	3/4	-	021-6731
R17	330	10	1/4	-	022-1173
R18	330k	5	3/4	-	021-6731
R19	330k	5	3/4	-	021-6731
R20	1		0.5A	KA88172/13	
R21	1		0.5A	KA88172/13	
R22	1		0.5A	KA88172/13	
R23	1		0.5A	KA88172/13	
R24	6.8	5	3	-	011-9780
R25	100	10	1/4	-	022-1110
R26	6.8	5	3	-	011-9780
R27	6.8	5	3	-	011-9780
R28	6.8	5	3	-	011-9780
R29	6.8	5	3	-	011-9780
R30	100	10	1/4	-	022-1110
R31	470	10	1/4	-	022-1194
R32	100	10	1/4	-	022-1110
R33	100	10	1/4	-	022-1110
R34	100	10	1/4	-	022-1110
R35	100	10	1/4	-	022-1110
R36	470	10	1/4	-	022-1194
R37	470	10	1/4	-	022-1194
R38	470	10	1/4	-	022-1194
R39	470	10	1/4	-	022-1194
R40	2.5		200mA	KA88172/15	
R41	470	10	1/4	-	022-1194
R42	330k	5	3/4	-	021-6731

POSITIVE STABILIZED POWER UNIT 87997/1 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R43	68k	5	3/4	-	021-6103
R44	1		0.5A	KA88172/13	
R45	82k	1	3/4	-	021-6472
R46	4.7k	1	3/4	-	021-5797
R47	150k	1	3/4	-	021-6487
R48	330k	1	3/4	-	021-6559
R49	470k	1	3/4	-	021-6591
R50	39k	1	3/4	-	021-6347
R51	50M	5	2	C25-	
R52	68k	1	3/4	-	021-6407
R53	10k	1	3/4	-	021-6208
R54	470k	1	3/4	-	021-6591
R55	470k	1	3/4	-	021-6591
R56	4.7	5	3	-	011-9778
R57	200k	1	3/4	-	021-6516
R58	4.7	5	3	-	011-9778
R59	1M	1	3/4	-	021-6655
R60	120k	5	1	-	011-8036
R61	1	10	0.5A	KA88172/13	
Resistors variable					
RV1	50k	10	1/2	CLR1206	
RV2	50k	10	1/2	CLR1206	
RV3	50k	10	1/2	CLR1206	
RV4	50k	10	1/2	CLR1206	
RV5	50k	10	1/2	CLR1206	
Capacitors					
C1	18pF	5			011-8303
C2	8 μF	20			011-2629
C3	27pF	5			011-8307
C4	0.1 μF	20			011-5507
C5	0.1 μF	20			011-5506
C6	0.1 μF	20			011-5507
C7	0.1 μF	20			011-5506
C8	8 μF	20			011-2629
C9	8 μF	20			011-2629
C10	2 μF	25			011-9839
Valves					
V1					CV2135
V2					CV4004
V3					CV4048

POSITIVE STABILIZED POWER UNIT 87997/1 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Valves (cont.)					
V4					CV2135
V5					CV4060
V6					CV4060
V7					CV4060
V8					CV4060
V9					CV4060
V10					CV4060
Misc.					
SA	Switch 2-pole 11-way			B95948/1	
SB	Switch 6-pole 2-way			B95948/18	
PLA.	Unitor plug 25way				056-2007
M.1.	Meter, E. Turner type 703.			B96354/1	
T.1.	Transformer				

4.

NEGATIVE STABILIZED POWER UNIT 87997

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	330k	5	3/4	-	021-6731
R2	100	10	1/4	-	022-1110
R3	470	10	1/4	-	022-1194
R4	820k	1	3/4	-	021-6639
R5	1.2M	1	3/4	-	021-6764
R6	470	10	1/4	-	022-1194
R7	330k	5	3/4	-	021-6731
R8	330	10	1/4	-	022-1173
R9	22k	5	3/4	-	021-6043
R10	22k	5	3/4	-	021-6043
R11	680k	5	3/4	-	021-6747
R12	330k	5	3/4	-	021-6731
R13	470	10	1/4	-	022-1194
R14	1.5k	5	3/4	-	021-5263
R15	15k	5	3/4	-	021-5263
R16	100	10	1/4	-	022-1110
R17	470	10	1/4	-	022-1194
R18	5.05		100mA	KA88172/12	
R19	180k	1	3/4	-	021-6506
R20	180k	1	3/4	-	021-6506
R21	1		0.5A	KA88172/13	
R22	1		0.5A	KA88172/13	
R23	1		0.5A	KA88172/13	
R24	470k	5	3/4	-	021-6739
R25	6.8	5	3	-	011-9780
R26	6.8	5	3	-	011-9780
R27	6.8	5	3	-	011-9780
R28	12k	5	3	-	011-3513
R29	6.8	5	3	-	011-9780
R30	8.2k	5	3	-	011-3342
R31	6.8	5	3	-	011-9780
R32	100	10	1/4	-	022-1110
R33	100	10	1/4	-	022-1110
R34	100	10	1/4	-	022-1110
R35	120k	5	1	-	011-8036
R36	470	10	1/4	-	022-1194
R37	470	10	1/4	-	022-1194
R38	100	10	1/4	-	022-1110
R39	470	10	1/4	-	022-1194
R40	270k	5	1	-	021-6152

NEGATIVE STABILIZED POWER UNIT 87997 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R41	270k	5	1	-	021-6152
R42	270k	5	1	-	021-6152
R43	100	10	1/4	-	011-1110
R44	1		0.5A	KA88172/13	
R45	1		0.5A	KA88172/13	
R46	5.05		100mA	KA88172/12	
R47	330k	1	1		021-6560
R48	150k	1	3/4		021-6487
R49	180k	1	3/4	-	021-6506
R50	68k	5	3/4	-	021-6103
R51	330k	1	1	-	021-6560
R52	150k	1	3/4	-	021-6487
R53	270k	1	1	-	021-6544
R54	51k	1	3/4	-	021-6377
R55	18k	5	4.5	-	011-3517
R56	4.7	5	3	-	011-9778
R57	4.7	5	3	-	011-9778
R58	1M	1	3/4	-	021-6655
R59	1		0.5A	KA88172/13	
R60	1M	10	1/4		022-3164
R61	15k	5	4.5	-	011-3515
R62	1.8k	1	1/4	-	021-5695
R63	1.8k	1	1/4	-	021-5695
R64	1.8k	1	1/4	-	021-5695
R65	6.8k	5	3	-	011-9780
R66	100	10	1/4	-	022-1110
R67	470	10	1/4	-	022-1194
Variable resistors					
RV1	50k	10	1/2	CLR1206/95	
RV2	50k	10	1/2	CLR1206/95	
RV3	50k	10	1/2	CLR1206/95	
RV4	50k	10	1/2	CLR1206/95	
RV5	250	10	1	CLR1206/95	
Capacitors			(V)		
C1	18pF	5	750	-	011-8303
C2	0.1 μF	20	350	-	011-7818
C3	27pF	5	750	-	011-8307
C4	0.1 μF	20	350	-	011-7818
C5	0.1 μF	20	350	-	011-7818

NEGATIVE STABILIZED UNIT 87997 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Capacitors (cont.)					
C6	0.1 μF	20	350	-	011-7818
C7	0.1 μF	20	350	-	011-7818
C8	0.1 μF	20	500	-	011-7823
C9	0.1 μF	20	500	-	011-7823
C10	18pF	2	750	-	011-8327
C11	8 μF	20	800	-	011-2629
C12	8 μF	20	800	-	011-2629
C13	2 μF	25	200	-	011-9839
Valves					
V1	-	-	-	-	CV2135
V2	-	-	-	-	CV4004
V3	-	-	-	-	CV4060
V4	-	-	-	-	CV2135
V5	-	-	-	-	CV4060
V6	-	-	-	-	CV4060
V7	-	-	-	-	CV4060
V8	-	-	-	-	CV4060
V9	-	-	-	-	CV4060
V10	-	-	-	-	CV4080
V11	-	-	-	-	CV4080
V12	-	-	-	-	CV4080
Switches					
S1	2p		11	B95948/1	
S2	2p		2	B95948/17	
Plugs and sockets					
PLA	Unitor plug 25-way				056-2007
SKTA	Unitor socket 25-way				056-2008
SKTB	Unitor socket 25-way				056-2008
SKTC	Unitor socket 25-way				056-2008
SKTD	Unitor socket 25-way				056-2008
Misc.					
M1	Meter E. Turner Type 703			B96354/1	
T1	Transformer			KA30773	
MR1	Silicon rectifier CV7015				
MR2	" " "				
MR3	" " "				
MR4	" " "				

SWITCHING UNIT 87999

Cct. Ref.		Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
R1		56k	5	4.5	-	011-8252
V1		SH342				053-0533
MR1	Diode	0A211				
PLA	Plug	25-way Unitor RCL321				056-2007
RLA	Relay	590 ohms 3PNO Magnetic devices				590/ACIE4/25
RLB	Relay	6000 ohms 5PNO Magnetic devices				TS3098
RLC	Relay	350 ohms 5PNO Magnetic devices				285/350-AIEE-2X/25
RLD	Relay	350 ohms 6PNO Magnetic devices				285/350-AIEE-2X/25
RLE	Relay	1200 ohms 2PNO Magnetic devices				596/1200/E4/25

WAVEFORM GENERATOR (INTEGRATOR) 87989

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	47k	5	6	-	011-3437
R2	180k	2	3/4	-	021-6511
R3	390k	2	3/4	-	021-6579
R4	150k	2	3/4	-	021-8753
R5	470	10	1/4	-	022-1194
R6	1.2M	2	3/4	-	021-6766
R7	2.2k	10	1/2	-	022-2048
R8	120k	5	3/4	-	021-6711
R9	56k	5	3/4	-	021-6093
R10	22k	5	3/4	-	021-6043
R11	120k	5	3/4	-	021-6711
R12	10k	5	3	-	011-3344
R13	470	10	1/4	-	022-1194
R14	10k	5	3	-	011-3344
R15	47k	5	6	-	011-3437
R16	1.5k	5	3/4	-	021-5263
R17	18k	10	1/2	-	022-2165
R18	330k	10	1/2	-	022-3102
R19	470	10	1/2	-	022-1194
R20	270k	10	1/2	-	022-3093
R21	1M	10	1/4	-	022-3164
R22	1k	5	3/4	-	021-5243
R23	22k	5	4.5	-	011-8242
R24	56k	5	6	-	011-4678
R25	33k	5	1.5	-	011-8246
R26	100	10	1/4	-	022-1110
R27	10k	10	1/4	-	022-2131
R28	180k	10	1/4	-	022-3071
R29	100k	2	3/4	-	021-6452
R30	470	10	1/4	-	022-1194
R31	82	10	1/4	-	022-1101
R32	56k	5	6	-	011-4678
R33	22k	5	4.5	-	011-8242
R34	22k	5	4.5	-	011-8242
R35	270k	2	3/4	-	021-6547
R36	82	10	1/4	-	022-1101
R37	470	10	1/4	-	022-1194
R38	22k	5	4.5	-	011-8242
R39	22k	5	4.5	-	011-8242

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R40	10	10	1/2	-	022-1003
R41	10	10	1/2	-	022-1003
R42	1M	10	1/2	-	022-3165
R43	470	10	1/4	-	022-1194
R44	2.2k	10	1/2	-	022-2048
R45	1.8k	10	1/2	-	022-2039
R46	1.8k	10	1/2	-	022-2039
R47	100k	10	1/2	-	022-3039
R48	2.2k	10	1/2	-	022-2048
R49	100k	10	1/2	-	022-3039
R50	82k	10	1/2	-	022-3030
R51	470	10	1/4	-	022-1194
R52	470	10	1/4	-	022-1194
R53	470	10	1/4	-	022-1194
R54	150k	10	1/2	-	022-3060
R55	270k	2	3/4	-	021-6547
R58	1.8M	10	1	-	011-1527
R59	1.8M	10	1	-	011-1527
R60	470	10	1/4	-	022-1194
R62	47k	5	3/4	-	021-6083
R69	180k	5	3/4	-	021-6719
R71	68k	5	1	-	021-6104
R72	33k	5	3/4	-	021-6063
R75	390k	5	3/4	-	021-6735
R79	6.8k	10	1/4	-	022-2110
R80	6.8k	10	1/4	-	022-2110
R82	1k	5	3/4	-	021-5243
R83	470	10	1/4	-	022-1194
R88	680k	2	1.5	-	021-6629
R89	680k	2	1.5	-	021-6629
R90	330k	2	3/4	-	021-6563
R91	220k	2	3/4	-	021-6531
R92	470	10	1/4	-	022-1194
R93	470	10	1/4	-	022-1194
R94	82k	2	3/4	-	021-6432
R95	120k	1	1	-	021-6468
R96	470k	10	1/4	-	022-3122
R97	470k	10	1/4	-	022-3122
R98	6.8k	5	3/4	-	021-5343
R99	470	10	1/4	-	022-1194
R100	470	10	1/4	-	022-1194
R101	270k	5	3/4	-	021-6727

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R102	27k	5	3/4	-	021-6053
R103	470	10	1/4	-	022-1194
R104	560k	5	3/4	-	021-6743
R105	56k	5	3/4	-	021-6093
R106	470	10	1/4	-	022-1194
R107	100	10	1/4	-	022-1110
R108	1.5k	5	1	-	021-5264
R109	18k	5	4.5	-	011-3517
R110	47k	5	4.5	-	011-8250
R111	39k	10	1/4	-	022-2206
R112	150k	10	1/4	-	022-4059
R113	180k	10	1/4	-	022-3071
R122	47k	5	3/4	-	021-6083
R129	180k	5	3/4	-	021-6719
R131	68k	5	1	-	021-6104
R132	33k	5	3/4	-	021-6063
R135	390k	5	3/4	-	021-6735
R142	1k	5	3/4	-	021-5243
R143	470	10	1/4	-	022-1194
R148	680k	2	1.5	-	021-6629
R149	680k	2	1.5	-	021-6629
R150	330k	2	3/4	-	021-6563
R151	220k	2	3/4	-	021-6531
R152	470	10	1/4	-	022-1194
R153	470	10	1/4	-	022-1194
R154	82k	2	3/4	-	021-6432
R155	120k	1	1	-	021-6468
R156	470k	10	1/4	-	022-3122
R157	470k	10	1/4	-	022-3122
R158	6.8k	5	3/4	-	021-5343
R159	470	10	1/4	-	022-1194
R160	470	10	1/4	-	022-1194
R161	270k	5	3/4	-	021-6727
R162	27k	5	3/4	-	021-6053
R163	470	10	1/4	-	022-1194
R164	560k	5	3/4	-	021-6743
R165	56k	5	3/4	-	021-6093
R166	470	10	1/4	-	022-1194
R167	100	10	1/4	-	022-1110
R168	1.5k	5	1	-	021-5264

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R169	18k	5	4.5	-	011-3517
R170	47k	5	4.5	-	011-8250
R171	39k	10	1/4	-	022-2206
R172	330k	10	1/2	-	022-3102
R173	10k	10	1/4	-	022-2131
R174	330k	10	1/2	-	022-3102
R175	10k	10	1/4	-	022-2131
R177	10k	10	1/2	-	022-2132
R178	56k	5	6	-	011-4678
R179	470	10	1/4	-	022-1194
R180	4.7M	10	1/2	-	022-3248
R181	2.2M	10	1/2	-	022-3207
R182	18k	10	1/2	-	022-2165
R183	680k	10	1/2	-	022-3144
R184	47k	10	1/2	-	022-2216
R185	150k	10	1/2	-	022-3060
R186	100k	10	1/2	-	022-3039
R187	1M	10	1/2	-	022-3165
R188	1.2M	10	1/2	-	022-3177
R189	1M	10	1/2	-	022-3165
R190	8.2M	10	1/2	-	022-3282
R191	15k	10	1/4	-	022-2152
R192	1M	10	1/2	-	022-3165
R193	1.5M	10	1/2	-	022-3186
R194	1M	10	1/2	-	022-3165
R195	470	10	1/4	-	022-1194
R196	15k	10	1/4	-	022-2152
R197	330k	10	1/2	-	022-3102
R198	100	10	1/2	-	022-1111
R199	15k	5	3	-	011-3348
R200	22k	5	4.5	-	011-8242
R201	470	10	1/4	-	022-1194
R202	47k	10	1/2	-	022-2216
R203	3.9M	10	1/2	-	022-3240
R204	100	10	1/4	-	022-1110
R205	82k	5	6	-	011-4682
R206	15k	10	1/4	-	022-2152
Variable resistors			(W)		
RV1	100k	10	1	-	027-2549
RV6	100k	10	1	-	027-2549
RV8	100	10	1/2	-	011-9486

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
Variable resistors (cont.)					
RV10	1.5k	10	1/2	-	011-9490
RV16	100k	10	1	-	027-2549
RV18	100	10	1/2	-	011-9486
RV20	2.5k	10	1/2	-	011-9490
Capacitors			(V)		
C1	330pF	10	750	-	012-3943
C2	2200pF	2	750	-	012-4189
C3	3000pF	20	500	-	012-0121
C4	1 μF	20	600	KU92886/31	
C5	82pF	2	750	-	011-8319
C6	0.1 μF	20	1000	-	011-7829
C8	2-8.5pF	20	500	-	016-0040
C9	0.5 μF	20	350	-	011-7820
C10	0.5 μF	20	350	-	011-7820
C11	2-8.5 μF	20	500	-	016-0040
C12	0.5 μF	20	350	-	011-7820
C13	0.5 μF	20	350	-	011-7820
C14	1.0 μF	20	600	-	011-2823
C15	1.0 μF	20	600	-	011-2823
C16	0.1 μF	20	1000	-	011-7829
C21	1-10pF			S55-11(A96140)	
C22	3.3pF	.5p	750	-	011-8679
C23	680pF	1	250	TMC Type S125503	
C24	10pF	5	750	-	011-8297
C25	0.04 μF	20	250	-	012-0116
C26	0.04 μF	20	250	-	012-0116
C27	0.04 μF	20	250	-	012-0116
C28	0.04 μF	20	250	-	012-0116
C29	0.04 μF	20	250	-	012-0116
C30	0.04 μF	20	250	-	012-0116
C31	1-10pF			S55-11(A96140)	
C32	3.3pF	.5p	750	-	011-8679
C33	680pF	1	250	TMC Type S125503	
C34	10pF	.5p	750	-	011-8297
C35	56pF	2	750	-	011-8620
C36	1000pF	20	750	KT95804/1	
C40	0.001 μF	20	350	-	011-5623
C41	470pF	2	750	-	012-3947
C42	0.1 μF	20	350	-	011-7818
C43	47pF	2	750	-	011-8313

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
Capacitors (cont.)					
C44	0.001 μF	20	350	-	011-5623
C45	0.01 μF	25	350	-	011-5625
C46	2200pF	2	750	-	012-4189
C47	0.01 μF	25	350	-	011-5625
Valves and Diodes					
V1					CV4064
V2					CV4007
V3					CV4024
V4					CV4055
V5					CV4055
V6					CV4055
V7					CV4024
V8					CV4014
V9					CV4007
V10					CV4007
V11					CV4024
V12					CV4024
V13					CV4055
V14					CV4055
V15					CV4014
V16					CV4007
V17					CV4007
V18					CV4024
V19					CV4024
V20					CV4055
V21					CV4055
V22					CV4014
V23					CV4007
V24					CV4024
MR1 Diode					CV2413
MR2 Diode					CV7025
Misc.					
RLA Relay 6800 ohms					011-9098
T1 Transformer				KA30772	
TP1 Socket Type L1318				KS945451/21	
TP2 Socket Type L1318				KS945451/20	
TP3 Socket Type L1318				KS945451/21	
SB Wafer switch 1 pole, 11 way				B95948/4	
SC Toggle switch double pole				Z510554	

WAVEFORM GENERATOR (INTEGRATOR) 87989 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
PLA	Plug, Unitor, 25 way				056-2007
PLD	Plug BNC 75 ohm			KS94417/8	972-8285
SKT A	Coaxial 75 ohm type BNS/7B				
SKT B	"				
SKT C	"				
SKT D	"				
SKT E	"				
SKT F	"				
SKT G	Coaxial 75 ohm type BN5/B				
SKT H	"				
SKT A.A.	"				
SKT J	"				
SKT K	"				
SKT L	"				
SKT M	"				
SKT N	"				
SKT O	"				
SKT P	"				
SKT Q	"				
SKT R	"				
SKT S	"				
SKT T	"				
SKT U	"				
SKT V	"				
SKT W	"				
SKT X	"				
SKT Y	"				
SKT Z	"				
SKT spare	"				

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WAVEFORM GENERATOR (VIDEO) 87998

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R220	3.3M	10	1/2	-	022-3228
R221	390	2	1/4	-	021-5540
R222	100	10	1/4	-	022-1110
R223	56k	10	1/4	-	022-3008
R224	100k	10	1/2	-	022-3039
R225	47k	10	1/4	-	022-2215
R226	68k	10	1/2	-	022-3018
R227	1k	10	1/4	-	022-2005
R228	10k	5	4.5	-	011-3511
R229	2.2k	10	1/2	-	022-2048
R230	100	10	1/2	-	022-1111
R231	6.8k	10	1/2	-	022-2111
R232	180k	10	3/4	-	022-3310
R233	100	10	1/2	-	022-1111
R234	33k	1	3/4	-	021-6328
R235	4.7k	10	1/4	-	022-2089
R236	15k	1	3/4	-	021-6248
R239	1.5M	2	1	-	021-6779
R240	47k	5	3/4	-	021-6083
R241	33k	5	4.5	-	011-8246
R242	180k	5	3/4	-	021-6719
R243	560k	5	3/4	-	021-6743
R244	390	10	1/2	-	022-1186
R245	10k	5	4.5	-	011-3511
R246	2.2k	10	1/2	-	022-2048
R247	12k	10	1/2	-	022-2144
R248	270k	10	1/2	-	022-3093
R249	270k	10	1/2	-	022-3093
R251	1k	10	1/2	-	022-2006
R252	5.6k	5	3/4	-	021-5333
R253	100k	5	1.5	-	021-6125
R254	680k	5	3/4	-	021-6747
R255	1k	10	1/2	-	022-2006
R257	4.7k	5	3/4	-	021-5323
R258	100k	5	1.5	-	021-6125
R259	560k	5	3/4	-	021-6743
R260	1k	5	3/4	-	021-5243
R261	1k	5	3/4	-	021-5243
R262	1k	5	3/4	-	021-5243
R263	1.8k	5	3/4	-	021-5273

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R264	1k	5	3/4	-	021-5243
R265	68k	5	4.5	-	011-8254
R266	4.7k	10	1/2	-	022-2090
R267	100	10	1/2	-	022-1111
R268	82	10	1/2	-	022-1102
R269	18	10	1/4	-	022-1017
R270	100	10	1/4	-	022-1110
R278	330k	10	1/2	-	022-3102
R279	150k	10	1/4	-	022-3059
R280	100	10	1/4	-	022-1110
R281	1k	10	1/4	-	022-2005
R282	270k	10	1/2	-	022-3093
R283	100	10	1/4	-	022-1110
R284	39k	2	3/4	-	021-6352
R286	220k	10	1/4	-	022-3080
R287	150k	5	3/4	-	021-6715
R288	150k	2	3/4	-	021-8753
R290	100k	10	1/4	-	022-3038
R291	47k	2	3/4	-	021-6372
R292	100	10	1/4	-	022-1110
R293	100	10	1/4	-	022-1110
R294	100	10	1/4	-	022-1110
R295	100	10	1/4	-	022-2174
R296	3.9k	5	3/4	-	021-5313
R297	47	10	1/4	-	022-1068
R298	200k	2	3/4	-	021-6521
R299	27k	5	3/4	-	021-6053
R300	27k	5	3/4	-	021-6053
R301	68k	5	3/4	-	021-6103
R302	100	10	1/4	-	022-1110
R303	68k	5	3/4	-	021-6103
R304	270k	2	3/4	-	021-6547
R305	150k	5	3/4	-	021-6715
R306	330k	5	3/4	-	021-6731
R307	220k	10	1/4	-	022-3080
R308	47k	2	3/4	-	021-6372
R309	100	10	1/4	-	022-1110
R310	150k	2	3/4	-	021-8753
R311	100	10	1/4	-	022-1110
R312	100	10	1/4	-	022-1110
R313	1M	10	1/4	-	022-3164

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R314	33k	10	1/4	-	022-2194
R315	560	10	1/4	-	022-1206
R316	560	10	1/4	-	022-1206
R317	3.9k	5	3/4	-	021-5313
R318	82k	5	1	-	021-6114
R319	33k	5	3/4	-	021-6063
R320	1M	10	1/4	-	022-3164
R321	33k	10	1/4	-	022-2194
R322	100	10	1/4	-	022-1110
R323	100	10	1/4	-	022-1110
R324	120k	2	3/4	-	021-6472
R325	180k	5	3/4	-	021-6719
R326	6.8k	5	3/4	-	021-5343
R327	330k	5	3/4	-	021-6731
R328	150k	10	1/4	-	022-3059
R329	100	10	1/4	-	022-1110
R330	180k	10	1/4	-	022-3071
R331	4.7k	10	1/2	-	022-2090
R332	2.7k	10	1/2	-	022-2060
R333	2.7k	10	1/2	-	022-2060
R334	4.7k	10	1/2	-	022-2090
R335	100	10	1/4	-	022-1110
R336	22	10	1/2	-	022-1027
R337	1M	10	1/4	-	022-3164
R338	1M	10	1/4	-	022-3164
R339	270k	5	3/4	-	021-6727
R340	100	10	1/4	-	022-1110
R341	3.9k	5	3/4	-	021-5313
R342	330k	10	1/2	-	022-3102
R343	4.7k	10	1/2	-	022-2090
R344	4.7k	10	1/2	-	022-2090
R345	100	10	1/4	-	022-1110
R346	22k	5	4.5	-	011-8242
R360	220k	10	1/4	-	022-3080
R361	680	10	1/4	-	022-1215
R362	2.2k	2	3/4	-	021-5722
R363	180k	5	3/4	-	021-6719
R364	330k	2	3/4	-	021-6563
R366	100k	2	3/4	-	021-6452
R367	68	10	1/4	-	022-1089
R368	33k	5	3/4	-	021-6063

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R369	100k	10	1/2	-	022-3039
R370	220	10	1/4	-	022-1152
R371	1k	10	1/4	-	022-2005
R372	1k	10	1/4	-	022-2005
R373	220	10	1/2	-	022-1153
R374	22k	5	4.5	-	011-8242
R380	2.2M	2	3/4	-	021-6846
R381	470	10	1/4	-	022-1194
R382	22k	5	4.5	-	011-8242
R383	10k	10	1/2	-	022-2132
R384	47k	5	3/4	-	021-6083
R385	470	10	1/4	-	022-1194
R386	2.7M	2	3/4	-	021-6852
R387	150	10	1/4	-	022-1131
R388	100	10	1/4	-	022-1110
R391	100k	10	1/2	-	022-3039
R392	470	10	1/4	-	022-1194
R395	10k	10	1/4	-	022-2131
R398	220	10	1/4	-	022-1152
R399	15k	10	1/2	-	022-2153
R400	330k	10	1/2	-	022-3102
R401	5.6k	10	1/2	-	022-2102
R402	82	10	1/4	-	022-1101
R403	15k	10	1/2	-	022-2153
R404	150k	2	1	-	021-6492
R405	56k	5	3/4	-	021-6093
R406	150k	10	1/2	-	022-3060
R407	150k	10	1/4	-	022-3059
R408	47k	10	1/2	-	022-2216
R409	18k	5	3/4	-	021-6033
R410	4.7k	10	1/4	-	022-2089
R411	390k	2	1	-	021-6580
R412	470	10	1/4	-	022-1194
R413	220k	2	3/4	-	021-6531
R414	1.5M	2	3/4	-	021-6778
R415	330k	2	3/4	-	021-6563
R416	33k	5	4.5	-	011-8246
R419	470	10	1/4	-	022-1194
R420	1M	10	1/4	-	022-3164
R421	220k	10	1/4	-	022-3080
R422	220k	2	3/4	-	021-6531
R423	470	10	1/4	-	022-1194

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Variable resistors					
RV25	25k	10	1	-	027-2301
RV26	5k	10	1/2	-	011-9491
RV27	500	20	1/4	-	026-1054
RV28	100k	10	1	-	027-2549
RV29	10k	10	1/2	-	011-9492
RV30	50k	10	1/2	-	026-2004
RV31	100k	10	1	-	027-27549
RV32	50k	10	1	-	027-2409
RV33	500	20	1/4	-	026-1054
RV34	100k	10	1	-	027-2549
RV35	100	10	1/2	-	011-9845
RV36	100	10	1/2	-	011-9845
RV37	100	10	1/2	-	011-9845
RV38	100	10	1/2	-	011-9845
Capacitors			(V)		
C63	180pF	5	750	-	012-3933
C64	120pF	2	750	-	011-8323
C65	0.1 μF	20	350	-	011-7818
C66	220pF	5	750	-	012-3936
C67	47pF	10	750	-	012-3913
C68	0.1 μF	20	350	-	011-5506
C69	270pF	5	750	-	012-3939
C70	0.1 μF	20	200	-	011-5631
C71	150pF	5	750	-	012-3930
C72-	47pF	2	750	-	011-8313
C73	100pF	2	750	-	011-8321
C74	560pF	2	350	-	012-3950
C75	0.1 μF	20	350	-	011-5506
C76	150pF	20	500	B96705/6	
C77	0.1 μF	20	350	-	011-5506
C78	330pF	5	750	-	012-3942
C79	150pF	20	500	B96705/6	
C80	0.1 μF	20	350	-	011-5506
C81	820pF	2	350	-	012-3956
C82	0.1 μF	20	350	-	011-5506
C83	27pF	5	750	-	011-8307
C84	120pF	2	750	-	012-3926
C85	4700pF	2	750	-	012-4288

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (V)	Part No.	Inter-services No.
Capacitors (cont.)					
C86	0.1 μF	20	350	-	011-5506
C87	0.1 μF•	20	350	-	011-5506
C90	1500pF	10	350	-	012-4705
C91	0.1 μF	20	350	-	011-5506
C92	1000pF	10	350	-	012-4702
C94	0.1 μF	20	350	-	011-5506
C95	47pF	2	750	-	011-8313
C96	0.5 μF	25	200	-	011-9833
C99	100pF	2	750	-	011-8321
C100	2pF	20	600	KU92886/34	
C101	0.1 μF	20	350	-	011-5506
C102	0.5 μF	20	350	-	011-7820
C108	470pF	5	750	-	012-3948
C109	680pF	5	350	-	012-3954
C110	100pF	2	750	-	011-8321
C111	10pF	0.5	750	-	011-8297
C112	3300pF	2	750	-	012-4251
C113	56pF	10	750	-	012-3916
C115	0.05 μF	25	400	-	011-9826
C117	10pF	5	750	-	011-8297
C120	150pF	5	750	-	012-3930
C121	1500pF	5	350	-	012-4704
C122	0.1 μF	20	350	-	011-5506
C123	0.04 μF	20	250	-	012-0116
C125	0.1 μF	20	350	-	011-5506
C126	0.01 μF	20	350	-	011-5552
C127	220pF	10	750	-	012-3937
C128	0.005 μF	20	500	-	012-0122
C129	0.05 μF	25	350	-	011-5585
C130	390pF	5	750	-	012-3944
C131	100pF	10	750	-	012-3925
C132	27pF	10	750	-	012-3907
C133	0.01 μF	20	350	-	011-5552
Valves					
V25					CV4007
V26					CV4014
V27					CV4024
V28					CV4007
V29					CV4064
V30					CV4024

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (V)	Part No.	Inter-services No.
V31					CV4024
V32					CV4007
V33					CV4024
V34					CV4024
V35					CV4024
V36					CV4014
V37					CV4062
V38					CV4007
V39					CV4024
V40					CV4007
V41					CV4024
V42					CV4014
V43					CV4064
V44					CV4007
V45					CV4024
V46					CV4024
V47					CV4024
V48					CV2302
V49					CV4024
V50					CV4014
V51					CV4024
MR6	Diode 0A81				CV448
MR7	Diode 0A81				CV7025
Transformers					
T1	Oscillator coil			KA30902	
T2	Pulse transformer			KA30190	
T3	Pulse transformer			KA30190	
T4	Pulse transformer			KA30191	
T5	Pulse transformer			KA30191	
T7	Transformer			KA30772	
T8	Pulse transformer			KA30898	
T9	Pulse transformer			KA30696	
Sockets					
SKT E	12-way Unitor				056-2508
SKT G	Cable mounting			KS92407	
SKTS A, C, D, M, P, Q, R, S, T, U, V, W, X, Y, AB and spare sockets					
	75 ohm co-axial				

WAVEFORM GENERATOR (VIDEO) 87998 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
Plugs					
PLA	25-way Unitor Patent B				056-2007
PLF	Cable mounting			KS93406	
Misc.					
X1	Crystal 80.89Kc/s				
TP1	Belling Lee socket type L1318 Red				
TP2	Belling Lee socket type L1318 Black				
TP3	Belling Lee socket type L1318 Red				
L1	Choke 200 H			KA88114/8	
L2	Choke			X1500	
L3	Choke 200 H			KA88114/8	
SA	Switch 3-pole - 2 way				
SC	Switch 2-pole - 11 way				

8.

DEFLECTION AMPLIFIER 86756 ('X' Channel)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	470	10	1/4	-	022-1194
R2	68k	5	4.5	-	011-8254
R3	68k	5	4.5	-	011-8254
R4	33k	5	4.5	-	011-8246
R5	120k	1	3/4	-	021-6467
R6	470k	1	3/4	-	021-6591
R7	470	10	1/4	-	022-1194
R8	47k	5	6	-	011-3437
R9	39k	1	3/4	-	021-3647
R10	330k	1	3/4	-	021-6559
R11	330k	1	3/4	-	021-6559
R12	100k	10	1/4	-	022-3038
R13	270k	1	3/4	-	021-6543
R14	470	10	1/4	-	022-1194
R15	68k	1	3/4	-	021-6407
R16	470	10	1/4	-	022-1194
R17	10k	5	6	-	011-3421
R18	10k	5	6	-	011-3421
R19	470	10	1/4	-	022-1194
R20	470	10	1/4	-	022-1194
R21	68	10	1/2	-	022-1090
R22	68	10	1/2	-	022-1090
R23	470	5	6	-	011-3389
R24	270k	1	3/4	-	021-6543
R25	27k	10	1/4	-	022-2185
R26	100k	10	1/4	-	022-3038
R27	2.7k	10	1/4	-	022-2059
R28	470	5	6	-	011-3389
R29	68k	1	3/4	-	021-6407
R30	100k	5	6	-	011-4684
R31	330k	1	3/4	-	021-6559
R32	150k	1	3/4	-	021-6487
R33	150k	1	3/4	-	021-6487
R34	390k	1	3/4	-	021-6575
R35	150k	1	3/4	-	021-6487
R36	150k	1	3/4	-	021-6487
R37	68k	5	6	-	011-4680
R38	470	10	1/4	-	022-1184
R39	150k	1	3/4	-	021-6487

DEFLECTION AMPLIFIER 86756 ('X' Channel) (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R40	270k	1	3/4	-	021-6543
R41	220k	10	1/4	-	022-3080
R42	220k	10	1/4	-	022-3080
R43	220k	10	1/4	-	022-3080
R44	220k	10	1/4	-	022-3080
R45	220k or	1	3/4	-	021-6559
	330k	1	3/4	-	021-6526
R46	110k	1	3/4	-	021-6457
R47	56k	1	3/4	-	021-6387
R48	56k	1	3/4	-	021-6387
R49	1M	1	3/4	-	021-6655
R50	220k	1	3/4	-	021-6526
R51	3M	1	3/4	-	021-6856
	2M or	1	3/4	-	021-6788
R52	1M	1	3/4	-	021-6655
R53	470k	1	3/4	-	021-6591
R54	470k	1	3/4	-	021-6591
R55	150k	2	1/4	-	021-6490
R56	68k	10	1/4	-	022-3017
R57	620k	1	3/4	-	021-6615
R58	470	10	1/4	-	022-1194
R59	56k	5	6	-	011-4678
R61	1M	1	3/4	-	021-6655
R61	1.5M	1	3/4	-	021-6776
R62	560k	1	3/4	-	021-6607
R63	270k	1	3/4	-	021-6543
R64	270k	1	3/4	-	021-6543
R65	3.9M	1	3/4	-	021-6865
R66	4.3M	1	3/4	-	021-6868
R67	3.3M	1	3/4	-	021-6859
R68	39k	5	6	-	011-3435
R69	39k	5	6	-	011-3435
R70	5.6k	5	3	-	011-3338
R71	5.6k	5	3	-	011-3338
R72	1.8M	5	3/4	-	021-6786
R73	10k	10	3/4	-	022-2131
Capacitors (Fixed and Variable)			(V)		
C1	4.7pF	10	750	-	011-8681
C2	10pF	10	500	-	011-9200
C3	22pF	10	500	-	011-9202
C4	22pF	10	500	-	011-9202

DEFLECTION AMPLIFIER 86756 ('X' Channel) (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
Capacitors (Fixed and Variable) (cont.)					
C5	6.8pF	10	750	-	011-8683
C6	1.0pF	10	750	-	011-8901
C7	2.2pF	10	750	-	011-8337
C8	4.7pF	10	750	-	011-8681
C9	4.7pF	10	750	-	011-8681
C10	4.8-92.4pF		750	-	016-0020
C11	1.0-13pF		750	S50-11/3	
C12	1.0-13pF		750	S50-11/3	
C13	1.0-13pF		750	S50-11/3	
C14	1.0-13pF		750	S50-11/3	
C15	1.0-13pF		750	S50-11/3	
C16	0.1 μF		350	-	011-7818
C17	0.1 μF		350	-	011-7818
C18	68pF		500	-	011-9205
C20	0.01 μF		350	-	011-5625
Resistors (Variable)			(W)		
RV1	500		1/2		011-9488
RV2	50k		1		027-2410
RV3	100		1		027-1305
RV4	10k		1/2		011-9492
RV5	10k		1/2		011-9492
RV6	10k		1		027-2141
Valves					
V1					CV4014
V2					CV4024
V3					CV4055
V4					CV4055
V5					CV4055
V6					CV4055
V7					CV4014
V8					CV4024
V9					CV4007
Misc. Relays					
RLA	2500 ohms 2c 2k		11.5mA		011-9249
RLB	" "		11.5mA		011-9249
RLE	" "		11.5mA		011-9249

DEFLECTION AMPLIFIER ('X' Channel) (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Plugs and Sockets					
PLA	Plug 25-way Unitor				056-2007
SKT A	Socket, Banana, Red			KS95451/21	
B	" "	Black		KS95451/20	
E	" "	Black		KS95451/20	
F	" "	White		KS95451/11	
G	" "	White		KS95451/11	
H	" "	White		KS95451/11	
P	" "	Black		KS95451/20	

DEFLECTION AMPLIFIER 86756 ('Y' Channel)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R101	470	10	1/4	-	022-1194
R102	68k	5	4.5	-	011-8254
R103	68k	5	4.5	-	011-8254
R104	33k	5	4.5	-	011-8246
R105	120k	1	3/4	-	021-6467
R106	470k	1	3/4	-	021-6591
R107	470	10	1/4	-	022-1194
R108	47k	5	6	-	011-3437
R109	39k	1	3/4	-	021-6347
R110	330k	1	3/4	-	021-6559
R111	330k	1	3/4	-	021-6559
R112	100k	10	1/4	-	022-3038
R113	270k	1	3/4	-	021-6543
R114	470	10	1/4	-	022-1194
R115	68k	1	3/4	-	021-6407
R116	470	10	1/4	-	022-1194
R117	10k	5	6	-	011-3421
R118	10k	5	6	-	011-3421
R119	470	10	1/4	-	022-1194
R120	470	10	1/4	-	022-1194
R121	68	10	1/2	-	022-1090
R122	68	10	1/2	-	022-1090
R123	470	5	6	-	011-3389
R124	270k	1	3/4	-	021-6543
R125	27k	10	1/4	-	022-2185
R126	100k	10	1/4	-	022-3038
R127	2.7k	10	1/4	-	022-2059
R128	470	5	6	-	011-3389
R129	68k	1	3/4	-	021-6407
R130	100k	5	6	-	011-4684
R131	330k	1	3/4	-	021-6559
R132	150k	1	3/4	-	021-6487
R133	150k	1	3/4	-	021-6487
R134	390k	1	3/4	-	021-6575
R135	150k	1	3/4	-	021-6487
R136	150k	1	3/4	-	021-6487
R137	68k	5	6	-	011-4680
R138	470	10	1/4	-	022-1194
R139	150k	1	3/4	-	021-6487
R140	270k	1	3/4	-	021-6543
R143	220k	10	1/4	-	022-3080
R144	220k	10	1/4	-	022-3080

DEFLECTION AMPLIFIER 86756 ('Y' Channel) (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R145	330k or	1	3/4	-	021-6559
	220k	1	3/4		021-6526
R146	110k	1	3/4	-	021-6457
R147	56k	1	3/4	-	021-6387
R148	56k	1	3/4	-	021-6387
R149	1M	1	3/4	-	021-6655
R150	220k	1	3/4	-	021-6526
R151	3M	1	3/4	-	021-6856
R151	2M	1	3/4	-	021-6788
R152	1M	1	3/4	-	021-6655
R153	470k	1	3/4	-	021-6591
R154	470k	1	3/4	-	021-6591
R155	150k	2	1/4	-	021-6490
R156	68k	10	1/4	-	022-3017
R157	620k	1	3/4	-	021-6615
R158	470	10	1/4	-	022-1194
R159	56k	5	6	-	011-4678
R161	1.5M	1	3/4	-	021-6776
R162	560k	1	3/4	-	021-6607
R163	270k	1	3/4	-	021-6543
R164	270k	1	3/4	-	021-6543
R165	3.9M	1	3/4	-	021-6865
R166	4.3M	1	3/4	-	021-6868
R167	3.3M	1	3/4	-	021-6859
R168	39k	5	6W	-	011-3435
R169	39k	5	6	-	011-3435
R170	5.6k	5	3	-	011-3335
R171	5.6k	5	3	-	011-3335
R172	1.8M	5	3/4	-	021-6786
R173	10k	10	1/4	-	022-2131
Resistors - variable					
RV101	500		1/2	-	011-9488
RV102	50k		1	-	027-2410
RV103	100		1	-	027-1305
RV104	10k		1/2	-	011-9492
RV105	50k		1	-	027-2410
RV106	10k		1	-	027-2141
Capacitors					
C101	4.7pF	0.5pF	750VW	-	011-8681
C102	10pF	10	500VW	-	011-9200
C103	22pF	10	500VW	-	011-9202

DEFLECTION AMPLIFIER 86756 ('Y' Channel) (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Capacitors (cont.)					
C104	22pF	10	500VW	-	011-9202
C105	6.8pF	0.5pF	750VW	-	011-8683
C106	1.0pF	0.5pF	750VW	-	011-8901
C107	2.2pF	0.5pF	750VW	-	011-8337
C108	4.7pF	0.5pF	750VW	-	011-8681
C109	4.7pF	0.5pF	750VW	-	011-8681
C118	68pF	10	500VW	-	011-9205
C200	0.01 μF	25	350VW	-	011-5625
Capacitors - variable					
C110	4.8-92.4pF		750VW	-	016-0006
C111	1-13pF		750VW	S50-11/3	
C112	1-13pF		750VW	S50/11/3	
C113	1-13pF		750VW	S50/11/3	
C114	1-13pF		750VW	S50/11/3	
C115	1-13pF		750VW	S50/11/3	
Valves					
V101					CV4014
V102					CV4024
V103					CV4055
V104					CV4055
V105					CV4055
V106					CV4055
V107					CV4014
V108					CV4024
V109					CV4007
Relays					
RLC	Relay 2500 ohms 2c 2k		11.5mA		011-9249
RLD	"		"		011-9249
RLF	"		"		011-9249
Misc.					
SKT C	Socket, Banana, Red			KS95451/21	
SKT D	Socket, Banana, Black			KS95451/20	
SKT J	Socket, Banana, White			KS95451/11	
SKT K	Socket, Banana, White			KS95451/11	
SKT L	Socket, Banana, White			KS95451/11	

VIDEO MIXER 86755

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors					
R1	470	10	1/4	-	022-1194
R2	820	10	1/4	-	022-1227
R3	27k	5	3/4	-	021-6053
R4	27k	5	3/4	-	021-6053
R5	27k	5	3/4	-	021-6053
R6	27k	5	3/4	-	021-6053
R7	8.2k	10	1/4	-	022-2122
R8	27k	5	3/4	-	021-6053
R9	1.8M	10	1/4	-	022-3197
R10	470	10	1/4	-	022-1194
R11	100k	5	3/4	-	021-6123
R12	1.8M	10	1/4	-	022-3197
R13	470	10	1/4	-	022-1194
R14	100k	5	3/4	-	021-6123
R15	220k	5	3/4	-	021-6723
R16	470	10	1/4	-	022-1194
R17	100k	5	3/4	-	021-6123
R18	470	10	1/4	-	022-1194
R19	100k	5	3/4	-	021-6123
R20	27k	5	3/4	-	021-6053
R21	470	10	1/4	-	022-1194
R22	100k	5	3/4	-	021-6123
R23	1.8k	5	3/4	-	021-5273
R24	470k	2	3/4	-	021-6595
R25	470	10	1/4	-	022-1194
R26	100k	5	3/4	-	021-6123
R27	1M	10	1/4	-	022-3164
R28	470	10	1/4	-	022-1194
R29	1.8k	5	3/4	-	021-5273
R30	33k	5	4.5	-	021-8246
R31	1M	2	3/4	-	021-6757
R32	120k	5	3/4	-	021-6711
R33	1M	10	1/4	-	022-3164
R34	470	10	1/4	-	022-1194
R35	1.5k	5	3/4	-	021-5263
R36	470k	2	3/4	-	021-6595
R37	22	10	1/2	-	022-1027
R38	12k	2	3/4	-	021-6233
R39	330k	5	3/4	-	021-6731
R40	470	10	1/4	-	022-1194

VIDEO MIXER 86755 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R41	820	10	1/4	-	022-1227
R42	8.2k	10	1/4	-	022-2122
R43	470	10	1/4	-	022-1194
R45	470	10	1/4	-	022-1194
R46	220k	5	3/4	-	021-6723
R47	470	10	1/4	-	022-1194
R48	68k	5	3/4	-	021-6103
R49	100k	5	3/4	-	021-6123
R50	68k	5	3/4	-	021-6103
R51	1.2M	5	3/4	-	021-6768
R52	1.8M	5	3/4	-	021-6786
R53	270k	1	3/4	-	021-6543
R54	330k	1	3/4	-	021-6559
R55	22k	5	4.5	-	011-8242
R56	220	5	1.5	-	011-3239
R57	1k	5	1.5	-	011-3255
R58	1k	10	1/4	-	022-2005
R59	220k	10	1/2	-	022-3081
R63	22k	5	3/4	-	021-6043
R64	100k	5	3/4	-	021-6123
R65	470	10	1/4	-	022-1194
R66	470	10	1/4	-	022-1194
R67	100k	5	3/4	-	021-6123
R68	12k	5	3/4	-	021-6013
R69	22k	5	3/4	-	021-6043
R70	22k	5	3/4	-	021-6043
R71	10	10	1/2	-	022-1003
R72	100k	5	3/4	-	021-6123
R73	470	10	1/4	-	022-1194
R74	470	10	1/4	-	022-1194
R75	100k	5	3/4	-	021-6123
R76	27k	5	3/4	-	021-6053
R77	22k	5	3/4	-	021-6043
R78	4.7k	5	3/4	-	021-5323
R79	22k	5	3/4	-	021-6043
R80	1M	5	3/4	-	021-6757
R81	100k	5	3/4	-	021-6123
R82	470	10	1/4	-	022-1194
R83	470	10	1/4	-	022-1194
R84	1M	10	3/4	-	022-3164
R85	22k	5	4.5	-	011-8242
R86	82k	5	3/4	-	021-6113

VIDEO MIXER 86755 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors (cont.)					
R87	47k	5	4.5	-	011-8250
R88	27k	5	3/4	-	021-6053
R89	39	10	1/2	-	022-1060
R90	47k	5	4.5	-	011-8250
R91	4.7k	5	15	-	024-2098
R92	470	10	1/4	-	022-1194
R93	47k	5	3/4	-	021-6083
R94	150k	5	3/4	-	021-6715
R95	180k	5	3/4	-	021-6719
R96	47k	5	3/4	-	021-6083
R97	39k	5	3/4	-	021-6073
R98	6.8M	5	3/4	-	021-6881
R99	6.8M	5	3/4	-	021-6881
R100	27k	5	4.5	-	011-8244
R101	27k	5	4.5	-	011-8244
R102	27k	5	4.5	-	011-8244
R103	27k	5	4.5	-	011-8244
R104	1M	10	1/4	-	022-3164
R105	150k	5	3/4	-	021-6715
R106	270k	5	3/4	-	021-6727
R107	180k	5	3/4	-	021-6719
R108	470	10	1/4	-	022-1194
R109	1.2M	2	3/4	-	021-6768
R110	82	10	1/4	-	022-1101
R111	10M	10	1/2	-	022-3291
R112	1.8M	5	3/4	-	021-6786
R113	56	10	1/4	-	022-1080
R114	56	10	1/4	-	022-1080
R115	150k	5	3/4	-	022-1080
R116	150k	5	3/4	-	022-1080
R118	56k	10	1/4	-	022-3008
R119	68k	10	1/4	-	022-3017
Variable resistors					
RV1	100k	10	1	-	027-2549
RV2	100k	10	1/2	-	011-9486
RV3	100k	10	1	-	027-2549
RV4	25k	10	1	-	027-2301
RV5	25k	10	1	-	027-2301

VIDEO MIXER 86755 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (V)	Part No.	Inter-services No.
Capacitors					
C1	0.1 μF	20	350	-	011-7818
C2	68pF	2	750	-	011-8317
C3	68pF	2	750	-	011-8317
C4	68pF	2	750	-	011-8317
C5	100pF	2	750	-	011-6321
C6	68pF	2	750	-	011-8317
C7	0.05 μF	25	400	-	011-9826
C8	68pF	2	750	-	011-8317
C9	1.0 μF	25	200	-	011-9836
C10	0.01 μF	20	350	-	011-5625
C11	0.5 μF	20	200	-	011-9833
C12	2.0 μF	20	350	-	011-2880
C13	0.1 μF	20	350	-	011-7818
C14	1500pF	10	350	-	012-4705
C15	100pF	25	750	-	011-8321
C16	68pF	2	750	-	011-8317
C17	1.0 μF	20	600	KU92886/31	
C18	470pF	20	750	-	012-3413
C19	0.1 μF	15	200	-	011-9827
C20	0.1 μF	20	500	-	011-7823
C21	0.01 μF		2000	-	932-4382
C22	0.1 μF	20	350	-	011-7818
C25	0.5 μF	25	200	-	011-9833
C26	0.5 μF	20	350	-	011-5511
C27	0.1 μF	20	350	-	011-7818
C28	47pF	20	350	-	011-8313
C29	47pF	20	350	-	011-8313
C30	47pF	20	350	-	011-8313
C31	47pF	20	350	-	011-8313
C32	1.0 μF	25	200	-	011-9836
C33	1.0 μF	25	200	-	011-9836
C34	1.0 μF	25	200	-	011-9836
C35	1.0 μF	25	200	-	011-9836
C36	47pF	2	750	-	011-8313
C37	2.0 μF	20	250	-	011-2880
C38	0.5 μF	25	200	-	011-9833
C39	1.0 μF	25	200	-	011-9836
C40	1.0 μF	25	200	-	011-9836
C41	1.0 μF	25	200	-	011-9836
C42	1.0 μF	25	200	-	011-9836

VIDEO MIXER 86755 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (V)	Part No.	Inter-services No.
C43	47pF	2	750	-	011-8313
C44	1.0 μF	25	200	-	011-9836
C45	1.0 μF	25	200	-	011-9836
C46	1.0 μF	20	250	-	011-2823
C47	0.25 μF	20	200	-	011-5509
C48	39pF	5	750	-	011-8311
C49	1.0 μF	25	200	-	011-9836
C50	0.1 μF	20	350	-	011-7818
C51	0.01 μF		2000	-	932-4382
Valves					
V1	-	-	-	-	CV4024
V2	-	-	-	-	CV4024
V3	-	-	-	-	CV4024
V4	-	-	-	-	CV4014
V5	-	-	-	-	CV4014
V6	-	-	-	-	CV4024
V7	-	-	-	-	CV4007
V8	-	-	-	-	CV4024
V9	-	-	-	-	CV2721
V10	-	-	-	-	CV4061
V11	-	-	-	-	CV4061
V12	-	-	-	-	CV4024
V13	-	-	-	-	CV4024
V14	-	-	-	-	CV4024
V15	-	-	-	-	CV4014
V16	-	-	-	-	CV4055
V17	-	-	-	-	CV4024
Diodes					
MR1	-	-	-	-	CV7053
MR2	-	-	-	-	OA211
MR3	-	-	-	-	CV7025
MR4	-	-	-	-	CV7025
Inductors					
L1	58μH	10		KA88114/7	
L2	58μH	10		KA88114/7	
L3	58μH	10		KA88114/7	
Relays					
RLA/1	6,800 ohms	-	-	-	011-9098
RLB/1	6,800 ohms	-	-	-	011-9098

VIDEO MIXER 86755 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating	Part No.	Inter-services No.
Plugs and sockets					
PLA	Plug 25-way Unitor				056-2007
PLB	Plug 25-way Unitor				056-2007
SKT C	Socket 25-way Unitor				056-2008
SKT D	Bulkhead socket			KS94417/16	
SKT E	"			"	
SKT F	"			"	
SKT G	"			"	
SKT H	"			"	
SKT M	"			"	
SKT N	"			"	
SKT P	"			"	
SKT Q	"			"	
SKT R	"			"	
SKT Y	"			"	
SKT Z	"			"	
SKT J	Banana socket white			KS95451/11	
SKT K	"			"	
SKT U	"			"	
SKT T	"			"	
SKT L	"			"	
SKT X	"			"	
SKT S	Banana socket red			"	
SKT W	Banana socket black			"	

CONTROL BOX 87988/101

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Resistors.					
R1	100k	5	3/4	-	021-6123
R2	150k	5	3/4	-	021-6715
R3	12k	5	3/4	-	021-6013
R4	560k	5	3/4	-	021-6743
R5	12k	5	3/4	-	021-6013
R6	560k	5	3/4	-	021-6743
R7	12k	5	3/4	-	021-6013
R8	560k	5	3/4	-	021-6743
R9	22k	5	4.5	-	011-8242
R10	12k	5	3/4	-	021-6013
R11	560k	5	3/4	-	021-6743
R12	22k	5	3/4	-	021-6043
R13	820k	5	3/4	-	021-6751
R14	27k	5	4.5	-	011-8244
R15	22k	5	3/4	-	021-6043
R16	820k	5	3/4	-	021-6751
R17	33k	5	3/4	-	021-6063
R18	680k	5	3/4	-	021-6747
R19	33k	5	3/4	-	021-6063
R20	560k	5	3/4	-	021-6743
R21	27k	5	3/4	-	021-6053
R22	56k	5	4.5	-	011-8252
R23	56k	5	4.5	-	011-8252
R24	56k	5	4.5	-	011-8252
R25	56k	5	4.5	-	011-8252
R26	100k	5	3/4	-	021-6123
Variable resistors					
RV1	50k	10	1	-	027-2410
RV2	100k	10	1	KS95748	
RV3	100k	10	1	KS95748	
RV4	100k	10	1	KS95748	
RV5	100k	10	1	KS95748	
RV6	100k	10	1	KS95748	
RV7	100k	10	1	KS95748	
RV8	100k	10	1	KS95748	
RV9	100k	10	1	KS95748	
RV10	100k	10	1	-	027-2549
RV11	5k	10	1	-	027-2509

CONTROL BOX 87988/101 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
RV12	5k	10	1	-	027-2509
RV13	100k	10	1	KS95748	
RV14	100k	10	1	KS95748	
RV15	100	10	1	KU95742/12	
Zener diodes					
ZR1 S.T.C. Z2A56F		10		A97044/2	
ZR2 S.T.C. Z2A56F		10		A97044/2	
ZR3 S.T.C. Z2A56F		10		A97044/2	
ZR4 S.T.C. Z2A56F		10		A97044/2	
Switches					
SA1	Wafer size 2 ceramic			B95948/31	
SB	Toggle switch, double pole				051-0554
SC	Toggle switch, double pole				051-0554
SD	Toggle switch, double pole				051-0554
SE	Toggle switch, double pole				051-0554
SF	Toggle switch, double pole				051-0554
Plugs and sockets					
C SKT B					056-2008
C PLA					056-2007
Lamps					
LP1	28V		0.04A	KS95105/1	
LP2	28V		0.04A	KS95105/1	
LP3	28V		0.04A	KS95105/1	
LP4	28V		0.04A	KS95105/1	
LP5	28V		0.04A	KS95105/1	
LP6	28V		0.04A	KS95105/1	
LP7	28V		0.04A	KS95105/1	
LP8	28V		0.04A	KS95105/1	
LP9	28V		0.04A	KS95105/1	
LP10	28V		0.04A	KS95105/1	
LP11	28V		0.04A	KS95105/1	
LP12	28V		0.04A	KS95105/1	

ISO-ECHO VIDEO STRIP 87998/100

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
R1	22	10	1/4	-	022-2172
R2	1M	10	1/4	-	022-3163
R3	100	10	1/4	-	022-1109
R4	1.8k	5	1/2	-	021-5272
R5	1M	10	1/4	-	022-3163
R6	100	10	1/4	-	022-1109
R7	1.5k	5	1	-	021-5262
R8	330k	5	1/2	-	021-6730
R9	2.2k	5	1/2	-	021-5282
R10	1M	10	1/4	-	022-3163
R11	100	10	1/4	-	022-1109
R12	330	5	1/2	-	021-6730
R13	1k	10	1/4	-	022-1004
R14	100	10	1/4	-	022-1109
R15	10k	10	1/4	-	022-2130
R16	6.8k	10	1/4	-	022-2190
R17	120k	5	1	-	021-6130
R18	22k	10	1/4	-	022-2172
R19	22k	10	1/4	-	022-2172
R20	27k	5	1/4	-	021-6051
R21	150k	5	3/4	-	021-6715
R22	120k	5	1	-	021-6130
R23	1k	10	1/4	-	022-2004
R24	56	10	1/4	-	022-1079
Capacitors			(V)		
C1	0.1 μF	20	350	-	011-7818
C2	0.1 μF	20	350	-	011-7818
C3	0.5 μF	25	200	-	011-9833
C4	15pF	10	470	C96966/57	
C5	0.01 μF	20	250	-	012-0113
Valves					
V1	-	-	-	-	CV4014
V2	-	-	-	-	CV4014
V3	-	-	-	-	CV4024
VT1 Transistor (Texas) 25005				KS96194/5	
RLA Relay SM5C-N to RLC165 6,800 ohms					011-9098

ISO-ECHO VIDEO STRIP 87998/100 (cont.)

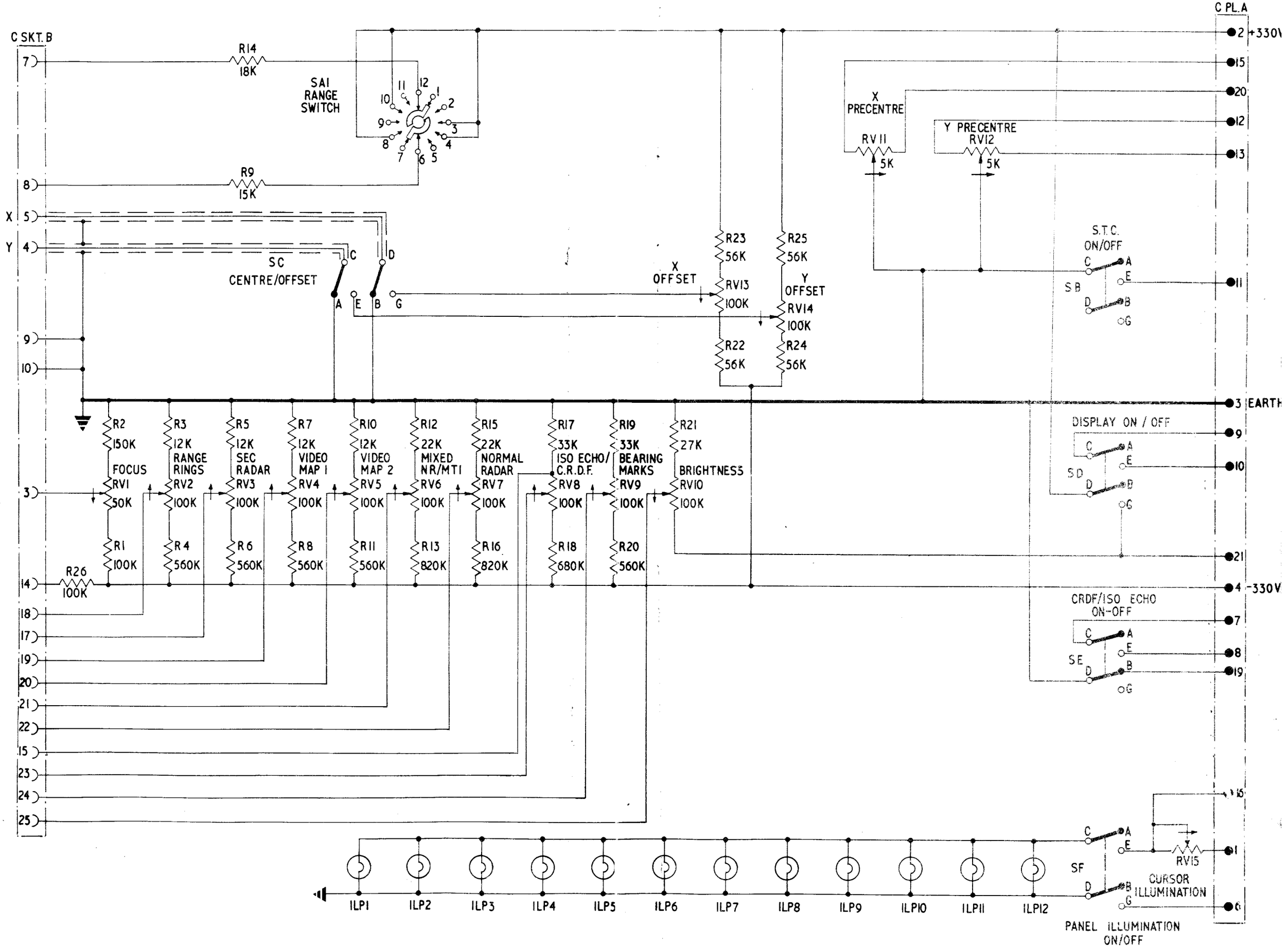
Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
Chokes					
L1	24 μH			KA88112/4	
L2	27 μH			KA88112/10	
MR1 Diode					CV448
PLE 12-way Unitor plug					056-2508
PLG Panel mtg. co-axial					054-0151
SKT-F Panel mtg. co-axial					054-0154

NORMAL RADAR IF AMPLIFIER EA1080

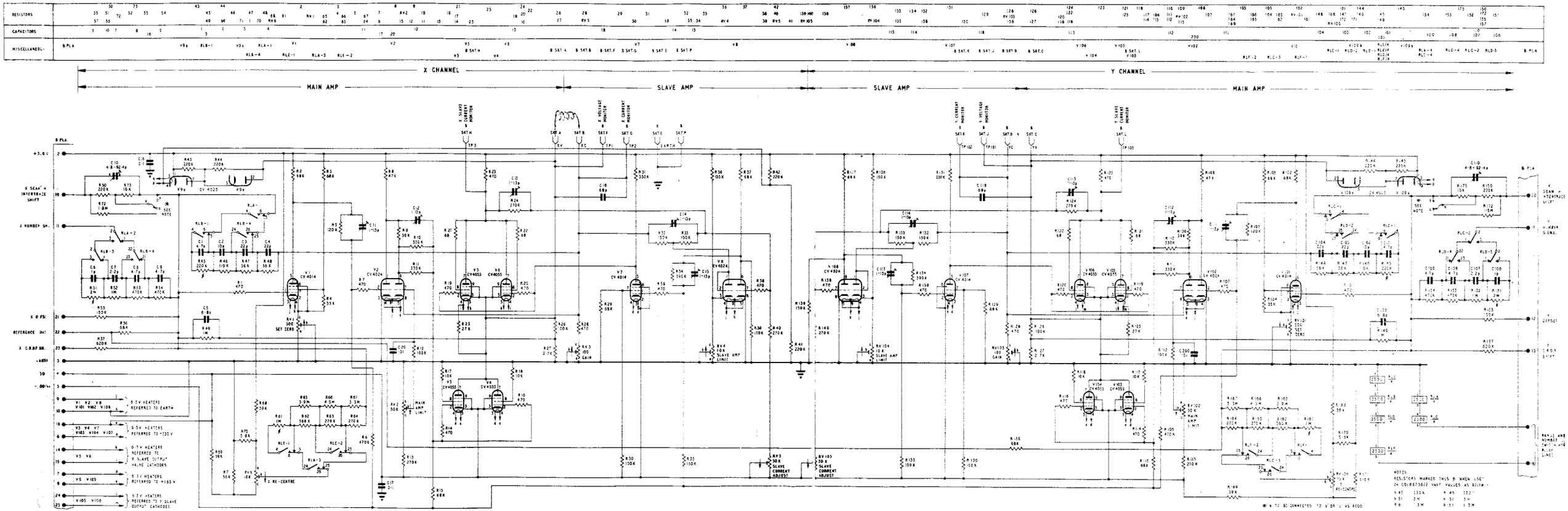
Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
R1	3.9k	10	1/4	G5000-125/26	O222-079
R2	4.7k	10	1/4	G5000-124/107	O222-089
R3	47	10	1/4	G5000-124/23	O221-068
R4	100	10	1/4	G5000-125/7	O221-109
R5	4.7k	10	1/4	G5000-124/107	O222-089
R6	47	10	1/4	G5000-124/23	O221-068
R7	100	10	1/4	G5000-125/7	O221-109
R8	4.7k	10	1/4	G5000-124/107	O222-089
R9	47	10	1/4	G5000-124/23	O221-068
R10	100	10	1/4	G5000-125/7	O221-109
R11	8.2k	10	1/4	G5000-124/118	O222-122
R12	180	10	1/4	G5000-124/47	O221-143
R13	100	10	1/4	G5000-125/7	O221-109
R14	3.3k	10	1/4	G5000-125/25	O222-067
R15	2.7k	10	1/4	G5000-125/24	O222-058
R16	8.2k	10	1/4	G5000-125/30	O222-121
R17	8.2k	10	1/4	G5000-125/30	O222-121
R19	100	10	1/4	G5000-125/7	O221-109
R20	470k	10	1/4	G5000-125/51	O223-121
R21	20k	5	4.5	G5000-106/80	O244-125
R22	100	10	1/4	G5000-125/7	O221-109
R23	10k	10	1/2	G5000-123/121	O222-132
R24	470	10	1/4	G5000-125/15	O221-193
C1	2200pF			KT92376/4	1 ONC/KT92376/4
C2C3, C4	3 x 1000pF			KT92377/6	1 ONC/KT92377/6
C5, C6, C7	3 x 1000pF			KT92377/6	1 ONC/KT92377/6
C8	1000pF			KT92376/2	1 OC/18868
C9, C10	2 x 1500pF			KT92377/3	1 ONC/KT92377/3
C11, C12					
C13	3 x 1000pF			KT92377/6	1 ONC/KT92377/6
C14	22pF	10		G5011-101/20	O132-277
C15	100pF	10		G5011-101/44	O132-271
C16	0.1 μF		150V	KT92195/2	O111-160
C17, C18	2 x 1000pF			KT92377/2	1 OC/18879
C19, C20	2 x 1500pF			KT92377/3	1 ONC/KT92377/3
C21, C22	2 x 1500pF			KT92377/3	1 ONC/KT92377/3
C23	1000pF			KT92376/2	1 OC/18868
L1				KA88111/1	1 OC/19687
L2	8μH			KA88112/2	1 OC/19669

NORMAL RADAR IF AMPLIFIER EA1080 (cont.)

Cct. Ref.	Value	Tolerance (%)	Rating (W)	Part No.	Inter-services No.
L3	8 μH			KA88112/2	1 OC/19669
L4	1.5 μH			KA88112/1	1 OC/18497
L5	1.5 μH			KA88112/1	1 OC18497
L6	1.5 μH			KA88112/1	1 OC18497
L7	1.5 μH			KA88112/1	1 OC/18497
L8	8 μH			KA88112/2	1 OC/19669
L9	1.5 μH			KA88112/1	1 OC/18497
TR1				KA88111/4	1 OK/17961
TR2				KA88111/4	1 OK/17961
TR3				KA88111/4	1 OK/17961
TR4				KA88111/40	1 OK/17977
V1					CV138
V2					CV138
V3					CV138
V4					CV138
V5					CV858
SKT1				KT92411	054-0154
PL1				KT92410	054-0151
PL2				KS92362	056-2503
RLA				KU92652/2	011-9882
Valveholder B7G (V1-V5)				KS93703/5	056-0094
X1					CV448
X2					CV448
X3					CV448



CONTROL PANEL 87988/101



CD 86756/1 & 2 DEFLECTION AMPLIFIER.

UNSTAB MAINS IN

MAINTENANCE SOCKETS

D PL. B (A C B)

D SKT. A A (N E L)

D SKT. A B (N E L)

ANTI CONDENSATION HEATERS

HR2

HR1

MICRO SWITCHES

SB 1 2 1 2 SA

RLA

RLA

RLA RLA

BLOWER MOTOR

REFERENCE SHIFT

'Y' I/T WAVEFORM

'X' I/T WAVEFORM

'Y' C.R.D.F. SHIFT

'X' C.R.D.F. SHIFT

'Y' SCAN & I/T SHIFT

'X' SCAN & I/T SHIFT

D SKT. U 22

D SKT. T 17

D SKT. S 11

D SKT. K 13

D SKT. J 23

D SKT. B 20

D SKT. A 19

B PL.F

T2

240V

230V

6·35V 4·4A

6·35V 4A

6·35V 1·5A

6·35V 3·5A

6·35V 1·5A

28V 1A

6·35V 0·6A

6·35V 0·6A

47µ

3·9M

3·3K

330M

330K

10M.

EHT O/P

D PL.A 25 WAY UNITOR

12

+28V

RLA 4

D SKT. X

D SKT. W

D SKT. V

D SKT. L

D SKT. D

D SKT. C

SPARES

BACK PANEL

DEFLECTION AMPLIFIER

B PL.C

B PL.D

B PL.E

B PL.B

B PL.A

RANGE RINGS

SEC. RADAR SIGS.

VIDEO MAP 2 SIGS.

VIDEO MAP 1 SIGS.

NR SIGS.

MAIN SCAN BRIGHT

M.T.I./NR SIGS.

NTH. & BEARING MARKS

INTERTRACE BRIGHT

RR & BM BRIGHT

C.R.D.F. BRIGHT

D SKT. Z A PL.Z

D SKT. Y A PL.Y

D SKT. R A PL.R

D SKT. Q A PL.Q

D SKT. P A PL.P

D SKT. N A PL.N

D SKT. M A PL.M

D SKT. H A PL.H

D SKT. G A PL.G

D SKT. F A PL.F

D SKT. E A PL.E

82 R11

82 R10

82 R9

82 R8

82 R7

82 R6

82 R5

82 R4

82 R3

82 R2

82 R1

E2

E1

A PL.W

BRAID

VIDEO MIXER

A PL.K

A PL.L

A PL.J

A PL.U

A PL.S

A PL.D

A PL.T

A PL.C

A SKT.B

A SKT.A

25 WAY UNITORS

1

12

11 2 10 A B C A B C D E

L3

L2

L1

FOCUS PRECENTRE DEFLECTION

C.R.T. CV429 V1

E3

BRAID

F SKT.A

a

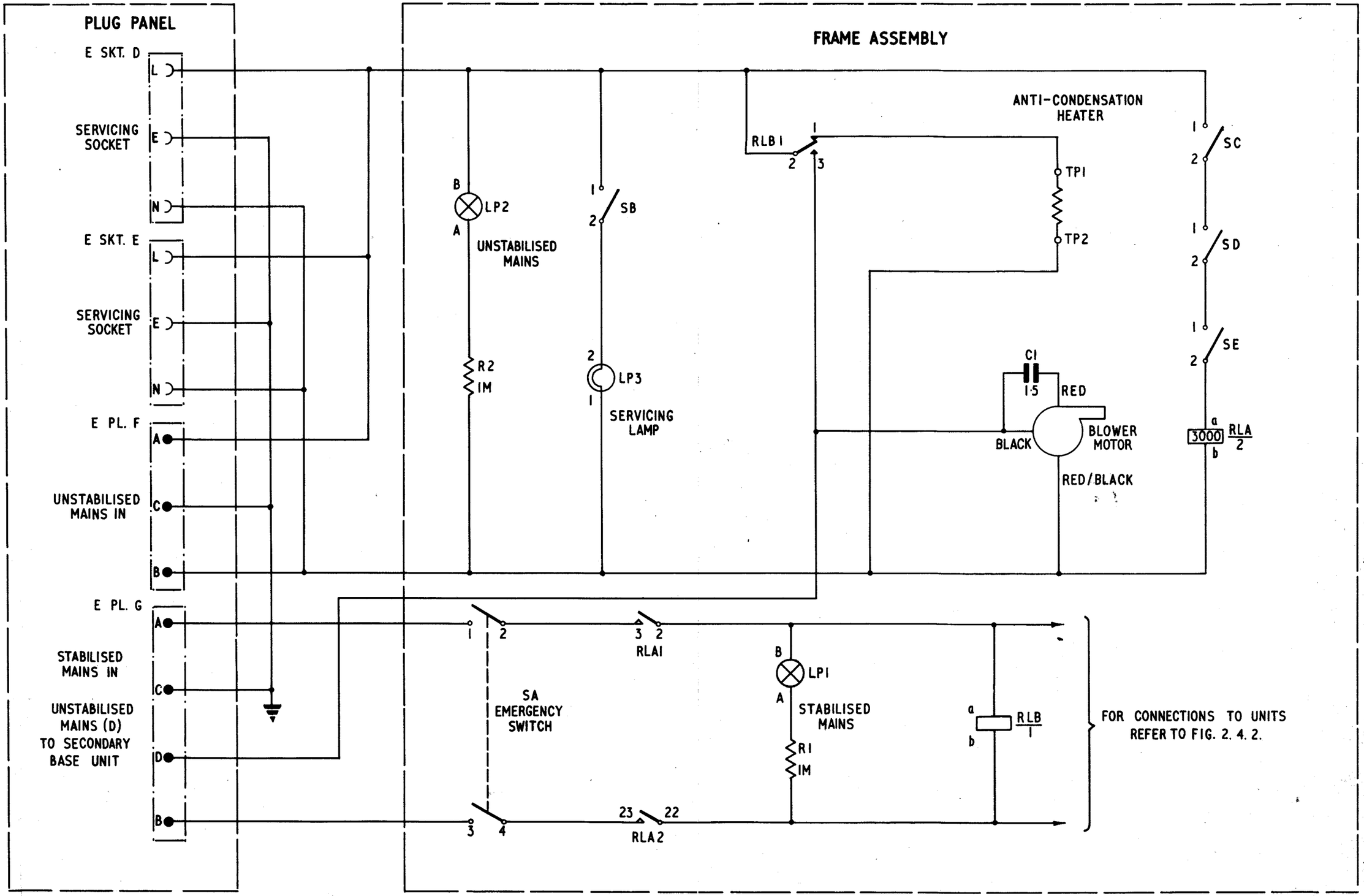
b

TO REFLECTION PLOTTER

C1

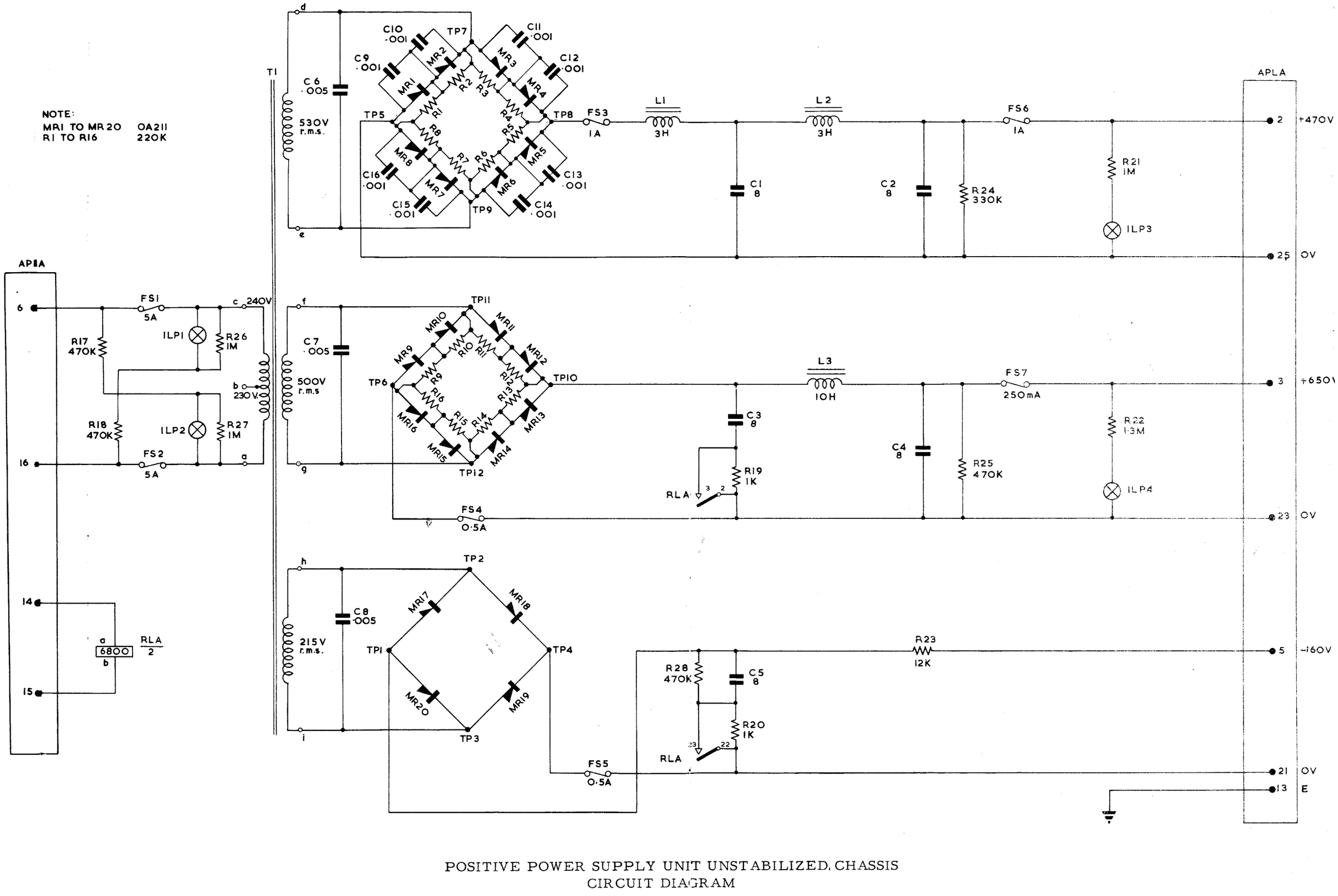
1000pf

VIEWING UNIT WIRING DIAGRAM



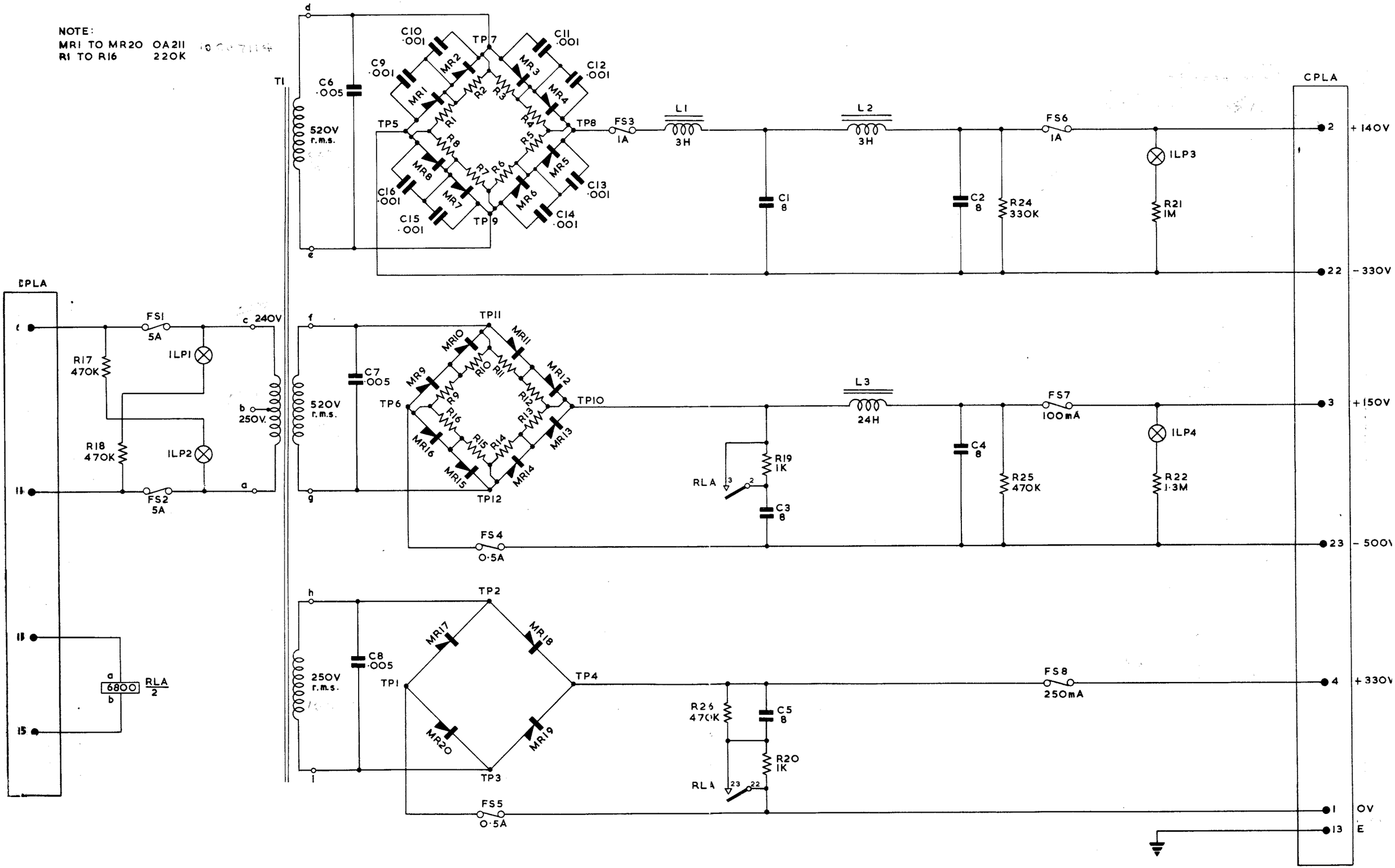
BASE UNIT WIRING DIAGRAM

NOTE:
MR1 TO MR20 OA211
R1 TO R16 220K



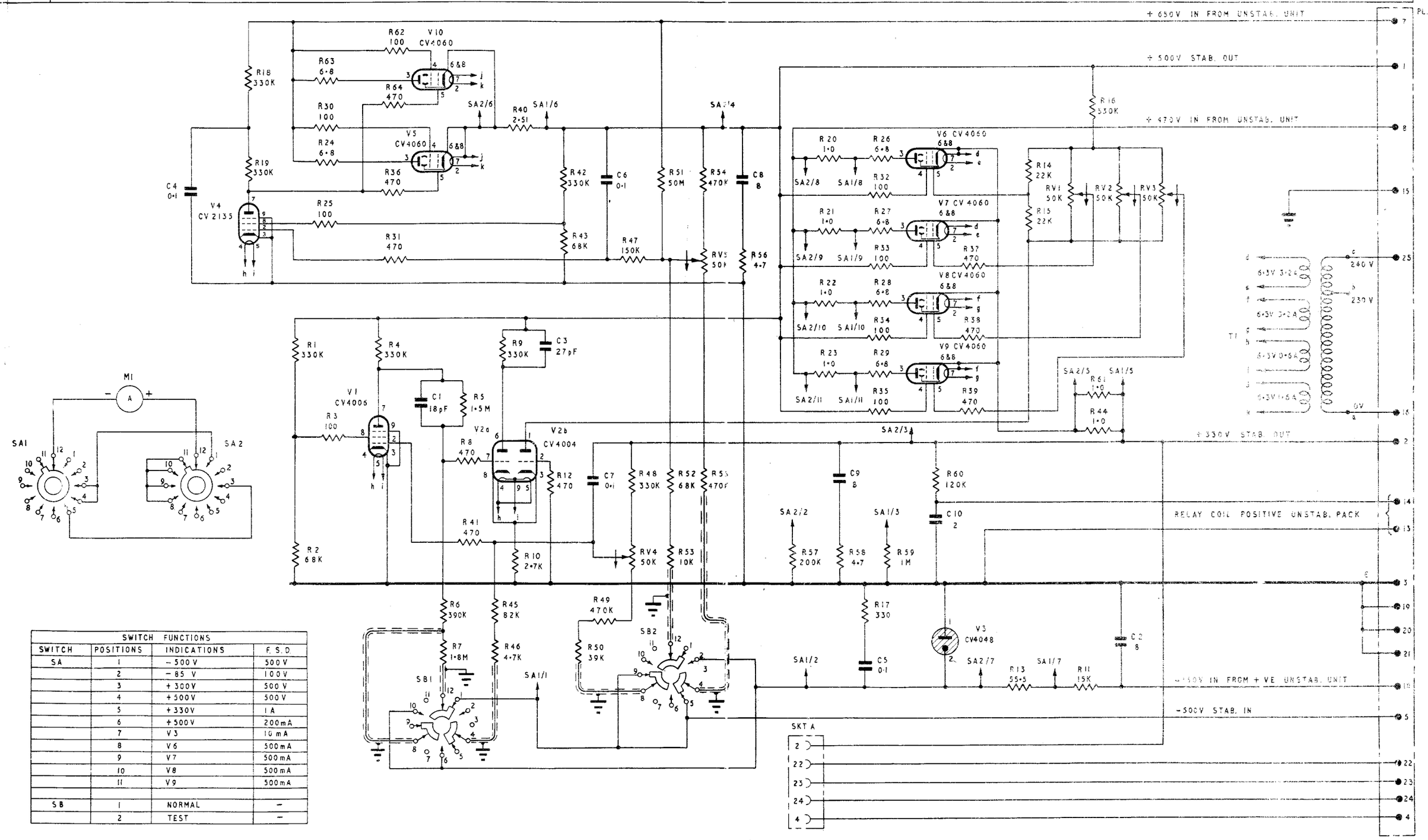
POSITIVE POWER SUPPLY UNIT UNSTABILIZED, CHASSIS
CIRCUIT DIAGRAM

NOTE:
MR1 TO MR20 OA211
R1 TO R16 220K



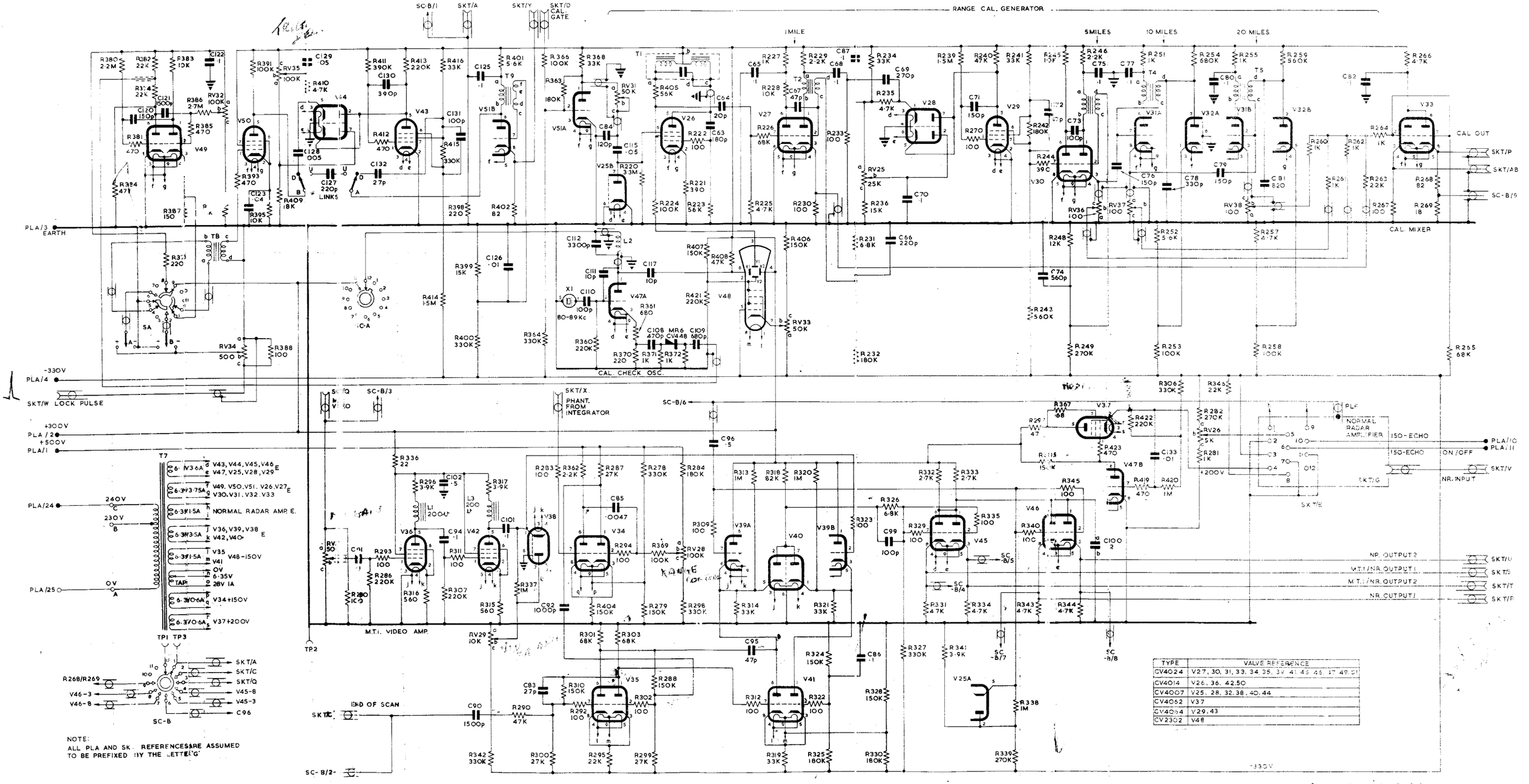
NEGATIVE POWER SUPPLY UNIT UNSTABILIZED CHASSIS
CIRCUIT DIAGRAM

RESISTORS	18 19 1 2 63 30 3 4 24 25 62 64 36 31 5 6 8 7 9 45 41 46 10 42 43 50 47 48 49 RV4 51 52 53 54 RV5 55 56 57 20-23 58 26-29 32-35 17 59 60 37-39 13 14 15 RV1 16 51 64 RV2 RV3
CAPACITORS	4 1 3 6 7 8 9 5 10 2
MISCELLANEOUS	SA1 MI V4 VI V10 V5 SB1 V2 SB2 SKT A V6-9 V3 T1 PLA



SWITCH FUNCTIONS			
SWITCH	POSITIONS	INDICATIONS	F. S. D.
SA	1	– 500 V	500 V
	2	– 85 V	100 V
	3	+ 300 V	500 V
	4	+ 500 V	500 V
	5	+ 330 V	1 A
	6	+ 500 V	200 mA
	7	V3	10 mA
	8	V6	500 mA
	9	V7	500 mA
	10	V8	500 mA
	11	V9	500 mA
SB	1	NORMAL	–
	2	TEST	–

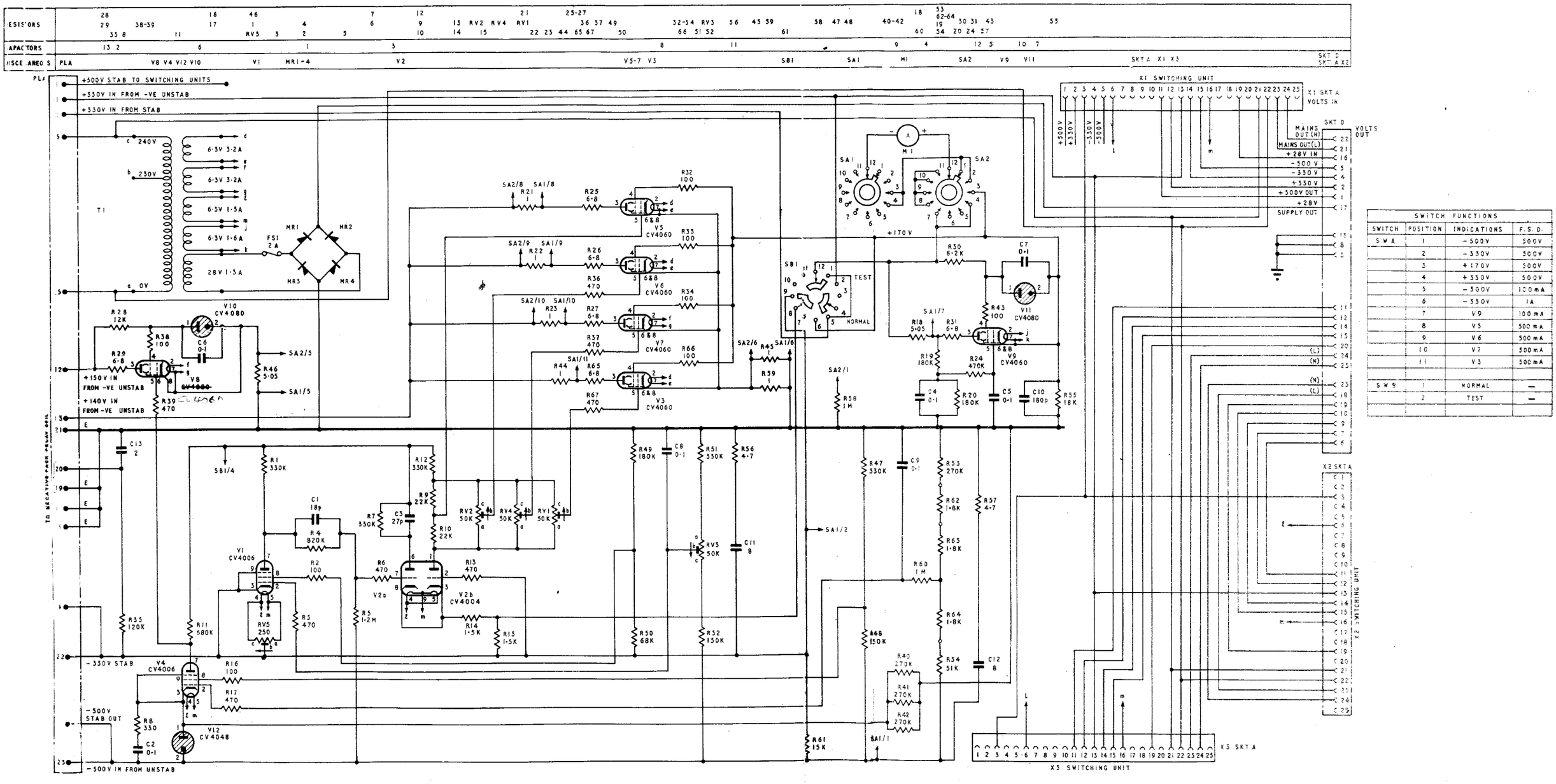
CD.87997 **POSITIVE STABILISED POWER UNIT**



TYPE	VALVE REFERENCE
CV4024	V27, 30, 31, 33, 34, 35, 39, 41, 45, 46, 47, 49, 51
CV4014	V26, 36, 42, 50
CV4007	V25, 28, 32, 38, 40, 44
CV4062	V37
CV4064	V29, 43
CV2302	V48

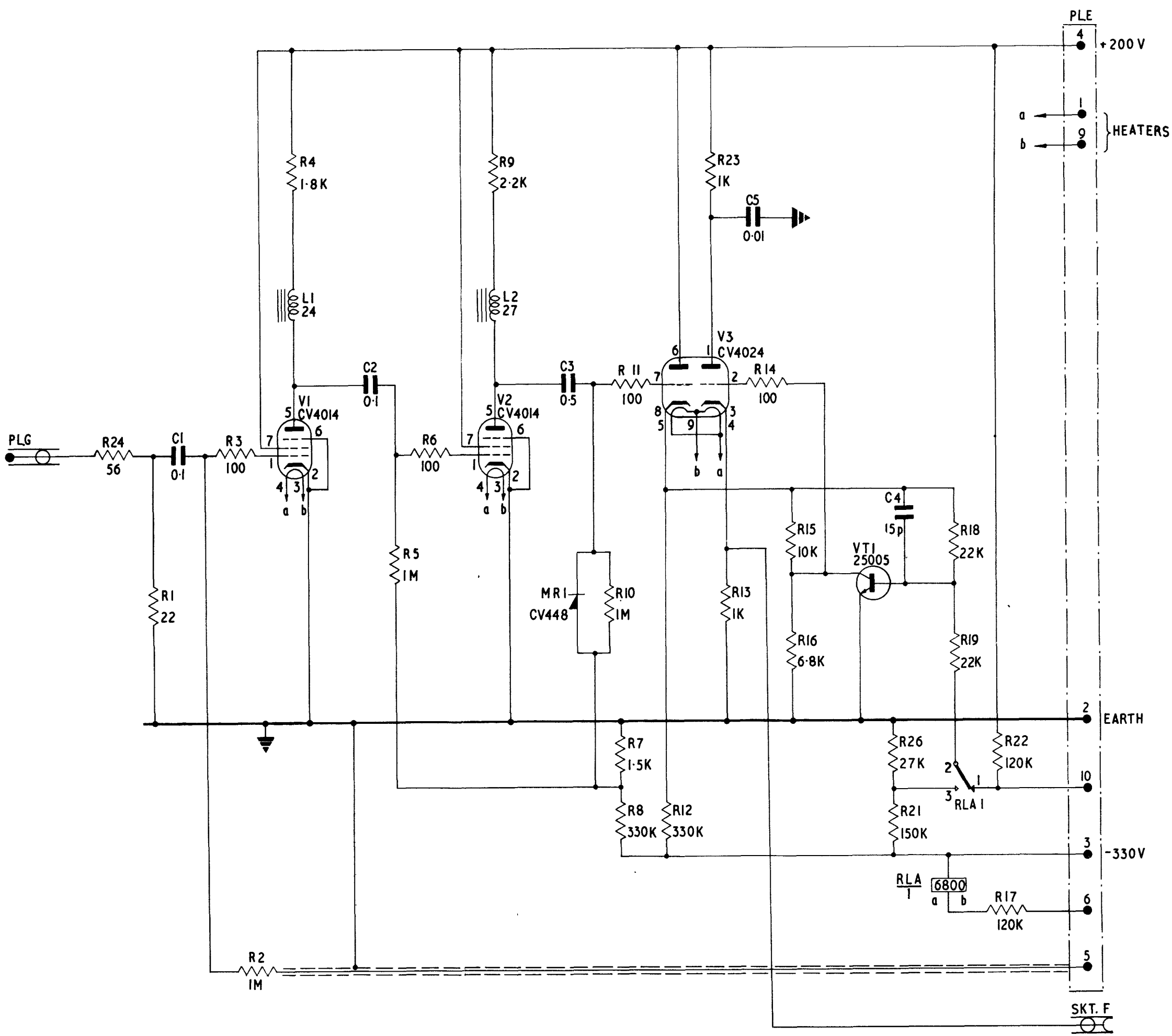
NOTE:
ALL PLA AND SK. REFERENCES ARE ASSUMED TO BE PREFIXED BY THE LETTER 'G'

WAVEFORM GENERATOR (VIDEO)
CIRCUIT DIAGRAM



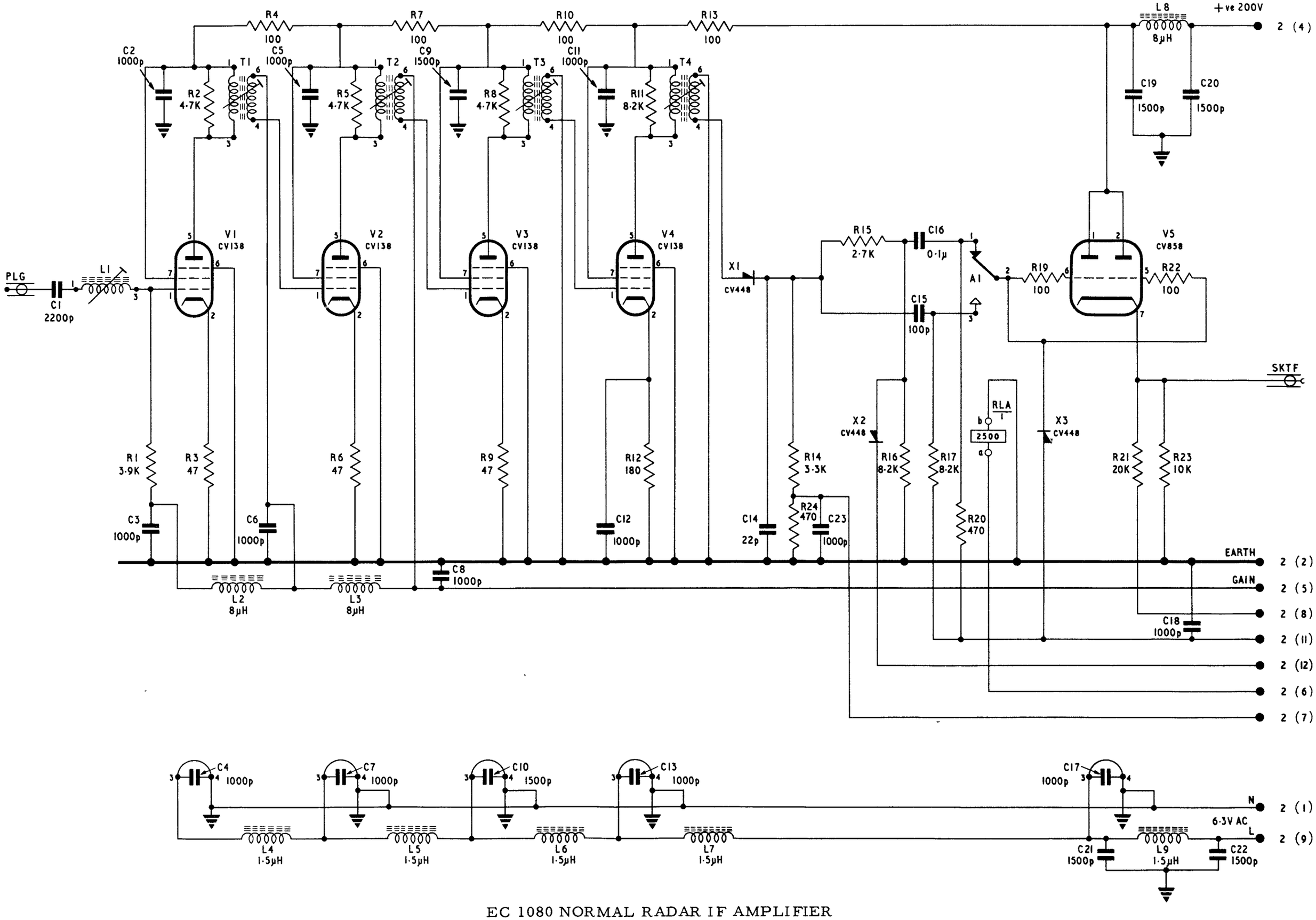
SWITCH FUNCTIONS			
SWITCH	POSITION	INDICATIONS	F.S.D.
SWA	1	-500V	500V
	2	-330V	500V
	3	+170V	500V
	4	+330V	500V
	5	-500V	100mA
	6	-330V	1A
	7	V9	100mA
	8	V5	500mA
	9	V6	500mA
	10	V7	500mA
	11	V3	500mA
SW9	1	NORMAL	—
	2	TEST	—

CD 87997 NEGATIVE STABILISED POWER UNIT

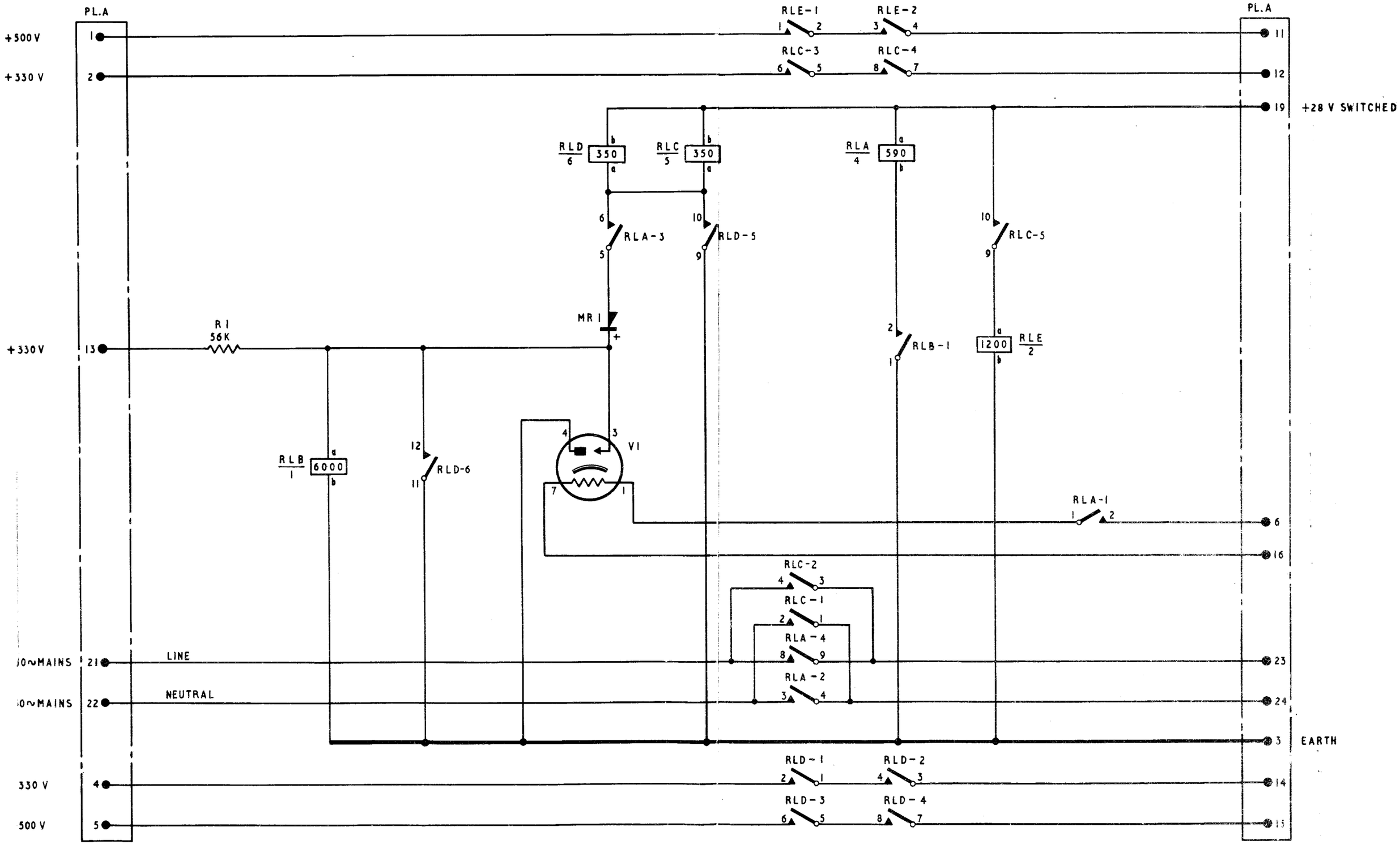


ISO-ECHO VIDEO UNIT 87998/100

30Mc/s 30Mc/s 30Mc/s 30Mc/s 30Mc/s



EC 1080 NORMAL RADAR IF AMPLIFIER



CD 87999 SWITCHING UNIT

SKTH SB/5 SKTAA Y OUTPUT

PLA/12 SC POT GROUND

SKTE SB/7 SKTF X OUTPUT

+3 PLA/2

R75 390K

R62 47K R71 68K

V8 CV4014 R63 470

R88 680K

V9 CV4007

C22 3·3p

C23 680p

V11 CV4024 R93 470 R99 470

R96 470K R97 470K

C24 10p R95 120K R10 2·5K

V13 CV4055 R103 470 R107 100

R111 39K

RV8 100 R69 180K

RV6 100K R72 33K R82 1K

PLA/3 EA

SB/4 TP2

COS Y INPUT PLA/16

R207 220K

R85 R86 R87

R80 R81

SC/2

PLA/17

V10 CV4007

C21 2·8-5p

R89 680K

R58 1·8M R90 330K

V12 CV4024 R92 470 R100 470

R101 270K

R94 82K R98 6·8K C26 ·04

R104 560K R106 470 V14 CV4055 R109 18K

R105 56K C27 ·04 R108 1·5K R110 47K

C25 ·04 R91 220K R79 6·8K

+30 PLA/4

−50 PLA/5

+50 PLA/1

R122 47K R131 68K

R135 390K

V15 CV4014 R143 470

R172 33K

RV18 100 R129 180K

RV16 100K R173 10K R132 33K R142 1K

R148 680K

V16 CV4007

C32 3·3p

C33 680p

V18 CV4024 R153 470 R159 470

R156 470K

C34 10p R155 120K RV20 2·5K

V20 CV4055 R163 470 R167 100

R171 39K

SB/6

R208 220K

R145 R147

R140

R141

SC/1

SINE X INPUT

PLA22 PLA21

V17 CV4007

C31 2·8-5p

R149 680K

R59 1·8M R150 330K

V19 CV4024 R152 470 R160 470

R151 270K

R154 82K R158 6·8K C29 ·04

R162 27K

C28 ·04 R151 220K R78 6·8K

V21 CV4055 R164 560K R169 18K

R166 470 R165 56K C30 ·04 R168 1·5K R170 47K

X NEG. GATE

Y POS. GATE

10° AND N.M. TRIGGER

PLA/13 PLA/18 PLA/14 PLA/19 PLA/9 SB/9

SB/10 N.M. OUT SKTK N.M. RELAY OUT PLA/11

RANGE GATE OUT SKTX

SB/1 TO-ve IN SKTA

CAL. GATE OUT PLD

SKTC

END OF SCAN -ve OUT SB/2 SKTZ

END OF SCAN +ve OUT

VIDEO MAP GATE SKTN

S3/3

Y NEG. GATE

Y POS. GATE

SB/8 SKT B SKTL

MAIN SCAN BRIGHTENERS OUT

R54 150K

R4 150K

R10 22K

RV1 100K

CV7025 MR2

R1 47K

R50 120K

R52 470

C1 330P

R51 470

C35 56p

C3 3000p R7 2·2K R8 120K

V2 CV4007

C2 220P

R53 470

R40 10

C14 1·0

R14 10K R16 1·5K

V3 CV4024

R13 470 R19 470

C5 82p

C6 ·1

R24 56K R32 56K

R9 56K

R12 10K R56 82

R22 1K R25 33K

R23 22K R29 100K

R60 470

V4 CV4055

R26 100

R17 18K R20 270K

R15 47K

R18 330K R21 1M

R27 10K

R28 180K

C10 ·5 C12 ·5

R33 22K R38 22K

C13 0·5

R31 82 R36 82

R30 470 R37 470

V5 CV4055 V6 CV4055

R35 270K R34 22K R112 150K R39 22K

C15 1·0

R55 270K R41 10

R113 180K

C8 2·8-5p C11 2·8-5p

MR3 CV2413 NE.

C40 ·001

R180 4·7M

C41 470p

R184 47K R186 100K

V22 CV4014

R179 470

R187 1M

R181 2·2M R185 150K

C43 ·05

R202 47K

C47 ·005

V23 CV4007

R182 18K

R177 10K R178 56K

R188 1·2M C42 ·1

R189 1M R190 8·2M

R192 1M C44 ·001

C39 ·05

C45 ·01

R193 1·5M R195 470

V24 CV4024

R199 15K R200 22K R203 3·9M

C46 2200p

R201 470

R205 8·2K R206 15K

R198 100 R204 100

RLA1

R196 15K R194 1M

R197 330K

R183 680K

R191 15K

6800 RLA

MONITOR WAVEFORM TP1 TP2 TP3 SCOPE TRIGGER

SKT 10 PLA 18 SKT B SKT F

SKTA SKTC V4/9 SC/F SKTAA SC/E

S.B.

PLA/24 240V LIVE

230V

PLA/25 0V NEUTRAL

d −150V

6·35V 3·6A V5,V6

e f E V1,V2,V3,V8,V9

6·35V 3·75A V10,V22,V23,V24.

g h

6·35V 1·5A CF V20

i j

6·35V 3·5A 5-330V, V4,V7,V12,V14,V19,V21.

k l

6·35V 1·5A CF V13

m n

6·35V 1·A E V15, V16, V17.

tap o p

6·35V ·6A CF VII

q r

6·35V ·6A CF V18

s

NOTE:
ALL PLA AND SKT REFERENCES ARE ASSUMED TO BE PREFIXED BY THE LETTER 'F.

Mod 7248. MR fitted in N.M. ckt &.

Mod 7744 2 capacitors changed
C47 & C43
1 cap. added C39.

WAVEFORM GENERATOR (INTEGRATOR) CD87989