BWD ELECTRONICS PTY LTD
MILES STREET
MULGRAVE VIC 3170
AUSTRALIA

PO BOX 325
SPRINGVALE 3171

PHONE (03) 561 2888 (3 LINES)

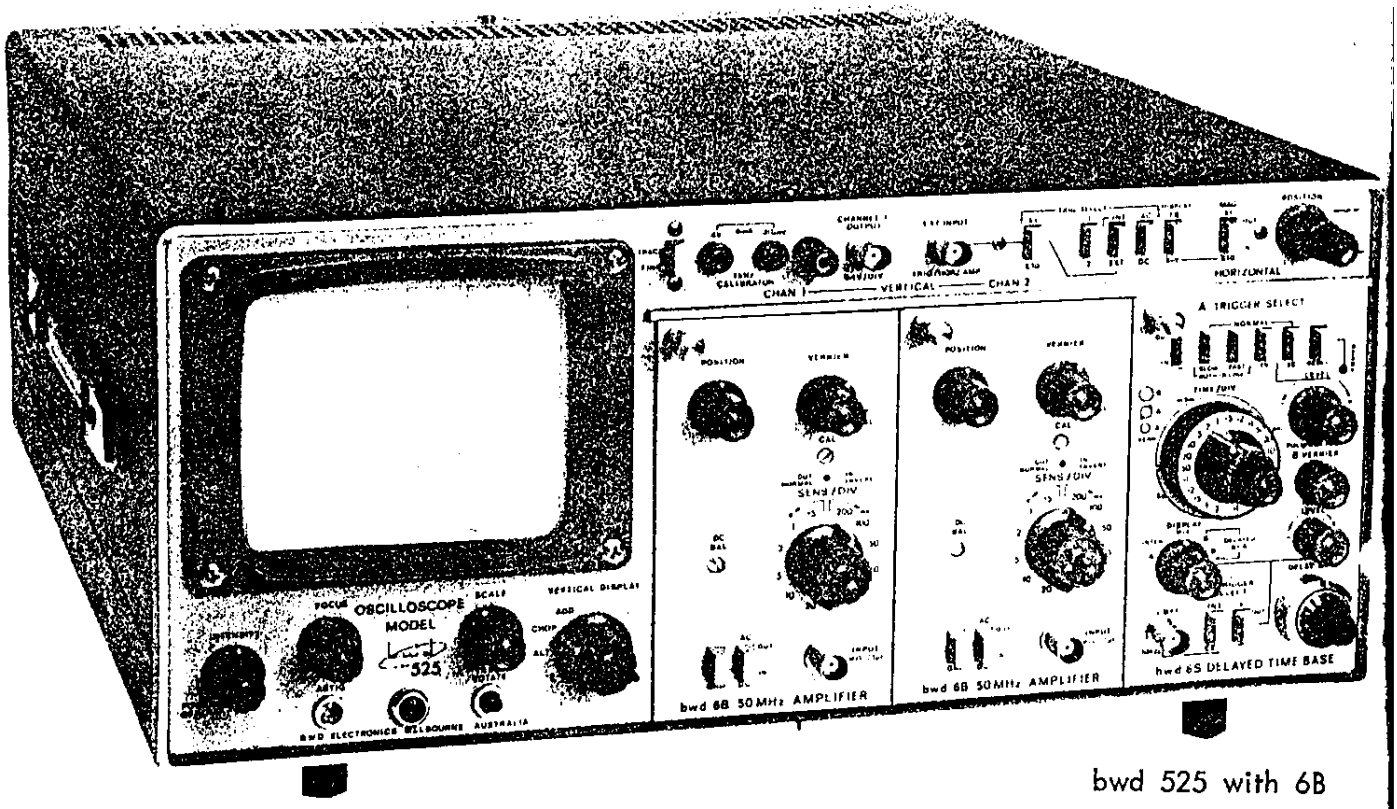
CABLES 'OSCILLOSCOPE'

TELEX AA35115

525

DC to 50MHz OSCILLOSCOPE

ISSUE 13



bwd 525 with 6B
Amplifiers and 6S Time Base

INDEX

INSTRUMENT HANDBOOK

MODEL bwd 525

50MHz OSCILLOSCOPE MAIN FRAME

1. GENERAL

The bwd 525 main frame and 6 series plug-ins provide a performance and versatility for almost every measurement need in the DC to 50MHz range.

The instrument is 100% silicon solid state and incorporates three plug-in compartments for the 6 series amplifiers and time bases. As the two vertical amplifier plug-ins are quite independent of each other, identical or different plug-ins can be used to suit the requirements of a particular application.

The main frame contains the low voltage supplies, EHT supply, vertical and horizontal deflection systems, CRT and signal switching circuits. All DC supplies are electronically regulated to accommodate input voltage and load variations of plug-ins.

Long term reliability is a major feature of the design which has been subject to environmental and vibration tests and each instrument is heat soaked, vibrated, as part of its alignment procedure.

Plug-in amplifiers for the 525 main frame provide sensitivities from 10μV at 1MHz bandwidth to 5mV at 50MHz. Additionally an output signal from Channel 1 is available on the front panel enabling it to be cascaded with Channel 2 to increase gain by x10 at reduced bandwidth.

Time base plug-ins sweep over an extremely wide range from 10nSec. to 10Sec/div. with very comprehensive trigger facilities including TV line and frame lock.

Identical X-Y operation is incorporated in the main frame with a phase variation at similar sensitivities of less than 2° at 1MHz.

Although the facilities incorporated are very comprehensive, operation is remarkably easy. Normal operation is obtained with all push button out and only if a selected function is needed, does a button require to be operated.

Plug-in units can be removed and interchanged whilst the oscilloscope is operating and all amplifier inputs are fully protected against damage by overload.

Cabinet universal for bench or rack mounting, the latter with rack adaptors. For portable use a handle is fitted to one side, making it as convenient to carry as a small suitcase.

For maximum reliability it is advisable to replace power and supply 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 or 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 together with a full range of accessories is available (see catalogue).

2. PERFORMANCE

2.1 Main Frame Specification

CRT:	80 x 100mm rectangular single gun, mesh PDA, fitted internal graticule, type D14-121/08.
EHT:	10kV stabilised.
Deflection:	Vertical 80mm, horizontal 100mm; with dual trace operation both displays cover the entire screen area.
Phosphor:	Normally supplied with P31. P7 available as option.
Graticule:	Internal parallax free with variable illumination. (Calibration 8 x 10 divisions with 5 subdivisions on main axis). Fitted with light blue filter for P31 or amber for P7. (1 div. = 1cm).
Z Modulation (rear panel):	+2V will blank trace at normal intensity from DC to >10MHz. Input impedance 4.7KΩ and 10pf.
Calibrator:	Output, rectangular positive going from ground, 1kHz frequency. Voltage: 40mV and 4V into 1MΩ. Current: 4mA rectangular waveshape with optional accessory current loop connected between output socket. Accuracy: 4V 1% 15-35°C, 2% 0-50°C. 40mV and 4mA 2% 15-35°C and 3% 0-50°C. 1kHz frequency 1% 15-30°C and 2% 0-50°C.

2.2 Vertical Deflection System

Channels:	Two left hand compartments accommodate all 6 series amplifiers.
Sensitivity:	Dependent on plug-in.
Bandwidth:	Dependent on plug-in. Max. bandwidth >50MHz.
Display Modes:	Channel 1, Channel 2, Alternate, Chopped and Add. (1+2 or 1-2).
Chopping Frequency:	Approximately 500kHz.
Delay Line:	Permits viewing of leading edge of display waveform with 10nSec. min. visible delay at max. time base speed.
Amplifier Output:	0.1V/div. of display from Channel 1. Max. cascade gain x10, bandwidth DC to 15MHz, output impedance 180Ω.

2.3 Horizontal Deflection System

Channel:	One right hand compartment accommodates all 6 series time bases.
Horizontal Display:	Switches allow selection of time base waveform, identical X-Y display from vertical amplifier plug-ins or external horizontal input with wide bandwidth but no phase correction.
Time Base Range:	Dependent on plug-in. Max. speed 10nSec/div.

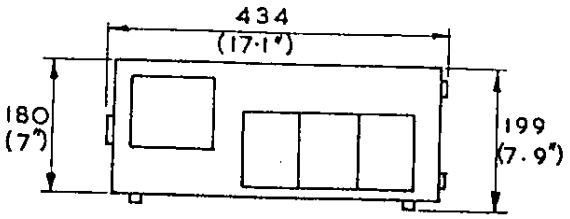
2. PERFORMANCE. (Cont'd.)

2.3 Horizontal Deflection System (Cont'd.)

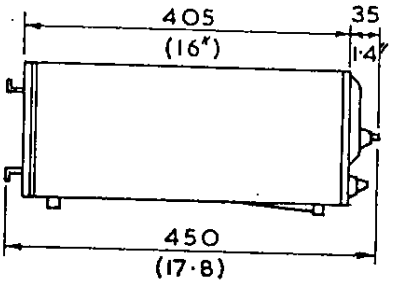
Horizontal Amplifier:	Bandwidth: DC or 2Hz (AC coupled) to 4MHz-3db. Input: 1MΩ and 20pf. Sensitivity: 500mV and 5V/div. approximately.
Identical X-Y Operation:	With two identical plug-in amplifiers fitted, phase shift between the X & Y channels will be within 2° from DC to 1MHz at identical amplifier sensitivities.
Time Base Magnification:	x1 and x10 switched.
Time Base Trigger Selection:	Source: Internal from Channel 1 or 2, External with x1 or x10 sensitivity. Coupline: AC or DC.
Outputs (rear panel):	The displayed time base +1 to +13V, 5KΩ Z out. A time base gate waveform +0.2 to +4V approximately 470Ω Z out. B time base gate waveform +0.2 to +4V approximately 470Ω Z out. A & B gates +0.2V during sweep time.

2.4 General Details

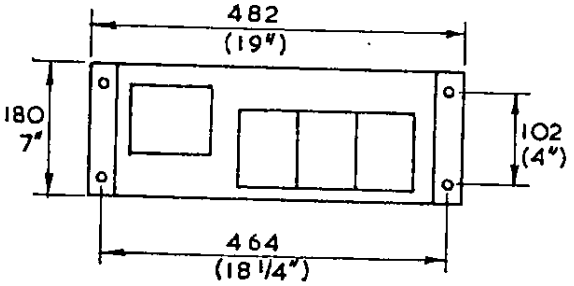
Beam Find:	Limits display to within the area of graticule and overides intensity control.
Line Voltage Ranges:	90 to 135V and 190 to 265V internally selectable with transformer links.
Frequency:	48 - 440Hz.
Power:	75W maximum with three plug-ins operating.
Environmental:	Operational specifications will be met with 10% line voltage change either side of normal value on transformer tapping and from 5° to 35°C 0-80% RH.
Storage:	-20 to +70°C.
Dimensions:	190mm high x 425mm wide x 435mm deep. When fitted with rack adaptors cabinet extends 450mm behind panel and fits a standard 7" 177mm high x 19" 480mm rack space.
Weight:	12kg complete with 3 plug-ins.
Finish:	Light grey and anodised front panels with natural anodised surrounds and dark grey-blue vinyl coated aluminium covers.
Accessories:	Blue or grey light filter (P31) or amber with P7. BNC-BNC patch cord, power cord, instruction and maintenance manual. For other probes, cameras, etc. see bwd catalogue list of accessories.



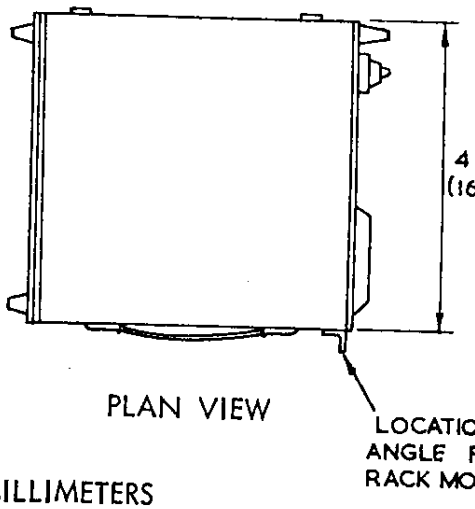
FRONT VIEW



SIDE VIEW



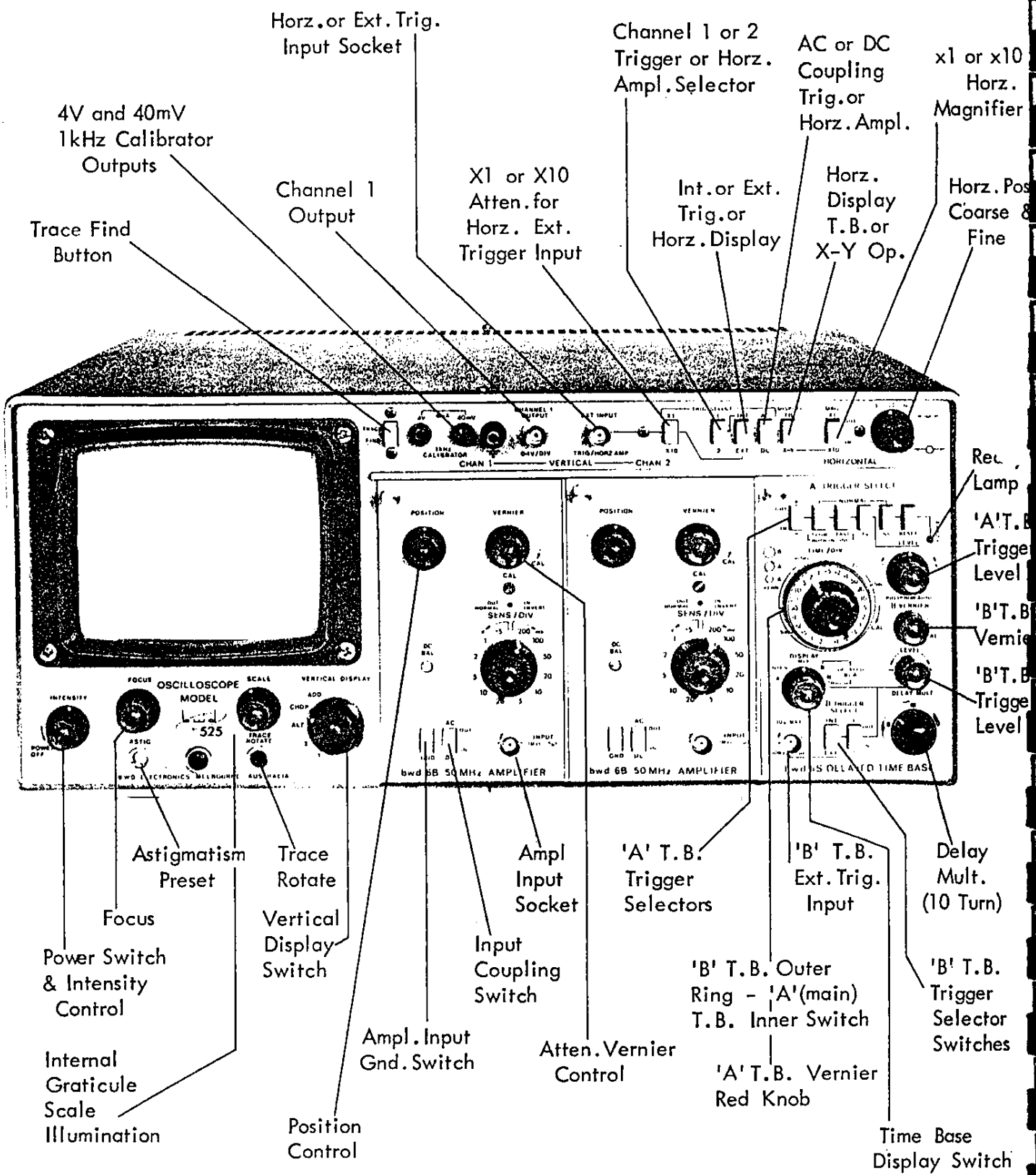
FRONT VIEW RACK MOUNTING



PLAN VIEW

OVERALL DIMENSIONS IN MILLIMETERS

MODEL bwd 525 AND 6 SERIES PLUG - INS



bwd 525 OSCILLOSCOPE WITH 6B AMPLIFIERS AND 6S DELAY TIME BASE PLUG-INS

3. 6-SERIES PLUG-IN SUMMARY

3.1 6A Differential Amplifier

Bandwidth:	DC to 40MHz-3db from 1mV to 20V/div.
Rise Time:	9nSec.
Input:	Balanced differential, individual AC-DC-GND switch for each input. 1MΩ and 25pf each side.

3.2 6B 50MHz Amplifier

Bandwidth:	DC to 50MHz-3db from 5mV to 20V/div.
Rise Time:	7nSec.
Input:	Single ended 1MΩ and 27pf.

3.3 6C High Sensitivity Differential Amplifier

Bandwidth:	DC to 1MHz-3db from 10μV to 20V/div.
Rise Time:	70nSec.
Input:	Differential, individual AC-DC-GND switches for each input 1MΩ and 35pf each side.

3.4 6D Dual Trace Amplifier (2 bwd 6D plug-ins provide 4 trace operation)

Bandwidth:	DC to 50MHz, 5mV to 20V/div. (both channels).
Rise Time:	7nSec.
Input:	Single ended, 1MΩ and 28pf.

3.5 6S Wide Range Delayed Time Base

T.B. Range:	10nSec to 10Sec/div. in 23 ranges plus vernier.
Delay Range:	100nSec to 5Sec in 21 ranges and x10 multiplier.
Modes:	Normal, intensified mixed, delayed trigger, delayed sweep, Single shot, free running.
Trigger Range:	DC to 70MHz.

3.6 6T Wide Range Time Base

Range:	10nSec. to 10Sec/div.
Selection:	Auto, Level Select, TV Trigger, AC, DC, HF or LF.
Trigger Range:	DC to 70MHz.

3.7 6Z Blank Unit

Blank plug-in for custom building special equipments or as a blank when only one amplifier is required for single beam displays.

4. FUNCTION OF CONTROLS

Description is based on 525 main frame fitted with two type 6B amplifiers in left-hand compartments and one 6S in right-hand compartment.

Application details for each 6 series plug-in is contained in its own handbook and should be read in conjunction with the following.

4.1 Main Frame Controls (L.H. Side under CRT)

Power On-Off/Intensity

Control in fully anticlock - switched position removes AC from instrument. Clockwise rotation of control initially switches on AC power. Further clockwise rotation controls intensity of both traces simultaneously from zero to maximum. Adjust control for minimum brightness for satisfactory viewing as this produces sharpest focus and reduces possibility of screen burns.

Focus

Adjust the sharpness of the beam. Control should initially be set in conjunction with astigmatism preset to obtain sharpest display over entire deflection area. Once set astigmatism control will only require infrequent adjustment but focus control will need resetting if intensity control is varied over wide limits.

Astigmatism

Used in conjunction with focus control as above to adjust roundness of spot.

Scale

Controls internal graticule illumination.

Trace Rotate

Adjusts entire display about the X-Y axis and permits the horizontal trace to be referenced accurately against the CRT internal graticule.

Vertical Mode

Five position switch which selects the vertical channel used to present the display.

Sequence

(a) Channel 1 (left compartment) only.
(b) Channel 2 (centre compartment) only.
(c) Alternate with both 1 and 2 displayed on alternate sweeps, changeover being made during the return sweep. Normally employed at time base rates above 1mSec/div.

(d) Chopped

Both traces displayed but now switched at approximately 500kHz between the beams. Transients and switching waveforms are blanked out and to minimise trigger interference the trigger bandwidth is reduced to 1MHz maximum. Chopped mode normally used for displays below 0.5mSec/div. but is in no way limited to this rate for special applications.

(e) Add

Both channels are again displayed but as a single beam display. If both channels are switched to normal display the resultant trace is the addition of both inputs. If channel 2 is switched to invert, the result will be the difference between the two signals thus enabling differential measurements to be made when both attenuators are at identical settings.

4. FUNCTION OF CONTROLS (Cont'd.)

Controls above Plug-In Compartments (from L to R)

Trace Find

Depressing this spring return button will reduce the X & Y gain to return deflection within the limits of the CRT face and also turns the intensity to maximum. Although the trace appears at a high brightness, it is well defocussed and will not damage the phosphor if it is left on for a few seconds.

Calibrator

Two output voltage levels of 4V and 40mV are available at a 1kHz rate. Placing a shorting link (bwd L1 option) between the outlets produces a current flow of 4mA peak at a 1kHz rate.

Channel 1 Output

Any 6 series plug-in amplifier placed in Channel 1 will provide at the panel jack 0.1V output per div. of vertical deflection. Source impedance is 180Ω and bandwidth DC to >5MHz into another 6 series plug-in. This output enables Channel 1 to be cascaded into Channel 2 to increase the sensitivity by at least a factor of x10, e.g. to 500μV/div. using 6B amplifiers. The output may also be used to drive recorders, counters, and the Ext. trigger input of time base B on 6S plug-in.

Ext. Input-Trigger/Horizontal Amplifier.

Input jack for external trigger signals for T.B. or for an external horizontal input when time base is off and horizontal amplifier is in use.
Maximum input is ±400V DC or p-p AC up to 1kHz.

Trigger Select Switches

x1 or x10	Enables ext. input signal to be attenuated by 10 to increase trigger range over large signal amplitudes or to contain them within the horizontal display when X-Y operation is employed.
1 or 2	Button 'out' Channel 1 trigger is selected as the trigger source. Button 'in' Channel 2 is selected.
Int.or Ext.	Channel selected by the previous button is switched into circuit when this button is out. When it is pressed to select Ext. the signal via the x1 or x10 button is operative.
AC or DC	A capacitor is switched in series with the signal selected by the previous button in the 'out' position. It is bypassed, when DC is selected by pushing the button 'in'. LF bandwidth is 10Hz-3db.

Display T.B.

The time base plug-in located in the horizontal compartment is coupled to the horizontal amplifier and trigger selection switches when button is 'out'.

Display X-Y

In this mode it is also necessary to press the x10 button alongside. The signal selected by the previous buttons is now presented as the horizontal display.

Mag. x1 or x10

The output from the time base plug-in in the horizontal compartment can be displayed at the rate calibrated on the time range switch or magnified x10 to increase the sweep speed to a maximum of 10nSec/div.

4. FUNCTION OF CONTROLS (Cont'd.)

Position Control

Coarse and fine concentric controls position the trace horizontally on the CRT.

4.2 Controls on 6B 50MHz Amplifier

Position

Moves the trace over a minimum of 10 div. of CRT display.

Vernier

A 2.5-1 variable sensitivity control which adjusts gain between the calibrated attenuator steps and increases input to 50V/div. Control must be turned to the CAL position (fully clockwise) when making calibrated measurements.

Cal.

Preset that permits the vertical sensitivity to be accurately set against the calibrator standard.

Volts/Div. (Attenuator)

Switch selects the required sensitivity to permit a wide range of signal amplitudes to be contained within the CRT limits. Bandwidth remains constant at 50MHz for all settings from 5mV to 20V/div.

Normal-Invert

Chrome push-push button located co-axially with Volts/Div. switch. With switch 'out' a positive input will be displayed upwards, when pressed 'in' a positive input will deflect the trace downwards.

DC Bal.

With trace centred and vernier fully anticlock, balance is adjusted to eliminate vertical movement of trace when vernier is turned to Cal position.

AC or DC

Push button - input to amplifier is AC coupled when button is out and DC coupled when pushed in.

GND

Push button - when a ground reference line is required on the CRT pressing GND button open circuits the input jack and grounds the amplifier input.

Input

BNC input jack for amplifier signals input impedance is constant at 1MΩ and 27pf parallel capacitance.

4.3 Controls on 6S Delayed Time Base

This plug-in incorporates two complete time base generators which may appear complex but layout and operation of controls has been simplified so that familiarisation of the facilities will only take a few minutes. The time bases are referred to as A (main) and B (delayed). The time base providing the CRT display is selected by the DISPLAY selector switch beneath the TIME/DIV switches.

'A' Trigger Select Buttons

With all buttons out +ve trigger slope is selected and normal coupling. When the -ve button is depressed -ve trigger slope is obtained.

4.3 'A' Trigger Select Buttons (Cont'd.)

The Slow button removes high frequencies above approximately 10kHz whilst the Fast button removes frequencies below 10kHz from the trigger signal. When both buttons are depressed line frequency is switched into circuit to trigger the time base.

Depressing the TV button brings in a separate sync separator stage which eliminates line and video signals and feeds a sharp frame pulse to the trigger circuits. Line trigger is obtained when the button is 'out'.

Single stroke operation of the time base for one shot photography is obtained when SS button is 'in'. Once trace is initiated and sweeps across CRT trigger will not reset until Reset button is pressed. The Ready lamp indicates the time base is reset (armed) in readiness to receive a trigger pulse to initiate the trace. The lamp operates in normal as well as SS operation to indicate time base readiness to receive a trigger signal.

'A' Level Control

Sets the point on the trigger signal at which the time base will initiate. When the control knob is pushed 'in', a bright base line will be displayed if no trigger signal is present or if the trigger rate is >0.002% of the time base sweep speed.

When the knob is pulled out display will remain off with no trigger signal.

NOTE: Level control is adjustable for both Auto and non Auto operation.

Time/Div. Triple Concentric Control.

The large outer knob controls 'B' time base range from 100nSec. to 0.5Sec/div.

The winged grey knob is the Main or 'A' time base range and covers the entire range from 100nSec. to 2Sec/div.

The small red knob is the 'A' vernier control providing a 5-1 range overlapping each step and extending range down to 10Sec/div.

'B' Vernier

Provides a 5-1 vernier range of the 'B' or delayed time base and extends slowest speed to 2.5Sec/div.

Display Switch

'A': Normal 'A' time base operation with no delay.

Inten.: 'A' time base brightened over a selected portion as determined by 'B ' time base and the 10 turn Delay Multiplier.

Mix.: 'A' time base starts the display but 'B' takes over at a point determined by 'B' time base and Delay Multiplier.

B delayed by A: Only the intensified section of the trace will be displayed, covering the full CRT width.

B Trigger delayed by A.: As for previous step but trace will only be initiated by triggering B time base.

B Trigger Facilities

Level: Sets the point on the delayed trigger signal at which the B time base will initiate.

Int.-Ext.: Push button selects the trigger signal source. Ext. is via the adjacent BNC jack. Int. signals are from the main frame as selected by the switches above the plug-in compartments.

4. FUNCTION OF CONTROLS (Cont'd.)

B. Trigger Facilities (Cont'd.)

±: Selects polarity of the trigger source.

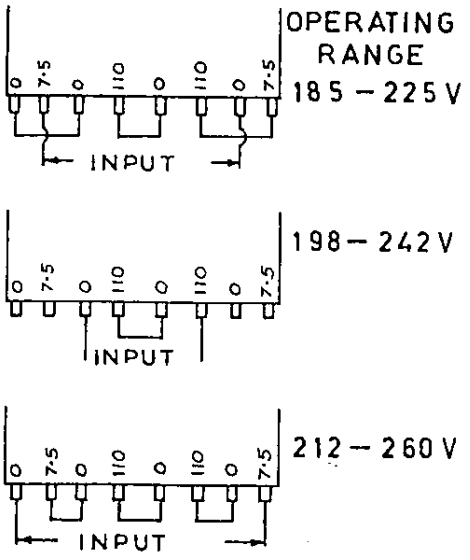
Delay Multiplier

Multiplies the Time/Div. as selected by the 'A' time base switch (and vernier) over the range of x1 to x10 providing a total delay time of 100nSec. to 100Sec.

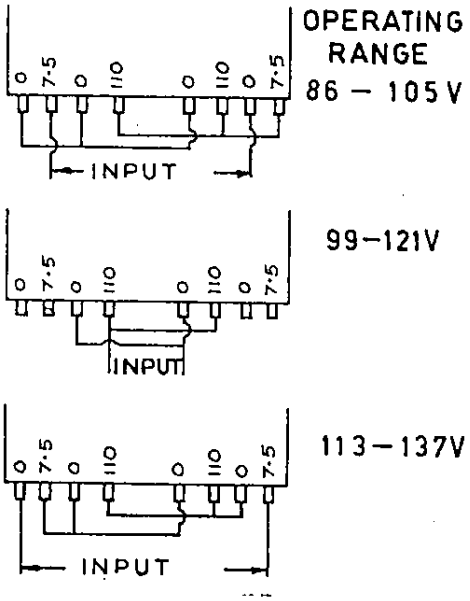
5. FIRST TIME OPERATION

Check transformer primary taps are correctly wired to suit local line voltage supply.

185 - 260 Connections



86 - 137 Connections



TRANSFORMER CONNECTIONS

5.1 The following descriptions applicable to Model bwd 525 with 6B amplifiers in the Channel 1 and 2 cavities and 6S or 6T in the Time Base cavity.

One of the major features of the 525 main frame and 6 series plug-ins is that normal operation is obtained when all push buttons are 'out'. A quick scan over the panel therefore immediately indicates any variation to normal and assists in quick familiarisation with the instrument's operation.

For first time operation, if unfamiliar with this class of oscilloscope, set the controls as below and follow the steps outlined until each feature is understood.

Main Frame:	Intensity	Off
	Focus	Centre
	Scale	Fully clockwise
	Vertical Display	1
	Horizontal Position	Centre
	Push Buttons	All Out
6B Amplifier:	Attenuator	1V/Div.
	Vernier	Cal (clockwise)
	Position	Centre
	Input Buttons	Both Out
	Norm-Invert Button	Out
6S Time Base:	A Time Base	1mSec/Div.
	A Vernier	Cal (clockwise)
	Trigger Level	Centre (knob in)
	Push Buttons	All Out
	Display	A
	B Time Base, Trigger Selectors, Level and Delay Multiplier	Any Position (not in use)

5. FIRST TIME OPERATION (Cont'd.)

Connect power lead to 50-60Hz AC supply (see previous page for tappings) and switch instrument on. Turn intensity control to approximately 2 o'clock position, after a few seconds trace will appear. Adjust intensity and focus then position it centrally across screen. If trace is not horizontal, adjust the Trace Rotate preset carefully until it aligns with the graticule line.

Turn vernier control of 6B Channel 1 anticlock, recentre trace with position control, then rotate vernier to Cal, if trace moves recentre with DC Bal control. Repeat if necessary to eliminate movement.

Connect a wire from the 4V calibrator socket to Channel 1 input, centre trace and adjust preset Cal control until display is 4 div. high - make sure vernier control is turned to Cal.

The 1kHz square wave will be displayed 4 div. high and one waveform per division horizontally. Depress the DC button on 6B amplifier - the trace will rise and the bottom of the waveform will now correspond with the CRT centreline indicating the input signal is a waveform positive going with respect to ground. Depress the GND button on 6B, the trace will disappear then after 0.3 sec. a bright reference base line will appear as the Auto time base operates. The GND switch disconnects the input signal in this condition but grounds the amplifier. Release GND push button on 6B, trace will again be standing on the centreline.

Release DC button then rotate position control and note display can be moved off CRT above and below.

5.2 Dual Trace Operation

Set Channel 2 amplifier as for Channel 1 and then switch Vertical Display to 2 and depress Trigger Selector Channel 2 button at top right of main frame.

Take a parallel signal from the 4V calibrator output to Channel 2 input (leave Channel 1 signal connected). Set Balance and Cal as for Channel 1 previously described.

Reduce attenuator settings on both amplifiers to 2V/div. then switch Vertical Display to ALT. Two traces will appear which can be positioned above and below CRT centreline.

If Channel 2 is moved up and down the screen it will be noticed no interaction occurs between the displays and trigger is uneffected by the position control.

Turn Channel 2 attenuator to 0.5V/div., the waveform is now 8 div. high, rotate position control and note how display covers the entire display area and can be positioned over a 20 div. range vertically. Return Channel 2 attenuator to 2V/div.

With the traces positioned above each other, switch the time base range switch to slower sweep speeds and observe how flicker between the traces increases until at 10mSec/div. the switching between the traces is readily visible. This is the useful lower limit of the Alternate switching mode.

Now increase the time base speed, the traces will remain locked to at least 1μSec/div. before Auto takes over or right up to maximum sweep speed with the Level knob pulled out to non-Auto. Return time base range to 1mSec/div. again and switch the main frame Vertical Display to Chop. Trace flicker immediately stops. The slight change in intensity is due to the blanking of about 20% of each trace during the chopping transient.

When the time Base Frequency is reduced, the two traces now appear simultaneously down to the lowest sweep frequency.

Return switch to 1mSec/div. and then increase frequency. At speeds around 20μSec/div. the waveforms will start to show the individual chopping sections indicating the useful upper limit of this method of vertical display.

As has been seen, a wide overlap exists where both forms of dual trace display can be used satisfactorily.

With the time base returned to 1mSec/div. and attenuators set to 2V/div. the traces will be 2 div. high. In this condition set the Vertical Mode to ADD. A single trace will appear with a 4 div. display, i.e. the two traces have been added together. Now press the chrome Invert button on Channel 2, the waveform will disappear leaving only a line. This is the difference between the two signals or the result when one is subtraced from the other. Applications for this form of measurement are described later. Return switches to ALT and normal.

5.3 Time Base Operation

Replace the input signal to Channel 1 with a 2kHz (approximately) sine wave and adjust attenuator or input for 4 div. display. Time Base to 0.2mSec/div.

Trigger Level

With knob pushed in turn the control and observe that the trigger point moves up and down the wavefront. When it reaches the top or bottom extreme of the waveform the trace blanks out for a fraction of a second when trigger is lost, then the trace free runs in the Auto condition until the level control is readjusted to select a trigger signal. Now push in the ± button to select -ve trigger. The waveform will now trigger on a -ve going slope. Clockwise rotation of the level control will increase the trigger point level towards the positive point of the waveform, anticlock rotation towards the negative point as for +slope.

Revert to +ve trigger selection, then pull out the Level control knob. Auto is now switched off, turn the knob to select level and note the trace disappears when the level extends past the waveform limits. Push knob in again and reduce amplitude of displayed signal, with Level control carefully adjusted, signal can be reduced to less than 4mm and stable lock is still obtained.

T.B. Vernier

Turn Vernier anticlockwise - observe approximately x5 the number of waveforms on CRT when fully anticlockwise. Return to Cal position.

Magnification

Adjust input frequency to produce one sine wave per div. and locate the peak of each waveform on a vertical graticule line. Press the x10 button alongside the horizontal position control.

The trace will expand either side of the centre and any portion of it can be viewed by rotating the position control, fine control for precise adjustment being made with the red knob. Return to x1 and recentre trace horizontally.

5.4 Horizontal Amplifier

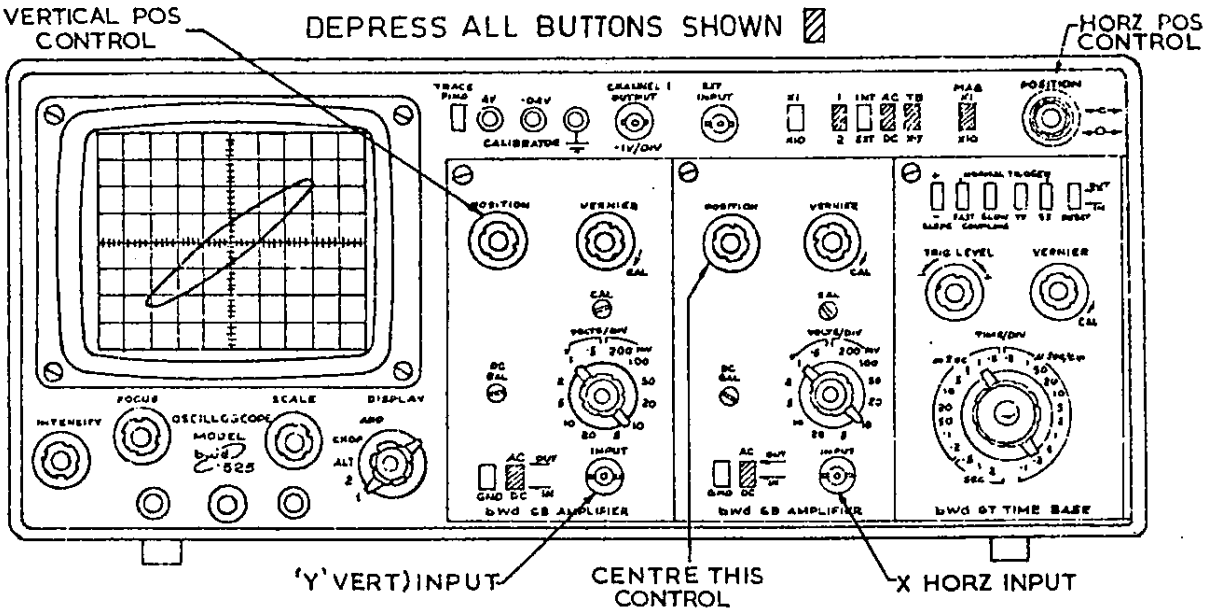
Disconnect signal from vertical channel and reconnect it into Ext Input top centre of main frame. Depress Ext Trigger selector button, X-Y button and x10 Mag. If input voltage is 1V p-p a horizontal line will now appear 2 div. long. If the x1/x10 button is pressed the trace length will decrease to 1/10th, decreasing sensitivity to approximately 5V/div. When utilising the horizontal amplifier, the x10 Mag. button must always be pressed or insufficient drive will exist to fully scan the CRT.

Identical X-Y (See illustration Below)

Connect the external signal source to Channel 1, reset Int-Ext buttons to Int., leave X-Y and x10 Mag. buttons depressed, switch Vertical Mode to 1, a line will appear diagonally across the CRT. The input signal is being applied at identical sensitivity to X & Y systems. Next parallel the input sine wave to Channel 2, set Vertical Display to 1, Trigger Selectors to 2, Int. and DC, leave X-Y and x10 depressed. Channel 1 will now preset the vertical display and Channel 2 the horizontal. To position the horizontal display leave the 6B control centred and use the main frame fine and coarse horizontal position control to do the positioning.

NOTE: X-Y displays should be contained within the 8 x 10 div. graticule to eliminate distortion due to signal overdrive.

For zero phase shift between the two traces at low frequencies it is essential to use DC coupling into amplifiers and trigger selection coupling.



Z Modulation

Reset all push buttons to 'out', connect 1V p-p sine wave to Channel 1, switch attenuator to 0.5V/div. Set Vertical Display to ALT. Set displays one above the other. Now parallel 1V signal into rear panel Z mod. The tops of each displayed sine wave will diminish in intensity and the Channel 2 trace will be broken into a series of light and dark sections.

NOTE: A positive going signal decreases the trace brightness. As input is DC coupled, it will modulate at constant sensitivity from zero frequency to over 10MHz.

5.5 High Impedance Probes

For high frequency measurements the input loading on circuits particularly capacitance must be kept to minimum levels. The simplest way to achieve this is by use of a high impedance probe which reduces the input signal by a factor of x10 or x100 but simultaneously reduces the input capacitance to approximately 12pf and increases the input resistance to 10MΩ. Two types are available for this model. The bwd P22 for applications up to 40MHz (it is a 70MHz probe) and the bwd P33 200MHz probe for applications involving the full 50MHz bandwidth.

5. FIRST TIME OPERATION (Cont'd.)

5.5 High Impedance Probes (Cont'd.)

To align a probe, couple it to Channel 1 input jack. Set attenuator to 100mV/div. and time base to 0.2mSec/div. Place the point of the x10 probe tip on the 4V main frame calibrator socket, a square wave will appear probably with the top and bottom faces tilted in or out. With a small screwdriver adjust the screw in the side of the probe housing near the BNC jack connector until waveform is square. It will remain correct at all settings.

6. MEASUREMENT OF VOLTAGE & TIME

The following sections describe the method making specific measurements with the 525 main frame and 6B/6S plug-ins.

Start with controls set as follows:-

All buttons out, T.B. to 1mSec., Trigger Level centred. Vertical Mode to 1.

6.1 Measurement of DC (Direct) Voltages

Depress Channel 1 AC-DC 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 main frame terminal, set the trace to the centre of the graticule, touch a lead from positive end of the battery to the Channel 1 input socket, the trace will move up 3 div., e.g. 3 x 0.5V ± 1.5V. Now reverse the connections to the battery and note how the trace moves down 3 div. This illustrates how an oscilloscope can display positive or negative voltages or both simultaneously, i.e. when viewing a sine input or square wave.

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 or the gate of FET's working with high value loads.

The DC input facility may be used to measure AC waveforms swinging about a DC voltage, as at the collector 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 recentre the trace to view a signal superimposed on it. If a higher input impedance is required, use a bwd P22 x10 probe to increase input to 10MΩ and 12pf for general purpose work or a P33 for wide band (50MHz) work.

6.2 Measurement of an AC (Alternating) Voltage

Set the amplifier AC-DC switch to AC and the attenuator to 20V (if the input voltage is unknown). Connect a lead from ground to the ground side of the signal to be measured, then connect a lead from the input socket to the signal source. (Models bwd 112B, 141 or 603A oscillators are suitable for initial experiments in this test).

Increase the vertical sensitivity by the Volts/Div., switch until a display between 3 divisions and 8 div. 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 divisions against 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 div. high and the attenuator is set at 0.5V, then the amplitude is 6 x 0.5 = 3V peak to peak; to convert to RMS voltage for sine wave, divide the 3V by 2.84, e.g. $\frac{3.00}{2.84}$ = 1.06V rms.

The frequency of a waveform can be found by checking that the Time Base Vernier is turned to Cal (clockwise) then switch the Time/div. switch to a range where the signal can be clearly seen, e.g. if a waveform is 5 div. long and the switch is at 100μSec., then the duration of the waveform is 5 x 100μSec. = 500μSec. The frequency can be determined by dividing 1 Sec., i.e. 1,000,000μSec. by the duration of the waveform - $\frac{1,000,000}{500}$ = 2,00Hz or 2kHz.

6.3 Inverted Displays

Where it is required to display a waveform inverted on the CRT, push the chrome invert switch button in (6B and D) or feed the signal into the -ve socket (6A and C). All information relating to display and measurement of inverted signals is identical to the

6.3 Inverted Displays (Cont'd.)

normal input details. The calibration and accuracy are as detailed in the specification for the particular plug-in.

6.4 Balanced or Differential Measurements.

AC Measurements

NOTE: Very high Common Mode Reejection is provided in plug-ins 6A and 6C, however, with 6B and 6D plug-ins using the 'Add' facility between two channels, the following limitations must be considered.

Max. AC or DC Common Mode signal is x20 attenuator setting, if a larger DC signal exists, it should be eliminated by using AC coupling into the amplifiers.

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 HT ripple or AC power line frequency as much as possible, the following method is used.

Connect a probe from Channel 1 input socket to one side of the component across which the waveform is developed and another probe from Channel 2 input socket to the other side. The invert button on Channel 2 is depressed to INVERT and the main frame Vertical Display is switched to ADD. Attenuators are adjusted to identical settings to present a suitable display. The resultant CRT 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.

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 signals generate hum and noise in ground loops and can completely mask the signal to be observed and a probe from the Channel 2 or -ve socket to the nearest ground or common point to the signal on the equipment under test. Hum and noise will be greatly attenuated by this means.

6.5 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.

When 6B plug-ins are used, the following limits should be observed:-

Differential rejection will only operate if the Common Mode signal to be rejected is less than x20 the attenuator setting, e.g. with the attenuator set at 1V/div. the Common Mode signal must not be greater than 20V AC p-p or ±20V DC, or the input amplifier will be overloaded and the signal will be distorted.

The accuracy of the input attenuator resistors also controls the rejection ratio and the other than 5mV 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.

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.

6. MEASUREMENT OF VOLTAGE & TIME (Cont'd.)

6.6 Current Measurements AC or DC

A differential input 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 a 1Ω resistor connected across the vertical input terminal of the amplifier will enable the oscilloscope to read directly in mA or Amps in lieu of mV and Volts. Current through the 1Ω resistor will develop a mV for every mA flowing and provides the direct conversion for currents. This configuration will read both AC or DC current and unlike an 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.

6.7 Identical X-Y Operation

Start with all buttons out. Then set following controls:

Display mode - Channel 1. Depress Trigger Selector Channel 2, DC X-Y and x10 Mag. on main frame.

Signals for vertical display can be fed into Channel 1 and for horizontal display to Channel 2. If phase measurements are to be made on frequencies below 100Hz., the two amplifiers must be DC coupled to minimise variations in the input circuit time constants.

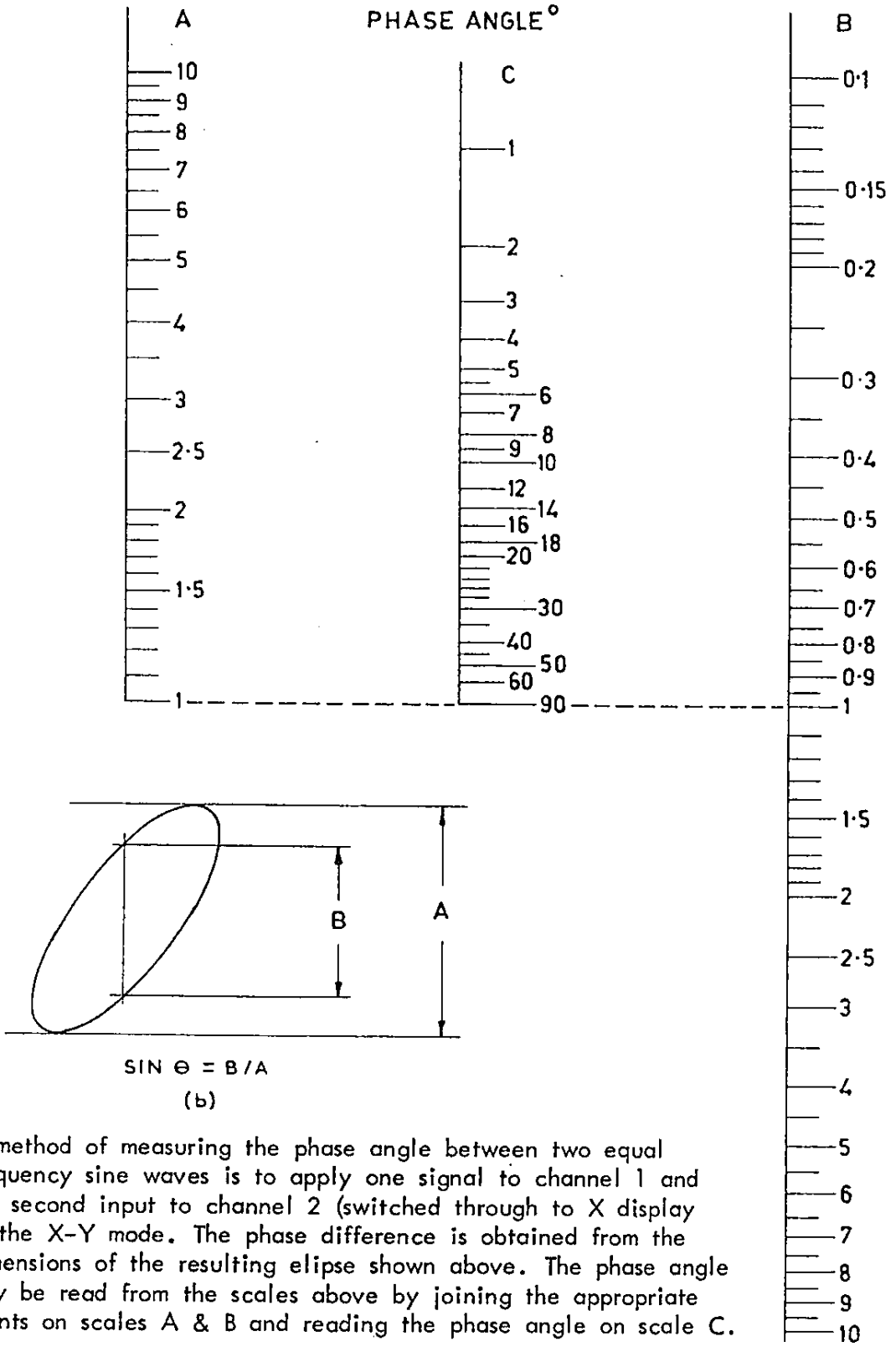
If zero phase shift exists the line will be almost straight up to 1MHz. Phase between the two signals can be determined from the chart on the next page.

NOTE: x10 probes will produce additional phase shift and they must be checked and matched from a common signal source over the range to be measured if it is essential to use them.

6.8 Cascaded Amplifier Operation

When the sensitivity of the vertical amplifier requires to be higher than the direct calibration allows, single channel operation with a sensitivity increase of x10 is available. A patching cable is included with the 525 main frame accessories. This should be connected between the Channel 1 Output socket and Channel 2 input.

6.8 Cascaded Amplifier Operation (Cont'd.)



A method of measuring the phase angle between two equal frequency sine waves is to apply one signal to channel 1 and the second input to channel 2 (switched through to X display in the X-Y mode. The phase difference is obtained from the dimensions of the resulting elipse shown above. The phase angle may be read from the scales above by joining the appropriate points on scales A & B and reading the phase angle on scale C.

6. MEASUREMENT OF VOLTAGE & TIME (Cont'd.)

6.8 Cascaded Amplifier Operation (Cont'd.)

Irrespective of the input attenuator setting an output of 100mV p-p is present at the Channel 1 output socket for every 1 div. deflection on the CRT, therefore if Channel 2 is set to 10mV/div. a gain of x10 will exist between Channel 1 input and the CRT display from Channel 2. If less gain than x10 is required, reduce the sensitivity of Channel 2 - this will increase the DC stability of the display.

Bandwidth is approximately DC to 18MHz (15MHz-3db specified). For sensitivities below 1mV/div. it is recommended AC coupling be used for Channel 2 input to minimise trace movement. Select the time base trigger from Channel 2.

6.9 Delayed Time Base Operation

Three types of display are available to view a waveform delayed in time by 6S time base; these are MIXED, DELAYED SWEEP and DELAYED TRIGGER.

In the first mode a combined trace displays the 'A' or main time base on the left, then at the point selected by the Delay Multiplier dial the delayed or 'B' time base completes the trace at a faster speed, thus presenting a non-magnified and magnified waveform simultaneously.

With the Delayed Sweep mode no display is presented during the delaying period, but immediately following this period the B time base is displayed. If very long delay periods are involved jitter of the waveform and the inherent jitter of the 6S plug-in may produce an unstable display in this mode. Complete stability of the delayed waveform is available, however, when Delayed Trigger is employed.

In this mode again no display is presented during the delaying period, but immediately after the B time base is armed in readiness to receive a trigger signal. When this is received, B time base will fire and present a stable display even with delay periods of >20,000-1.

A single rotary switch on 6S marked DISPLAY selects the three modes together with 'A' time base only and intensified in the following manner:-

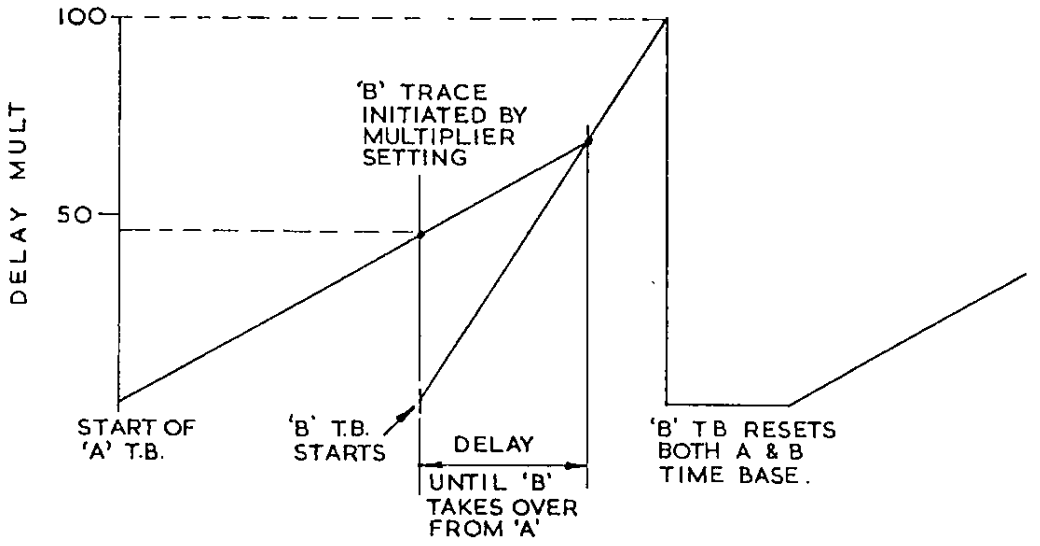
With all push buttons 'out' feed in a 10kHz signal to Channel 1 amplifier, set to approximately 4 div. amplitude and set A time base to 0.5mSec/div. Five waveforms will appear per div. Align the start of the trace with the first graticule mark. Now set the B time base to 50μSec/div. (vernier to Cal) and the 10 turn Delay Multiplier to 50.

Turn the DISPLAY switch to Int., a section one div. long starting at the 5th div. (CRT centre) will be brightened. Turn the Delay Multiplier down to zero and then up to 100 and note how the intensified portion tracks accurately with the dial calibration between 10 and 100, return dial to 50, now turn the B time base range switch and note how the segment becomes shorter at higher sweep speeds and vice versa.

With the aid of both controls any section of the main display can be selected for delayed presentation. With the B time base returned to 50μSec. rotate the Display switch to MIX. The first 5 div. of trace will remain as before, but the remaining 5 divisions will be displayed at 50μSec/div. Turn the Delay Multiplier and note how the waveforms appear to 'peel off' the main display. Changing the B time base speed will change the magnification of the waveforms on the right.

NOTE: The point at which the transition from time base A to B occurs in the MIX display is slightly delayed to the start of the intensified section. This is shown in the illustration on next page.

6.9 Delayed Time Base Operation (Cont'd.)



To display only the delayed or B time base, move the Display switch to B delayed by A. The start point of the delayed trace is now accurately controlled by the Delay Multiplier dial. If for example a pulse is brought in line with the first graticule mark using the B delayed by A mode, the A time base speed is 0.5mSec/div. and the Delay Multi. dial reads 50, then the pulse is 0.5 x 5mSec = 2.5mSec from the pulse which initially triggered the A time base. The pulse width etc., can be read off directly from the CRT screen - remember the displayed sweep speed is set by B time base.

If in the previous example the trace is jittering due to an unstable signal or noise etc., then the Display switch is turned to its final step B trigger delayed by A. The B time base will not commence immediately after the delay period, instead the B time base will be set ready to receive a trigger pulse to initiate the trace to ensure a stable trace which may be from internal or external sources.

6.10 T.V. Line and Frame

With a positive going video displayed the sync pulses will be negative going, therefore the -ve trigger selection button is depressed together with the TV button on the T.B. plug-in. Set the time base to 2mSec/div. and adjust the trigger level control for a stable lock.

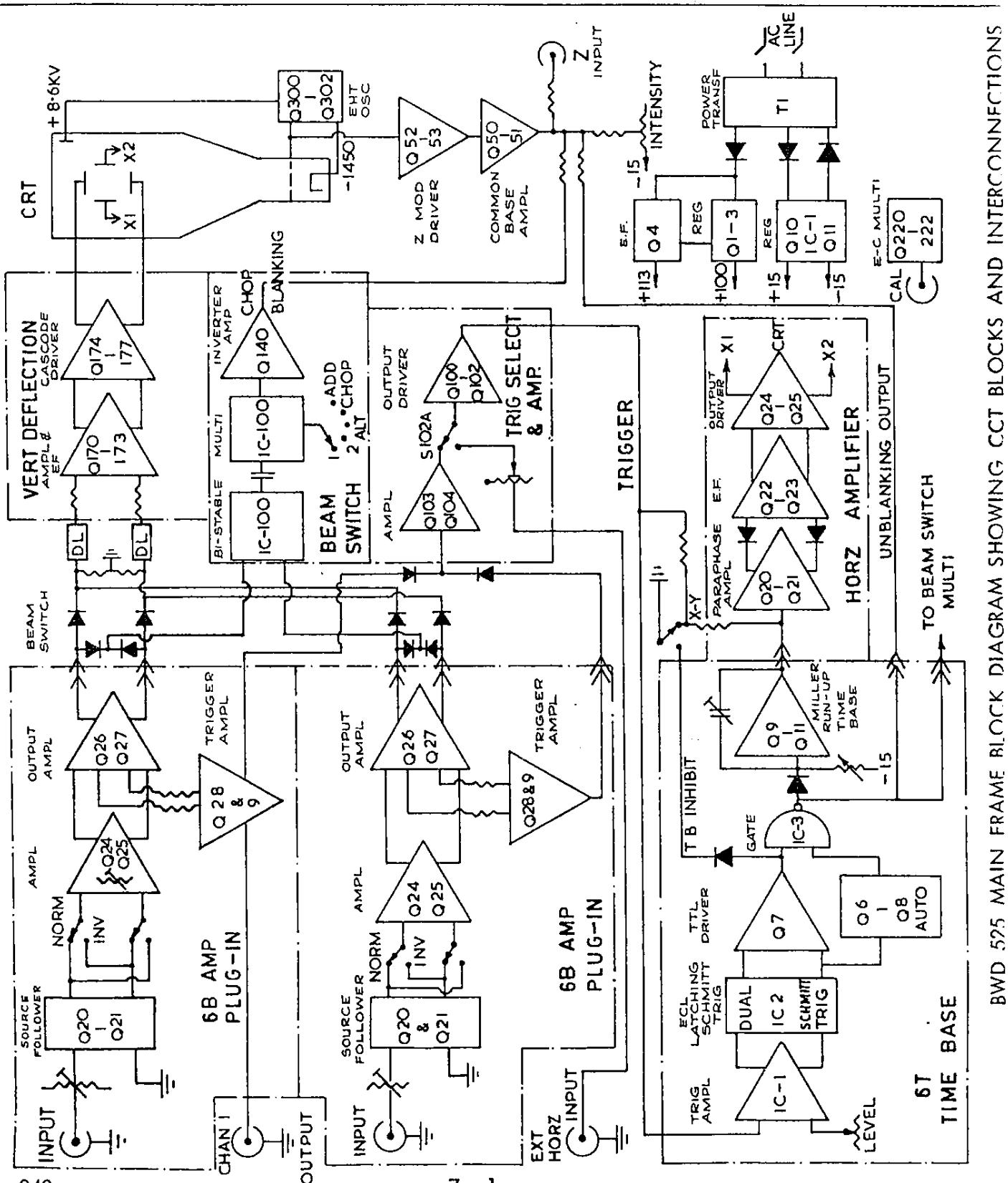
To select a particular line from the video signal switch Display to Intensified. With B time base at 10μSec. turn the Delay Mult. 10 turn control until the desired line is intensified, turn display switch to B and the selected line will be presented. If the line is unstable select B trigger delayed by A and with -ve internal trigger selected, adjustment of B level control will present the line with complete stability.

NOTE: As the gating pulse is available at the rear panel the selected line may be distinguished on a Video monitor by mixing the 'B' gate pulse with the video to bright up the monitor CRT during the line presentation.

7. CIRCUIT DESCRIPTION

This section contains a detailed explanation of circuit employed in the main frame only. For plug-in description refer to separate handbooks. Circuit Diagram at the rear of the book should be referred to when reading this section. The main frame consists of the following:

7.1 Low Voltage Power Supplies. 7.2 Distribution Board.
7.3 High Voltage (EHT) Supplies. 7.4 Z Modulation, CRT and Controls.
7.5 Vertical Output Amplifier, Beam Switch and Delay Line.
7.6 Horizontal Output Amplifier. 7.7 Trigger Selection Circuit.
7.8 Calibrator.



BWD 525 MAIN FRAME BLOCK DIAGRAM SHOWING CCT BLOCKS AND INTERCONNECTIONS

7. CIRCUIT DESCRIPTION (Cont'd.)

7.1 Low Voltage Power Supplies (Drg. No.950)

Input AC power to transformer T1 can be applied to one of six alternative input tappings, enabling voltages from 90-135 and 195 to 265 to be accommodated as shown in Section 5.1.

Three rectified outputs are taken from the secondary +135 +22 and -22. Each is filtered before being regulated to provide +100 +15 and -15. The +100V rail regulator consists of Q1 series pass transistor, Q2 emitter follower driver and Q2 feedback amplifier which senses the difference between ground and the voltage on divider R5, RV2 and R6. This is referred to -15V and any tendency from the output to vary is detected by Q3 which produces an amplified and inverted signal at its collector. This in turn controls Q1 via Q2 to return the output to its original voltage. An additional +113V rail for the horizontal amplifier is obtained from Q4 emitter follower referencing back to the +100V rail by D5 zener diode.

The + and -15V rails are controlled by IC-1, a dual voltage regulator with very high stability to load, input and temperature changes. To carry the additional current required by the ±15V rails, series pass transistors Q10 and Q11 are mounted on a heat sink attached to the rear panel. Precise setting of -15V is accomplished by RV4 and RV3 sets the +15V rail. Both rails are short circuit proof with maximum current of 1Amp. each. The +100 and 113V rails are protected by current overload circuit Q5, R5 and R9 which turns Q1, 2 and 3 off under short circuit conditions.

7.2 Distribution (Drg. No.951)

Low voltage supplies together with switching signals, trigger output and a 6.3V AC rail are distributed to the three plug-in compartments by a PC board grounded to the main chassis, which acts as a grounding plane for all supplies and signals.

7.3 EHT Supplies and CRT Controls (Drg. No.953)

The CRT requires 1450V cathode potential and +8.6kV on the PDA electrode, providing approximately 10kV operating potential. The CRT grid is directly coupled and also requires its own - 1500V rail to which modulation signals are applied.

All EHT supplies are developed by an oscillator operating at approximately 22kHz. Q303 oscillator developes a 40V p-p sinusoidal waveform across its collector winding on T300. Positive feedback is applied to Q302 base to maintain oscillation. Two secondary windings provide the necessary voltages to operate the CRT.

The main secondary is grounded and supplies two outputs. Tapping 6 is rectified by D302, filtered by C312 and C313 and C57 and supplies the CRT cathode with -1450V. Two dividers are taken from this voltage, one is via R76 to RV53 front panel FOCUS control. The other divider is R68-70 RV50 and R50, which is referenced to the +100V rail.

The junction of RV50 and R68 is taken to Q300 emitter follower. Any voltage variation at base of Q300 will change the current drawn by Q300 through R305 and thus control the base current of Q301. If the -1450V rail should increase, Q300 base will be taken negatively, its emitter will take less current away from Q301 so it will increase conduction causing its collector to fall. This fall will be transmitted via D300 zener diode, the base feedback winding diode D301 and L301 to reduce the available base current to drive Q302 oscillator.

7. CIRCUIT DESCRIPTION (Cont'd.)

7.3 EHT Supplies and CRT Controls (Drg. No. 953) (Cont'd.)

In turn, its collector output will fall so reducing the output voltage until the voltage at Q300 base reaches a quiscent condition again. An extension of the cathode winding is rectified by a Cockcroft-Walton four stage multiplier to produce +8.6kV for the PDA electrode.

The CRT grid winding 8 and 9 is isolated from the main winding and separately rectified by D303 filtered by C314 and C315.

To maintain a negative voltage on the CRT grid, the winding supplies -1530V, this is adjusted by a high impedance divider RV51 and R72-4 for the required intensity range. Protection for Q302 is by Fuse F3 mounted on the lower edge of the main centre chassis.

7.4 Z Modulation Amplifier

All signals that affect the CRT intensity are applied through an amplifier to modulate the grid winding.

Q50 is a common base amplifier with a very low input impedance. This enables signals to be mixed at the emitter without interaction from one source to another being fed back via the coupling resistors.

Intensity is controlled by the current through R56, external Z modulation is applied via R55, unblanking from the time base plug-in is through R54, chopped blanking via R53 and via R51-2 to S104A to adjust intensity level when the time base is switched off for X-Y operation. C60, R180 is a hum cancelling input.

The combined emitter currents in Q50 produce a voltage in R60 proportional to them. This voltage is taken to Q51 emitter follower via D50 limiting diode. Q53 output amplifier is driven via R62 and will switch between the limits of +77 and zero. Shunt feedback is applied around Q51 and Q53 through R65 to control the gain linearise the amplifier and reduce the output impedance. To speed up the amplifier rise time Q52 PNP transistor acts at low frequencies as a constant current load for Q53 but as the frequency increases negative going inputs couple through C54 to Q52 base bausing it to draw a higher current and pull up the output voltage more rapidly.

The high frequency component of the output signal from Q52 and Q53 is AC coupled via C58 to the CRT grid. The DC component is fed through R71 and R303 filter resistor to the grid winding of T300 and thence via D303, RV51 and R75 to the CRT grid.

7.5 Vertical Output Amplifier and Beam Switch (Drg. No. 954)

To view the entire amplifier and switching circuit it is necessary to also include the output stage of a 6 series amplifier in this description. This stage is identical in all plug-in amplifiers and consists of a high current PNP series compensated transistor pair. The collector loads are a combination of by-passed DC level setting resistors within the plug-in and R140-1 delay line terminating resistor in the 525 main frame. R140 and R141 are paralleled by R142 and R143 producing a 75Ω termination for the delay line.

The beam switching diodes D140 to 143 and D146 to 149 are located before the 75Ω terminating resistor so that a common termination is provided for both plug-in amplifiers.

The main frame amplifier following the delay line is a shunt feedback pair Q170 and Q171 followed by emitter follower Q172 and Q173 which drive the cascade CRT deflection plate amplifiers Q174 to 177.

The Vertical display switch S200A-G selects the channel(s) to be coupled through to the output stage. All switching is performed by IC-100 a TTL quad nand gate.

7.5 Vertical Output Amplifier and Beam Switch (Drg. No. 954)

The first two gates are cross coupled as an edge triggered bistable switch. The remaining gates are coupled by S200E and F either as a free running multivibrator in the chopped mode or as a pulse shaper in the alternate mode.

When vertical display is set to Channel 1, gate A has pin 5 grounded by S200E, its output goes high reverse biasing diodes D141 and D142 thus permitting channel 1 to conduct through D140 and 143 across R140 and 141 loads.

When Channel 2 is selected, gate B input is grounded by S200E and the switching action is reversed.

Alternate operation is as follows. A positive going alternative trigger pulse from the 6 series time base is switched by S200G to gate D input via R150 and C144. S200E grounds R153 but leaves the second input open. The increasing +ve pulse drives gate 4 input high, its output falls to low, pulling gate C input low. In turn, its output rises for approximately 2μSec. determined by C143 and R157. When gate C output falls after 2μSec. it couples through C140 and C141 to trigger the bistable and change over the channel selected for display.

The 2μSec. delay is sufficient to allow the switching to take place after the time base has blanked out the display during time base flyback.

When chopped mode is selected, R152 is grounded by S200E completing a symmetrical bistable circuit of gates C & D. The free running frequency is approximately 500kHz which triggers gates A & B, the bistable switch, this in turn switches the Channels 1 and 2 via the diodes. The switching signal to gates A & B is also taken through R149, C145, R156 limiter-differentiator circuit, then D150 to Q140 PNP chop blanking amplifier. Negative going excursions drive Q140 into conduction during the switching transition and the resultant positive going pulses are applied via R156 and R53 in series to the Z modulation amplifier.

Also switched in circuit in the chopped mode is capacitor C232 which shunts high frequencies in the trigger signals and also eliminates switching transients from the chopping signals being superimposed on the trigger signal.

Diodes on the input to Q140 are to isolate the chop blanking signals from 6D beam switched amplifiers which contain the same switching circuits. S200B and C also select the necessary gating signals from the 6D beam switch to ensure correct sequential operation when 3 or 4 traces are being displayed.

The final display selection is ADD. In this condition both channels conduct into the load as both A & B gates have their inputs grounded by S200E and F, therefore both outputs are high and both channels conduct. To correct the change in DC level across the load that occurs when current from both amplifiers is applied to R140 and R141, the paralleling resistors R142 and R143 are taken via a common resistor R144 to -14.5, so returning the quiscent DC condition back to the single channel operating levels.

The delay line is terminated at the output end by R170 and R171 with R172 in parallel. As Q170 and Q171 are shunt feedback stages, their input impedance is almost zero, so the resistor forms the entire termination.

To obtain the maximum output swing from Q170 and Q171, the feedback resistors R179 and R180 are fed from Q172 and Q173 emitter follower to eliminate the additional voltage drop across R177 and R178 collector loads, that would be caused by the current through them. The feedback resistors also provide the emitter loads from Q172 and Q173, minimising circuit current drain and transistor dissipation.

7. CIRCUIT DESCRIPTION (Cont'd.)

7.5 Vertical Output Amplifier and Beam Switch (Drg. No. 954)

The lower pair of transistors in the cascade CRT deflection amplifier are driven by the emitter followers. The cascode emitter loads consist of R188 and R189, R181 and R182 and RV100, which are in operation when diodes D170 and D171 are conducting. When the input to Q174 and Q175 is asymmetrical, one stage will conduct more heavily than the other, however, R182 will endeavour to maintain the cathodes of diodes D170 and D171 at the same potential. The result is that when one stage becomes negatively biased, its series diode ceases to conduct and the conducting transistor now sees a high impedance in its emitter. This degenerates the amplifier gain and prevents either side going into saturation when overdriven by high amplitude signals. Diodes D144 and D145 across the delay line also serve to clamp the signal to prevent excessive overdrive.

The current driven upper stage of the output amplifier Q176 and Q177 have low resistance collector loads and small shunt peaking coils to maintain the wide overall bandwidth. Amplifier response is adjusted by C173 and RV172, C172 and RV171 across the emitter circuit of Q174 and Q175.

The Trace Find button S20A affects the vertical circuit by introducing R202 in Series with R201 which reduces the collector voltages and limits the available display to bring it onto the CRT screen.

When S20A opens, R202 drops the voltage so that less than a 30V p-p signal is available at the deflection plates.

7.6 Horizontal Amplifier (Drg. No. 952)

The three stage balanced amplifier consists of a series-shunt circuit with an emitter follower drive between them.

Several signals are mixed and applied to Q20. These are the time base output via R20, the horizontal position voltages via R101 and R102, preset entering voltages from R103 and R104 and when S104 is switched to X-Y operation, the trigger output or external inputs are applied via R105 and preceeding drive circuit.

The horizontal drive for the CRT requires 156V p-p for a 100mm deflection. This represents a 78V p-p signal from each side.

To obtain this voltage swing and to accommodate the voltage drop across the collector loads caused by the shunt feedback components R38 and R39, the loads are taken to +113. This allows the collectors a 20% overswing, necessary for good display linearity.

Output from the series stage is limited by diodes D20 and D21 to prevent overdrive and then passes via D22 and D23 to Q22 and Q23 emitter followers. D22 and D23 turn off the input drive when Q24 and Q25 drop to a low voltage and prevent them from going into saturation. x10 magnification is obtained by decreasing the degeneration across Q20 and Q21 emitters by paralleling RV21 and R24 by S105A across RV20 and R23 which set the x1 magnification.

Additionally R100 which is switched in circuit in x1 magnification to reduce the input signal is removed for x10 magnification.

The trace find button S20Aintroduces R42 in series with the emitter resistor R35, so reducing the available current through the circuit and thus limiting the output swing to within the confines of the CRT.

7.7 Trigger Selection Circuit (Drg. No. 952)

Selection of trigger source, its amplification and output to the time base on horizontal amplifier is accomplished as follows:

Internal Channel 1 or 2 trigger source is selected by turning off the non required signal by the appropriate diode gate (Drg. 951). S101 Channel 1 or 2 selector button applies via R124 a negative voltage to the turn off diode. The remaining signal from the selected channel couples via a co-ax cable to Q104 shunt feedback stage. To obtain a zero volts output level, an emitter follower and zener diode are incorporated in the feedback loop with R121 and L100. Adjustment of output voltage level is set by RV103.

Signals from the trigger amplifier Q103 and Q104 or external signals are selected by S102A. External signals pass through S100 A & B, x1 or x10 divider before connecting to S102A. S102B connects the phase correcting components C100 and C101 to ground when internal signals are selected.

After selection by S102A the signal passes to S103A and B which places C111 in series with it, when AC coupling is selected or directly coupled it when pushed in for DC.

The driver stage consists of Q102 FET follower driving Q100 and Q101 complementary emitter follower output.

Diodes D102 and D103 protect the input from excessive overdrive by external signals RV102 adjusts the output DC level to zero. Two outputs are taken from Q100 and Q101, one directly via a co-ax cable to the time base plug-in, the second via R106 and R105 to the horizontal amplifier input. When normal time base operation is in use, S104B shorts the junction of R105 and R106 to ground so no signal passes however, when X-Y operation is selected, S104B changes over to inhibit the time base and lifts the junction of R105 and R106 from ground.

If identical X-Y operation is selected with one channel as the X deflection, then C100 and C101 will be grounded. These components correct the phase of the signal so that the same delay exists in the horizontal amplifier as is produced in the vertical output circuit by the delay line. RV101 sets the gain for identical X-Y sensitivity.

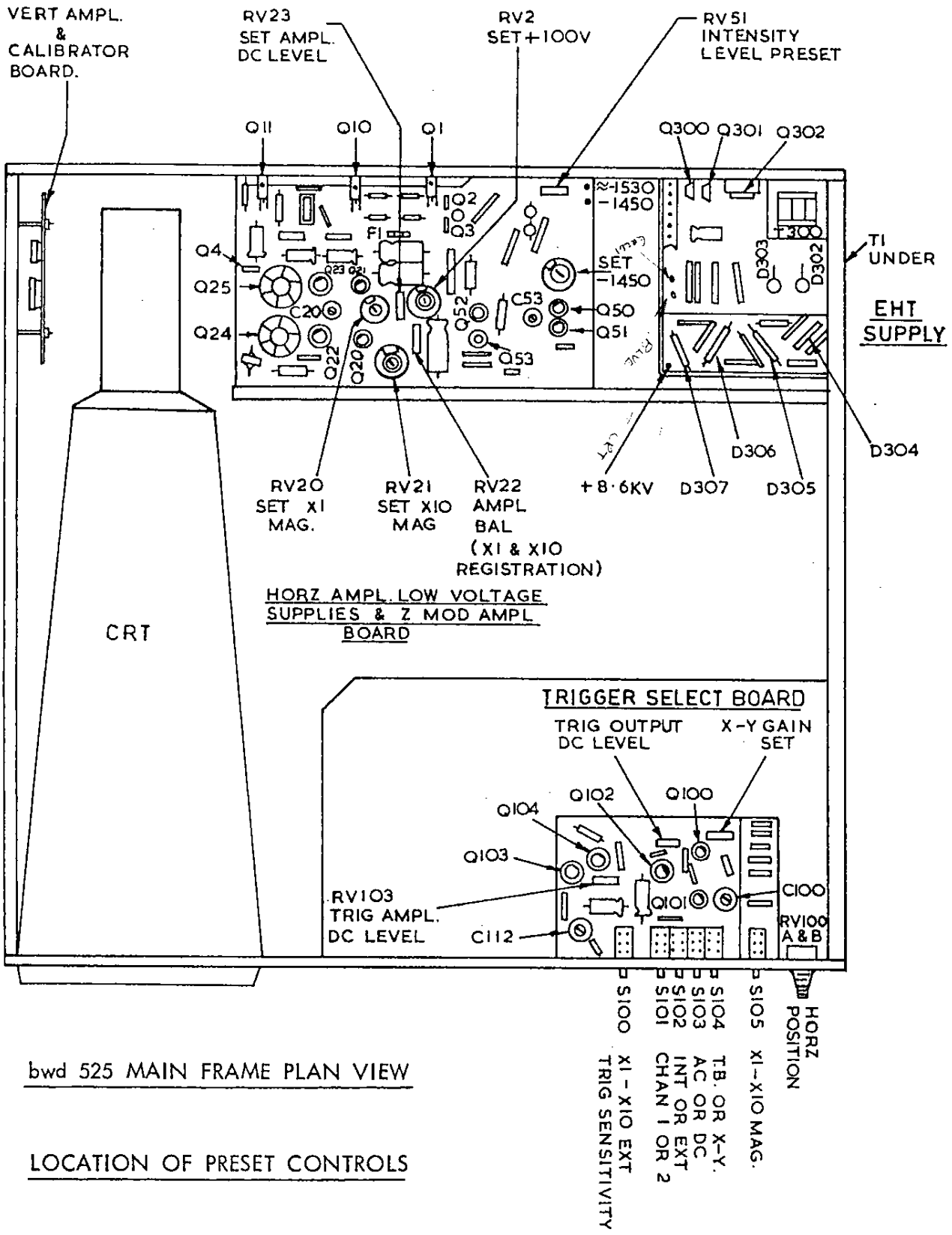
If the horizontal display is supplied by an external signal via the panel jack, then C100 and C101 are isolated from ground, phase is not corrected but the horizontal bandwidth is increased from 2MHz to >4MHz-3db.

7.8 Calibrator

Q220 and Q221 comprise a free running emitter coupled multivibrator operating at 1kHz. RV220 sets the frequency of operation. The output voltage across R225 is limited in a positive direction (when Q221 cuts off) by the divider action of D220, R226 and RV221, the output calibration control. In a negative direction Q221 pulls the collector below ground, but emitter follower Q222 has its load taken to ground, so cuts off and the output signal swings between ground and +8V as set by RV221.

The emitter load of Q222 is selected so that 4mA will flow through a shorting link placed between the 4V and 40mV output sockets for calibration of a current probe. D220 compensates for change in value of Q222 with temperature change.

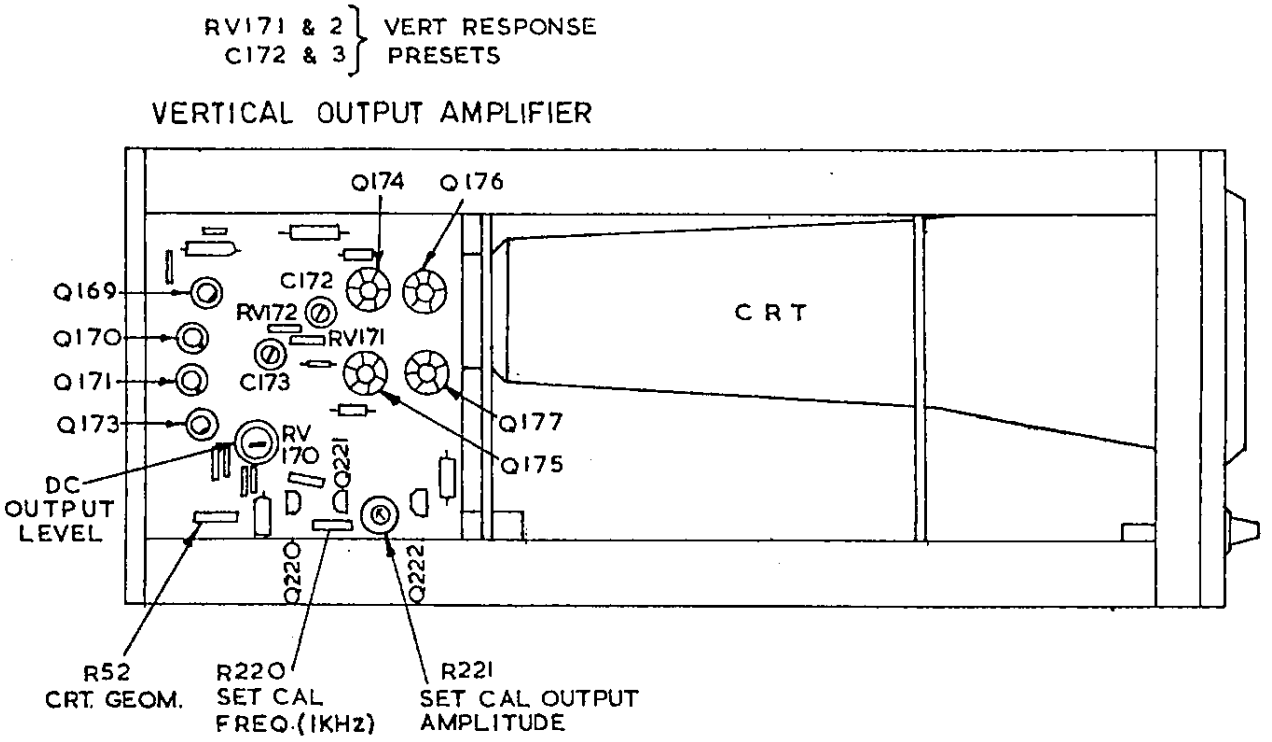
8. ALIGNMENT & MAINTENANCE

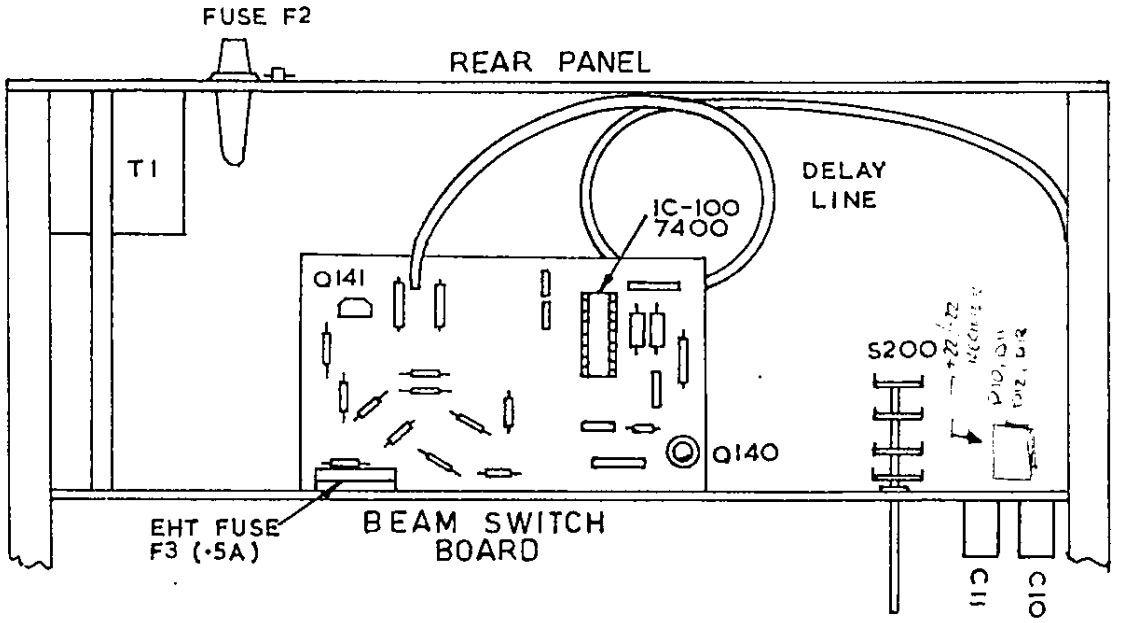


bwd 525 MAIN FRAME PLAN VIEW

LOCATION OF PRESET CONTROLS

SIDE VIEW





UNDERSIDE VIEW

COMPONENT ABBREVIATIONS (Cont'd)

PL	Plug
PS	Socket
Preset	Internal Preset
PYE	Polyester
pot	Potentiometer
prec	Precision
PC	Printed circuit
PIV	Peak Inverse Voltage
PYS	Polystyrene
p-p	Peak to Peak
P.Shaft	Plain Shaft
Q	Transistor
R	Resistor
rot	Rotary
R log	Reverse Logarithmic Taper
rms	Root Mean Squared
SM	Silver Mica
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw
S.Shaft	Slotted Shaft
Si	Silicon
Ta	Tantalum
tol	Tolerance
trim	Trimmer
V	Volt(s)
var	Variable
vdcw	Volts Direct Current Working
w	Watt(s)
ww	Wire Wound
Z	Zener
*	Factory Selected value, nominal value may be shown
**	Special component, no part no. assigned.

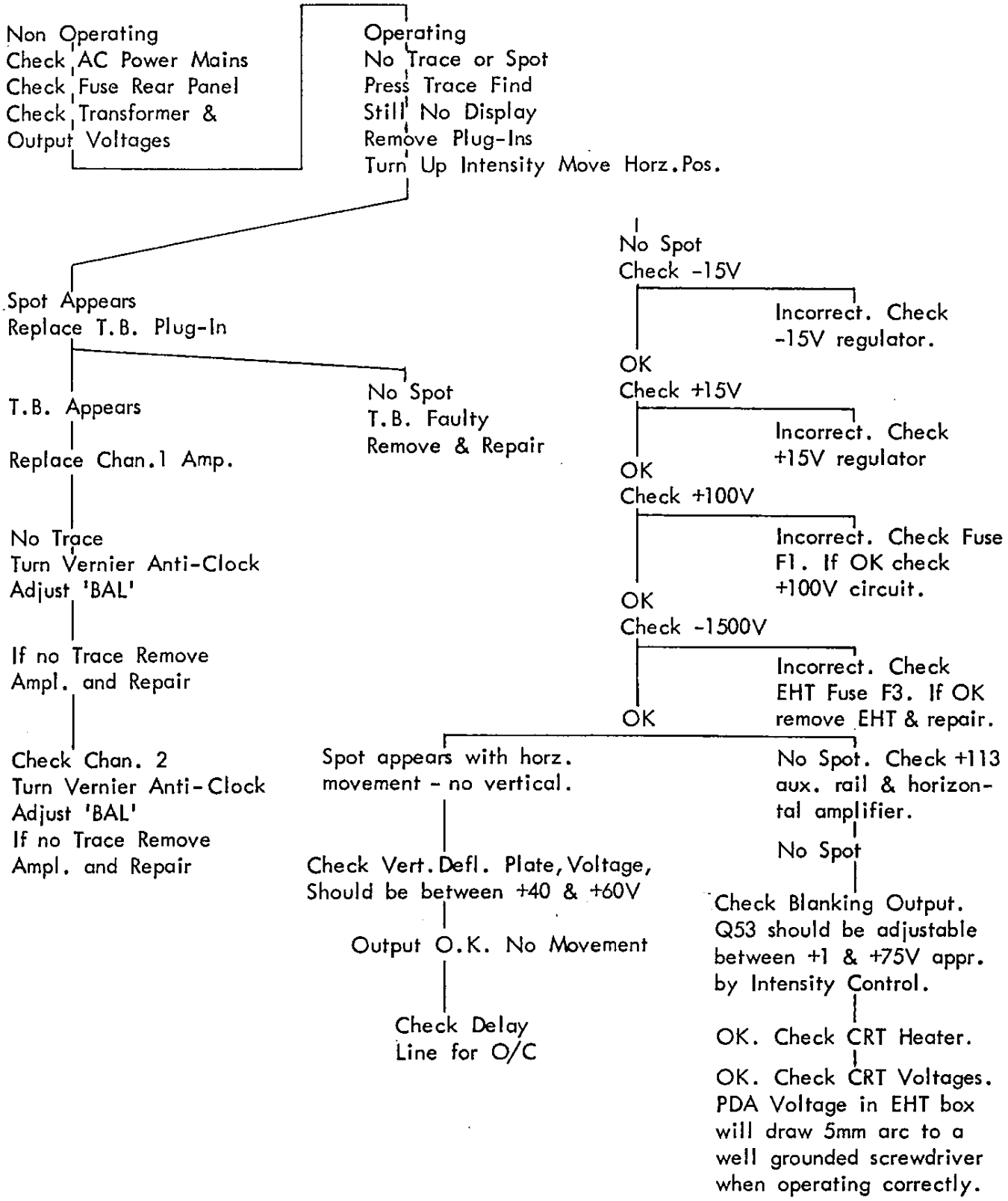
MANUFACTURERS ABBREVIATIONS

AB	A.B. Electronics
AEE	AEE Capacitors
AC	Allied Capacitors
AST	Astronic Imports
AWA	Amalgamated Wiress of Aust.
ACM	Acme Engineering Pty.Ltd.
AMP	Aircraft Marine Products(Aust)P/L
AR	A.& R. Transformers
AUS	Australux Fuses
AWV	Amalgamated Wireless Valve Co.
ACA	Amplifier Co.of Aust.
ARR	Arrow
BWD	B.W.D. Electronics Pty.Ltd.
BL	Belling & Lee Pty.Ltd.
BR	Brentware(Vic.) Pty.Ltd.
BU	Bulgin
CF	Carr Fastener
CAN	Cannon Electrics Pty.Ltd.
CIN	Cinch
DAR	Darstan
DIS	Distributors Corporation P/L.
ELN	Elna Capacitors(Sonar Elec.P/L).
ETD	Electron Tube Dist.
F.	Fairchild Australia Pty.Ltd.
GRA	General Radio Agencies
GE	General Electric (USA)
GEC	General Electric Co.(UK)
GES	General Electronic Services
HW	Hurtle Webster
HOL	R.G. Holloway
H	Haco Distributors(National)
HS	Hawker Sidley
J	Jabel
McH	McKenzie & Holland(Westinghouse)
MAS	Master Instrument Co.Pty.Ltd.
MOR	Morganite(Aust.) Pty.Ltd.
MSP	Manufacturers Special Products(AWA)
McM	McMurdo(Aust.) Pty.Ltd.
MOT	Motorola
NU	Nu Vu Pty.Ltd.
NAU	A.G. Naunton Pty.Ltd.
NS	National Semiconductor
PA	Painton
PAL	Paton Elect.Pty.Ltd.
PI	Piher Resistors(Sonar Electronics)
PH	Philips Electrical Industries Pty.Ltd.
PL	Plessey Pacific
PRO	Procel
PV	Peaston Vic.
RC	Radio Corporation(Electronic Inds).
RCA	Radio Corporation of America
RHC	R.H. Cunningham
STC	Standard Telephone & Cables
SI	Siemens Electrical Industries
SIM	Simonson Pty.Ltd.
SF	Selectronic Components
SON	Sonar Electronics
TR	Trimax Erricson Transformers
TI	Texas Instruments Pty.Ltd.
TH	Thorn Atlas
UC	Union Carbide
W	Wellwyn Resistors (Cannon Elec. P/L).
WH	Westinghouse
Z	Zephyr Prod.Pty.Ltd.

CCT Ref.	DESCRIPTION	MFR. OR SUPPLY	PART NO.	
	RESISTORS			
R1	100KΩ 1/2W 5% MF	IRH		
R2	12KΩ 1/4W 5% MF	IRH		
R3	1KΩ 1/4W 5% MF	IRH		
R4	1MΩ 1/2W 5% CC	PI		
R5	39KΩ 1/4W 5% MF	IRH		
R6	4K7 1/4W 5% MF	IRH		
R7	5K6 1/4W 5% MF	IRH		
R8	560Ω 4 W 5% METOX	IRH		
R9	3.3Ω 1/2W 5% W.W	IRH		
R10	5K6 1/2W 5% CC	PI		
R11	100Ω 1/4W 5% MF	IRH		
R12	100Ω 1/4W 5% MF	IRH		
R13	0.68Ω 1/2W WW 5% BW½	IRH		
R14	0.68Ω 1/2W WW 5% BW½	IRH		
R15	56KΩ 1/4W 5% MF	IRH		
R16	330KΩ 1/4W 5% MF	IRH		
R17	4K7 1/4W 5% MF	IRH		
R18	1KΩ 1/4W 5% MF	IRH		
R19	DELETED			
R20	2K2 1/4W 5% MF	IRH		
R21	1K2 1/4W 5% MF	IRH		
R22	1K2 1/4W 5% MF	IRH		
R23	470Ω 1/4W 5% MF	IRH		
R24	150Ω 1/4W 5% MF	IRH		
R25	100Ω 1/4W 5% MF	IRH		
R26	470Ω 1/4W 5% MF	IRH		
R27	470Ω 1/4W 5% MF	IRH		
R28	270Ω 1/4W 5% MF	IRH		
R29	68K 1/4W 5% MF	IRH		
R30	68K 1/4W 5% MF	IRH		
R31	2.2KΩ 1/4W 5% MF	IRH		
R32	2.2KΩ 1/4W 5% MF	IRH		
R33	680Ω 1/4W 5% MF	IRH		
R34	680Ω 1/4W 5% MF	IRH		
R35	390Ω 1 W 5% CC	PI		
R36	10Ω 1/4W 5% MF	IRH		
R37	10Ω 1/4W 5% MF	IRH		
R38	33KΩ 1/4W 5% MF	IRH		
R39	33KΩ 1/4W 5% MF	IRH		
R40	3.3KΩ 7 W WW 5% ACW7	IRH		
R41	3.3KΩ 7 W WW 5% ACW7	IRH		
R42	39KΩ 1/4W 5% MF	IRH		
R43	100Ω 1/4W 5% MF	IRH		

8. ALIGNMENT & MAINTENANCE (Cont'd.)

The following chart suggests steps to be followed to localise a fault causing instrument failure : -



8. ALIGNMENT & MAINTENANCE (Cont'd.)

The following alignment procedure assumes the instrument has been operating and has had a component replacement or is being recalibrated.

Before making any measurements or setting controls, check that primary connections of the power transformer are correctly connected for the line voltage applied. Line voltage should be slowly applied via a variable voltage transformer if changes have been made to the power supply circuit or EHT supply to check correct operation as volatge is increased.

NOTE: Throughout this instrument the following wire colour codes are adopted:

-15V	Violet
+15V	Yellow
+100V	Orange
Ground	Black
AC Line	Brown/White and Blue/White after Power Switch. Brown and Blue before Power Switch.
6.3V AC	Brown and Black/White Twisted Pair

All DC measurements should be made with a DVM or 20.000Ω/V meter. Oscilloscope waveforms were obtained using a x10 high impedance probe. Power supply lines can be checked using a x1 probe, but in each case a ground lead must be used to minimise noise and interference effects

8.1 Covers

To remove top cover remove screws holding handle and two in top and two at side. Bottom cover is removed by unscrewing feet.

8.2 DC Voltage Settings

-15V (Violet Wire)

A convenient connection to the rail is near the front panel on the trigger selector board where three violet wires meet at a solder tag. Set voltage to -15 ± 0.2V by RV4 located on the power supply board.

+15V (Yellow Wire)

Connection available on trigger selector board solder tag. Set voltage to +15V ±0.2V by RV3 on power supply board.

+100V (Orange Wire)

Measuring point available on positive end of C6, 50μF capacitor. Adjust RV2 for +100V ±0.5V.

-1450V EHT (Heavy Blue Wire)

Connection at R.H. side rear of power supply board. Adjust RV50 for -1450V ±25V. -1530 for CRT grid and +8600 PDA voltages are automatically set when -1450V rail is correctly adjusted.

8.3 Intensity Adjust

RV51 located at rear R.H. of top PC board adjusts intensity range. With 'A' time base operating in AUTO at 1mSec., horizontal display to intensified (if 6S time base is fitted), time base 'B' to 0.1mSec. and intensity control turned to minimum, adjust RV51 until trace is fully blanked out. Now turn control fully clockwise. Trace will bloom at maximum intensity.

This level will not be used in continuous displays, but fast, low repetition rate pulses require high intensity levels to produce a visible display.

8. ALIGNMENT & MAINTENANCE (Cont'd.)

8.4 CRT Geometry

With an amplifier and time base plug-ins fitted, first align the trace with no input signal and free running in Auto to the centre graticule line with the Trace Rotate preset. Then feed in a 10kHz sine wave and adjust for 8 div. vertical deflection. Set time base to 1mSec/div. With trace centred vertically and horizontally, first adjust intensity focus and astigmatism for a normal intensity sharp trace.

RV52 on the vertical amplifier board is adjusted to obtain the squarest image against the graticule lines.

8.5 Vertical Amplifier.

The design of the output stage is such that slight variations in DC levels of the plug-in amplifiers have little effect on its DC levels. However, before resetting RV170, check the plug-in amplifier is correctly set according to its handbook recommendations.

With Channel 1 selected and the trace centred, adjust RV170 for +52V at the collector of Q176 and Q177.

Vertical response should only be adjusted if the CRT has been changed or if it is desired to optimise a particular plug-in in one of the cavities. A 1nSec. rise time pulse generator is required.

If a 6B plug-in is fitted to Channel 1, set attenuator to 50mV and vernier to CAL. Centre trace and adjust input pulse amplitude to 6 div.

NOTE: Cable must be correctly terminated by a 50Ω load at the amplifier input.

The pulse leading edge is adjusted for maximum sharpness with minimum overshoot by R172 and C173 on the vertical board and RV26 and C29 in the 6B amplifier.

RV184 and C172 set the overall flatness of the waveform behind the leading edge.

These are the only adjustments needed to align the vertical amplifier.

8.6 Horizontal Amplifier

This section requires lining up with a precision time mark generator with a 6T or 6S time base plug-in fitted.

Set time base to 1mSec/div., vernier to CAL. Feed time mark generator into Channel 1 and set Vertical Display to ALT. Check calibration of Channel 2 with x10 probe fitted (or another oscilloscope). Lock display to time pulses. Set Channel 2 trace to 1 div. up from bottom of graticule and attenuator to 100mV/div. (1V/div. with probe). Apply tip of probe to pin 25 (bottom pin) of time base interconnecting plug at back of PC board.

Channel 2 trace will slope up to right and start of trace should move up 1 div. (1V), if it does not, re-adjust RV60 on 6S or RV5 on 6T until start of Channel 2 moves up 1 div. (1V). Now move trace to left until end of trace is on the screen.

Switch Channel 2 attenuator to 200mV/div. (2V/div. with probe). With no input adjust trace to 1 div. up from bottom of CRT as before and again place probe on pin 25. End of trace should be half a division down from top line of graticule, i.e. +13V from ground.

Trace length in time base plug-in is now set. Centre trace on CRT, set RV20 for a trace (approximately) 4mm longer than the 10 div. graticule (2mm each end). Reposition trace with 1st time mark pulse in line with 1st graticule. If necessary adjust RV66 on 6S and RV4 on 6T time base to align pulses with graticule marks. Remove amplifier in centre compartment for access or use bwd 160/170 extension board.

8. ALIGNMENT & MAINTENANCE (Cont'd.)

8.6 Horizontal Amplifier (Cont'd.)

Now press x10 magnification button and note position of pulse on graticule centre line. The expanded pulse should not move sideways. If it does, centre the leading edge of the pulse on the graticule centre line, then reset x10 button back to x1, adjust RV22 to make centre pulse line up with graticule centre line. Repeat and check. Increase input to 100μSec. pulses, press x10 mag. Adjust RV21 for 1 pulse per div.

Increase time base and time mark frequency checking calibration as detailed in 6S or 6T handbook.

The set DC control RV23 is adjusted to set the nominal voltage on Q24 and Q25 output transistor collectors to +52V.

Press x10 magnification and X-Y display button, centre spot on CRT. Measure DC at collector of Q24 and Q25 and adjust RV23 for +52V. Horizontal position may require minor adjustment to equalise both collectors. Release X-Y button, apply 50MHz signal to Channel 1, set time base to 0.1μSec. (maximum speed) and shift trace across screen to check linearity. C20 trimmer will adjust linearity between start of trace and remainder of display and should be adjusted for the best overall trace linearity.

8.7 Blanking Amplifier.

Only one adjustment is incorporated, C53 which sets the sharpness of the turn on unblanking pulse. With time base to 0.1μSec./Div. and a 1MHz square wave of 4 div. amplitude displayed. Adjust C53 for even intensity of display with brightest leading edge.

8.8 Trigger Selector

Three controls and two trimmers are provided in this board. RV103 adjusts the output DC level of the trigger amplifier. With an amplifier plug-in fitted to Channel 1, position the trace on the graticule centre line. Measure with a meter or DC coupled oscilloscope (e.g. Channel 2 of this oscilloscope) the voltage on the L.H. end of C111 (0.22μF) soldered to the switch contacts protruding through the switch top. Adjust RV103 for zero volts.

Now transfer the meter to the co-ax cable located between RV101 and RV102 at the back of the board. Adjust RV102 this time for zero volts. Before aligning RV101 and C100, the output level of the plug-in amplifier must be checked. Feed in a 1kHz sine and adjust for precisely 6 div. deflection. Measure with a calibrated scope Channel 1 output at the front panel BNC jack. Adjust RV27 on 6B amplifier or output level contrc of other amplifier plug-ins as described in their respective handbooks until output is 600mV p-p.

With the same input signal to Channel 1 (1kHz sine wave 6 div. deflection exactly), switch in the following buttons on the Trig. Select, 1 DC, X-Y and x10 mag. Set Vertical Display to Channel 2. A horizontal line will be presented which should be set to 6 div. length by RV101.

Now turn the Vertical Selector to Channel 1, the trace will appear diagonally across the graticule. Increase the frequency of the input sine wave oscillator to 1MHz, the trace should remain a straight line although it will shorten horizontally. C100 will bring the trace to a straight line and maintain 1% phase shift between X & Y axis.

Ext. trigger input compensation is set by pushing in all buttons across the top of the 525 main frame (excluding trace find). Connect into the EXT input BNC socket 30-50V p-p, 1kHz square wave centre trace and adjust C112 for no overshoot. A 1kHz (approximately) sine wave applied to Channel 1 producing a 3 div. vertical deflection will assist in determining the correct setting of C112.

8. ALIGNMENT & MAINTENANCE (Cont'd.)

8.9 Calibrator

Calibrator is located on vertical amplifier board. Feed in a 1kHz, 1V p-p square wave with a known amplitude accuracy (better than 0.25%) to Channel 1. Set attenuator to 0.5V/Div. and vernier to CAL. Adjust preset CAL control on amplifier for precisely 8 division deflection. Remove external reference and instead couple in 4V calibrator signal from socket on front panel. Adjust RV221 for precisely 8 division deflection.

Disconnect input and couple in a precision time mark generator (0.1% accuracy). Set time base with range switch and vernier if necessary until 1 pulse appears every graticule division. Remove time mark generator and reconnect calibrator signal. Adjust RV220 until each pulse lines up with graticule lines. Alternatively, the frequency can be set by feeding 4V output into a digital counter and adjust RV220 for 1kHz.

9. REPLACEMENT PARTS

Spares are normally available from the manufacturer, B.W.D. Electronics Pty.Ltd. When ordering, it is necessary to indicate the Model No. and Serial No. 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 B.W.D. Electronics Pty.Ltd., is one of continuing research and development, the Company reserves the right to supply the latest equipment and make amendments to circuit and parts without notice.

10. GUARANTEE

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

Please refer to Guarantee Registration Card No.:....., which accompanied instrument for full details of warranty.

B.W.D. ELECTRONICS PTY.LTD.

REPLACEABLE PARTS

1. This section contains information for ordering replacement parts, it provides the following details:-

   (a) Description of part (see list of abbreviations)
   (b) Typical manufacturer or supplier of the part (see list of abbreviations).
   (c) Manufacturer's Part Number, and
   (d) Defence Stock Number, where applicable.

2. Ordering - Please quote Model Type No., e.g. bwd 539C Serial No. Circuit Reference No. and component details as listed in parts list.

COMPONENT DESIGNATORS

A	Assembly	H	Heater	RV	Resistor Variable
B	Lamp	J	Jack (socket)	S	Switch
C	Capacitor	L	Inductor	T	Transformer
D	Diode	M	Meter	TH	Thermistor
DL	Delay Line	P	Plug	V	Valve
E	Misc. Elect.Part	Q	Transistor	VDR	Voltage Dependent Resistor
F	Fuse	R	Resistor		

ABBREVIATIONS

Amp	Ampere	L	Inductor
C	Capacitor	lin	Linear
cc	Cracked Carbon	Log	Logarithmic Taper
c	Carbon	m	Milli = 10^{-3}
cd	Deposited Carbon	MHz	Mega Hertz = 10^{6} Hz
comp	Composition	MF	Metal Film
CDS	Ceramic Disc Capacitor	ma	Milli Ampere
cer	ceramic	MΩ	Meg Ohm = 10^{6} Ω
Com l	Common	mfr	Manufacturer
DPST	Double Pole Single Throw	MO	Metal Oxide
DPDT	Double Pole Double Throw	MHT	Polyester/Paper Capacitor
ELECTR	Electrolytic	MPC	Metalised Polyester Capacitor
F	Farad	Ne	Neon
f	Fuse	NPO	Zero temperature co-efficient
FET	Field Effect Transistor	nsr	Not separately replaceable
Ge	Germanium	NC	Normally Closed
H	Henry(ies)	NO	Normally Open
H.S.	High Stability	ns	Nano second
HTC	High Temp Coating	obd	Order by Description
ins	Insulated	OD	Outside Diameter
KHz	Kilo Hertz = 10^{3} Hz	p	Peak
KΩ	Kilo Ohm = 10^{3} Ω	pf	pico farad = 10^{-12}F

GET Ref.	DESCRIPTION				MFR. OR SUPPLY	PART NO.	
R44	DELETED						
R50	470KΩ	1/4W	5%	MF	IRH		
R51	82K	1/4W	5%	MF	IRH		
R52	8K2	1/4W	5%	MF	IRH		
R53	1K	1/4W	5%	MF	IRH		
R54	1K	1/4W	5%	MF	IRH		
R55	4K7	1/4W	5%	MF	IRH		
R56	3K9	1/4W	5%	MF	IRH		
R57	100K	1/4W	5%	MF	IRH		
R58	33Ω	1/4W	5%	MF	IRH		
R59	33Ω	1/4W	5%	MF	IRH		
R60	5K6	1/4W	5%	MF	IRH		
R61	390Ω	1/4W	5%	MF	IRH		
R62	220Ω	1/4W	5%	MF	IRH		
R63	12K	1/4W	5%	MF	IRH		
R64	470Ω	1/4W	5%	MF	IRH		
R65	27K	1/4W	5%	MF	IRH		
R66	4K7	1/4W	5%	MF	IRH		
R67	5K6	1/4W	5%	MF	IRH		
R68	2.7MΩ	1/2W	5%	CC	PH	VR37	
R69	2.7MΩ	1/2W	5%	CC	PH	VR37	
R70	2.7MΩ	1/2W	5%	CC	PH	VR37	
R71	15KΩ	1/4W	5%	MF	IRH		
R72	10MΩ	1/2W	5%	CC	PI		
R73	10MΩ	1/2W	5%	CC	PI		
R74	10MΩ	1/2W	5%	CC	PI		
R75	1MΩ	1/4W	5%	MF	IRH		
R76	1.5MΩ	1/2W	5%	CC	PI		
R77	3.9MΩ	1/2W	5%	CC	PH	VR37	
R78	3.9MΩ	1/2W	5%	CC	PH	VR37	
R79	100KΩ	1/4W	5%	MF	IRH		
R80	100KΩ	1/4W	5%	MF	IRH		
R81	DELETED						
R82	180KΩ	1/4W	5%	MF	IRH		
R83	1K	1/4W	5%	MF	IRH		
R84	220Ω	1/4W	5%	MF	IRH		

eet Ref.	DESCRIPTION				MFR. OR SUPPLY	PART NO.	
R100	330Ω	1/4W	5%	MF	IRH		
R101	4K7	1/4W	5%	MF	IRH		
R102	47K	1/4W	5%	MF	IRH		
R103	680Ω	1/4W	5%	MF	IRH		
R104	4K7	1/4W	5%	MF	IRH		
R105	1K8	1/4W	5%	MF	IRH		
R106	2K2	1/4W	5%	MF	IRH		
R107	10Ω	1/4W	5%	MF	IRH		
R108	10Ω	1/4W	5%	MF	IRH		
R109	10Ω	1/4W	5%	MF	IRH		
R110	2K7	1/4W	5%	MF	IRH		
R111	47Ω	1/4W	5%	MF	IRH		
R112	10Ω	1/4W	5%	MF	IRH		
R113	220KΩ	1/4W	5%	MF	IRH		
R114	1M	1/4W	2%	MF	IRH		
R115	10Ω	1/4W	5%	MF	IRH		
R116	1K5	1/4W	5%	MF	IRH		
R117	900K	1/4W	2%	MF	IRH		
R118	111K	1/4W	2%	MF	IRH		
R119	150	1/4W	5%	MF	IRH		
R120	1K	1/4W	5%	MF	IRH		
R121	1K5	1/4W	5%	MF	IRH		
R122	3K3	1/4W	5%	MF	IRH		
R123	47	1/4W	5%	MF	IRH		
R124	1K	1/4W	5%	MF	IRH		
R125	56	1/4W	5%	MF	IRH		
R140	91Ω	1/4W	1%	MF	IRH		
R141	91Ω	1/4W	1%	MF	IRH		
R142	820Ω	1/4W	5%	MF	IRH		
R143	820Ω	1/4W	5%	MF	IRH		
R144	56Ω	1/4W	5%	MF	IRH		
R145	680Ω	1/4W	5%	MF	IRH		
R146	680Ω	1/4W	5%	MF	IRH		
R147	2K2	1/4W	5%	MF	IRH		
R148	2K2	1/4W	5%	MF	IRH		
R149	1K	1/4W	5%	MF	IRH		
R150							
R151	2K2	1/4W	5%	MF	IRH		
R152	1K5	1/4W	5%	MF	IRH		
R153	680Ω	1/4W	5%	MF	IRH		

CCT Ref.	DESCRIPTION				MFR. OR SUPPLY	PART NO.	
R154	100	1/4W	5%	MF	IRH		
R155	100	1/4W	5%	MF	IRH		
R156	6K8	1/4W	5%	MF	IRH		
R157	6K8	1/4W	5%	MF	IRH		
R158	1K	1/4W	5%	MF	IRH		
R159	4K7	1/4W	5%	MF	IRH		
R160	33	1/4W	5%	MF	IRH		
R161	180	1/4W	5%	MF	IRH		
R162	3K3	1/4W	5%	MF	IRH		
R170	82	1/4W	2%	MF	IRH		
R171	82	1/4W	2%	MF	IRH		
R172	2K2	1/4W	5%	MF	IRH		
R173	3K9	1/4W	5%	MF	IRH		
R174	3K9	1/4W	5%	MF	IRH		
R175	120Ω	1/4W	5%	MF	IRH		
R176	330Ω	1/4W	5%	MF	IRH		
R177	330Ω	1/4W	5%	MF	IRH		
R178	330Ω	1/4W	5%	MF	IRH		
R179	470Ω	1/4W	5%	MF	IRH		
R180	470Ω	1/4W	5%	MF	IRH		
R181	470Ω	1 W	5%	CC	PI		
R182	470Ω	1 W	5%	CC	PI		
R183	100Ω	1/4W	5%	MF	IRH		
R184	2K2	1/4W	5%	MF	IRH		
R185	47	1/4W	5%	MF	IRH		
R186	47	1/4W	5%	MF	IRH		
R187	DELETED						
R188	1K5	1/4W	5%	MF	IRH		
R189	1K5	1/4W	5%	MF	IRH		
R190	220Ω	1 W	5%	CC	PI		
R191	220Ω	1 W	5%	CC	PI		
R192	33	1/4W	5%	MF	IRH		
R193	33	1/4W	5%	MF	IRH		
R194	6K8	1/4W	5%	MF	IRH		
R195	150Ω	1 W	5%	CC	PI or R Ohm		
R196	150Ω	1 W	5%	CC	PI or R Ohm		
R197	150Ω	1 W	5%	CC	PI or R Ohm		
R198	150Ω	1 W	5%	CC	PI or R Ohm		
R199	150Ω	1 W	5%	CC	PI or R Ohm		
R200	150Ω	1 W	5%	CC	PI or R Ohm		

CCT Ref.	DESCRIPTION				MFR. OR SUPPLY	PART NO.	
R201	220Ω	4W	5%	MO	W or IRH		
R202	390Ω	1W	5%	CC	PI		
R203	47K	1/4W	5%	MF	IRH		
R204	47K	1/4W	5%	MF	IRH		
R205	10Ω	1/4W	5%	MF	IRH		
R220	2K2	1/4W	5%	MF	IRH		
R221	8K2	1/4W	5%	MF	IRH		
R222	15K	1/4W	5%	MF	IRH		
R223	12K	1/4W	5%	MF	IRH		
R224	3K9	1/4W	5%	MF	IRH		
R225	4K7	1/4W	5%	MF	IRH		
R226	5K6	1/4W	5%	MF	IRH		
R227	33	1/4W	5%	MF	IRH		
R228	33	1/4W	5%	MF	IRH		
R229	2K	1/4W	1%	MF	IRH		
R230	82Ω	1/4W	5%	MF	IRH		
R231	10Ω	1/4W	5%	MF	IRH		
R232	4K7	1/4W	5%	MF	IRH		
R233	2KΩ	1/4W	1%	MF	IRH		
R234	220K	1/4W	5%	MF	IRH		
R235	20Ω	1/4W	1%	MF	IRH		
R236	33Ω	1/4W	5%	MF	IRH		
R237	33Ω	1/4W	5%	MF	IRH		
R238	15Ω	1/4W	5%	MF	IRH		
R300	560Ω	1/4W	5%	MF	IRH		
R301	100Ω	1/4W	5%	MF	IRH		
R302	100K	1/4W	5%	MF	IRH		
R303	5K6	1/4W	5%	MF	IRH		
R304	10K	1/4W	5%	MF	IRH		
R305	100K	1/4W	5%	MF	IRH		
R306	10K	1/4W	5%	MF	IRH		
R307	220K	1/4W	5%	MF	IRH		
R309	470Ω	1/4W	5%	MF	IRH		

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION				Mfr. OR SUPPLY	PART NO.
	CAPACITORS					
C1	50µF	150V		Electro	PH	2222/040/11509
C2	50µF	150V		Electro	PH	2222/040/11509
C3	0.047µF	160V	10%	PYE	PH	2222/311/31474
C4	1µF	200V	10%		Elna 1	Type N
C5	47µF	25V		Electro	PH	2222-015-16479
C6	50µF	150V		Electro	PH	2222/040/11509
C7						
C8						
C9						
C10	2500µF	63V		Electro	Elna	RG
C11	4700µF	25V		Electro	Elna	RG
C12	1µF	63V		Electro	PH	2222-015-18108
C13	4.7µF	63V		Electro	PH	2222-015-18478
C14	0.05µF	100V		G/C		Greencap
C15	0.05µF	100V		G/C		Greencap
C16	150µF	16V		Electro	PH	2222-016-16101
C17	150µF	16V		Electro	PH	2222-016-16101
C18						
C19						
C20	1-5pf	Trimmer			PH	2222-808-60004
C21	0.1µF	50V	CER DISC			
C22	2.2pf	500V	±0.5% NPO CDS		PL	CDS
C50	0.1µF	500V	CER DISC			
C51	0.1µF	50V	CER DISC			
C52	0.1µF	50V	CER DISC			
C53	1-5pf	Trimmer			PH	
C54	0.047µF	160V	10%	PYE	PH	2222-311-31474
C55	0.1µF	160V	10%	PYE	PH	2222-311-31104
C56	0.0075µF	4kV			PL	CDH
C57	0.01µF	2.5kV or 3kV			PL	CDH
C58	0.01µF	2.5kV or 3kV			PL	CDH
C59	0.22µF	100V	10%	MET PL	Elna	Type N
C60	0.1µF	100V	10%	MET PL	Elna	Type N
C61	0.1µF	160V	10%	PYE	PH	2222-311-31104
C62	0.01µF	2.5kV	10%	CER DISC.	PH	2222-311-31104
C63	0.01µF	50V	20%	PYE	H.S.	CDS

CCT Ref.	DESCRIPTION			Mfr. or SUPPLY	PART No.
C100	5-60pf	Trimmer		PH	2222-808-01001
C101	100pf	500V	5% N750 CER	PL	CDS
C102	0.1µF	50V	Hi K CER DISC		CDS
C103	0.1µF	50V	Hi K CER DISC		
C104	150µF	25V	Electro	PH	2222-016-16101
C105	0.1µF	50V	Hi K CER DISC		
C106	100pf	5%	N750 500V CER	PL	CDS
C107	0.001µF	20%	Curve YY CER	PL	CDS
C108	0.1µF	50V	Hi K CER DISC		
C109	150µF	25V	Electro	PH	2222-016-16101
C110	0.0022µF	20%	500V CER DISC	PL	CDS
C111	0.022µF	400V	10% PYE	PH	2222-311-51101
C112	2-6pf	Trimmer		Stetner	2-6-10S
C113	22pf	5%	N330 500V CER	PL	CDS
C114	0.001µF	20%	Curve YY CER	PL	CDS
C115	0.001µF	20%	Curve YY CER	PL	CDS
C116	0.1µF	20%	Curve YY CER	PL	CDS
C117	22pf	5%	CER	HC	CDS
C118	10-40pf	Trimmer		Stetner	10-40-10S
C119	0.1µF	63V	Curve YY CER	PL	CDS
C140	15pf	10%	NPO 500V CER Disc	PL	CDS
C141	15pf	10%	NPO 500V CER Disc	PL	CDS
C142	180pf	5%	400V PYS	H.S.	TCS
C143	180pf	5%	400V PYS	H.S.	TCS
C144	180pf	5%	400V PYS	H.S.	TCS
C145	33pf	5%	500V N750 CER	PL	CDS
C146	0.1µF	50V	Hi K CER DISC	H.S.	CDS
C147	0.1µF	50V	Hi K CER DISC	H.S.	CDS
C170	0.1µF	50V	Hi K CER DISC		
C171	82pf	5%	N750 500V CER	PL	CDS
C172	4-20	Trimmer		Stetner	10-40-10S
C173	10-40pf	Trimmer		Stetner	10-40-10S
C174	0.1µF	160V	10% PYE	PH	2222-311-31104
C175	0.1µF		CER DISC		
C176	0.1µF	100V	10%	Elna	
C177	0.1µF		CER DISC		
C178	22pF	NPO	CER DISC		

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION			Mfr. or Supply	PART No.
C220	0.47µF	200V	10% MET PL	Elna	Type N
C221	0.1µF	100V	1% MET PL	Elna	Type N
C222	0.1µF	100V	1% MET PL	Elna	Type N
C230	0.0022µF	500V	20% CER DISC	PL	CDS
C231	0.0022µF	500V	20% CER DISC	PL	CDS
C232	0.0022µF	500V	20% CER DISC	PL	CDS
C300	0.22µF	100V	10% MET PL	Elna	Type N
C301					
C302	47µF	40V	Electro	PH	2222-016-17479
C303	0.0075µF	4kV	CER DISC	PL	CDH
C304	0.0075µF	4kV	CER DISC	PL	CDH
C305	0.0075µF	4kV	CER DISC	PL	CDH
C306	0.0075µF	4kV	CER DISC	PL	CDH
C307	0.0075µF	4kV	CER DISC	PL	CDH
C308	0.0075µF	4kV	CER DISC	PL	CDH
C309	DELETED				
C310	0.0075µF	4KV	CER DISC	PL	CDH
C311	0.0075µF	4kV	CER DISC	PL	CDH
C312	0.01µF	2.5kV or 3kV	CER DISC	PL	CDH
C313	0.01µF	2.5kV or 3kV	CER DISC	PL	CDH
C314	0.01µF	2.5kV or 3kV	CER DISC	PL	CDH
C315	0.01µF	2.5kV or 3kV	CER DISC	PL	CDH
	POTENTIOMETERS				
RV1	50Ω	WW	2W	Darstan	P121
RV2	4K7	Preset		PL	MPD/PC
RV3	100K	Preset		PI	PT15LB
RV4	100K	Preset		PI	PT15LB

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION	Mfr. OR SUPPLY	PART No.	
RV20	200Ω Preset	PL	MPD/PC	
RV21	100Ω Preset	PL	MPD/PC	
RV22	100Ω Preset	PI	PT15LB	
RV23	200Ω Preset	PI	PT15LB	
RV50	220K Preset	PL	MPD/PC	
RV51	1MΩ Preset	PI	PT15LB	
RV52	100KΩ Preset	PI	PT15LB	
RV53	2.5MΩ Lin Carbon	IRH	CT45	
RV54	100K Lin Carbon Preset	IRH	CT45	
RV55	5K WW 2W	Darstan	P121	
RV56	10K Lin Carbon with DPST Rotary Switch			
RV100	5K Lin Carbon) Dual Conc.	IRH	CT45	
A & B	5K Lin Carbon)			
RV101	1K Preset	PI	PT15LB	
RV102	500Ω Preset	PI	PT15LB	
RV103	2K Preset	PI	PT15LB	
RV170	100Ω WW Preset	Darstan	P109-6	
RV171	200Ω Preset	PI	PT15LB	
RV172	1KΩ Preset	PI	PT15LB	
RV220	10K Preset	PI	PT15LB	
RV221	2K2 Preset	PL	MPD/PC	

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION	Mfr. or Supply	PART No.	
	SEMI CONDUCTORS			
Q1	MJE340 NPN SI	MOT		
Q2	MJE340 NPN SI	MOT		
Q3	MJE340 NPN SI Or BF 337	MOT		
Q4	MJE340 NPN SI	MOT		
Q5	BC147 NPN SI	PH		
Q6-9				
Q10	MJE2955 PNP SI	MOT		
Q11	MJE3055 or 2801 NPN SI	MOT		
Q20	2N4121 PNP SI	F		
Q21	2N4121 PNP SI	F		
Q22	2N4121 PNP SI	F		
Q23	2N4121 PNP SI	F		
Q24	BF337 NPN SI	PH		
Q25	BF337 NPN SI	PH		
Q50	2N3646 or 2N5772 NPN SI	F		
Q51	2N3646 or 2N5772 NPN SI	F		
Q52	2N4888 PNP SI	F		
Q53	BF337 NPN SI	F		
Q100	AY1119 or 2N2369A NPN SI	F		
Q101	2N4121 or AY1114 PNP SI	F		
Q102	2N3819 or MPF106 FET N Channel	TI		
Q103	AY1119 or 2N2369A NPN SI	F		
Q104	AY1119 or 2N2369A NPN SI	F		
Q140	2N4121 or AY1114 PNP SI	F		
Q141	BC147 NPN SI	PH		
Q170	BFY90 or FMT990 NPN SI	PH or F		
Q171	BFY90 or FMT990 NPN SI	PH or F		
Q172	2N3564 or 2N5770 NPN SI	F		
Q173	2N3564 or 2N5770 NPN SI	F		

GGT Ref.	DESCRIPTION				Mfr. of Supply	PART No.	
Q174	BFW17 or 17A		NPN	SI	PH		
Q175	BFW17 or 17A		NPN	SI	PH		
Q176	2N2219		NPN	SI	STC		
Q177	2N2219		NPN	SI	STC		
Q220	BC147		NPN	SI	PH		
Q221	BC147		NPN	SI	PH		
Q222	BC147		NPN	SI	PH		
Q300	BC147		NPN	SI	PH		
Q301	BC157		PNP	SI	PH		
Q302	TIP30A (Low HFE)		PNP	SI	TI		
IC-1	MC1468) SG4501) +15V Regulator Dual in Line				MOT S & G		
IC-100	7400 TTL Quad Nand Gate				F		
D1	EM404	400V	SI	Diode	STC		
D2	EM404	400V	SI	Diode	STC		
D3	EM404	400V	SI	Diode	STC		
D4	EM404	400V	SI	Diode	STC		
D5	BZY79 or 88/C13V		Zener Diode		PH		
D10	EM404	400V	SI	Diode	STC		
D11	EM404	400V	SI	Diode	STC		
D12	EM404	400V	SI	Diode	STC		
D13	EM404	400V	SI	Diode	STC		
D20	AN206	75V	SI	Signal Diode	F		
D21	AN206	75V	SI	Signal Diode	F		
D22	AN206	75V	SI	Signal Diode	F		
D23	AN206	75V	SI	Signal Diode	F		
D24	AN206	75V	SI	Signal Diode	F		
D25	AN206	75V	SI	Signal Diode	F		
D50-51	AN206	75V	SI	Signal Diode	F		
D52-53	AN206	75V	SI	Signal Diode	F		
D54	AN206	75V	SI	Signal Diode	F		
D100	AN206	75V	SI	Signal Diode	F		
D101	AN206	75V	SI	Signal Diode	F		

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION	Mfr. or Supply	PART No.	
D102	AN206 75V SI Signal Diode	F		
D103	AN206 75V SI Signal Diode	F		
D104	BZY79 or 88 / C6V2 Zener Diode	PH		
D140	AN206 75V SI Signal Diode	F		
D141	AN206 75V SI Signal Diode	F		
D142	AN206 75V SI Signal Diode	F		
D143	AN206 75V SI Signal Diode	F		
D144	AN206 75V SI Signal Diode	F		
D145	AN206 75V SI Signal Diode	F		
D146	AN206 75V SI Signal Diode	F		
D147	AN206 75V SI Signal Diode	F		
D148	AN206 75V SI Signal Diode	F		
D149	AN206 75V SI Signal Diode	F		
D150	AN206 75V SI Signal Diode	F		
D151	BZY79 or 88 / C6V2 Zener Diode	PH		
D170	AN206 75V SI Signal Diode	F		
D171	AN206 75V SI Signal Diode	F		
D172	BZY79 or 88 / C15 Zener Diode	PH		
D220	AN206 75V SI Signal Diode	F		
D230	AN206 75V SI Signal Diode	F		
D231	AN206 75V SI Signal Diode	F		
D232	AN206 75V SI Signal Diode	F		
D233	AN206 75V SI Signal Diode	F		
D234	AN206 75V SI Signal Diode	F		
D235	AN206 75V SI Signal Diode	F		
D300	BZY79 or 88 / C10V Zener Diode	PH		
D301	AN206 75V SI Signal Diode	F		
D302	BY176 12kV SI Diode	PH		
D303	BY176 12kV SI Diode	PH		
D304	BY176 12kV SI Diode	PH		
D305	BY176 12kV SI Diode	PH		
D306	BY176 12kV SI Diode	PH		
D307	BY176 12kV SI Diode	PH		

PARTS LIST - MODEL bwd 525

CCT Ref.	DESCRIPTION	Mfr. or Supply	PART No.	
	SUNDRIES			
B1	6.3V 100mA Les Lamp			
B2	6.3V 100mA Les Lamp			
B3	6.3V 100mA Les Lamp			
B4	6.3V 100mA Les Lamp			
B5	220V Neon Indicator	Sato		
B50	NE2 Neon			
B51	NE2 Neon			
F1	0.25A QB Size 00	B & L	Only reqd. S. No. Below 21005	
F2	0.5A QB Size 0			
F3	(0.5A SB Size 0 (190-260V) (1A SB Size 0 (95-135V)			
T1	Power Transformer Secondary	BWD	090/112/2	
T300	EHT Transformer	BWD	090/141/1	
CRT	D14-121/08 with internal graticule D14-121 without graticule Phosphors GH = P31, GM = P7	PH		
DL	100nSec. Delay Line	BWD		
S1A/B	DPST on rear of RV56			
S2A/B	2 Pos. 2 Pole Spring Return 'Isostat'	McM	100/79/1	
S220A - G	5 Pos. 2 Pole 3 Deck Type 'F'	AWA		
S100 - 105	2 Pole, 2 Pos. 6 Section 'Isostat'	McM	100/81/1	
L301	22µH			
L 20	330µH			
L140	12 Turns			
L141	12 Turns			
	ALL OTHER ITEMS ORDER BY DESCRIPTION			

	MODIFICATIONS
R 1-9 10-16 220-230	RB 560Ω ADDED
	R17 4K7 "
C 1-6 10-17 220-221	R9 3·3Ω "
	Q5 BC147 "
Q 1-5 10-11 220-222	FUSE F1 REMOVED
	R2 12K WAS 22K
	R4 1M WAS 3M9
D 1-5 10-13 220	CIRCUIT REDRAWN
	ISSUE 4 6-73
	ISSUE 5 10-11-73
	C13 WAS 1μF
	ISSUE 6 18-1-74
	C10 2500 / 63
	C11 4700 / 25
	ISSUE 7 8/74
	REF TO DRG. NO. 953
	ISSUE 8 12/74
	APPLICABLE FROM SERIAL NO. 23000
	ISSUE 9 4/75
	REFER DRG. No. 954
	ISSUE 10 9-76
	REF. DRG. No. 952
	ISSUE 11 10-76
	APPLICABLE FROM SERIAL No. 35 210
	C5 50μF → 47μF 25V
	C13 5μF → 47μF 63V
	C16, C17 125/16V → 150/16V
	SEE ALSO DRG. Nos. 952, 3 & 4.
	ISSUE 12 10-77
	REF. DRG. No. 954

SWITCHES

SIA & B AC POWER

CONTROLS

RV1 GRATICULE LIGHT

RV2 SET +100V

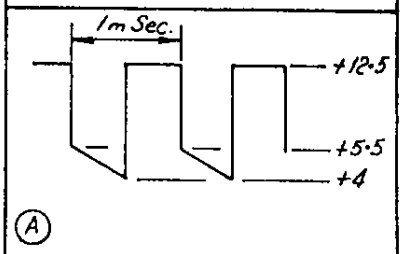
RV4 SET −15V

RV3 SET V. BAL. (SET • 15V)

RV220 SET 1KHZ CALIBRATOR

RV221 4V OUT "

WAVEFORMS



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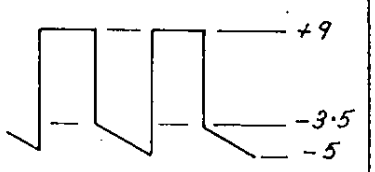

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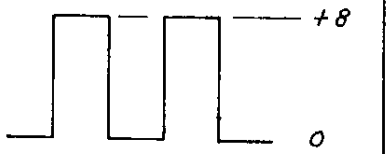

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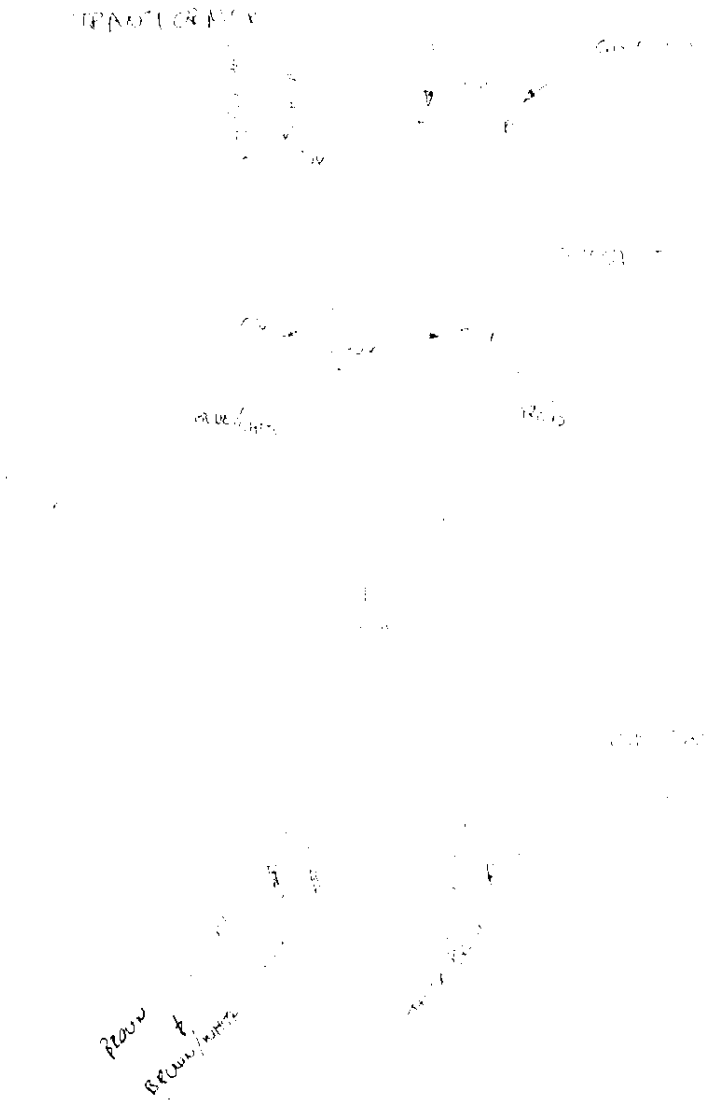
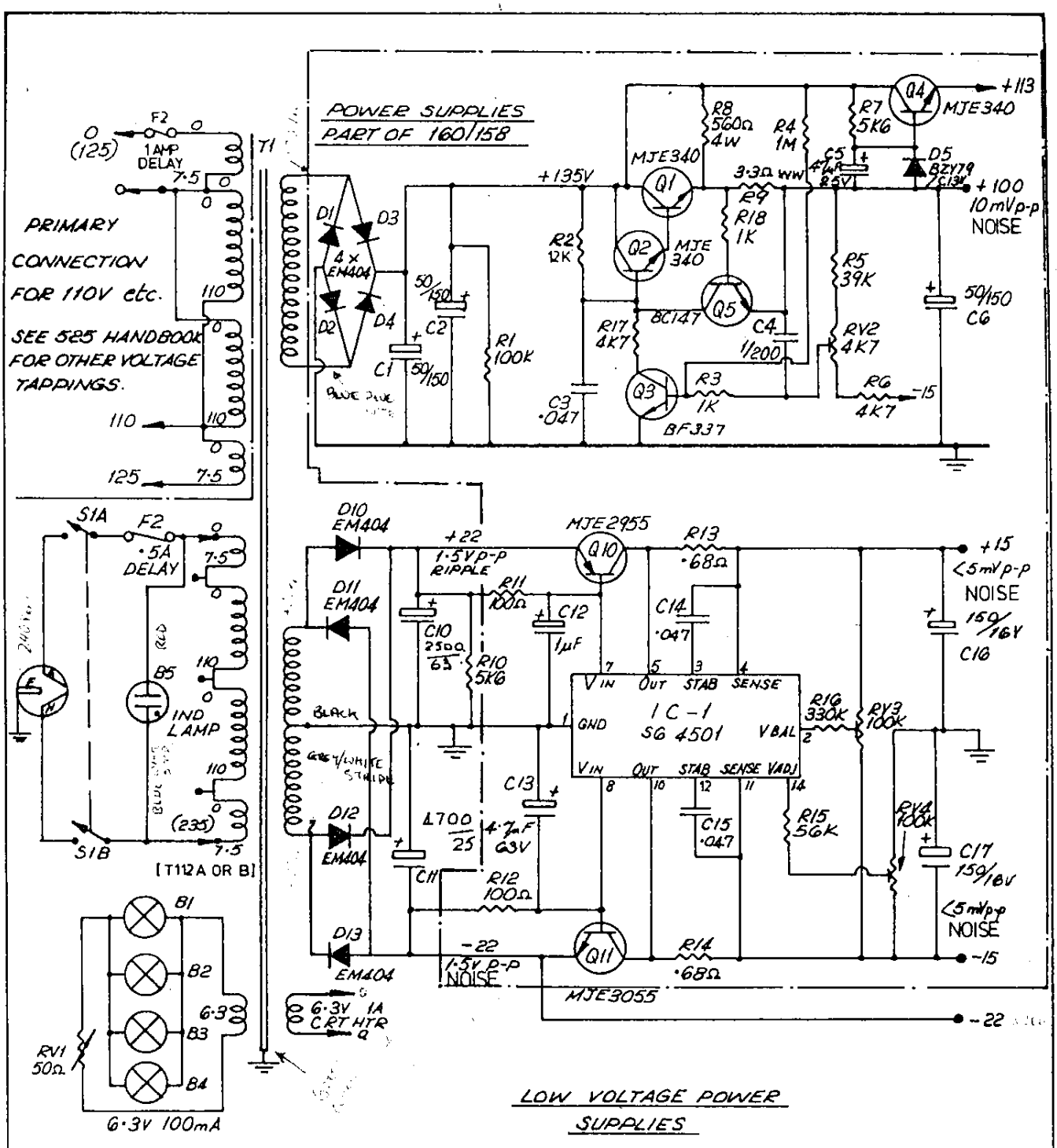
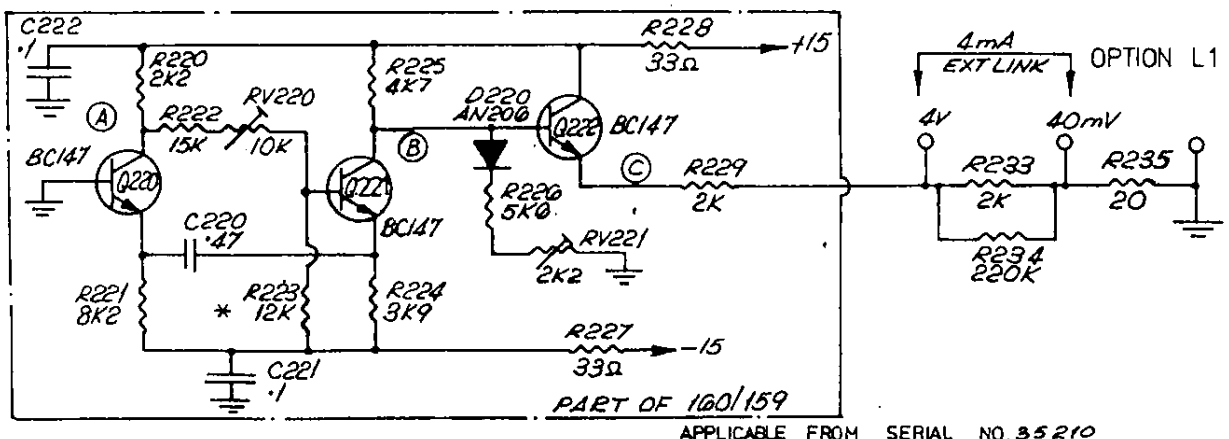
525/950







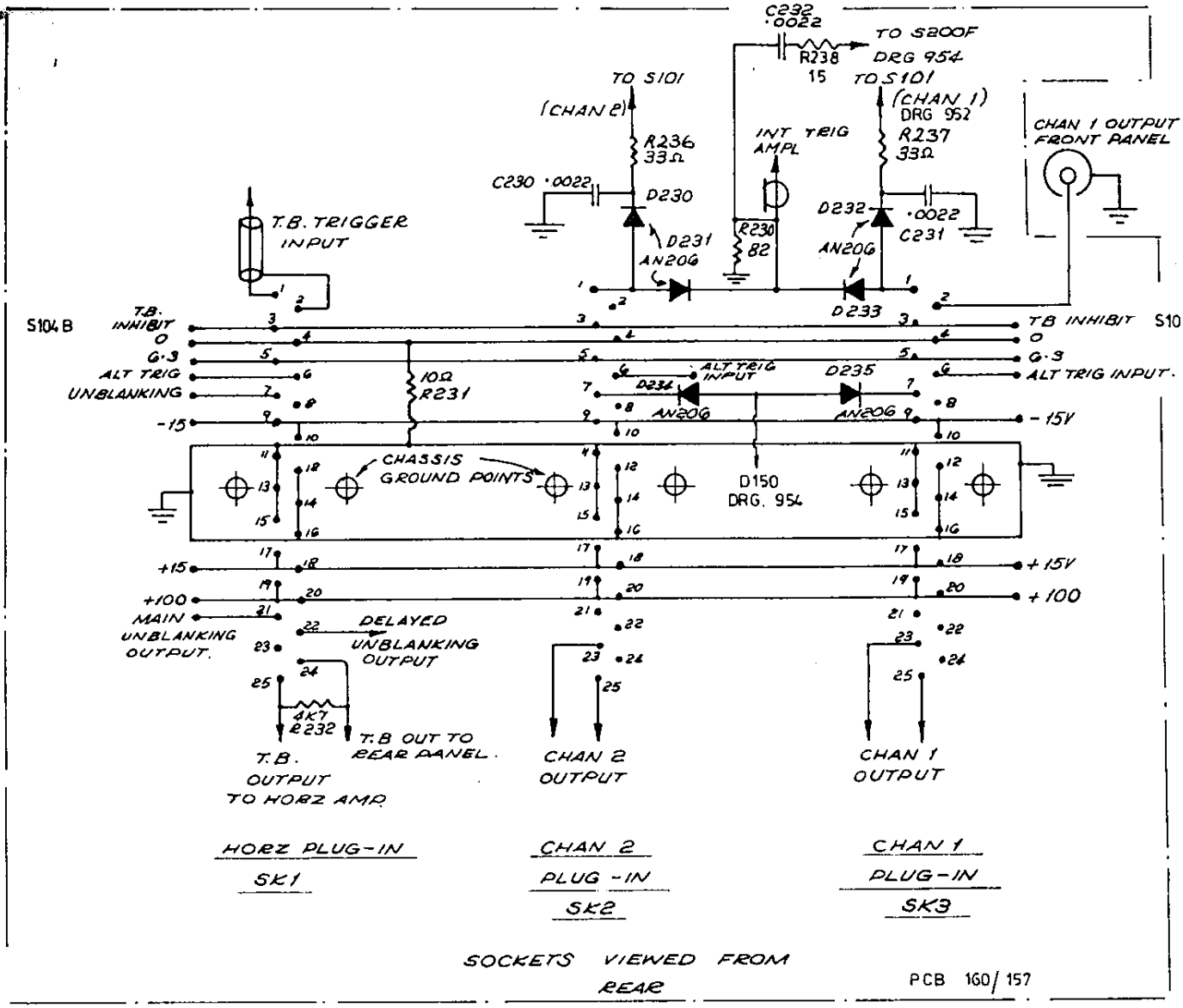
APPLICABLE FROM SERIAL NO. 35210

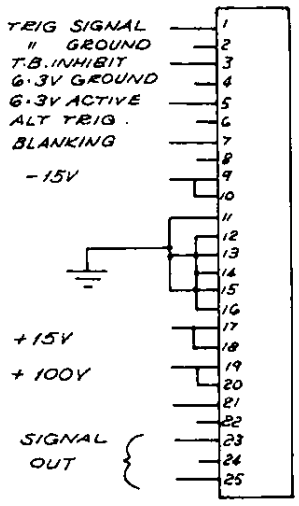
NOTE:- COMPONENT VALUES MAY VARY FROM THOSE SPECIFIED TO OBTAIN OPTIMUM PERFORMANCE.

* SELECTED ON TEST

ISSUE	525	BWD ELECTRONICS P/L.MELB			DRG.NO
13 / 3 7	DRAWN J.B. / TRACED L.P. / CHECKED / DATE 21-6-74	MODEL BWD 525 POWER SUPPLIES CALIBRATOR	951 I 954	5	950

B 230-8	MODIFICATIONS	WAVEFORMS
C 230-2	ISSUE 2 3/73 REF. DRG. NOS 952, 953 & 954	
Q —	ISSUE 3 4/73 REF. DRG. NOS 952, 953 & 954	
D 230-5	ISSUE 4 8/73 REF. DRG. NOS 950, 952 & 954	
	ISSUE 5 11/73 REF. DRG. NOS 950, 952, 953 & 954	
	ISSUE 6 12/73 REF. DRG. NOS 950, 952 & 953	
	ISSUE 7 8/74 REF. DRG. NO. 953	
	ISSUE 8 12/74 APPLICABLE FROM SERIAL NO. 23000	
	ISSUE 9 4/75 REFER DRG. No. 954	
	ISSUE 10 9-76 REF. DRG. No. 952	
	ISSUE 11 10-76 REF. DRG. Nos. 950, 2, 3 & 4	
	ISSUE 12 10-77 REF. D/No. 954	
		525 / 951





PL 1

PLUG-IN P.C. BOARD. CONNECTOR VIEWED FROM COPPER SIDE

NOTE:- COMPONENTS VALUES MAY VARY FROM THOSE SPECIFIED TO OBTAIN OPTIMUM PERFORMANCE.

13 / 3 19	DRAWN J.B. / TRACED L.P. / CHECKED / DATE 9-10-72.	SUPPLY INTERCONNECTION bwd 525	950 952 1 950	5	DRG N° 951

B 20-41 100-123	MODIFICATIONS
	ISSUE 2 4-73
C 20-21 100-118	Q100 PE5030B WAS AY1119.
	Q102 CAN EITHER BE MPF106 OR 2N3819
D 20-25 100-104	C114 .001 DELETED
	C103 .1 DELETED.
	C101 120 WAS 100
	C100 5-60 WAS 10-40
	R110 2K7 WAS 1K8
	Q101 2N4121 OR PN4121
	Q103 & Q104 AY1119 OR 2N5770
	ISSUE 3 R123 39Ω DELETED R119 WAS 47Ω
	ISSUE 4 C110 WAS .001 C118 ADDED
	ISSUE 5 1-74 C116 → C117 22pf C116 0·1 µf ADDED
	ISSUE 6 4-74 C117 22pf — DELETED C101 200 CHANGED TO C101 82 R43 100 CHANGED TO R43 10
	ISSUE 7 8/74 REF. DRG. NO 953
	ISSUE 8 12/74 APPLICABLE FROM SERIAL NO 23000
	ISSUE 9 4/75 REFER DRG. No. 954
	ISSUE 10 9-76 APPLICABLE FROM SERIAL No. 35210 Q24,25 BE337 → BD115
	ISSUE 11 10-76 APPLICABLE FROM S/No. 35210 C104 & 109 100µF → 150/16 CIRCUIT ERRORS CORRECTED SEE ALSO DRG Nos. 950, 3 & 4
	ISSUE 12 10-77 REFER DRG. No. 954

SWITCHES

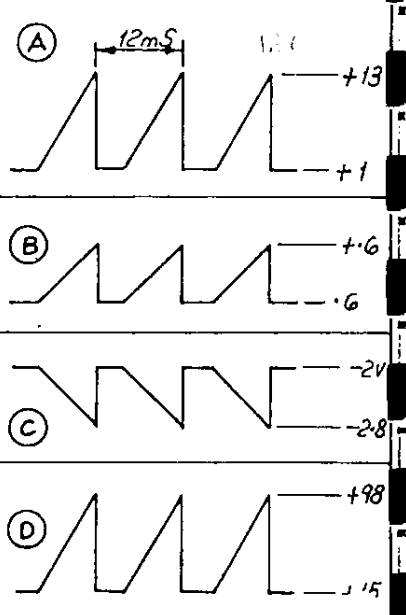
S100 A & B	X1 or ÷10 EXT INPUT
S101	CHANNEL A OR B TRIGGER
S102A & B	INT - EXT TRIG.
S103A & B	AC OR DC COUPLING.
S104A & B	TB OR X-Y OPERATION.
S105A & B	X1 OR X10 HORZ MAG.
S2A	BEAM FINDER (SEE DRG. 953 #4)

CONTROLS

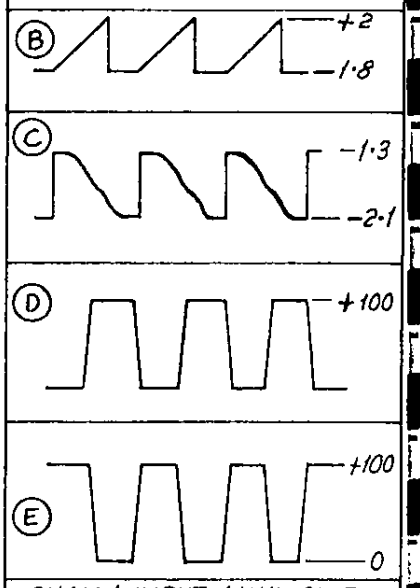
RV20	SET X1 MAG.
RV21	SET X10 MAG.
RV100A	HORZ POSITION COARSE
RV100B	" " FINE
RV101	SET HORZ X-Y GAIN
RV102	SET DC OUTPUT LEVEL
RV103	SET ZERO TRIG AMPL.
RV22	DC BALANCE
RV23	HORZ. AMP. DC LEVEL 53V

WAVEFORMS

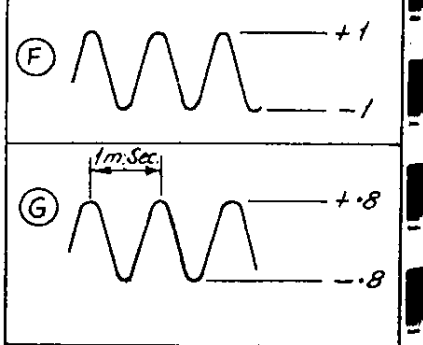
TB TO 1 m Sec/DIV MAGNIFIED TO X1.



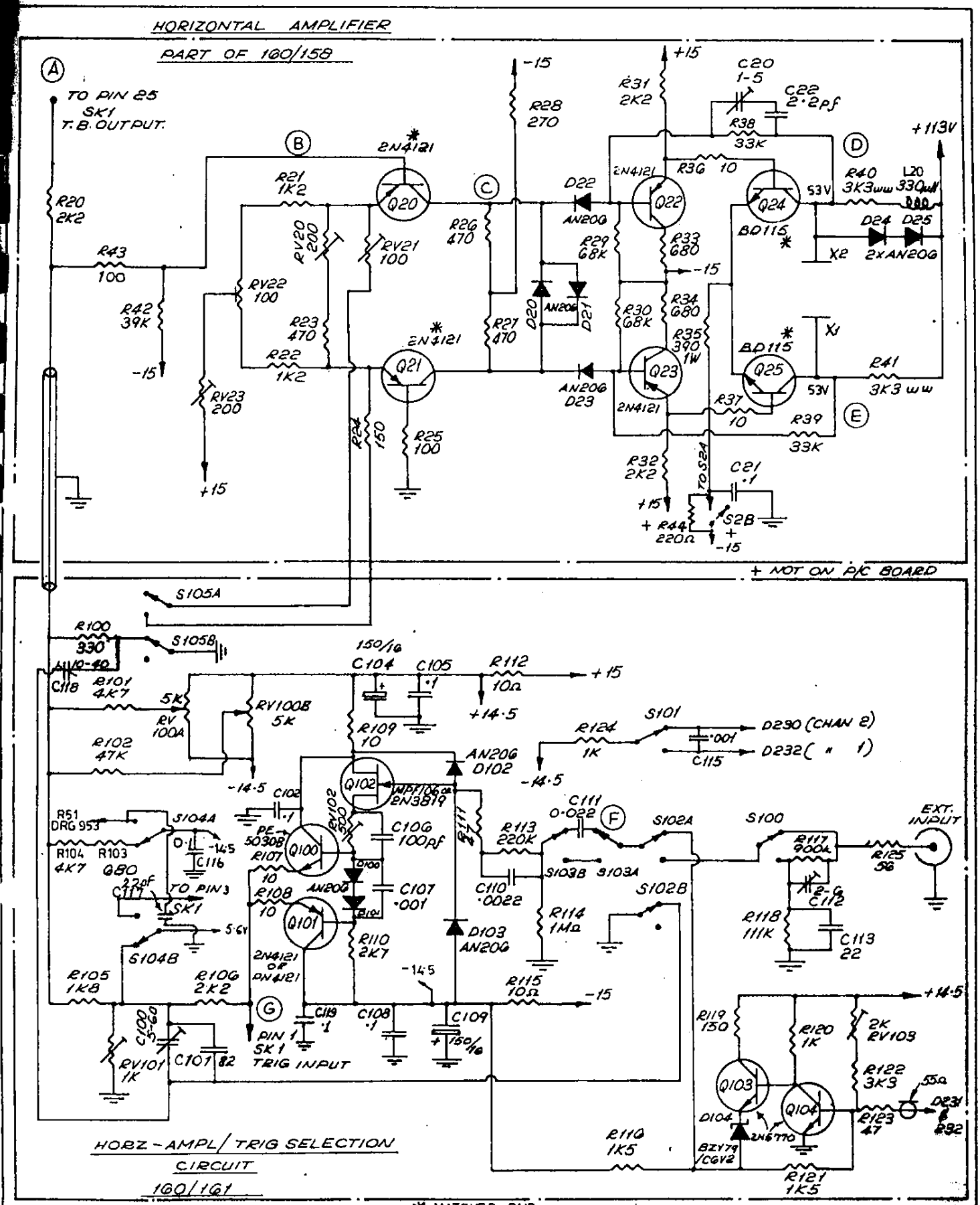
TB TO 1m.Sec. MAGNIFIED TO X 10



CHAN 1 INPUT 1KHZ SINE WAVE 4 DIV DEFLECTION.



525/952


HORIZONTAL AMPLIFIER
PART OF 160/158
TO PIN 25 SK1 T.B. OUTPUT.
+ NOT ON P/C BOARD
HORZ-AMPL/TRIG SELECTION CIRCUIT
160/161
* MATCHED PAIR
NOTE: COMPONENT VALUES MAY VARY FROM THOSE SPECIFIED TO OBTAIN OPTIMUM PERFORMANCE.
HORZ AMP & TRIGGER SELECTION CIRCUIT
522-525
950
951
953
954
DRG. NO. 952

R	50-85, 300-309
C	50-63
Q	50-53
D	50-54

MODIFICATIONS

ISSUE 2 3/73
R84, D52, D53, D54 ADDED

ISSUE 3 4/73
Q50 AND Q51 CAN BE EITHER PN 5772 OR 2N3646
R61 390 WAS R61 560
C54 0·047 WAS ·0033

ISSUE 5 7/73
R309 470Ω ADDED

ISSUE 6 12/73
C63 ·01μF ADDED

ISSUE 7 8/74
REDRAWN

ISSUE 8 12/74
APPLICABLE FROM SERIAL NO. 23000

ISSUE 9 4/75
REFER DRG. No. 954

ISSUE 10 9-76
REF. DRG. No. 952

ISSUE 11 10-76
APPLICABLE FROM SERIAL No. 35210
C304, 306, 308, 311 REMOVED
C303, 305, 307, 310 ·01/25kV → ·0068/5kV
C312,13,14,15 2·5kV ADDED
C302 50/40 → 47/40
C56 ·0075 → ·01/2·5kV
C57 ·047 → ·068
R51 8K2 — 82K
R52 82K — 8K2
SEE ALSO DRG. Nos. 950, 2 & 4

ISSUE 12 10-77
REF. DRG. No. 954

SWITCHES

S2B BEAM FINDER (ALSO ON DRG. NO. 952)

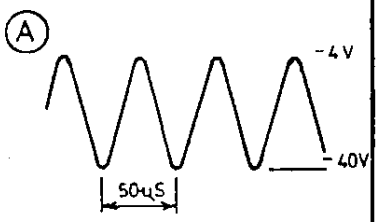
CONTROLS

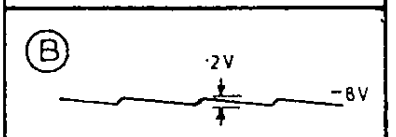
RV50	SET 1450V
RV51	INTENSITY PRESET
RV52	CRT GEOMETRY
RV53	CRT FOCUS
RV54	CRT ASTIGMATISM
RV55	CRT BEAM ROTATION
RV56	CRT INTENSITY

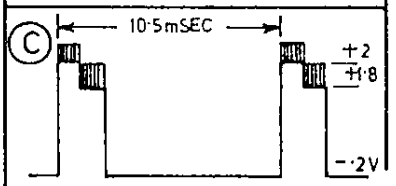
PIN OUTS D14-121 CRT

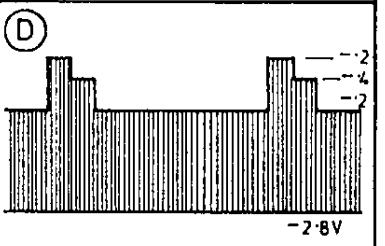
WAVE FORMS

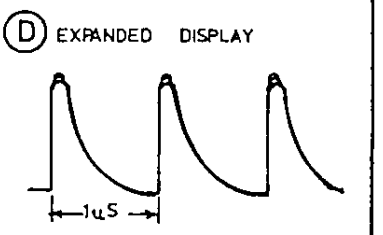
TB A ONLY 1mSEC/DIV
VERTICAL DISPLAY TO CHOPPED
INPUT 1kHz SINE WAVE

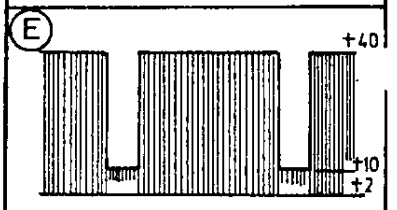






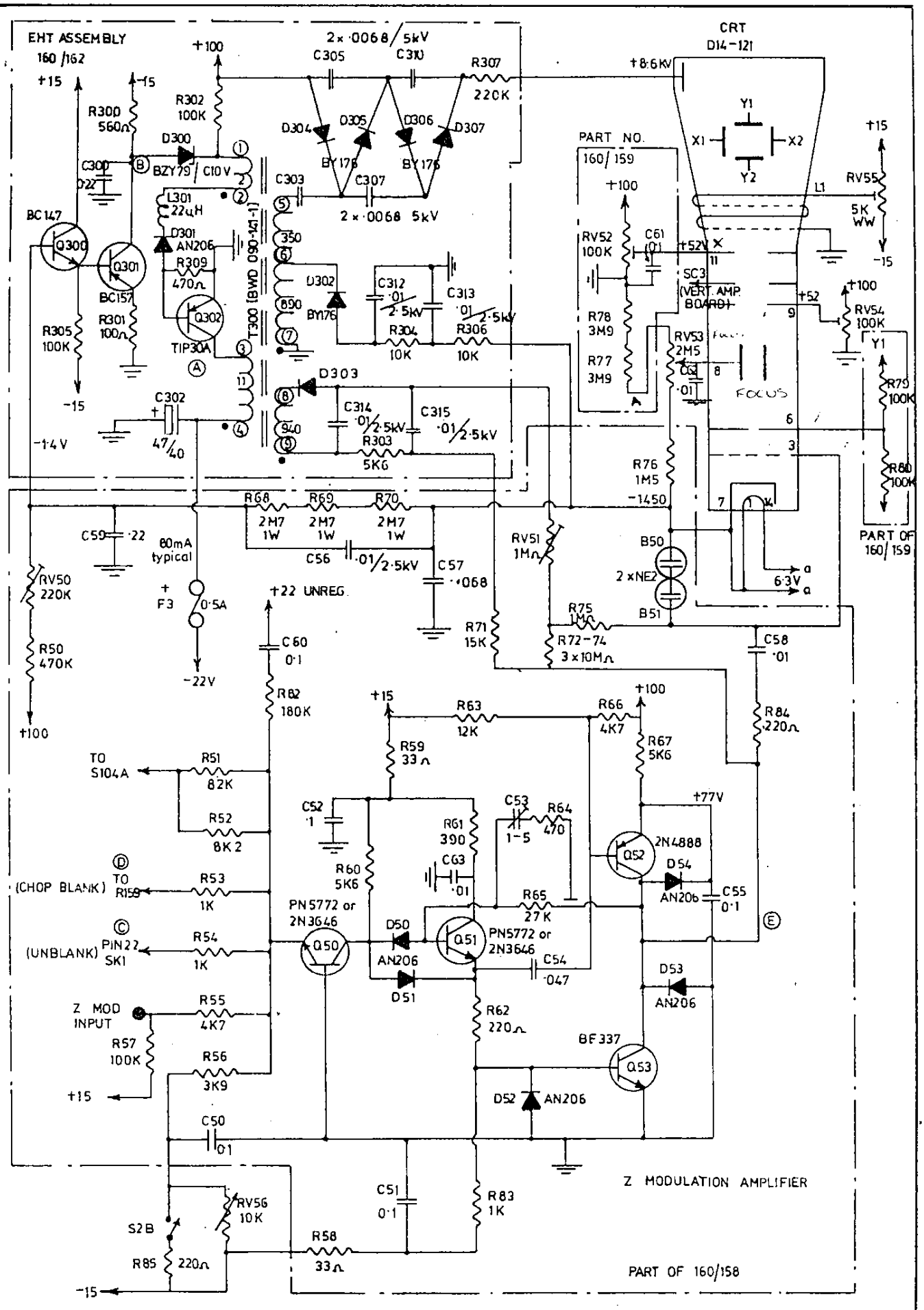






525/953

A — YELLOW BLUE STRIPE



+ NOT ON PC BOARD

NOTE:- COMPONENT VALUES MAY VARY FROM THOSE SPECIFIED TO OBTAIN OPTIMUM PERFORMANCE

13 / 3-74	DRAWN	EHT, CRT & Z MOD AMPLIFIER 525	DRG. NO. 953
	TRACED HS		
	CHECKED RJ		
	DATE 6·8·74		

R 140-162 170-203	
C 140-147 170-177	
Q 140-147 170-177	
D 140-151 170-172	

MODIFICATIONS

ISSUE 2 18-4-73

Q172 & Q173 CAN BE EITHER 2N5770's or 2N3564's

R163 10K DELETED

R152 2K2 CHANGED TO 1K5

ISSUE 3 12-7-73

R150 470Ω REMOVED
R153 WAS 1K
R157 WAS 22K
C144 WAS 100pf

ISSUE 4 8-73

R145 & 146 WERE 100Ω.

ISSUE 5

R207 ADDED

ISSUE 6 12/73

REF. DRG. NOS 950, 952 & 953

ISSUE 7 8/74

REF. DRG. NO. 953

ISSUE 8 12/74

APPLICABLE FROM SERIAL NO. 23000

C172 10-40 CHANGED TO 4 - 20

ISSUE 9 4/75

R153 WAS 820
APPLICABLE FROM SERIAL No. 25000

ISSUE 10 9-76

REF. DRG. No. 952

ISSUE 11 10-76

APPLICABLE FROM SERIAL No. 35210
R187 REMOVED
C175, 6& 7 ADDED
SEE ALSO DRG. Nos. 950, 2& 3.

ISSUE 12 10-77

APPLICABLE FROM S/No. 38440
RV 171 100Ω → 200Ω
Q176 } 2N3118 → 2N2219
Q177 }

SWITCHES

S200A-G VERTICAL DISPLAY.

S2A BEAM FIND (ALSO ON DRG 952)

CONTROLS

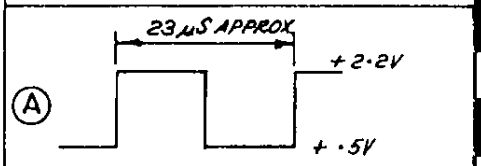
RV170 SET + 5.2 V OUTPUT LEVEL
RV171 AMPL. RESPONSE
RV172 " "
RV173 " "

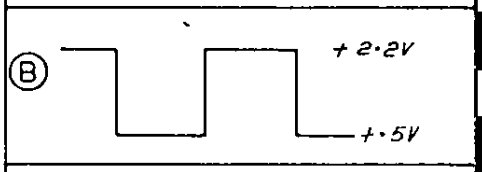
I.C.100 7400 TTL QUAD GATE
PIN 7 GROUND
PIN 14 +5·6V

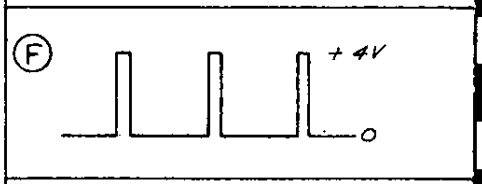
WAVEFORMS

TB TO 1m Sec/DIV
VERTICAL INPUT 1KHz
DISPLAY TRIGGERED.

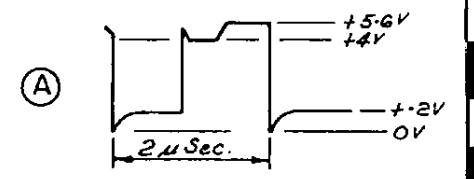
S200 SET TO ALT.

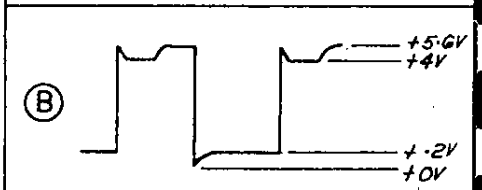


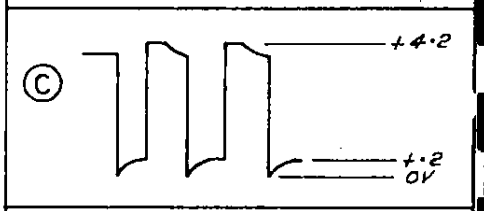


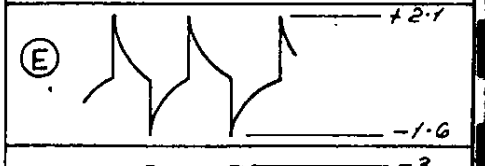


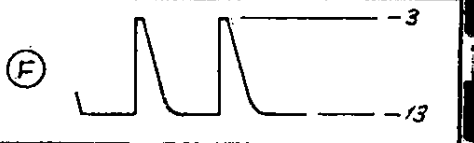
WAVEFORMS WITH S200 SET TO CHOP.



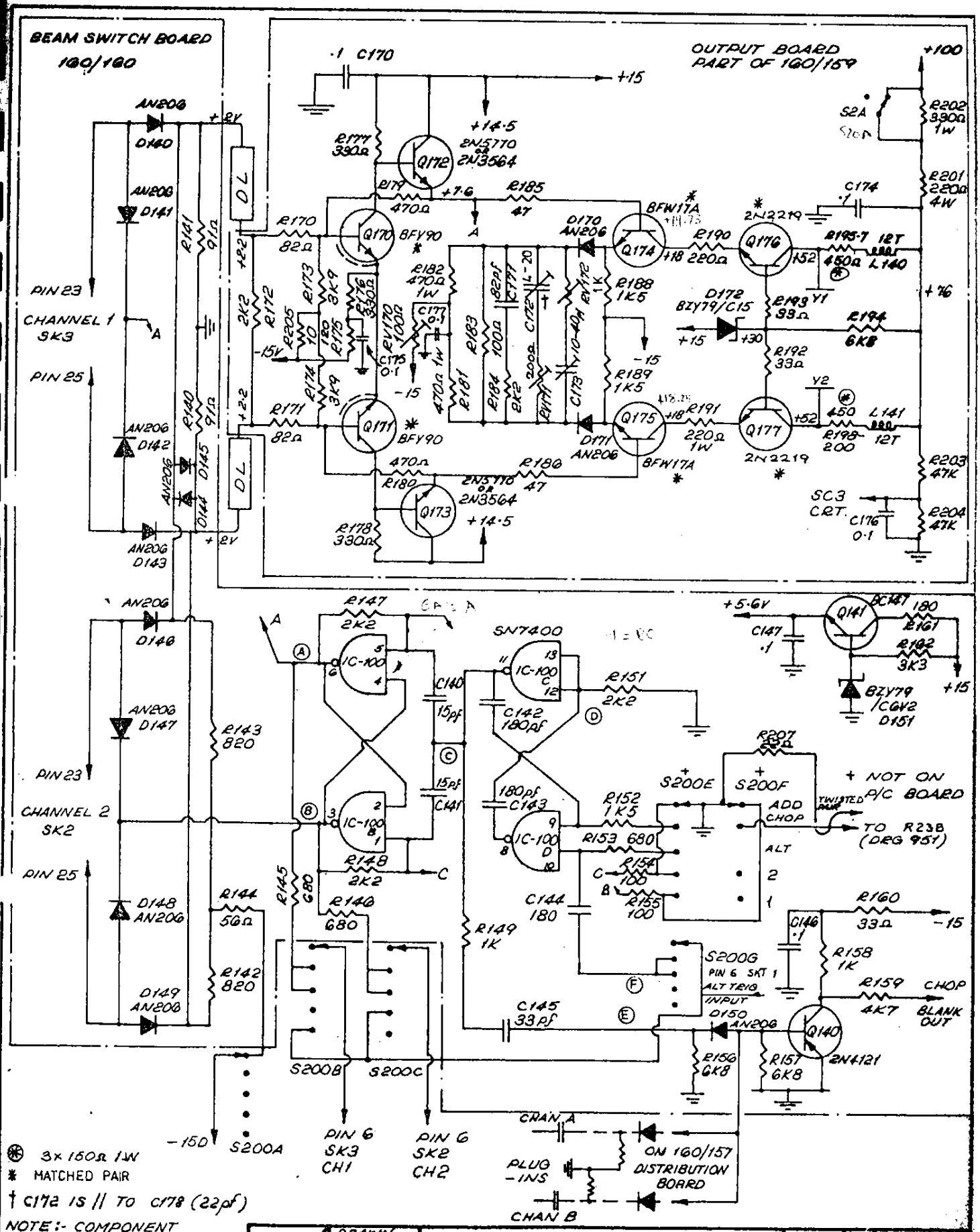








DRG. 954/525



⊛ 3 x 150Ω 1W

* MATCHED PAIR

† C172 IS // TO C178 (22pf)

NOTE:- COMPONENT VALUES MAY VARY FROM THOSE SPECIFIED. TO OBTAIN OPTIMUM PERFORMANCE.

13/3/79	DRAWN J.B.	VERT AMPLIFIER & BEAM SWITCH 525	950 1 953	5	DRG. No 954
	TRACED L.P.				
	CHECKED				
	DATE 19-9-72				

B.W.D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 525

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO	ISSUE	DATE
16000	1	9.9.72	22150	6	18.1.74
20000	2	18.4.73	22200	7	6.8.74
20900	3	12.7.73	23000	8	8.12.74
21005	4	24.8.73	25000	9	12.4.75
21005	5	16.11.73	35210	10	5.9.76

Issue	Page	Sect.	Cct.	AMENDMENT
2	D-3	11	952	R110 Changed from 1K8 to 2K7
2	D-7	11	952	C100 Changed from 10-40pF to 5-60pF
2	D-7	11	952	C101 Changed from 100pF to 120pF
2	D-7	11	952	C103 0.1µF removed.
2	D-7	11	952	C114 .001µF removed.
2	D10	11	952	Q100 Changed from AY1119 to PE5030B
2	D-10	11	952	Q101 Changed from AY1114 to 2N4121 or PN4121
2	D10	11	952	Q102 may be either MPF106 or 2N3819
2	D-10	11	952	Q103 & Q104 may be either AY1119 or 2N5770
2	D-2	11	953	ADD R84 220Ω 1/4W 5% MF IRH
2	D-11	11	953	ADD D52, D53 & D54 AN206
2	D-3	11	954	R152 Changed from 2K2 to 1K5
2	D-4	11	954	R163 Removed.
2	D-10	11	954	Q172 & Q173 may be either 2N5770 or 2N3564
3	D-3	11	952	R119 Changed from 47Ω to 150Ω
3	D-3	11	952	R123 39Ω removed.
3	D-2	11	953	R61 Changed from 560Ω to 390Ω
3	D-6	11	953	C54 Changed from 0.0033 to 0.047
3	D-10	11	953	Q50 and Q51 may be either PN5772 or 2N3646 or 2N5772
3	D-3	11	954	R150 470Ω removed.
3	D-3	11	954	R153 Changed from 1K0 to 820Ω
3	D-4	11	954	R157 Changed from 22K to 6K8
3	D-7	11	954	C144 Changed from 100pF to 180pF
4	D-1	11	950	R2 Changed from 22K to 12K
4	D-1	11	950	R4 Changed from 3M9 to 1M0
4	D-1	11	950	ADD R8 560Ω 4W 5% METOX IRH
4	D-1	11	950	ADD R9 3.3Ω ½W 5% WW IRH BW½
4	D-1	11	950	ADD R17 4K7 1/4W 5% MF IRH
4	D-13	11	950	F1 Removed and replaced with link (was in series with lead from junction of C1, C2, R1 and Q1/Q2 collector. Was 0.25A Q.B. Size 00.).
4	D-10	11	950	ADD Q5 BC147
4	D-7	11	952	C116 Changed from 0.001 to 0.1µF
4	D-7	11	952	ADD C118 10 - 40pF CER VAR STE 10-40-10S
4	D-3	11	954	R145 & R146 Changed from 100Ω to 680Ω

B.W.D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 525

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
16000	1	9.9.72	22150	6	18.1.74
20000	2	18.4.73	22200	7	6.8.74
20900	3	12.7.73	23000	8	8.12.74
21005	4	24.8.73	25000	9	12.4.75
21005	5	16.11.73	35210	10	5.9.76

Issue	Page	Sect.	Cct.	AMENDMENT
5	D-6	11	950	C13 Changed from .1µF to 4.7MF or 5µF
5	D-7	11	952	ADD C117 22pF 5% CDS
5	D-5	11	953	ADD R309 470Ω 1/4W 5% MF IRH
5	D-5	11	954	ADD R207 22Ω 1/4W 5% MF IRH
6	D-6	11	950	C10 Changed from 2000/25 to 2200/63
6	D-6	11	950	C11 Changed from 2000/25 to 4700/25
6	D-1	11	952	R43 Changed from 10Ω to 100Ω
6	D-7	11	952	C101 Changed from 120pF to 82pF
6	D-6	11	953	ADD C63 0.01µF 50V 20% CDS
7	-	-	953	Circuit re-drawn - no component change.
8	D-7	11	954	C172 Changed from 10 - 40pF to 4 - 20pF
9	D-3	11	954	R153 Changed from 820Ω to 680Ω
10	D-10	11	952	Q24 and Q25 Changed from BF337 to BD115

B.W.D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 525

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
35210	11	5.10.76			
38440	12	5.10.77			
40200	13	13.3.79			

Issue	Page	Sect.	Cct.	AMENDMENT
11	D-6	11	950	C5 Change from 50µF to 47µF
11	-	-	950	C13 Change from 5µF to 4.7µF
11	D-6	11	-	C13 To be 4.7µF 63V only
11	D-6	11	950	C16 & C17 Changed from 12.5µF 16V to 150µF 16V
11	D-7	11	952	C104 & C109 Changed from 100µF 16V to 150µF 16V
11	D-2	11	953	R51 Changed from 8K2 to 82K
11	D-2	11	953	R52 Changed from 82K to 8K2
11	D-6	11	953	C56 Changed from 0.0075µF to 0.01µF 2.5KV
11	D-6	11	953	C57 Changed from 0.047 to 0.068
11	D-8	11	953	C302 Changed from 50µF to 47µF
11	D-8	11	953	C303 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C304 0.01/2.5kV removed (was in series with C303)
11	D-8	11	953	C305 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C305 0.01/2.5kV removed (was in series with C305)
11	D-8	11	953	C307 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C308 0.01/2.5kV removed (was in series with C307)
11	D-8	11	953	C310 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C311 0.01/2.5kV removed (was in series with C310)
11		-	953	Voltage rating of 2.5kV added to capacitors C312, C313, C314 and C315.
11	D-4	11	954	R187 10Ω replaced with link (was in series with +15V supply to all parts of Drg. 954).
11	D-7	11	954	ADD C175 0.1µF 50V HI-K CER DISC
11	D-7	11	954	ADD C176 0.1µF 100V 10% ELNA.
11	D-7	11	954	ADD C177 0.1µF 50V HI-K CER DISC
11	D10	11	952	Q103 & Q104 Delete AY1119 must be 2N5770
11	D13	11	953	Cct. Ref. of T2 changed to T300 and part number changed from T113A to 090-141-1. NOTE: Both old and new transformers are interchangeable.
11	-	-	-	Horiz. Amp. - Low voltage supply P.C. Board Part numbering of RV8 should read RV3.
11	-	-	-	Vert. Output amp. P.C. Board. Part numbering of C176 connected to junction of R175 and R176 should read C175.
12	D9	9	954	RV171 100Ω changed to 200Ω.
12	D11	9	954	Q176 and Q177 changed from 2N3118 to 2N2219.
13	D1	9	950	R15 150kΩ changed to 56kΩ

B.W.D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 525

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
35210	11	5.10.76			
38440	12	5.10.77			
40200	13	13.3.79			

Issue	Page	Sect.	Cct.	AMENDMENT
11	D-6	11	950	C5 Change from 50µF to 47µF
11	-	-	950	C13 Change from 5µF to 4.7µF
11	D-6	11	-	C13 To be 4.7µF 63V only
11	D-6	11	950	C16 & C17 Changed from 12.5µF 16V to 150µF 16V
11	D-7	11	952	C104 & C109 Changed from 100µF 16V to 150µF 16V
11	D-2	11	953	R51 Changed from 8K2 to 82K
11	D-2	11	953	R52 Changed from 82K to 8K2
11	D-6	11	953	C56 Changed from 0.0075µF to 0.01µF 2.5KV
11	D-6	11	953	C57 Changed from 0.047 to 0.068
11	D-8	11	953	C302 Changed from 50µF to 47µF
11	D-8	11	953	C303 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C304 0.01/2.5kV removed (was in series with C303)
11	D-8	11	953	C305 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C305 0.01/2.5kV removed (was in series with C305)
11	D-8	11	953	C307 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C308 0.01/2.5kV removed (was in series with C307)
11	D-8	11	953	C310 Changed from 0.01/2.5kV to 0.0068/5kV
11	D-8	11	953	C311 0.01/2.5kV removed (was in series with C310)
11		-	953	Voltage rating of 2.5kV added to capacitors C312, C313, C314 and C315.
11	D-4	11	954	R187 10Ω replaced with link (was in series with +15V supply to all parts of Drg. 954).
11	D-7	11	954	ADD C175 0.1µF 50V HI-K CER DISC
11	D-7	11	954	ADD C176 0.1µF 100V 10% ELNA.
11	D-7	11	954	ADD C177 0.1µF 50V HI-K CER DISC
11	D10	11	952	Q103 & Q104 Delete AY1119 must be 2N5770
11	D13	11	953	Cct. Ref. of T2 changed to T300 and part number changed from T113A to 090-141-1. NOTE: Both old and new transformers are interchangeable.
11	-	-	-	Horiz. Amp. - Low voltage supply P.C. Board Part numbering of RV8 should read RV3.
11	-	-	-	Vert. Output amp. P.C. Board. Part numbering of C176 connected to junction of R175 and R176 should read C175.
12	D9	9	954	RV171 100Ω changed to 200Ω.
12	D11	9	954	Q176 and Q177 changed from 2N3118 to 2N2219.
13	D1	9	950	R15 150kΩ changed to 56kΩ