MODEL bwd 521

5" DUAL BEAM OSCILLOSCOPE

INSTRUCTION MANUAL

BWD ELECTRONICS PTY. LTD.

MELBOURNE AUSTRALIA

INSTRUMENT HANDBOOK

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Applicable to Serial No. .....

MODEL bwd 521

5" DUAL BEAM OSCILLOSCOPE

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MODEL bwd 521

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INSTRUMENT HANDBOOK

MODEL bwd 521 & 521R OSCILLOSCOPES

1. GENERAL

Model bwd 521/521R is a true double beam, precision oscilloscope possessing by virtue of its range of plug-in Amplifiers and Time Bases a wide measuring range of both voltage and time.

1.1 The instrument is 100% Silicon Solid State design employing no valves or neons other than the double gun CRT and panel indicators. It incorporates three identical plug-in compartments for the series '5' interchangeable plug-ins providing facilities for single trace, dual trace, with similar or dissimilar amplitiers, delayed sweep, identical X-Y operation or raster type displays. As no partition exists between the plug-in compartments special twin or triple units can be supplied for specific applications.

1.2 The main frame consists ot the 5" double gun CRT, all low voltage power supplies, EHT supplies, two <30MHz vertical amplifiers, <15MHz horizontal amplifier, calibrator and plug-in cage, etc. All DC supplies are electronically regulated to accommodate input voltage and lead variations.

1.3 An additional feature of this model is in the complete DC isolation of all circuits permitting the input COMMON terminal to be connected to DC voltage rails up to ± 400V from ground, making isolated measurements as simple as clipping a meter across the circuit.

1.4 Where signals require measuring between two points, both of which are varying with respect to a reference or ground rail, Differential Amplifiers Models 5A or 5C can be employed in which either input can be separately AC or DC coupled to further increase their measuring flexibility.

1.5 All inputs are protected against overload. However, care must always be exercised to not exceed the specified voltage limits of each input and, in particular, do not attempt to connect the COMMON of each plug-in to different voltages or damage may result to the power supplies or printed circuit ground line tracks.

1.6 It has been designed for reliable long-term use and has been subjected to environmental tests. Each instrument is heat soaked and vibrated as part of its alignment procedure.

1.7 For maximum reliability it is advisable to replace the power supply protection fuses every 2000 hours of operation to guard against thermal stress failure. Additionally, if the instrument is to be left non-operating for long periods and is stored in a dusty atmosphere, it is wise to drop a plastic protection cover over it to minimise dust ingress into switch wafers, etc. A storage cover and a carrying case are available from B.W.D. Electronics Pty. Ltd., together with a full range of accessories (see catalogue).

2. PERFORMANCE

2.1 MAIN FRAME SPECIFICATION

CRT: 5" diam. Flat faced, PDA dual gun GEC type 1300M series.

EHT: 4kV stabilised, deflection 8 x 10 cm overall. 6 x 10cm each beam with 4 cm min. overlap.

Phosphors: P2 normally supplied as standard. P31 and P7 available as options.

Graticule: 8 x 10cm with 2mm subdivisions, variable intensity edge illuminated. Fitted with filter to suit CRT phosphor.

2.2 VERTICAL AMPLIFIERS (Identical for both beams)

Bandwidth: DC to <30MHz -3db. Input DC level approx. +16V above common.

Sensitivity: 400mV cm approx.

Rise Time: 10 nano Seconds referred to 6cm deflection.

2.3 HORIZONTAL AMPLIFIER (Deflects both beams simultaneously)

Bandwidth: DC to <1.5MHz -3db. Input DC level approx. +16V above common.

Sensitivity: 300mV cm approx.

2.4 CALIBRATOR OUTPUT

5V and 50mV p-p square wave at line frequency. Amplitude accuracy: 5V 2%, 50mV 3%.

2.5 Z MODULATION

AC coupled to upper gun only. Input coupling 0.01μF and 560KΩ approx. to CRT grid. 20V p-p will blank trace at normal intensity.

2.6 HORIZONTAL AMPLIFIER EXT. TRIGGER OR LINE INPUT

Input Impedance: 1MΩ and 30pF approx. AC or DC coupled.

Sensitivity: X1 and X10 gain selection. Actual sensitivity depends on plug-in unit. See 5S/1 and 5T/1 for specification.

Line: Feeds line frequency to Trigger circuit or produces horizontal display when plug-in switched to EXT TB.

Trigger Selector: Selects upper or lower beam amplifier as trigger source.

2.7 POWER

90 - 135V and 185V to 265V in 6 internally adjustable transformer tappings.

3. ENVIRONMENTAL

Specifications detailed with tolerances are maximum limits which will be met between the limits of 0 to 40°C and 0 to 80% RH. For operation 0 to 50°C and 0 to 95% RH increase tolerance by 2%. Where no tolerance is listed specification represents an average figure obtained from production instruments.

3.1 DIMENSIONS

$10\frac{1}{2}$" (27cm) wide x $12\frac{1}{4}$" (37cm) high x 17" (43cm) deep dimensions overall knobs, feet, handle, etc. Weight 34 lbs. (15 kg) complete with three plug-in units.

3.2 FINISH

Dark blue grey vinyl coated aluminium covers, light grey panels surrounded by natural anodised aluminium trim.

3.3 ACCESSORIES

Power cord, handbook and grounding link.

3.4 OPTIONAL ACCESSORIES

See catalogue and price list for details.

4. This Oscilloscope operates only with series 5 plug-in units fitted. A brief summary of plug-ins is listed below. Full specifications are detailed in each plug-in handbook section.

4.1 5A WIDE BAND DIFFERENTIAL AMPLIFIER

Bandwidth:	DC to 20MHz -3db from 10mV to 5V/cm. DC to 10MHz 10V to 50V/cm. DC to 4MHz - 3db from 1mV to 5V/cm.
Rise Time:	17 nano Seconds and 80 nano Seconds.
Input:	Balanced differential. Isolated ground, individual AC-DC-OFF switches to each input. 1MΩ and 35pF each side.

4.2 5B WIDE BAND GENERAL PURPOSE AMPLIFIER

Bandwidth:	DC to 30MHz -3db from 50mV to 50V/cm. DC to 10MHz -3db from 5mV to 5V/cm.
Rise Time:	12 nano Seconds and 35 nano Seconds.
Input:	Single ended 1MΩ and 35pF. Isolated ground.

4.3 5C HIGH SENSITIVITY DIFFERENTIAL AMPLIFIER

Bandwidth:	DC to 500kHz -3db from 100μV to 20V/cm.
Rise Time:	1.2μSec.
Input:	Differential, isolated ground, individual AC-DC-OFF switches to each input 1MΩ and 30pF each side.

4.4 5D WIDE BAND HIGH SENSITIVITY AMPLIFIER

Bandwidth:	DC to 30MHz, 5mV to 20V/cm.
Rise Time:	12 nano seconds.
Input:	Single ended, 1MΩ and 30pF input grounded, cannot be used in isolated ground applications.

4.5 5S/1 WIDE RANGE DELAYED TIME BASE

T.B. Range: 40 nano Seconds to 10 Sec/cm.

Delay Range: 1μSec to 1 Sec.

Modes: Normal, delayed, single shot, free running.

Trigger Range: DC to 30MHz.

4.6 5T/1 WIDE RANGE TIME BASE

Range: 40 nano Seconds to 10 Sec/cm.

Selection: Auto, Select and Mechanical Trigger.

Trigger Range: DC to 30MHz.

4.7 5Z BLANK UNIT

Blank Plug-in fitted with shift control enabling the oscilloscope to operate as a single beam oscilloscope or for custom building special equipments.

5. FUNCTION OF CONTROLS

Description with 5A fitted to LH and centre compartments and 5T/1 to RH compartment. As other plug-ins have controls fitted in similar position, descriptions are applicable to all units.

5.1 CONTROLS MAIN FRAME LH SIDE

Intensity: (Upper Beam) controls intensity from zero to max. brightness. Always adjust control for minimum trace brightness necessary for good viewing as this also produces the sharpest focus and reduces possibility of screen burn.

Focus/Astig: Adjusts the sharpness of the upper gun beam. Controls should initially be set in conjunction with each other to obtain sharpest display over entire deflection area. Once set Astigmatism control will require only infrequent adjustment.

Intensity: (Lower Beam) as detailed above for upper beam.

Focus/Astig: As detailed above for upper beam.

5.2 MAIN FRAME RH SIDE ABOVE PLUG-IN COMPARTMENT (Rack Mount)

Graticule/Off: Fully anti-clock turns the power off. When switched on and rotated clockwise it controls the graticule illumination.

Horizontal Input Select Switch: Top position (X10) connects the input straight through to amplifier or trigger circuit. Centre position (X1) attenuates the input by a factor of ten. LINE position feeds in line frequency to produce either a horizontal trace or as a line frequency trigger signal.

T.B. Trigger Select Switch: Selects either the upper or lower beam signal as the internal trigger source.

Main Frame Terminals and Sockets for Horizontal Input or EXT Trigger.
AC-DC sockets : Permits either AC or DC coupling to be employed for horizontal Amplifier or Ext. Trigger. Input is 1MΩ shunted by 30pf approx. AC coupling is -3db at 1.6Hz.

BNC Input Socket (Rack Mount Only) : Input socket for Horizontal amplifier or External trigger.

AC-DC Switch : Selects either AC (-3db at 1.6Hz) or DC coupling for Horizontal input signal or External trigger signal.

50mV and 5V CAL OUT Sockets : Line frequency square wave, (mark space ratio approx. 45-55). Rise and fall time less than 25uSec suitable for probe alignment and amplifier calibration.

COMMON terminal (black) connected to oscilloscope common line which is DC isolated from chassis or mains earth. A 1MΩ resistor prevents common line from floating from ground potential and a 0.1uF capacitor grounds it for AC purposes.
With 3 plug-in units fitted total capacity to ground of the Common Line is approx. 1.6uF. Common may be grounded to chassis ⏚ terminal by grounding link supplied when isolated facility is not required.

5.3 VERTICAL AMPLIFIERS - Type 5A

VOLTS/CM (Attenuator)
Switch adjusts the sensitivity of the Vertical Amplifier from 10mV to 50V per cm in a 1, 2, 5, 10 series of steps. The attenuator varies the sensitivity of both + and - inputs simultaneously to maintain balanced input attenuation.

VERNIER
Adjust the vertical gain over a 2.5 - 1 range between the attenuator steps. When knob is pulled out amplifier gain is increased by x 10, but bandwidth is reduced to 4MHz.

SHIFT
Moves the trace up and down the C.R.T.

BAL
With trace centered and attenuator Vernier set anti-clockwise Preset Balance is adjusted to eliminate vertical trace movement when Vernier is turned clockwise to CAL position.

AC-DC-OFF Switch
In the DC position of this switch the amplifier is directly coupled from input to output. In the AC position a capacitor is placed in series with the input to eliminate any DC component and attenuate all frequencies below 2Hz. The OFF position enables a quick check to be made of the trace position with zero input, without removing the input connection or probe and eliminates pick up if one input is not used. Always switch unused inputs to OFF position.

CAL
Preset adjustment of amplifier calibration, adjusts both x 1 and x 10 gain simultaneously.

5.4 TIME BASE PLUG-IN - 5T/1

TIME/CM (Time Base) Switch
Provides 22 direct reading time base speeds. The switch speeds represent the fastest speed on each range with vernier in the CAL position.

VERNIER

Varies the time base speed over a range greater than 5-1 to provide a continuously variable range in conjunction with the TIME/CM switch of 10Sec/cm to 0.2μSec/cm. Rotation of the Time Base Vernier Control anti-clockwise will reduce the selected speed, e.g. on the 1mSec range the Vernier will vary the time base from 1mSec down to slower than 5mSec/cm when fully anti-clockwise.

SHIFT (Red Knob) moved the trace horizontally on the C.R.T.

MAG. (Grey Knob) when the Time Base is in use, this control varies the length of the trace from 10cms to 50cms, providing X5 magnification. When an external Hroizontal Input is used, the Gain control varies the sensitivity from 100mV to >1.5V per cm at X10 input and 1V to >15V at the X1 setting.

AUTO, TRIGGER LEVEL

Fully anti-clockwise and switched to the AUTO position, any signal greater than 0.5cm in amplitude will trigger the time base and with no input signal an Automatic trigger pulse is generated to produce a base line, the trigger rate increases as the Time Base speed range increases. When the knob is switched out of the AUTO position, it selects the level of a displayed waveform over ± 3cm to trigger the Time Base.

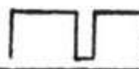
± Switch : Selects the positive (+) or negative (-) slope of the displayed signal or external trigger waveform to initiate the time base.

AC-DC (INT), EXT Switch: Selects the trigger signal from the displayed waveforms of either beam or an external waveform via the input sockets and selector switch on main frame to trigger the time base.

NORM-FAST-SLOW Switch: Selects the full frequency range of the trigger signal in NORM position, frequencies above 2kHz in FAST, and below 2kHz in SLOW.

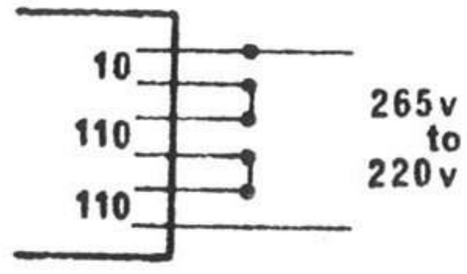
Mechanical Trigger: A switch or contacts connected across the pair of sockets will initiate the trace for single shot operation at each closure or opening of the contacts as selected by the ± switch.

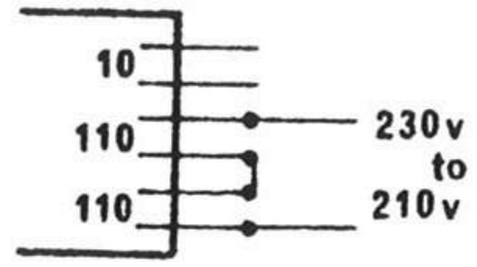
 Output: A positive going sawtooth of 1.5V p-p, swinging approx. -2 to -0.5 to Common is available at low impedance. Min. external loading 100KΩ.

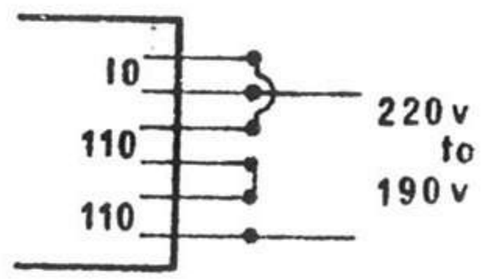
 Output: Blanking pulse output, Positive going during trace. Swinging between +0.75 to +2V.

TRANSFORMER CONNECTIONS

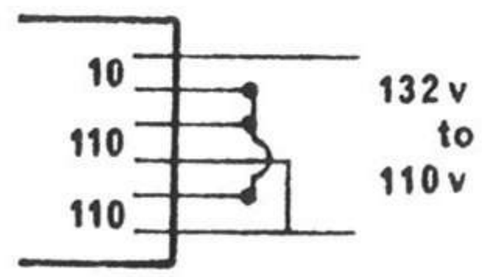
200-240 CONNECTION

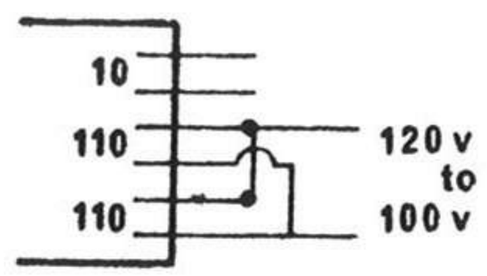


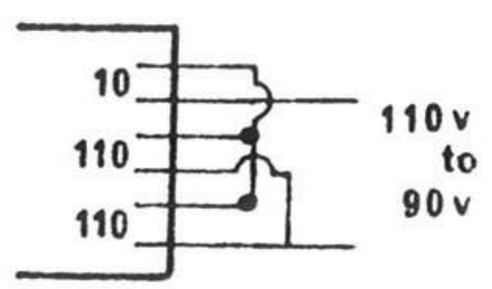




100-120 CONNECTION







6. FIRST TIME OPERATION

6.1. Description applicable with either 5A, 5B, 5C or 5D amplifiers in the L.H. and centre cavity and 5S/1 (operating on NORMAL TRIGGERED Mode) or 5T/1 in the R.H. cavity.

6.2. Set controls as follows:-

Main Frame	Upper Beam Intensity	-	mid-position
	Upper Beam Focus	-	mid-position
	Lower Beam Intensity	-	mid-position
	Lower Beam Focus	-	mid-position
	Mains Switch	-	OFF
	Horz. Input	-	AC
	Grounding Link	-	Grounded (common to ⏚)
	X10 X1 line switch	-	Line
	Upper - Lower Switch	-	Upper
Amplifier Plug-ins	ATTENUATOR	-	1V
	Vernier	-	fully clockwise
	Shift	-	mid-position
	+ Input Selector	-	AC
	- Input (5A & 5C only)	-	OFF

Time Base Plug-in	Time Base Range	-	10mSec/cm
	Vernier	-	clockwise
	Trigger Level	-	AUTO (anti-clockwise)
	± Select	-	+
	NORM-FAST-SLOW	-	NORM
	AC-DC, EXT	-	AC
	INT-EXT P-P Switch	-	INT. (Pushed in)
	GAIN	-	Anti-clockwise X1
	SHIFT	-	mid-position

6.3. Connect power lead to 50-60Hz AC supply (see P.7 re transformer tappings) and switch instrument on. After about 10 seconds when traces appear, adjust beams for suitable intensity and sharp focus. Now position traces centrally across screen, a cm above and below centreline vertically. Connect a lead from the 5V CAL socket to the L.H. amplifier input co-ax socket. A 50Hz square wave will be displayed on the upper trace with the top and bottom faces of the waveform sloping. Switch the input selector to DC. The square wave will be displayed positive going to the base line. Recentre with shift control. Now switch to OFF, signal is disconnected leaving reference base line. Switch back to DC. Adjust Time Base range switch and vernier to check characteristics with two waveforms displayed, change over ± trigger selector switch. Turn the Level Selector control clockwise. This switches off AUTO, the trace will disappear then re-appear as control is rotated and the point at which the trace is initiated will move up or down the edge of the waveform as selected by the ± selector. It will disappear when almost fully clockwise.

6.4. Return the control to AUTO and adjust the TIME/CM switch to give 5 waveforms across the C.R.T., then turn the HORZ. GAIN control clockwise until 1 waveform is 10cm long; this illustrates the trace expansion facility. If the HORZ. SHIFT is turned the trace can be tracked along to view any part of it from one end to the other.

6.5. To check the HORZ. INPUT, pull out the INT-EXT Time Base switch on 5S/1 or 5T/1 Plug-in. Connect a lead from the 5V CAL socket to the DC HORZ. INPUT socket directly above it on the main frame. A horizontal line will appear whose length can be varied by the HORZ. GAIN control and the X1, X10 switch from 50cm down to less than 5 mm. The Horizontal position of the trace can be set by the HORZ. SHIFT control.

6.6. To operate the mechanical or contact trigger set controls as follows:-

± selector to -; AC-DC-EXT to EXT; NORM-FAST-SLOW to NORM; T.B.RANGE to 1 Sec; VERNIER to CAL., LEVEL CONTROL set to ensure trace initiation (centred).

6.7. Short the MECHANICAL TRIGGER SOCKET - red to black with a link of wire (only +12V at high impedance exists on the red socket) and note how the trace is initiated each time the contact makes. Now switch to + on the ± switch. Trace will now be initiated each time the contact BREAKS.(LEVEL control may need slight readjustment).

6.8. Z Modulation - Feed an oscillator into the RED rear panel socket marked Z, ground connected to the BLACK socket or BLACK front panel COMMON terminal.

With an input of 6V RMS or 20V p-p approx., upper trace at normal brightness level will be fully intensity modulated. Lower trace is not connected to Z Modulation.

7. The following sections explain oscilloscope operation when used to make specific measurements.

7.1 NOTE : Measurements can be made using either the +ve socket and the Black terminal (Common) or -ve socket and common. For most applications other than differential measurements the +ve input and Black terminal should be used (applies to 5A and 5C only).

7.2 MEASUREMENT OF DC (DIRECT) VOLTAGES

Set T.B. LEVEL CONTROL to AUTO. Switch the Vertical Amplifier AC-DC-OFF switch to DC. For an initial test take a 1½V dry cell and set the attenuator to 0.5V. Connect the negative end to the BLACK COMMON terminal, set the trace to the centre of the graticule, touch a lead from positive end of the battery to the + socket; the trace will move up 3 cm, i.e. 3 x 0.5V ± 1.5V. Now reverse the connections to the battery and note how the trace moves down 3 cm. This illustrates how an oscilloscope can display positive or negative voltages or both simultaneously, e.g. when viewing a sine input or square wave.

7.3 NOTE : The 1MΩ input impedance of the oscilloscope must be taken into account when measuring high impedance points such as anode, grid or screen voltages of valves of the gate of F.E.T's working with high value loads.

7.4 The DC input facility may be used to measure AC waveforms swinging about a DC voltage, as at the collect or of a transistor or the anode of a valve, to check for bias settings or anode bottoming, etc. Maximum DC input should not exceed x10 input attenuator setting if it is required to re-centre the trace to view a signal superimposed on it.

8. MEASUREMENT OF AN AC (ALTERNATING) VOLTAGE

8.1 Set the Amplifier AC-DC-OFF switch to AC and the Attenuator to 50V (if the input voltage is unknown). Connect a lead from the COMMON (Black) input terminal to the ground (earth) side of the signal to be measured, then connect a lead from the + input socket to the signal source. (Models 112B, 140A or 602 Oscillators are suitable for initial experiments in this test).

8.2 Increase the Vertical sensitivity by the VOLTS/CM switch until a display between 2 and, say, 6 cm exists. Now adjust the Time Base Switch and Vernier to enable the waveform to be readily seen. To measure the amplitude of a displayed waveform, measure its overall height in centimetres by the calibrated graticule, then multiply this by the attenuator setting and the result is in Volts p-p, e.g. if the display is 6 cm high and the attenuator is set to 0.5V then the amplitude is 6 x 0.5 = 3V peak to peak; to convert to RMS voltage for sine waves, divide the 3V by 2.84, e.g.

$$\frac{3.00}{2.84} = 1.06V \text{ RMS}$$

8.3 The frequency of a waveform can be found by turning the Time Base Vernier to CAL (clockwise) then switch the TIME/CM switch to a range where the signal can be clearly seen, e.g. if a waveform is 5 cm long and the switch is on 100uSec, then the duration of the waveform is 5 x 100uSec = 500uSec. The frequency can be determined by dividing 1 second, i.e. $\frac{1.000.000}{500}$ = 2.000Hz or 2kHz.

9. INVERTED DISPLAYS (5A and 5C ONLY)

Where it is required to display a waveform inverted on the C.R.T., feed the signal into the -ve socket and set the input selector to either AC or DC as required. All information relating to display and measurement of signals applied to -ve input is identical to the +ve input details. The calibration and accuracy are as detailed in the specification.

10. BALANCED OR DIFFERENTIAL MEASUREMENTS (5A and 5C ONLY)

10.1 AC MEASUREMENTS

NOTE: Very high COMMON MODE REJECTION can be made with 5A and 5C Plug-Ins by connecting the COMMON Black terminal to the signal to be rejected when it is a low impedance source and can drive the 1.6μF capacitor and a 1MΩ resistor in parallel between Common and ground. However, if this is not possible the following limitations must be considered:-

Max AC common Mode signal connected directly to the COMMON terminal is $100V_{p-p}$. This may be superimposed on a DC signal - e.g. as ripple in a DC power supply up to a total peak voltage of 400V AC and DC combined.

10.2 To measure a signal appearing between two points in a circuit, neither of which is at earth (ground) potential, e.g. across a push-pull primary of an output transformer, between cathode and grid of a valve or emitter to collector of a transistor circuit and at the same time supress any signal common to both points such as H.T. ripple or AC power line frequency as much as possible, the following method is used:

10.3 Connect a lead from the +ve input socket to one side of the component across which the waveform is developed and another lead from the -ve socket to the other side. The attenuator is adjusted to present a suitable display and the resultant C.R.T. trace is then a true indication of the waveform being developed between the points to which the leads are coupled. Measurement of voltage and time may be made as described previously as the calibration remains constant irrespective of the input facility employed.

10.4 If a large 'Common Mode' signal still appears on the display, particularly when measuring signals on equipment connected in the AC supply, the COMMON terminal should be connected to the source of the interfering signal to obtain complete rejection of it. It must be noted, however, that a capacity of 1.6μF exists between common and ground, and the common mode signal must be able to drive this low impedance. Most power supply rails, etc. will do this readily.

10.5 The differential input coupling is almost essential when making low level measurements in the millivolt region even when one side of the signal source is grounded. This is because troubles due to ground loops generating hum and noise occur and can completely mask the signal. Connect a lead from the +ve socket to the signal to be observed and from the -ve socket to the nearest ground or common point to the signal on the equipment under test, and the COMMON to ground.

10.6. To measure AC signals which are superimposed on a high DC potential which would overload the input capacitors (400V DC or AC p-p + DC combined) the COMMON terminal may be taken to the DC potential around which the AC signal is swinging, subject to a maximum of ±400V DC. If still larger signals need to be accommodated a 10 - 1 high impedance probe, Type P22, should be employed when signals to ± 1000V DC or AC p-p may be displayed.

10.7. DIFFERENTIAL DC MEASUREMENTS

When low frequencies or signals with both AC and DC components are to be measured differentially, the mode of operation is almost identical to AC measurements.

10.8. Connect a lead from the COMMON terminal to the nearest DC potential of the signal being measured, e.g. if it is swinging about ground then it should be connected to ground or chassis; if it is say, a signal between the anodes of two valves then it should be taken to the +ve rail with a maximum limit of ±400V DC to which the common terminal can be taken. The display signal in the DC differential mode can be measured directly as calibration remains constant.

10.9. Differential rejection will only operate if the Common Mode signal to be rejected is less than X100 the Attenuator setting, e.g. with the attenuator set at 1V/cm the common mode signal must not be greater than 100V AC p-p or ±100V DC, or the input amplifier will be overloaded and the signal will be distorted. If the common mode signal is 100V p-p AC the attenuator should not be used below 1V/cm.

10.10. The accuracy of the input attenuator resistors also controls the rejection ratio and the other than 10mV settings may reduce the rejection to only 20-1 which means, in the case of a 100V p-p AC signal, a 5V p-p signal could still appear with the required signal superimposed on it unless the COMMON TERMINAL is also connected to the 100V supply as mentioned in the previous paragraph.

10.11. Provided the limits and methods of connection indicated above are observed when making measurements with a differential amplifier, far more information can be extracted from a circuit than with single ended amplifier operation, with only one signal lead and one side grounded.

11. ISOLATED MEASUREMENTS AC OR DC

With the isolated ground feature, measurements can be made between any two points of a circuit, even if neither are at ground potential. The COMMON terminal has an impedance to ground of 1MΩ and is shunted by 1.6μF - this must be taken into account when connecting the COMMON to a point of high impedance. Maximum voltage that may be applied to the COMMON terminal is ± 400V DC or 100V AC.

11.1. NOTE: Grounding link must be disconnected to isolate the common line.

12. CURRENT MEASUREMENTS AC OR DC

As this Model is isolated it may be used to measure the voltage drop across a known resistor, and by use of Ohms Law, this may be converted to current. At low currents place a 1Ω resistor across the vertical input terminals (+ and Common, or - and Common) of the oscilloscope. The attenuator will then read directly in mA or Amps in lieu of mV and Volts, when the oscilloscope is connected between source and load. This configuration will read both AC or DC current and unlike ammeter will show the actual current waveform. Practical applications are the charging currents in a filter capacitor of a power supply or the current through a rectifier, or high speed displays of pulse currents through memory cores, etc. in computors.

13. MECHANICAL CONTACT TRIGGER

To initiate the time base by an external mechanical contact which may be in part of a machine operation, the Mechanical Trigger sockets on 5T/1 are used. Set 5T/1 panel switches as follows:- EXT, NORM and -ve, Trigger level at maximum sensitivity. A pair of contacts, switch, etc. connected across the red and black panel sockets will initiate one sweep for each CLOSING contact. If the ± switch is changed to + an OPENING Contact will initiate the trace.(When LEVEL is correctly adjusted).

14. MEASUREMENTS WITH AN EXTERNAL HORIZONTAL INPUT

As the HORZ. INPUT is directly coupled, the C.R.T. display can be used for X-Y plotting over a 6 x 10cm area for each beam.

14.1 First calibrate the Horizontal Amplifier by feeding in the CAL waveform and adjusting the HORZ. GAIN until the display equals 1V/cm, set the Vertical Attenuator to 1V/cm. The oscilloscope has now identical X and Y sensitivities, of 1V p-p/cm. Other sensitivities can be used with equal or unequal sensitivities as required from 100mV to 15V/cm.

14.2 Remove the CAL. Waveform and centre the spot. Positive or negative voltages may now be applied to X and Y inputs. AC signals will show phase displays of Lissajous figures. With the vertical input switched to DC less than 1° phase shift exists up to 100kHz between X and Y inputs.

14.3 Balanced vertical inputs also permits algebraic subtractions to be incorporated in this type of display, e.g. +3V applied to the +ve input and +1V to the -ve input will produce only +2V deflection of the C.R.T.

14.4 For X - Y displays with bandwidths up to 1.5MHz and at sensitivities below 100mV/cm a 5A or other amplifier plug-in may be titted to the horizontal input cavity.

14.5 When option 23 is fitted (identical X-Y switching) switch rear panel switch to X-Y. The lower beam amplifier (centre plug-in) will now deflect the spot horizontally over the range DC to 1.5MHz without calibration changes. The lower beam intensity control should be turned off (anticlock). When a 5A or 5C differential amplifier is used in both plug-in centres deflection may be selected to enable a paritime signal to deflect the beam up and down, right or left.

15. RASTER DISPLAYS

If a 5T/1 time base is fitted to both the Upper Beam cavity and the Horizontal Display cavity a raster display will be obtained. Triggering of the normal horizontal display will still be available by selecting the Lower Beam trigger or EXT via main frame and the second (vertical time base) can be triggered externally via the MECH TRIG Socket by selecting EXT. NORM and + or - as required. Video or brightness modulation can then be applied to the rear panel Z modulation terminals. Although not provided for, a link can be connected internally from the output of the Lower Beam Vertical amplifier to the Z modulation input socket, the modulation polarity being selected from the appropriate collector to suit the input signal. Bandwidth of the main frame amplifier is approx. 25Hz to 2MHz - 3db when linked to the Z input.

16. CIRCUIT DESCRIPTION (Main Frame only, Drg. No. 680A)

16.1 The main frame contains two wide band vertical amplifiers, a horizontal amplifier, low voltage power supplies. EHT oscillator, calibrator, horizontal input circuit, plug-in compartment and interconnections.

16.2 Low Voltage Power Supplies

A single transformer T1 supplies the L.V. supplies from 5 secondary windings. All DC rails are referenced back to the +12V line. This is obtained by full wave rectifying the 13 - 0 - 13V secondary winding by D7 and 9; C5, 6 and 7 provide a single stage filter before the DC is stabilised by transistors Q5, 8, 9 and 10. Q10 reference amplifier is held at + 6.2V to the common line by zener D11 and supply resistor R23. Q10 base is taken through R22 limiter to divider R24, R25, RV3 across the +12V output line. If the +12V rail tends to rise Q10 base current will increase, pull more current through R10 and away from Q8 base. Q8 emitter current will drop reducing the feed to Q5 base. Its emitter will follow and the output voltage will drop until the base current of Q10 returns to normal. A fall in output will cause the opposite action to take place.

Output current of the +12V rail is monitored by Q9 across R20. When this rises above 1 Amp. Q9 base is forward biased causing it to conduct. This tends to pull Q8 base negative with respect to its emitter so reducing Q5 base current and in turn the output current causing the output voltage to fall to zero in the event of a short circuit.

16.3 +50V Rail

This follows a similar pattern to the +12V rail with Q6 as the feedback amplifier and Q4 series pass transistor. Q6 emitter returns to the +12V rail for reference whilst its base detects changes in output across divider R17, R18 and RV2. Overload conditions are monitored by PC board mounted fuse F2.

16.4 +100V Rail

A full wave bridge rectifies the 105V winding on T1 which is connected in series with the +18V rectified DC to add this to the output voltage. A two stage filter C1, R2, C2 follows, together with overload fuse F1. For the +100V supply Q1 is the series pass transistor, and Q3 the feedback amplifier using the +50V rail as reference.

16.5 + 122V Rail

This supply is used only for the Main Frame horizontal amplifier and consists of Q17 emitter follower controlled by a 22V zener diode D12 connected between its base and the + 100V rail.

16.6 - 12V Rail

Full wave rectifiers D8 and D10 supply C8 and 9 single stage filter. DC is stabilised by Q14 series pass transistor controlled by Q12 current amplifier and Q11 feedback amplifier. Overload protection at 0.6 Amp. is provided by Q13. A decoupled supply is taken off through R32 and C19 to supply the EHT oscillator from the - 12V rail.

16.7 - 50V Rail

A half wave rectifier D6 and capacitor C10 provide the unregulated DC before stabilising by Q25 series pass transistor. Q16 current driver and Q15 reference amplifier using −12V as its reference.

16.8 High Voltage Supplies (Drg. 1065) - 1000V EHT Rail

Transformer T2 and transistor Q42 function as a high frequency oscillator (22kHz). The base winding connected to Q42 provides feedback to maintain oscillation and the base drive is controlled by amplifier Q41 and emitter follower Q40.

The voltage divider R123, R124, R130 and RV12 located between the -1000V and the +100V rails provide the feedback voltage at approximately 0V, which is taken to the base of Q40 via R117.

As the - 1000V increases, the potential at the base of Q40 becomes negative. Q40 emitter follower follows this change and via amplifier Q41, reduces Q42 base current. The reduction in base drive to Q42 drops the amplitude of oscillation at the collector thereby reducing the - 1000V to the correct level.

Two secondary windings provide three voltage rails. An 80V supply is obtained from D18 and C80 for the CRT controls. The -1000V EHT is a half wave rectified supply from D17 filtered by C78, R119 and C79 to provide a low ripple output. The +3kV PDA supply is obtained by doubling the main secondary winding and returning the winding to 0V and the diode D15 to the 0V. A high overswing when D17 becomes non-conducting is responsible for the apparent higher output voltage obtained.

16.9 CRT and Controls

Type 1300M CRT incorporates two gun assemblies with independent vertical deflection plates, but a common horizontal drive. By equalising the gun sensitivities, good horizontal tracking of the two beams is ensured. This is adjusted by RV15 and RV18 preset controls which can provide a ±1.5% change of sensitivity. Further beam centring is provided by a small horizontal deflection plate controlled by RV19 which moves one beam relative to the other.

16.10 Intensity controls adjust the negative bias on the CRT grids whilst return trace blanking is obtained by deflecting each beam behind a deflection plate by means of a +40V pulse applied to pin 11.

16.11 CRT geometry is adjusted by RV13 to minimise barrel or pincushion distortion. Focus and astigmatism controls are available at the front panel, the astigmatism controls being preset and concentric with the focus controls.

16.12 VERTICAL DEFLECTION AMPLIFIERS. NON DELAYED (Drg 681A)

The upper beam amplifier consists of Q31 and 32 output amplifiers driven by Q33 and Q34. For the lower beam Q35 and 36 are the output amplifiers driven by Q37 and 38. Q30 emitter follower supplies base current for Q31, 32, 35 and 36. Compensation for pulse response is controlled by the RC networks between the emitters of the driven pairs in the cascode amplifiers.

16.13 VERTICAL DEFLECTION AMPLIFIERS WITH DELAY LINES (Drg 855)

The upper beam amplifier consists of Q45 and 46 delay line drivers, Q47 & 48 output drivers and Q49-52 cascode CRT deflection amplifier.

The lower beam is identical employing Q54-61 transistors. Only the upper beam is described.

Input signals from the plug-in amplifiers are at +16V to Common. D22 & 23, Zener diodes reduce the level to +4V, C100 & 102 eliminate zener noise from the signal path.. Q45 & 46 series compensated stage drives the delay line, RV26 in parallel with collector loads R145 & 146 correctly matches the line impedance. Q47 & 48 shunt compensated driver presents a low impedance input to the delay line so it is built out by R149 & 150 with R148 & RV27 to correctly terminate the delay line.

Q49 & 50 drive the cascode output stage emitter compensated pair which via compensated networks current drive the CRT deflection amplifiers Q51 & 52. Base current for Q51 & 52 is supplied by Q53 emitter follower held at +25V by R169 & 170 divider.

Input clamping diodes D21 & 24 hold the output stage in a safe operating condition if plug-in units are removed whilst the instrument is switched on.

16.14 HORIZONTAL AMPLIFIER (Drg 680A)

This is a similar configuration to the vertical amplifiers. It employs a balanced cascode stage with high voltage transistors Q19 and Q21 supplying a 280V p-p horizontal deflection voltage driven by Q20 and 21. Q16 supplies base current to Q19 and 21. As the base voltage of Q20 and 21 must be dropped to -30V approx. to enable Q19 and Q21 to provide sufficient deflection, the output voltage of the plug-in is dropped from +16 by matched 47V zener diodes D13 and 14 bypassed by large value capacitors to eliminate zener noise. Trace centring is effected by RV6 and H.F. compensation is provided by the emitter network.

16.15 CALIBRATOR

Q24 is connected with its emitter to the +12V rail and a collector load consisting of R60, R61 and 62 with RV7 in parallel. 50V AC is applied to Q24 base via R59 which alternatively drives the transistor into saturation (-ve going) and out of saturation (+ve going) producing a sharp positive going square wave at the collector with a mark space ratio of approx. 45-55. The output is attenuated, tapping off the load at R60/61 for the 5V output and at R61/62 for the 50mV output. Calibration adjustment is set by RV7.

16.16 PLUG-IN DISTRIBUTION BOARD.

The three plug-in sockets are located on a P.C. Board across the back of the plug-in circuitry. Decoupling components are located between the sockets and coupling resistors. R51 & 52, 66, 67 68 and 69 hold the output deflection amplifiers in a safe condition if the plug-ins are removed or changed whilst the instrument is operating. When delay lines are fitted diodes are also fitted to clamp the output.

17. MAIN FRAME ALIGNMENT PROCEDURE

17.1 L.V. DC Rails

This setting up may be carried out with or without plug-in units fitted. DC voltages for all rails are readily measured at the RH end of the plug-in distribution board. They must be adjusted in the following sequence: Connect grounaing link on front panel between common and ground to simplify measurements to chassis.

+12V (yellow wire). Set rail to +12V ±0.1V with respect to chassis by RV3 at front of main PC Board.

-12V (violet wire). Set rail to -12V ±0.1V w.r.t. chassis by RV 4 on main P/C board.

+50V (orange wire). Set to +50V ±0.5V w.r.t. chassis by RV 2 on main P/C board.

-50V (white wire). Set to -50V ±0.5V w.r.t. chassis by RV5 on main P/C board.

+100V (red wire). Set to +100V ±1V w.r.t. chassis by RV1 on main P/C board.

+122V Not adjustable but may be checked at the centre of R40 or R41 resistors on the rear of the board, rear end.

17.2 EHT Rail (brown wire) L.H. side of instrument. Connect meter (20,000Ω/V minimum) between top lug L.H. front P/C board (brown wire) and chassis. Adjust RV12 in centre of board for -1000V ±10V.

17.3 CRT Controls

Fit 5S/1 or 5T/1 time base to horizontal cavity and amplitiers in the vertical positions. Feed in CAL waveform to both amplifiers and adjust deflection to approx. 4 cm. each beam and 10mSec/cm horizontal. Turn RV15 and 18 (top of CRT control board) full anti-clockwise. Adjust each control as necessary to match waveforms on each trace for equal length. Then adjust RV19 to register the traces horizontally with respect to each other. Readjust RV15, 18 and 19 as necessary to obtain optimum registration along the full trace length.

17.4 Now remove CAL signal from amplifiers, and substitute a 50kHz sine wave, adjust for 6cm each beam, superimpose with upper trace in top 6cms and lower trace filling bottom 6cms. Adjust RV13 for best compromise of barrel or pincushion distortion and trace superimposition. Remove 50kHz signal and check straightness of traces at top bottom of screen, readjust RV13 if necessary for optimum setting. The astigmatism and focus controls may also be reset if necessary to optimise the display geometry and overall focus.

17.5 Vertical amplifier response adjustment can only be carried out when fitted with a special bwd test unit it inrerchange of amplifiers is necessary. If amplifiers are not interchanged the output stage can be adjusted to match its plug-in amplifier. This adjustment should not be necessary unless CRT is changed or if an output transistor is replaced. If an amplifier is fitted set attenuator to highest wide band sensitivity, i.e. 10mV on 5A, 50mV on 5B, and 5mV on 5D. Under no circumstances should an attempt to align deflection amplifiers be made with 5C fitted. Switch -ve input of 5A off before adjusting responses.

17.6 Upper Beam Amplifier

Feed in a correctly terminated 1MHz square wave with a rise time of less than 5 nano seconds and adjust amplitude for 5cms display. Adjust RV10 and C64 to optimise response with minimum ringing or overshoot. When delay lines are fitted additional response setting components RV25, C103 on driver board and RV27 on main board will require optimising.

17.7 Horizontal amplifier balance adjustment. Fit a 5S/1 or 5T/1 time base to horizontal display circuitry, centre TB at x1 expansion. Feed in CAL waveform to Upper Beam, TB at 10mSec/cm. Expand to X5. If centre of trace is moved to left or right recentre with RV6. Repeat until trace expands about approx. centre of screen. Check after setting RV6 that shift is approx. equal. A compromise between equal shift and expansion either side of centre may be necessary aue to slightly off centre CRT gun placement.

17.8 Calibration Adjustment

Feed in a known amplitude (better than 1%) 5V p-p signal into Upper Beam amplifier. Adjust sensitivity for 5cm deflection. Remove signal and couple 5V output of CAL waveform into the same amplifier input (DC coupled). Adjust RV7 on main P/C board for 5cm deflection.

18. REPLACEMENT PARTS

Spares are normally available from the supplier.
When ordering, it is necessary to indicate the serial number of the instrument. If exact replacements are not to hand, locally available alternatives may be used, provided they possess a specification not less than, or physical size not greater than, the original components.

As the policy of the manufacturer is one of continuing research and development, the company reserves the right to supply the latest equipment and make amendments to circuits and parts without notice.

19. WARRANTY

The equipment is guaranteed for a period of twelve (12) months from the date of purchase against taulty materials and workmanship.

Please refer to Guarantee Registration Card No.....which accompanied instrument tor full details or conditions of warranty.

****

MAIN FRAME

L.H. SIDE

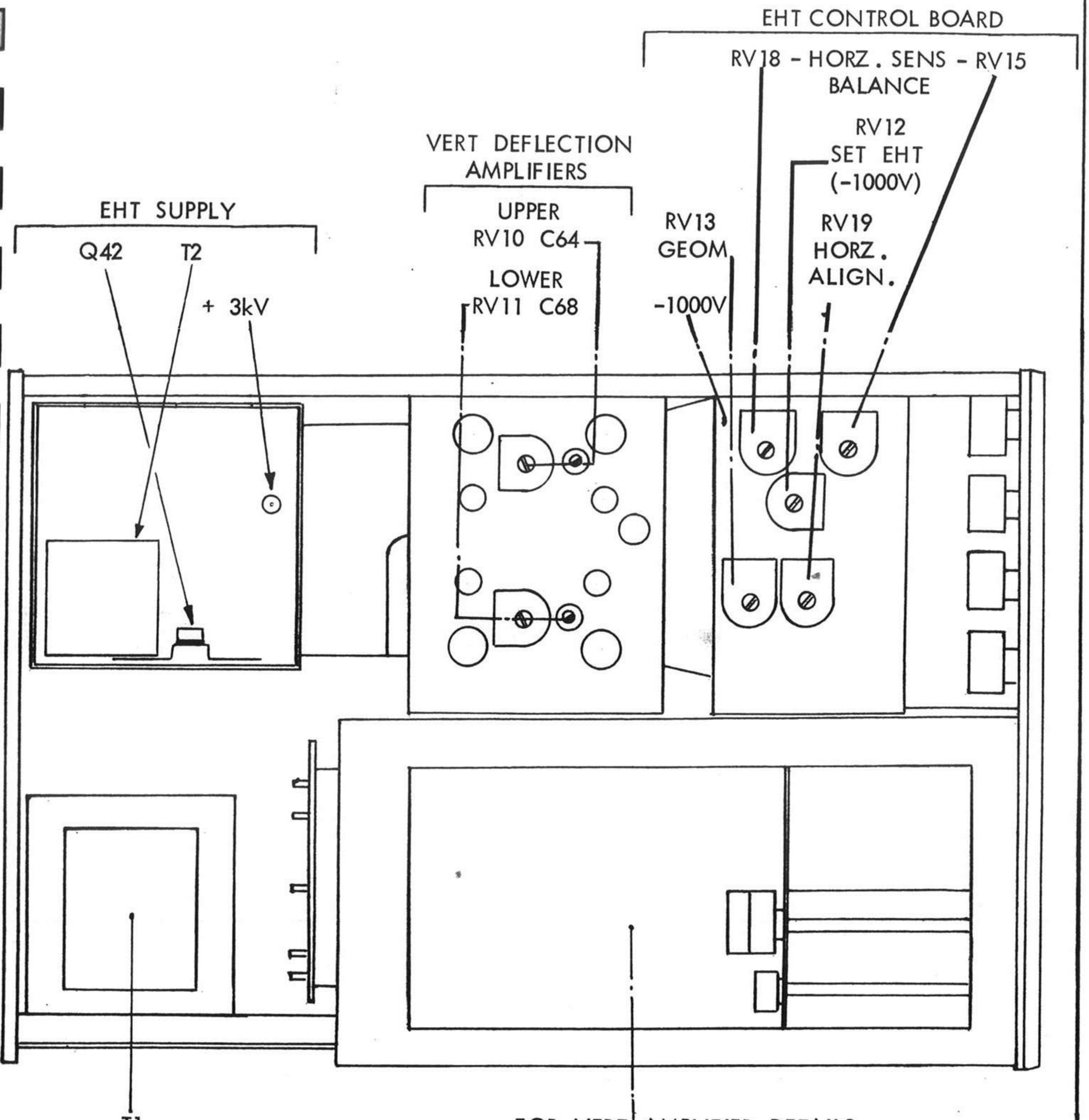


Fig. 1

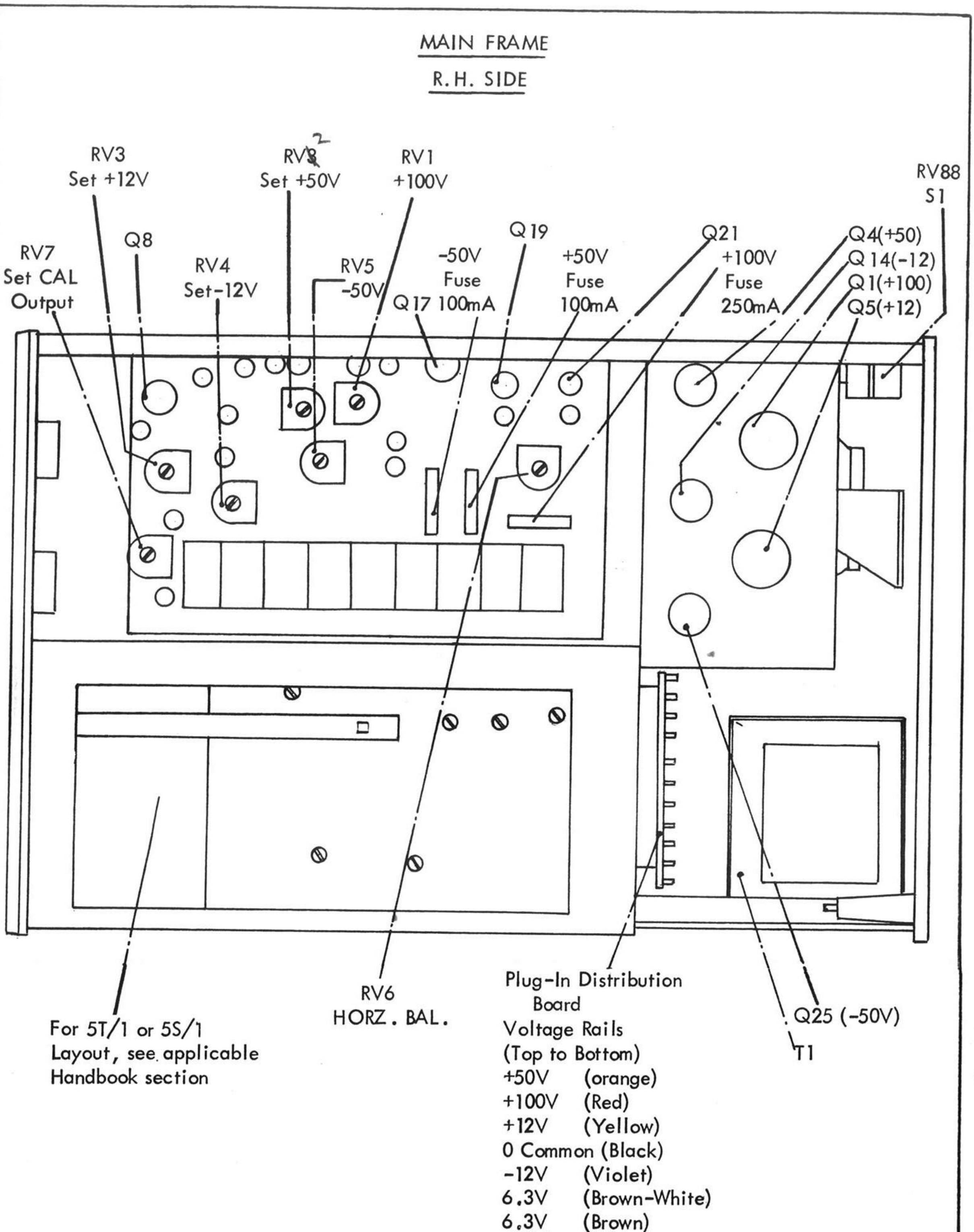

MAIN FRAME
R.H. SIDE
RV3
Set +12V
RV2
Set +50V
RV1
+100V
RV88
S1
Q8
RV7
Set CAL
Output
RV4
Set-12V
RV5
-50V
Q19
-50V
Fuse
100mA
Q17
+50V
Fuse
100mA
Q21
+100V
Fuse
250mA
Q4(+50)
Q14(-12)
Q1(+100)
Q5(+12)
For 5T/1 or 5S/1
Layout, see applicable
Handbook section
RV6
HORZ. BAL.
Plug-In Distribution
Board
Voltage Rails
(Top to Bottom)
+50V (orange)
+100V (Red)
+12V (Yellow)
0 Common (Black)
-12V (Violet)
6.3V (Brown-White)
6.3V (Brown)
-50V (White)
Q25 (-50V)
T1

Fig. 2

PARTS LIST

CCT Ref	DESCRIPTION - RESISTORS				Mfr. or Supplier	PART No.
R1	100K	½W	5%	CC	PI	
R2	22Ω	½W	5%	CC	PI	
R3	100K	½W	5%	CC	PI	
R4	100K	½W	5%	CC	PI	
R5	4.7K	½W	5%	CC	PI	
R6						
R7	39K	½W	5%	CC	PI	
R8						
R9	22K	½W	5%	CC	PI	
R10	22K	½W	5%	CC	PI	
R11	15K	½W	5%	CC	PI	
R12	6.8K	½W	5%	CC	PI	
R13	47K	½W	5%	CC	PI	
R14	4.7K	½W	5%	CC	PI	
R15	47K	½W	5%	CC	PI	
R16	1K	½W	5%	CC	PI	
R17	33K	½W	5%	CC	PI	
R18	10K	½W	5%	CC	PI	
R19						
R20	0.68Ω	½W	10%	WW	IRC	BW ½
R21	1K	½W	5%	CC	PI	
R22	1K	½W	5%	CC	PI	
R23	2.2K	½W	5%	CC	PI	
R24	2.7K	½W	5%	CC	PI	
R25	2.7K	½W	5%	CC	PI	
R26	1K					
R27	1KΩ	½W	5%	CC	PI	
R28	1.5Ω	½W	10%	WW	IRC	BW ½
R29	82Ω	½W	5%	CC	PI	
R30	8.2K	½W	5%	CC	PI	
R31	10KΩ	½W	5%	CC	PI	
R32	10Ω	½W	5%	CC	PI	
R33	4.7K	½W	5%	CC	PI	
R34	10KΩ	½W	5%	CC	PI	
R35	39KΩ	½W	5%	CC	PI	
R36	10KΩ	½W	5%	CC	PI	
R37	22KΩ	½W	5%	CC	PI	
R38	82Ω	½W	5%	CC	PI	
R39	180K	½W	5%	CC	PI	
R40	6.8K	4W	5%	METOX	W	
R41	6.8K	4W	5%	METOX	W	
R42	8.2K	½W	5%	CC	PI	
R43	1KΩ	½W	5%	CC	PI	

PARTS LIST

CCT Ref	DESCRIPTION - RESISTORS (Cont)				Mfr. or Supplier	PART No.
R44	6.8KΩ	½W	5%	CC	PI	
R45	1.8K	½W	5%	CC	PI	
R46	180Ω	½W	5%	CC	PI	
R47	1.8KΩ	½W	5%	CC	PI	
R48	6.8KΩ	½W	5%	CC	PI	
R49	1KΩ	½W	5%	CC	PI	
R50	82Ω	½W	5%	CC	PI	
R51	10KΩ	½W	5%	CC	PI	
R52	10KΩ	½W	5%	CC	PI	
R53	1.8MΩ	½W	5%	CC	PI	
R54	1.8MΩ	½W	5%	CC	PI	
R55	100KΩ	½W	5%	CC	PI	
R56	100KΩ	½W	5%	CC	PI	
R57	47Ω	½W	5%	CC	PI	
R58	22KΩ	½W	5%	CC	PI	
R59	27KΩ	½W	5%	CC	PI	
R60	3.3KΩ	½W	5%	CC	PI	
R61	9.9K	¼W	1%	HS	ELECTR	TYPE TR5
R62	100Ω	¼W	1%	HS	ELECTR	TYPE TR5
R63	1MΩ	1W	5%	CC	PI	
R64	100Ω	½W	5%	CC	PI	
R65	4.7KΩ	½W	5%	CC	PI	
R66	10KΩ	½W	5%	CC	PI	
R67	10KΩ	½W	5%	CC	PI	
R68	10KΩ	½W	5%	CC	PI	
R69	10KΩ	½W	5%	CC	PI	
R70	1KΩ	½W	5%	CC	PI	
R71	47Ω	½W	5%	CC	PI	
R72	6.8K	1W	5%	CC	PI	
R74	22K	½W	5%	CC	PI	
R75	3.9K	½W	5%	CC	PI	
R76	220Ω	½W	5%	CC	PI	
R77						
R78						
R79						
R80	12KΩ	½W	5%	CC	PI	
R81	12KΩ	½W	5%	CC	PI	
R82	1.5KΩ	1W	5%	CC	PI	
R83	560Ω	1W	5%	CC	PI	
R84	82Ω	½W	5%	CC	PI	
R85	180Ω	½W	5%	CC	PI	
R86	820Ω	½W	5%	CC	PI	
R87						
R88	180Ω	½W	5%	CC	PI	

PARTS LIST

CCT Ref	DESCRIPTION - RESISTORS (Cont)				Mfr or Supplier	PART No.
R89	82Ω	½W	5%	CC	PI	
R90	1.5KΩ	1W	5%	CC	PI	
R91	180Ω	½W	5%	CC	PI	
R92	820Ω	½W	5%	CC	PI	
R93	560Ω	1W	5%	CC	PI	
R94	1.5KΩ	1W	5%	CC	PI	
R95	180Ω	½W	5%	CC	PI	
R96	82Ω	½W	5%	CC	PI	
R97	820Ω	½W	5%	CC	PI	
R98						
R99	180Ω	½W	5%	CC	PI	
R100	82Ω	½W	5%	CC	PI	
R101	1.5KΩ	1W	5%	CC	PI	
R102	180Ω	1W	5%	CC	PI	
R103	820Ω	½W	5%	CC	PI	
R104	1KΩ	½W	5%	CC	PI	
R105	15Ω	1W	10%	C	Pi or MOR	
R106						
R107						
R108						
R109						
R110						
R111						
R112						
R113						
R114	82K	½W	5%	CC	PI	
R115	100Ω	½W	5%	CC	PI	
R116	560Ω	½W	5%	CC	PI	
R117	10KΩ	½W	5%	CC	PI	
R118	100KΩ	½W	5%	CC	PI	
R119	5.6KΩ	½W	5%	CC	PI	
R120		½W	5%	CC	PI	
R121	220KΩ	½W	5%	CC	PI	
R122						
R123	2.7MΩ	1W	10%	CC	PI	
R124	2.2MΩ	1W	10%	CC	PI	
R125	470Ω	½W	5%	CC	PI	
R126	470Ω	½W	5%	CC	PI	
R127	3.9KΩ	½W	5%	CC	PI	
R128	390KΩ	½W	5%	CC	PI	
R129	820KΩ	½W	5%	CC	PI	
R130	390KΩ	½W	5%	CC	PI	
R131	2.7MΩ	1W	5%	CC	PI	
R132	15KΩ	½W	5%	CC	PI	

PARTS LIST

CCT Ref	DESCRIPTION - RESISTORS (Cont)				Mfr or Supplier	PART No.
R133	15KΩ	½W	5%	CC	PI	
R134	22KΩ	½W	5%	CC	PI	
R135	100KΩ	½W	5%	CC	PI	
R136						
R137						
R138	100KΩ	½W	5%	CC	PI	
R139	560KΩ	½W	5%	CC	PI	
R140	2.2MΩ	½W	5%	CC	PI	
R141	270Ω	½W	5%	CC	PI	
R142	270Ω	½W	5%	CC	PI	
R143	330Ω	½W	5%	CC	PI	
R144	10KΩ	½W	5%	CC	PI	
R145	100Ω	½W	5%	CC	PI	
R146	100Ω	½W	5%	CC	PI	
R147	10KΩ	½W	5%	CC	PI	
R148	220Ω	½W	5%	CC	PI	
R149	82Ω	½W	5%	CC	PI	
R150	82Ω	½W	5%	CC	PI	
R151	680Ω	½W	5%	CC	PI	
R152	680Ω	½W	5%	CC	PI	
R153	270Ω	½W	5%	CC	PI	
R154	270Ω	½W	5%	CC	PI	
R155A	180Ω	½W	5%	CC	PI	
R155B	560Ω	½W	5%	CC	PI	
R156	22Ω	½W	5%	CC	PI	
R157	330Ω	½W	5%	CC	PI	
R158	330Ω	½W	5%	CC	PI	
R159	220Ω	½W	5%	CC	PI	
R160	180Ω	½W	5%	CC	PI	
R161	180Ω	½W	5%	CC	PI	
R162	470Ω	½W	5%	CC	PI	
R163	470Ω	½W	5%	CC	PI	
R164	82Ω	½W	5%	CC	PI	
R165						
R166	1.5KΩ	1W	5%	CC	PI	
R167	1.5KΩ	1W	5%	CC	PI	
R168	560Ω	1W	5%	CC	PI	
R169	12KΩ	½W	5%	CC	PI	
R170	12KΩ	½W	5%	CC	PI	
R171	270Ω	½W	5%	CC	PI	
R172	270Ω	½W	5%	CC	PI	
R173	330Ω	½W	5%	CC	PI	
R174	100Ω	½W	5%	CC	PI	
R175	100Ω	½W	5%	CC	PI	

PARTS LIST

CCT Ref	DESCRIPTION - RESISTORS (Cont)				Mfr or Supplier	PART No.
R176	10KΩ	½W	5%	CC	PI	
R177	10KΩ	½W	5%	CC	PI	
R178	220Ω	½W	5%	CC	PI	
R179	82Ω	½W	5%	CC	PI	
R180	82Ω	½W	5%	CC	PI	
R181	680Ω	½W	5%	CC	PI	
R182	680Ω	½W	5%	CC	PI	
R 183	270Ω	½W	5%	CC	PI	
R184	270Ω	½W	5%	CC	PI	
R185A	180Ω	½W	5%	CC	PI	
R185B	560Ω	½W	5%	CC	PI	
R186	22Ω	½W	5%	CC	PI	
R187	330Ω	½W	5%	CC	PI	
R188	330Ω	½W	5%	CC	PI	
R189	270Ω	½W	5%	CC	PI	
R 190	180Ω	½W	5%	CC	PI	
R191	470Ω	½W	5%	CC	PI	
R192	180Ω	½W	5%	CC	PI	
R193	470Ω	½W	5%	CC	PI	
R194	82Ω	½W	5%	CC	PI	
R195						
R196	1.5KΩ	1W	5%	CC	PI	
R197	1.5KΩ	1W	5%	CC	PI	
R198	560Ω	1W	5%	CC	PI	
R199						
		CAPACITORS				
C1	50μF	150V	elec		PH	2222-040-11509
C2	40μF	200V	elec		PH	2222-040-12409
C3	80μF	100V	elec		PH	2222-040-10809
C4						
C5	1000μF	25V	elec		PH	2222-017-16102
C6	1000μF	25V	elec		PH	2222-017-16102
C7	1000μF	25V	elec		PH	2222-017-16102
C8	1000μF	25V	elec		PH	2222-017-16102
C9	1000μF	25V	elec		PH	2222-107-16102
C10	80μF	100V	elec		PH	2222-040-10809
C11	47μF	63V	elec		PH	2222-016-18479
C12	4.7μF	63V	elec		PH	2222-015-18478
C13						
C14	4.7μF	63V	elec		PH	2222-015-18478
C15	4.7μF	63V	elec		PH	2222-015-18478
C16	0.1μF	100V	PYE		SON	TYPE N
C17	0.1μF	100V	PYE		SON	TYPE N

PARTS LIST

CCT Ref	DESCRIPTION - CAPACITORS (Cont)				Mfr or Supplier	PART No.
C18	4.7µF	63V	elec		PH	2222-015-18478
C19	150µF	16V	elec		PH	2222-016-15151
C20	0.1µF	100V	PYE		SON	TYPE N
C21	4.7µF	63V	elec		PH	2222-015-18478
C22	0.1µF	100V	10%	PYS	SOR	TYPE N
C23	0.1µF	100V	10%	PYS	SOR	TYPE N
C24						
C25						
C26						
C27						
C28						
C29						
C30	10pF	500V	10%	NPO CDS	H.S	CDS
C31	4.7µF	63V	elec		PH	2222-015-18478
C32	270pF	630V	5%	PYS	H.S	TCS605
C33	4,7µF	63V	elec		PH	2222-015-18478
C34	270pF	630V	5%	PYS	H.S	TCS605
C35						
C36						
C37						
C38						
C39						
C40	33pF	500V	5%	N750 CDS	H.S	CDS
C41	0.1µF	100V		PYE	SON	TYPE N
C42	0.1µF	100V		PYE	SON	TYPE N
C43	100µF	63V	elec		PH	2222-017-18101
C44	0.1µF	160V	10%	PYE	PH	2202-315-31104
C45	50µF	150V	elec		PH	2222-040-11509
C46	0.1µF	160V	10%	PYE	PH	2202-315-31104
C47	150µF	16V	elec		PH	2222-016-15151
C48	150µF	16V	elec		PH	2222-016-15151
C49	100µF	63V	elec		PH	2222-017-18101
C50	0.1µF	160V	10%	PYE	PH	2202-315-31104
C51	0.1µF	400V	10%	PYE	PH	2202-315-51104
C52	0.1µF	630V	20%	MPC	PH	2222-342-61104
C53	0.0022µF	500V	20%	CDS	H.S	CDS
C54						
C55						
C56						
C57						
C58						
C59						
C60	0.1µF	100V		PYE	SON	TYPE N
C61	.047µF	160V	10%	PYE	PH	2202-315-31473

PARTS LIST

CCT Ref	DESCRIPTION - CAPACITORS (Cont)				Mfr. or Supplier	PART No.
C62						
C63	39pF	500V	5%	N330 CDS	H.S	CDS
C64	5-60pF	trim			PH	C010GA/60E
C65	.047μF	160V	10%	PYE	PH	2202-315-311473
C66						
C67	39pF	500V	5%	N330 CDS	PH	CDS
C68	5-60pF	trim			PH	C010GA/60E
C69	68pF	500V	5%	N750 CDS	H.S	CDS
C70	0.1μF	100V		PYE	SON	TYPE N
C71	0.22μF	100V	10%	PYE	SON	TYPE N
C72	47μF	25V	elec		PH	2222-015-16479
C73						
C74						
C75	.0075μF	4KV		CDS	D	CDH
C76	.0075μF	4KV		CDS	D	CDH
C77	.0075μF	4KV		CDS	D	CDH
C78	.01μF	2.5KV		CDS	D	CDH
C79	.01μF	2.5KV		CDS	D	CDH
C80	.47μF	200V	10%	PYE	SON	TYPE N
C81						
C82						
C83						
C84						
C85						
C86						
C87						
C88						
C89						
C90	0.001μF	3KV		CDS	D	CDH
C91	.01μF	2.5KV		CDS	D	CDH
C92	0.1μF	100V		PYE	SON	TYPE N
C93	0.1μF	100V		PYE	SON	TYPE N
C94						
C95						
C96						
C97						
C98						
C99						
C100	22μF	25V		elec	PH	2222-015-16229
C101	2.20pF	Trimmer			PH	C010EA/20E
C102	22μF	25V		elec	PH	2222-015-16229
C103	47pF	500V	5%	N750 CDS	AC	CDS
C104	5.60pF	Trimmer			PH	C010GA/60E
C105	47pF	500V	5%	N750 CDS	AC	CDS

PARTS LIST

CCT Ref	DESCRIPTION - CAPACITORS (Cont)				Mfr or Supplier	PART No.
C106	100pF	500V	5%	N750 CDS	H.S	CDS
C107	100pF	500V	5%	N750 CDS	H.S	CDS
C108	100pF	500V	5%	N750 CDS	H.S	CDS
C109	0.047µF	160V	10%	PYE	PH	2202-315-31473
C110	0.1µF	100V	10%	PYE	SON	TYPE N
C111	22µF	25V		elec	PH	2222-015-16229
C112	2-20pF	Trimmer				C010EA/20E
C113	22µF	25V		elec	PH	2222-015-16229
C114	47pF	500V	5%	N750 CDS	H.S	CDS
C115	5-60pF	Trimmer			PH	C010GA/60E
C116	47pF	500V	5%	N750 CDS	H.S	CDS.
C117	100pF	500V	5%	N750 CDS	H.S	CDS
C118	100pF	500V	5%	N750 CDS	H.S	CDS
C119	100pF	500V	5%	N750 CDS	H.S	CDS
C120	0.047µF	160V	10%	PYE	PH	2202-315-31473
C121	0.1µF	100V	10%	PYE	SON	TYPE N
C122						
	POTENTIOMETERS					
RV1	10KΩ	LIN	PRESET	C	PH	2322-411-03307
RV2	4.7KΩ	LIN	PRESET	C	PH	2322-411-03306
RV3	2.2KΩ	LIN	PRESET	C	PH	2322-411-03305
RV4	4.7KΩ	LIN	PRESET	C	PH	2322-411-03307
RV5	4.7KΩ	LIN	PRESET	C	PH	2322-411-03307
RV6	4.7KΩ	LIN	PRESET	C	PH	2322-411-03307
RV7	4.7KΩ	LIN	PRESET	C	PH	2322-411-03307
RV8	50Ω WW	LIN with DPST ROTARY SWITCH			IRC	
RV9						
RV10	100Ω	LIN	PRESET	C	PH	2322-411-03301
RV11	100Ω	LIN	PRESET	C	PH	2322-411-03301
RV12	470KΩ	LIN	PRESET	C	PH	2322-411-03313
RV13	220KΩ	LIN	PRESET	C	PH	2322-411-03312
RV14A)	100KΩ	LIN	CONC.PRESET	C	D	PDU
RV14B)	2.5MΩ	LIN	CONC	C	D	
RV15	22KΩ	LIN	PRESET	C	PH	2322-411-03308
RV16	100KΩ	LIN	C		D	VCU
RV17	100KΩ	LIN	C		D	VCU
RV18	22KΩ	LIN	PRESET	C	PH	2322-411-03308
RV19	220KΩ	LIN	PRESET	C	PH	2322-411-03312
RV20A)	100KΩ	LIN	CONC.PRESET		D	PDU
RV20B)	2.5MΩ	LIN	CONC.	C	D	
RV21						
RV22						
RV23						

PARTS LIST

CCT Ref	DESCRIPTION - POTENTIOMETERS (Cont)				Mfr or Supplier	PART No.
RV24	1KΩ	LIN	PRESET	C	PH	2322-411-02204
RV25	220Ω	LIN	PRESET	C	PH	2322-411-02202
RV26	1KΩ	LIN	PRESET	C	PH	2322-411-02204
RV27	4.7KΩ	LIN	PRESET	C	PH	2322-411-03306
RV28	220Ω	LIN	PRESET	C	PH	2322-411-03302
RV29	4.7KΩ	LIN	PRESET	C	PH	2322-411-03306
RV30						
RV31	1KΩ	LIN	PRESET	C	PH	2322-411-02204
RV32	220Ω	LIN	PRESET	C	PH	2322-411-02202
RV33	1KΩ	LIN	PRESET	C	PH	2322-411-02204
RV34	4.7KΩ	LIN	PRESET	C	PH	2322-411-03306
RV35	220Ω	LIN	PRESET	C	PH	2322-411-03302
RV36	4.7KΩ	LIN	PRESET	C	PH	2322-411-03306
RV37						
		DIODES				
D1	200V	PIV	500mA	SI	STC	EM402/SD55-4
D2	200V	PIV	500mA	SI	STC	EM402/SD55-4
D3	200V	PIV	500mA	SI	STC	EM402/SD55-4
D4	200V	PIV	500mA	SI	STC	EM402/SD55-4
D5	200V	PIV	500mA	SI	STC	EM402/SD55-4
D6	200V	PIV	500mA	SI	STC	EM402/SD55-4
D7	200V	PIV	500mA	SI	STC	EM402/SD55-4
D8	200V	PIV	500mA	SI	STC	EM402/SD55-4
D9	200V	PIV	500mA	SI	STC	EM402/SD55-4
D10	200V	PIV	500mA	SI	STC	EM402/SD55-4
D11	6.2V	ZENER DIODE 350mW			PH	BZY88/C6V2
D12	22V	ZENER DIODE 350mW			PH	BZY88/C22
D13(1)	47V	ZENER DIODE 350mW			PH	BZX61/C47
D14(1)	47V	ZENER DIODE 350mW			PH	BZX61/C47
D15	70V	50mA		SI	F	AN206
D16	15KV	PIV	2.5mA	SI	PH	BY140
D17	15KV	PIV	2.5mA	SI	PH	BY140
D18	400V	PIV	500mA	SI	STC	EM404/SD55-4
D19	15KV	PIV	2.5mA	SI	PH	BY140
D20	6.2V	ZENER DIODE 350mW			PH	BZY88/C6V2
D21	75V	PIV	50mA	SI	F	AN206
D22(1)	12V	ZENER DIODE 350mW			PH	BZY88/C12
D23(1)	12V	ZENER DIODE 350mW			PH	BZY88/C12
D24	75V	PIV	50mA	SI	F	AN206
D25	75V	PIV	50mA	SI	F	AN206
D26(1)	12V	ZENER DIODE 350mW			PH	BZY88/C12
D27(1)	12V	ZENER DIODE 350mW			PH	BZY88/C12
D28	75V	PIV	50mA		F	AN206

(1) Matched Pair

PARTS LIST

CCT Ref	DESCRIPTION - TRANSISTORS					Mfr or Supplier	PART No.
Q1	300V	Vce	0.5A 20W	SI	NPN	M	MJE340
Q2							
Q3	300V	Vce	0.5A 20W	SI	NPN	M	MJE340
Q4	300V	Vce	0.5A 20W	SI	NPN	M	MJE340
A5	60V	Vce	10A 90W	SI	NPN	M	MJE3055
Q6	300V	Vce	0.5A 20W	SI	NPN	M	MJE340
Q7							
Q8	300V	Vce	hfe 100	SI	NPN	M	MJE340
Q9	45V	Vce	hfe 200	SI	NPN	PH	BC147
Q10	45V	Vce	hfe 200	SI	NPN	PH	BC147
Q11	-45V	Vce	hfe 100	SI	PNP	PH	BC157
Q12	-25V	Vce	hfe 25	SI	PNP	F	2N3638
Q13	-25V	Vce	hfe 25	SI	PNP	F	2N3638
Q14	60V	Vce	10A 20W	SI	NPN	M	MJE3055
Q15	-45V	Vce	hfe 100	SI	PNP	PH	BC157
Q16	-60V	Vce	hfe 100	SI	PNP	F	2N3645
Q17	300V	Vce	0.5A 20W	SI	NPN	M	MJE340
Q18	45V	Vce	hfe 200	SI	NPN	PH	BC147
Q19	150V	Vce	hfe 40	SI	NPN	PH	BD 115
Q20	45V	Vce	hfe 200	SI	NPN	F	BC147
Q21	150V	Vce	hfe 40	SI	NPN	PH	BD115
Q22	45V	Vce	hfe 100	SI	NPN	F	BC147
Q23	N CHANNEL FET					TI	2N3638
Q24	-25V	Vce	hfe 25	SI	PNP	F	2N3638
Q25	300V	Vce	0.5A 20W		NPN	M	MJE340
Q26							
Q27							
Q28							
Q29							
Q30	45V	Vce	hfe 200	SI	NPN	PH	BC147
Q31(1)	60V	Vce	hfe 25	SI	NPN	STC	TT3118
Q32(1)	60V	Vce	hfe 25	SI	NPN	STC	TT3118
Q33(1)	20V	Vce	hte 40	SI	NPN	F	AY1119
Q34(1)	20V	Vce	hfe 40	SI	NPN	F	AY1119
Q35(1)	60V	Vce	hfe 25	SI	NPN	STC	TT3118
Q36(1)	60V	Vce	hfe 25	SI	NPN	STC	TT3118
Q37(1)	20V	Vce	hfe 40	SI	NPN	F	AY1119
Q38(1)	20V	Vce	hfe 40	SI	NPN	F	AY1119
Q39							
Q40	45V	Vce	hfe 200	SI	NPN	PH	BC147
Q41	-45V	Vce	hfe 100	SI	PNP	PH	BC157
Q42	-60V	Vce	1 A 30W	SI	PNP	TI	TIP30A
Q43					NPN		
Q44					NPN		

(1) Matched Pairs

PARTS LIST

CCT Ref	DESCRIPTION - TRANSISTORS (Cont)	Mfr or Supplier	PART No.
Q45	-20V Vce hfe 100 SI PNP	F	AY1114
Q46	-20V Vce hfe 100 SI PNP	F	AY1114
Q47	20V Vce hfe 40 SI NPN	F	AY1119
Q48	20V Vce hfe 40 SI NPN	F	AY1119
Q49	20V Vce hfe 40 SI NPN	F	AY1119
Q50	20V Vce hfe 40 SI NPN	F	AY1119
Q51	60V Vce hfe 25 SI NPN	STC	TT3118
Q52	60V Vce hfe 25 SI NPN	STC	TT3118
Q53	45V Vce hfe 100 SI NPN	PH	BC147
Q54	- 20V Vce hte 100 SI PNP	F	AY1114
Q55	- 20V Vce hfe 100 SI PNP	F	AY1114
Q56	20V Vce hfe 40 SI NPN	F	AY1119
Q57	20V Vce hfe 40 SI NPN	F	AY1119
Q58	20V Vce hfe 40 SI NPN	F	AY1119
Q59	20V Vce hfe 40 SI NPN	F	AY1119
Q60	60V Vce hfe 25 SI NPN	STC	TT3118
Q61	60V Vce hfe 25 SI NPN	STC	TT3118
	SUNDRY		
V1	CRT 5" DOUBLE GUN 1324 = P31 1325 = P2 1346 = P7	GEC	1300M Series
B1	IND LAMP MIN	SON	
S1A-B	DPST SWITCH		Rear of RV8
S2	DPDT SLIDE SWITCH	MSP	22778
S3	3 PDT SLIDE SW TYPE S4	H	RQ 153S
F1	250mA CARTRIDGE FUSE	Y	
F2	100mA CARTRIDGE FUSE	Y	
F3	100mA CARTRIDGE FUSE	Y	
F4	1A DELAY CARTRIDGE FUSE	Y	
PS1	24 WAY RED RANGE SOCKET	McM	RS24
PS2	24 WAY RED RANGE SOCKET	McM	RS24
PS3	24 WAY RED RANGE SOCKET	McM	RS24
J1	4mm panel socket	GRA	GR165
J2	4mm panel socket	GRA	GR165
J3	TERMINAL JUNG	ACME	052
J4	TERMINAL JUNG	ACME	052
J5	4mm panel socket	GRA	GR165
J6	4mm panel socket	GRA	GR165
T1	POWER TRANSFORMER	BWD	6511
	GRATICULE	BWD	
	FILTER GREEN	BWD	
	FILTER AMBER	BWD	
	ESCHUTCHEON CRT	BWD	221/005
B1	6.3V 100mA LILLIPUT LAMPS	GRA	E5/8
B2	6.3V 100mA LILLIPUT LAMPS	GRA	E5/8

PARTS LIST

CCT Ref	DESCRIPTION - SUNDRY (Cont)	Mfr or Supplier	PART No.
	LAMP HOLDERS ¾" SHORTING LINK 9ft. Power Cord & 3 pin Plug	BULGIN GR BWD	LSS64 938L obd
	ALL OTHER ITEMS ORDER BY DESCRIPTION REPLACED Q14 30-4-86		
	McVane Instruments 58 Fedder St Mulgrave 3170 Paul Holyoake. Leslie — Boss 03 561 2888		

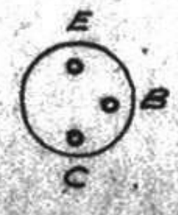
R / T9	MODIFICATIONS.
C' / 53	2 x 560Ω IN ADDED IN SERIES
Q / 23	COLLECTOR Q1. (R142 & R143)
D / 15	C23 0·01 REMOVED.
	R79 27K ADDED. Q20 & Q22 WERE AY1101. PIN #18 402. PS3 NOW TAKEN TO 0V.
ISSUE 6	R77 ADDED. C23 " ALTERNATIVE TRANSISTOR TYPES ADDED D16 ADDED. R16 WAS 1KΩ. C32 WAS 560pf.
ISSUE 7 17-3-70	R104 - R77 - R78 C55 - C34 ADDED C40 WAS 0.001

SWITCHES.

S1A & B.	POWER ON/OFF.
S2A & B.	TRIGGER SELECTOR.
S3A & B.	EXT. TRIG. & HORZ. AMP. ATTEN.

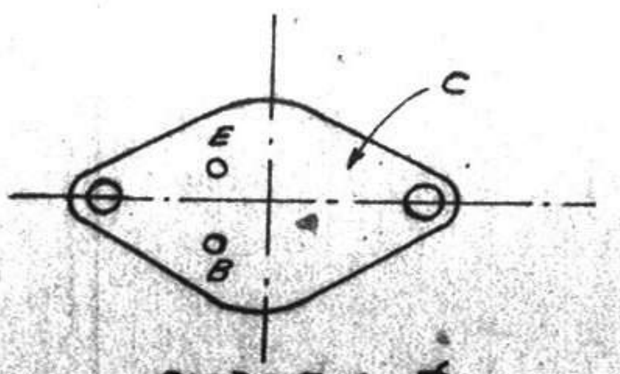
CONTROLS.

RV1.	SET +100V.
RV2.	SET +50V.
RV3.	SET +12V.
RV4.	SET -12V.
RV5.	SET -50V.
RV6.	HORZ. AMP. BALANCE.
RV7.	CAL. OUTPUT PRESET.
RV8.	GRATICULE ILLUMINATION.



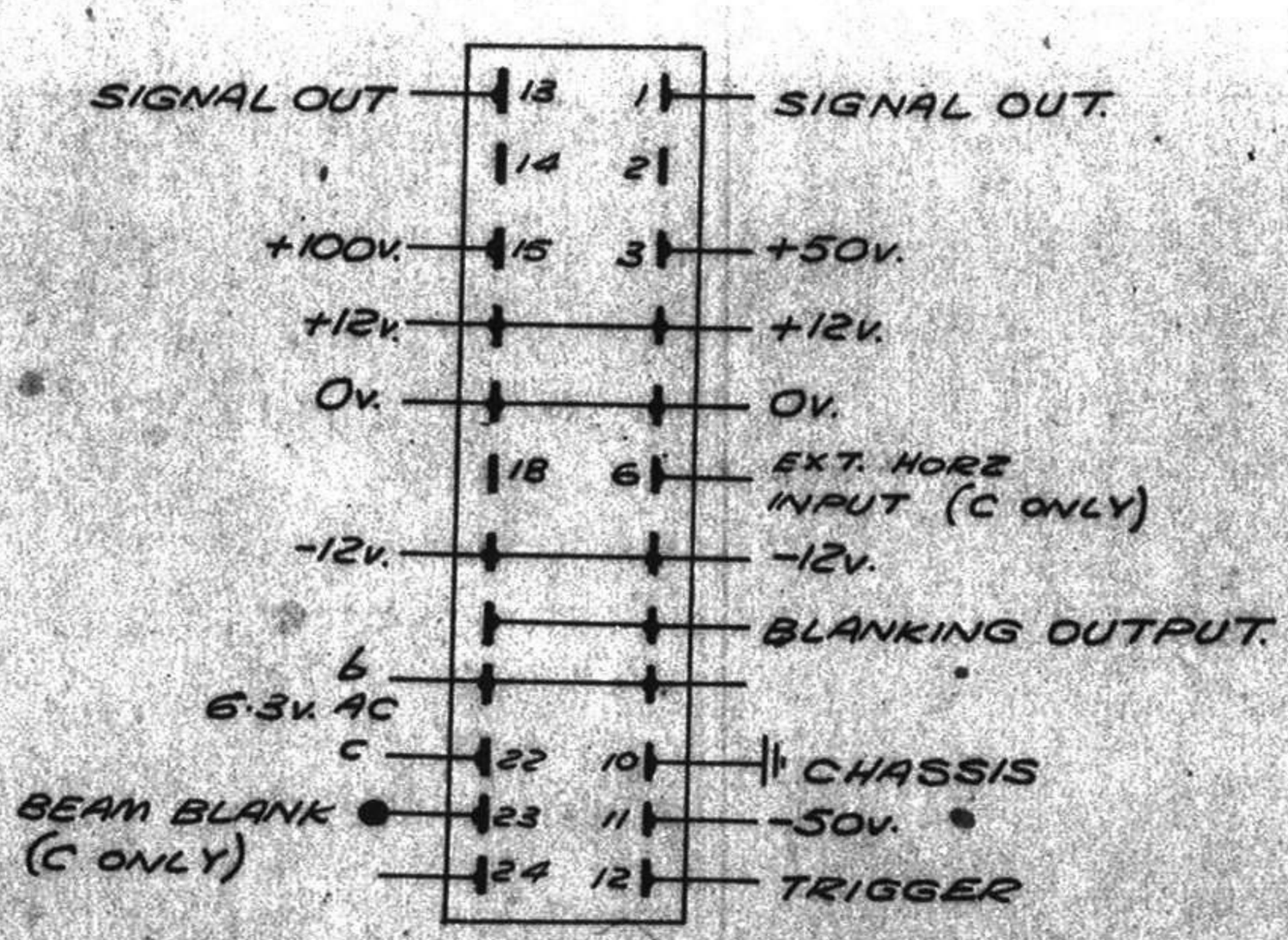
AY1101, BFY43, OC940, ETC. BASES.

2N3819 F.E.T. BASE.



2N3054 & 2N3055 BASES.

SOCKETS A, B & C SIGNAL VOLTAGES.



LOW VOLTAGE POWER SUPPLIES.

T1.

105 — 0 — 50 — 0 — 12 — 0 — 215 — 235

4 x EM402 (D1, D2, D3, D4)

F1 0.25A

A

C1 50/150

+18v.

+150v. (HUM: 7v. P-P)

R2 22Ω

R12 47k

R142 & R143 2 x 560Ω 1W

Q1

Q2 MJE340 or BFY43

BF178

C2 40/200

10v.

+122v.

+150v. MJE340 or 2N3055

R13 47k

C12 5/64

R72 4.7k

Q17 MJE340 or 2N3054

D12 BZY94/C22

+122v.

150Ω R77

0.1 C23

+100v. (HUM: 1mV) P-P

C13 12.5/150

Q3

R14 4.7k

RV1

R15 39k

EM401

10k

MJE340 or 2N3054

Q4

D5 EM402

F2 100mA

+64v.

R11 47k

+100v.

C22 0.1

R17 39k

C14 5/64

+50v. (Hum: 3mV P-P)

Q7 AY1101

R16 1K

R18 10k

D16

Q6 AY1101

RV2 4.7k

D6

R3 100k

-65v.

C3

F4

1A. DELAY

S1A — S1B

A.C. INPUT

IND. NEON. B1

+150v. A

-65v. B

B2 6.3v. 100mA.

B3 6.3v 100mA.

6V

50Ω RV8

MJE3055 or 2N3055

Q5

R20 0.6Ω

+18v.

D7 EM402

+50v.

210 22k

Q8 2N3054

R21 1k

Q9 AY1112

C15 5/64

C16 0.1

R73 8.2k

RV4 4.7k

R24 2.7k

D8 EM402

C5,6&7 3x 640/25.

Q10 AY1112

R22 1k

R19 6.8k

R23 2.2k

+12v.

D11 BZY88/C6V2

R25 3.3k

RV3 2.2k

0v.

AY1114

Q11

R26 1k

R50 6.8k

R30 8.2k

C19 125/16

D9 EM402

R9 22k

-50v.

2N3638

C17 0.1

C18 5/64

-11.5v.

R32 10Ω

C8&9 2x 640/25

R8 1.1k

Q12

R27 1k

Q13

R29 82Ω

R31 10k

D10 EM402

-18v.

Q14

R28 1.5Ω

2N3054 or MJE3055

-12v. (HUM: 1mV P-P)

6.3v. b — 6.3v. c — CRT HTR.

RV5 4.7k

C11 32/64

R33 1k

R34 10k

C10 80/100

R7 33k

Q15 2N3644

R5 4.7k

Q16

C20 0.1

R29 33k

C21 5/64

R6 1k

Q25 2N3054 or MJE340

F3 100mA.

R35 10k

-50v. (HUM: 3mV P-P)

NOTE. R142&143 ONLY FITTED WHEN Q1 IS A 2N3055 TRANSISTOR.

+122v. (HUM: 15mV. P-P)

-12v.

R40 6.8k 3W.

R41 6.8k 3W.

TO CRT

25 — 15

R36 10k

AY1101

Q18

R37 22k

R38 82Ω

SE7001

Q19

150k R77

SE7001

Q21

R39 82Ω

C30 0.1

R42 27k

C34 .001

R78 8.2k

-50v.

BC147

Q20

Q22

C31 5/64

R46 150Ω

C32 680pf.

C33 5/64

BZY94/C47 D13

R44 6.8k

R45 1.5k

R47 1.5k

R48 6.8k

BZY94/C47 D14

R43 1k

R49 1k

RV6 4.7k

-50v.

HORZ. AMP & EXT. TRIG. INPUT

J1 AC

C51 0.1/400

J2 DC

C53 0.0022

+12v.

X1

R56 100k

R57 47Ω

2N3819 Q23

50v. AC

R53 & R54 2 x 1.8mΩ

÷10 S3A

D15 IN914

-12v.

12v. AC

R74 22k

R58 22k.

C55 .001

RV7 4.7k

R55 100k

R75 6.8k

0v.

S3B.

-50v.

0v.

HORZ. "C".

Q37

LOWER "B"

Q38

Q33

UPPER "A"

+50v.

+100v.

PS3

PS2

PS1

R51 10k

R52 10k

C43

C44 0.01

C45 50/150

C46 0.01

R66 10k

R67 10k

R68 10k

+12v.

0v.

C41 0.1

C47 125/16

R64 100Ω

C42 0.1

C48 125/16

-12v.

R65. 4.7k

6

6.3v AC c

22 C

22 B

BEAM BLANK. ONCRT. 11

C49 100/64

C50 0.01

-50v.

R71 47Ω

C40 33pf

R104 22Ω

0v.

S2A — S2B

UPPER/LOWER TRIGGER SELECT.

Ø DENOTES

ISSUE	521	B.W.D. ELECTRONICS P/L. MELB. AUS
5 / 8 68	Drawn JG Traced	b.w.d 521 MAIN FRAM
		LOW VOLTAGE SUPPLIES

HORZ. AMP. & EXT. TRIG. INPUT.

CALIBRATOR.

HORZ. "C".

LOWER "B"

UPPER "A"

PS3

PS2

PS1

+122v. (HUM: 15mV. p-p)

+150v. (HUM: 7v. p-p)

+122v.

+150v.

+100v. (HUM: 1mV p-p)

+50v. (Hum: 3mV p-p)

+12v. (HUM: 1mV p-p)

-12v. (HUM: 1mV p-p)

-50v. (HUM: 3mV p-p)

0v.

+18v.

-18v.

+64v.

-65v.

-11.5v.

+50v.

+100v.

+12v.

-12v.

-50v.

6·3v. AC.

F1 0·25A.

F2 100mA

F3 100mA.

4 x EM402

D1 D2 D3 D4 D5 D6 D7 D8 D9 D10 D11 D12 D13 D14 D15 D16

EM402

BZY88/C6V2

BZY94/C22

BZY94/C47

EM401

IN914

AY1101

AY1112

AY1114

BC147

SE7001

BF178

BFY43

2N3054

2N3055

2N3638

2N3644

2N3819

MJE340

MJE3055

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25

R1 47k

R2 22Ω

R3 100k

R4 100k

R9 22k

R10 22k

R11 47k

R12 47k

R13 47k

R14 4·7k

R15 39k

R16 1K

R17 39k

R18 10k

R19 6·8k

R20 0·6Ω

R21 1k

R22 1k

R23 2·2k

R24 2·7k

R25 3·3k

R26 1k

R27 1k

R28 1·5Ω

R29 82Ω

R30 8·2k

R31 10k

R32 10Ω

R33 1k

R34 10k

R35 10k

R36 10k

R37 22k

R38 82Ω

R39 82Ω.

R40 6·8k 3W.

R41 6·8k 3W.

R42 27k

R43 1k

R44 6·8k

R45 1·5k

R46 150Ω

R47 1·5k

R48 6·8k.

R49 1k

R50 6·8k

R51 10k

R52 10k

R53 & R54 2 x 1·8mΩ.

R55 100k

R56 100k

R57 47Ω

R58 22k.

R59 27k

R60 3·3k

R61 9·5k.

R62 100Ω

R63 1MΩ.

R64 100Ω

R65. 4·7k

R66 10k

R67 10k

R68 10k

R69 10k

R70. 1k

R71. 47Ω

R72 4·7k

R74 22k

R75 6·8k

R76 1k

R77 150k

R78 8·2k

C1 50/150

C2 40/200

C3 80/100

C4 3 x 640/25.

C5,6&7

C8&9 2 x 640/25

C10 80/100

C11 32/64

C12 5/64

C13 12·5/150

C14 5/64

C15 5/64

C16 0·1

C17 0·1

C18 5/64

C19 125/16

C20 0·1

C21 5/64

C22 0·1

C23 0·1

C30 0·1

C31 5/64

C32 680pf.

C33 5/64

C34 ·001

C40 33pf

C41. 0·1

C42 0·1

C43 10/64

C44 0·01

C45 50/150

C46 0·01

C47 125/16

C48 125/16

C49 100/64

C50 0·01

C51 0·1/400

C52 0·1/630

C53 0·0022

C55 ·001

RV1 10k

RV2 4·7k

RV3 2·2k

RV4 4·7k

RV5 4·7k

RV6 4·7k

RV7 4·7k

S1A S1B

S2A S2B

S3A S3B

÷10

J1 AC

J2 DC

J3

J4

J5 5v. P-P

J6 50mV P-P

X1

LINK

BEAM BLANK. ONCRT.

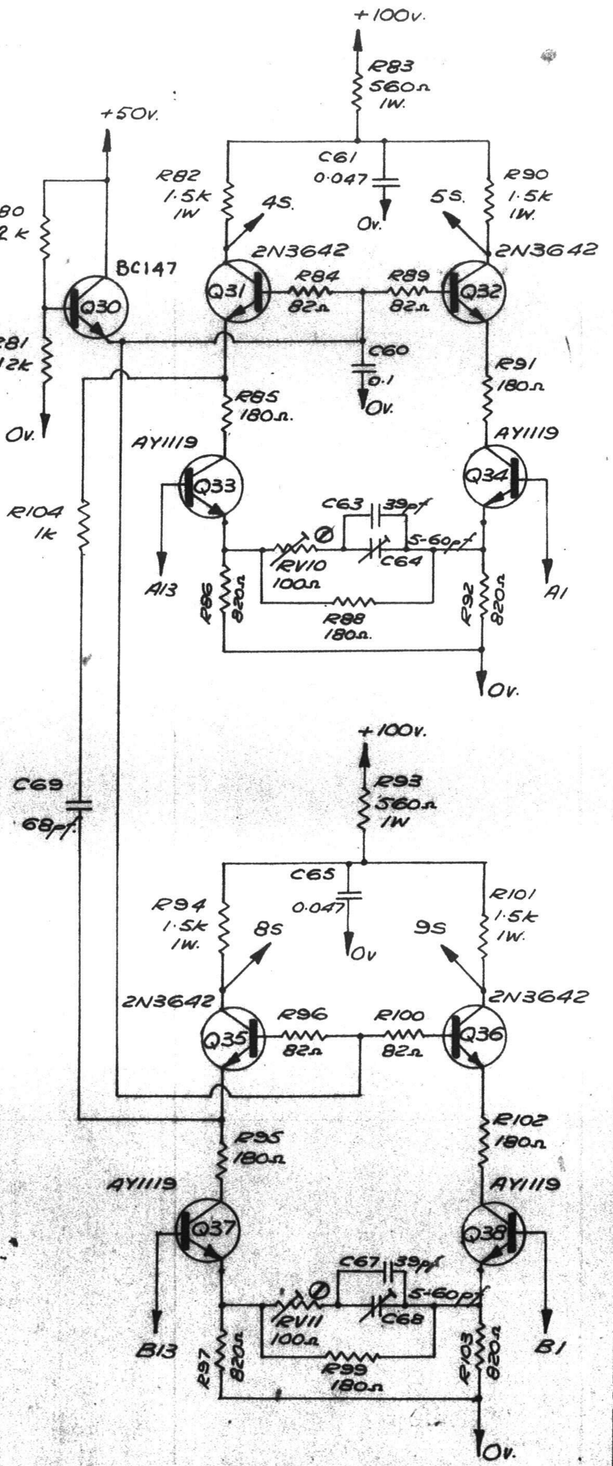
TO CRT 1S 2S

UPPER/LOWER TRIGGER SELECT.

CRT HTR.

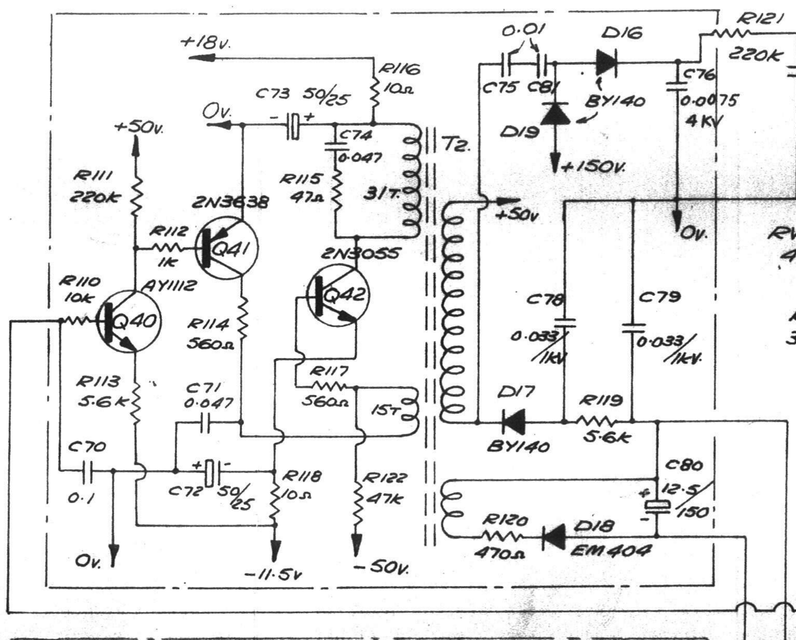
Ø DENOTES INTERNAL PRESET.

ISSUE	521	B.W.D. ELECTRONICS P/L. MELB. AUST.	Dgg. No.
5/8/68	Drawn / Traced	b.w.d 521 MAIN FRAME LOW VOLTAGE SUPPLIES.	680



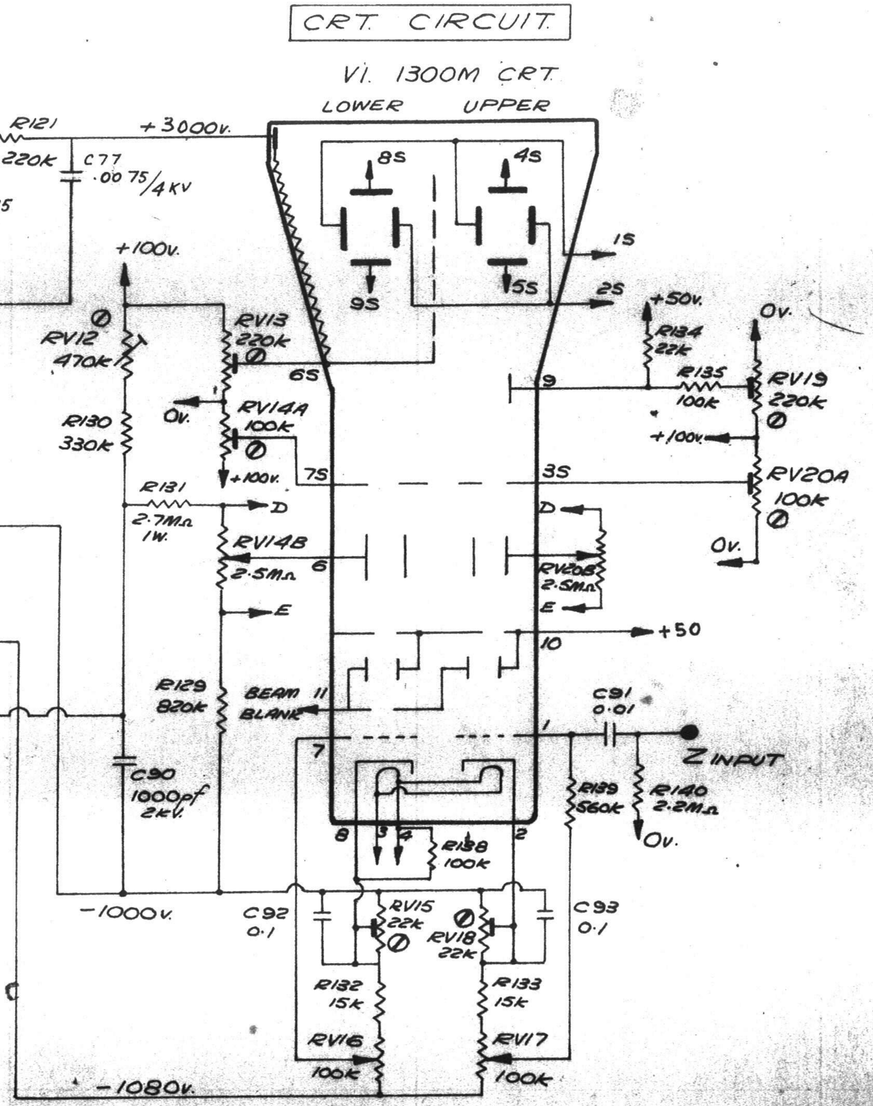
VERTICAL OUTPUT AMPLIFIERS.

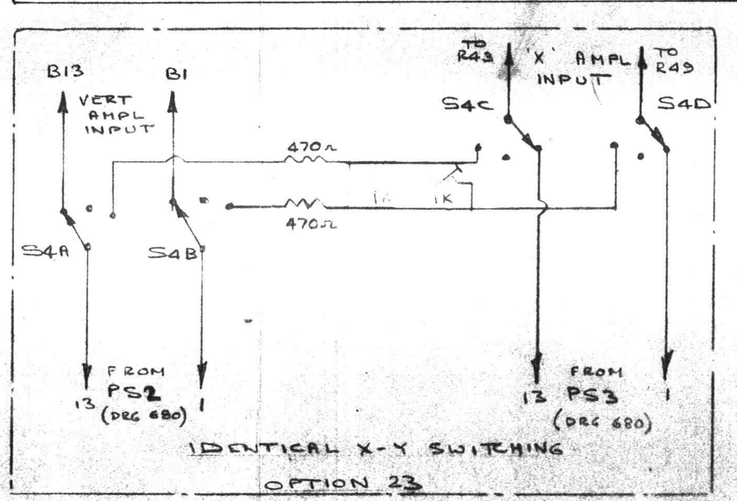
EHT. SUPPLY



CRT. CIRCUIT

VI. 1300M CRT.





Ø DENOTES INTERNAL PRESET.

ISSUE	521	B.W.D. ELECTRONICS P/L. MELB. AUST.	Dwg. N°
4 / 6/69	3 / 8/68	Drawn JS; Traced	b.w.d 521 MAIN FRAME VERT AMPS & CRT CIRCUIT	681

R 140	MODIFICATIONS:
C 93	ISSUE 4 OPTION 23 ADDED
D 19	ISSUE 5 R87 & 98. C62 & 66 REMOVED
Q 42	

CONTROLS

RV10. H.F. RESPONSE UPPER AMP.
RV11. " " LOWER AMP.
RV12. SET -1000V. EHT.
RV13. CRT. GEOMETRY.
RV14A. ASTIGMATISM (LOWER)
RV14B. FOCUS "
RV15. TRACE ALIGNMENT "
RV16. INTENSITY "
RV17. " (UPPER)
RV18. TRACE ALIGNMENT "
RV19. HORZ. " "
RV20A. ASTIGMATISM "
RV20B. FOCUS "
RV21. BEAM BLANKING PRESET.
RV22 UPPER BEAM GAIN PRESET - OPTION 23

SWITCHES

S4A-D NORMAL - IDENTICAL X-Y CHANGEOVER