WORKSHOP

b.w.d

MODEL bwd-509A

5" SINGLE BEAM

OSCILLOSCOPE

B.W.D. ELECTRONICS PTY. LTD.
331-333 BURKE ROAD, GARDINER
VICTORIA, AUSTRALIA

WORKSHOP

INSTRUMENT HANDBOOK

Applicable to Serial No. 9971.....

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5" SINGLE BEAM

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INSTRUMENT HANDBOOK

MODEL bwd-509A

1. GENERAL: The major requirements in a modern oscilloscope are; simplicity of operation, compactness, reliability and of course a first class performance. How well these features have been combined in the bwd 509A oscilloscope becomes self evident as soon as a signal is displayed. Direct reading controls enable voltages below 50mV to over 500V from DC to over 5MHz to be measured against time scales from 1 second to 200 nano Seconds - a range of 5 million to 1.

1.1 The bug-bear of a stability control needed on many oscilloscopes to set up the trigger condition is completely eliminated in this model either externally or internally, instead diode clamps lock the all solid state time base circuit in a sensitive ready state which is completely unaffected by input voltage changes from 170 to 265V or 85 to 132V - a truly stable circuit.

1.2 The time base and trigger circuit also incorporates other new techniques to ensure rock steady triggering. The gated AUTOmatic time base produces a bright reference line at all time base speeds - even at 1 μSec/cm with no signal present, and is teamed with a wide band trigger circuit which is preset for optimum sensitivity. As it does not contain the AUTO circuit it is not subject to annoying beats and jitter which often occur when input signal and the AUTO free run rate interact particularly when displaying low level pulse waveforms.

1.3 To ensure that readings of voltage or time are within specification irrespective of variations of local power lines, both the amplifier and time base is compensated to accommodate ± 10% line change. Tappings on power transformer permit larger variations to be accepted to suit local supply conditions.

2. SPECIFICATION

2.1	C.R.T.	Type	5" flat faced, type 5UP1F incorporating DC coupled Beam Blanking to the control grid.
		Phosphor	P1, normally supplied, P7 available as an option.
		EHT	1.6KV
		Graticule	8 x 10cm graticule with 2mm subdivisions on X & Y centreline and green filter (orange filter for P7 Phosphor option.)

2.2 VERTICAL AMPLIFIER

Bandwidth	DC or 2Hz (AC coupled) to 5MHz - 3db at all sensitivities referred to 4cm deflection at 1kHz.
Sensitivity	50, 100, 200, 500mV, 1, 2, 5, 10, 20, 50 & 100V per cm.
Rise Time	70 nano Seconds for 4cm deflection.
Calibration	Better than 5%
Input Impedance	1MΩ and approximately 43pF
Max. Input Voltage	400DC or 250AC or 400V AC and DC p-p combined.

2.3 TIME BASE

Range	1 μSec/cm to 100mSec/cm in 6 decade ranges with an uncalibrated vernier control between each step, extending range to 1Sec/cm.
Calibration	Better than 5% at all settings at X1 magnification, 1 μSec to 10mSec/cm <10% at 100mSec/cm.
Expansion	X1 to approx X5 continuously variable. Maximum sweep speed 200nSec/cm at X5 mag.
Blanking	Direct coupled to C.R.T. Grid.

2.4 TRIGGER

Facilities	2 switches and one switched potentiometer provide selection of following characteristics: INT or EXT + or - AUTO or LEVEL SELECT
Sensitivity	Int. AUTO - 3Hz to 10MHz with 1cm deflection sine or square wave. 1Hz to 10MHz with 4cm deflection. Int. Level Select Range ± 3cm deflection.
Sensitivity	Ext. AUTO 1V p-p 7Hz to 10MHz sine or square 5V p-p 1Hz to 10MHz sine or square Ext. Level Select range ± 10V p-p min.
Ext. Trigger Impedance	100KΩ and 20pF approximately. Max input ± 30V AC, DC, or AC and DC combined.

2.5 HORIZONTAL AMPLIFIER

Bandwidth	DC to 250kHz (-3db) at all sensitivities.
Sensitivity	500mV to 2.5V per cm approx. continuously variable.
Input Impedance	150KΩ and 15pF approx.
Vertical to Horz. Ampl. Phase Shift	Less than 5° from DC to 10kHz.

2.6 'Z' MODULATION

Rear socket input to C.R.T. grid, input time constant 0.01 MFD and 100KΩ. +20V will modulate trace at normal intensity.

Calibrate Waveform	1V p-p sine wave 50Hz unstabilised

2.7 POWER REQUIREMENTS

190 to 260V, 50 to 60Hz, approximately 30 watts.
95 to 130V 50 to 60Hz (110V option).

Dimensions	9" (23cm) high x 7" (18cm) wide x 16" (41cm) deep.
Weight	Approximately 16 lbs. (7¼kg)
Accessories	Supplies with instrument 1 Handbook, Circuit and Parts List. 1 Power Cord.
Optional Accessories	Refer Section 13 page 15 of this Handbook.

3. FUNCTION OF CONTROLS

3.1 Front Panel controls are grouped for ease of use and are clearly designated. The functions of these controls are as described below:

INTENSITY CONTROL	Fully anti-clockwise, this control switches the instrument OFF, When rotated clockwise the instrument is switched ON and further rotation controls the trace intensity (brightness) from zero to max.
FOCUS	Controls the sharpness of the trace. May require a slight re-adjustment over the full intensity control range.
HORZ. SHIFT	(Red Knob) moves the trace horizontally on the C.R.T.
HORZ. GAIN	(Grey Knob) when the Time Base is in use, this control varies the length of the trace from 10cms to approx. 50cms, providing X5 magnification. When an External Horizontal Input is used, the Horz. Gain varies the sensitivity from 500mV to 2.5V per cm approximately.

FUNCTION OF CONTROLS (Cont'd.)

T.B. VERNIER — Varies the Time Base speed over a 12 - 1 range approx. to provide a continuously variable range in conjunction with the TIME/CM switch from 1Sec/cm to 1 μSec/cm. When the VERNIER control is turned and switched fully anti-clockwise it switches off the internal Time Base permitting an external signal to be fed into the HORZ INPUT socket.

TIME/CM (Time Base) Switch — When the Time Base Vernier control is fully clockwise in the CAL position the 6 time base speeds on this control will be accurate to within 5%. The switch speeds represent the fastest speed on each range; rotation of the Time Base Vernier Control anit-clockwise will reduce the selected speed over a range greater than X 12, e.g. on the 1mSec range the Vernier will vary the time base from 1mSec down to approx. 12mSec/cm when fully anti-clockwise.

+ - SLOPE SELECTION — Selects the positive (+) or negative (-) slope of the displayed signal or external trigger waveform to inititate the time base.

INT. EXT.SWITCH — Selects the trigger signal from either the displayed waveform, or an external waveform applied to the EXT trigger socket. Line frequency trigger is available by link connection from the 1V p-p CAL socket to EXT trigger socket and by switching to EXT.

VERTICAL SHIFT — Moves the trace up and down the C.R.T. face.

AUTO. TRIG.LEVEL — Fully anti-clockwise, and switched to the AUTO position, any signal greater than 0.5cm in amplitude will trigger the time base but with no input the time base operates automatically producing a base line, the automatic rate increases as the Time Base speed range increases. When the knob is switched away from the AUTO position it permits selection of the point on the displayed or externally coupled waveform over a range of ±3cms which will trigger the time base.

VOLTS/CM (Attenuator) — Switch adjusts the sensitivity of the Vertical Amplifier from 50mV (.05V) per cm to 100V per cm in a 1, 2, 5, 10 series of steps. Attenuator accuracy is 2% and the overall oscilloscope accuracy is within 5% on any step.

DC - AC SWITCH — In the DC position of this switch the amplifier is directly coupled from input to output. In the AC position a capacitor is placed in series with the input to block the DC component of a signal. The AC component also is attenuated - 3db at 2Hz approx.

3.2 TERMINALS AND SOCKETS FRONT PANEL

VERTICAL INPUT SOCKET — A positive input will cause the trace to move upwards; a negative input will cause the trace to move downwards.

'E' — Black terminal, should be connected to the ground side of the signal being measured.

HORZ. INPUT — When the Time Base Vernier is turned anti-clockwise to "T.B. OFF" signals may be fed into the HORZ. INPUT socket to produce a horizontal display, Input is DC coupled. If sufficient DC is present on the signal to bias the trace off the screen a blocking capacitor must be placed in series with the input signal to remove the DC.

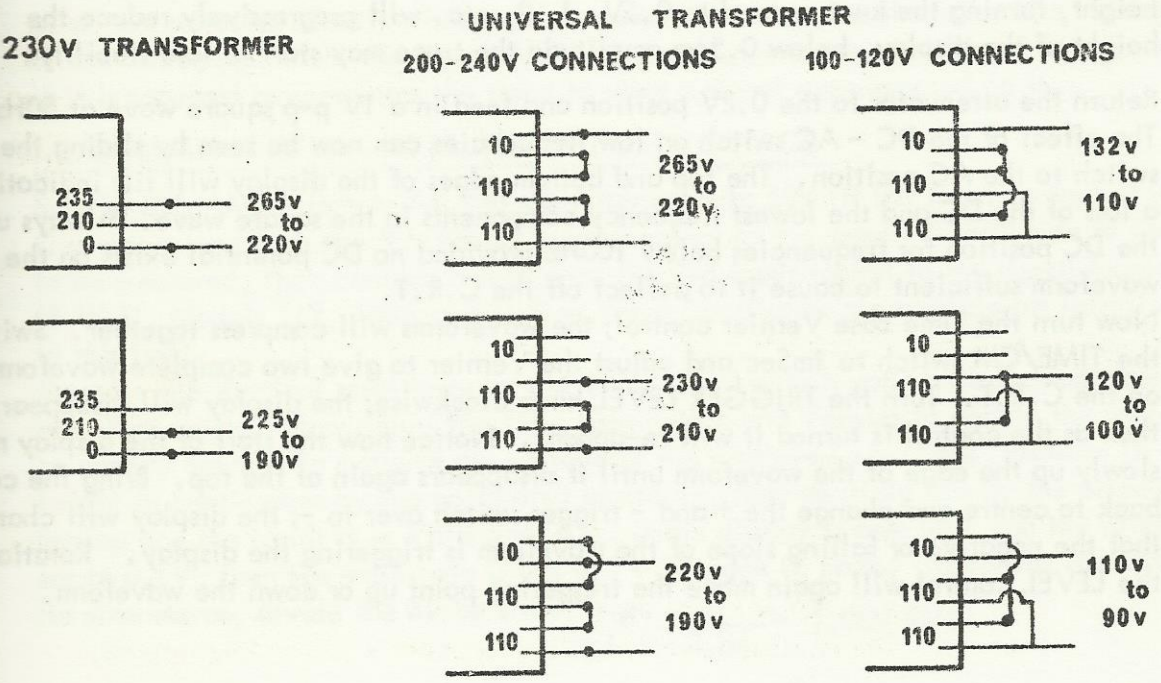
CAL. 1V p-p — A 1V p-p (approx) sine waveform is available to check the oscilloscope operation. T.B. calibration, or if linked to the EXT trigger input to provide line frequency triggering.

EXT.TRIGGER — When the Trigger Selection switch is in the EXT position, signals from 1 to 20V will trigger the time base. Full selection of amplitude over a range of ± 10V or AUTO with positive or negative selection is available.

3.3 REAR PANEL

'Z' Modulation — A 20V p-p square wave or a sine wave of 6V RMS or greater will blank the trace. Positive going signals blank the trace. Negative signals brighten the trace.

4. **FIRST TIME OPERATION** Check tapping on Power Transformer for correct connection for local supply mains. For operation from 220 to 260V use 235V tap. For operation from 190 to 220 use 215V tap. If instrument is fitted with universal primary for 110 to 230V operation connect as shown below.



4.1 Set the controls of Model bwd 509A as follows before switching on:

INTENSITY	Fully anti-clockwise
FOCUS	Centred
HORZ. SHIFT	Centred
HORZ. GAIN	Anti-clockwise
TIME BASE VERNIER	Clockwise - CAL
TIME/CM	10mSec
+ - SELECTOR	+
INT - EXT TRIGGER	INT
VERT SHIFT	Centred
TRIGGER LEVEL	Fully anti-clockwise - AUTO
VOLTS/CM	0.2V
DC - AC	DC

4.2 Connect instrument to power mains, check as above in 4.
Connect a link of wire from the CAL 1V p-p front panel socket to the vertical input socket on the L.H. side.
Switch on by rotating the INTENSITY control about $\frac{3}{4}$ of a turn. A display will appear after a few seconds.
5 cycles of the calibration waveform should be present on the C.R.T. Adjust the HORIZONTAL & VERTICAL SHIFT controls to centre the display and the FOCUS & INTENSITY for a sharp, bright image.

4.3 Now turn the VOLTS/CM switch to 0.1V and the display will expand over full screen height, turning the knob around to 0.5V, 1, 2, etc. will progressively reduce the height of the display, below 0.5cm amplitude the trace may start to lose stability.

4.4 Return the attenuator to the 0.2V position and feed in a 1V p-p square wave at 50Hz. The effect of the DC - AC switch on low frequencies can now be seen by sliding the switch to the AC position. The top and bottom edges of the display will tilt indicating a loss of the DC and the lowest frequency components in the square wave. Always use the DC position for frequencies below 100Hz provided no DC potential exists on the waveform sufficient to cause it to deflect off the C.R.T.
Now turn the Time Base Vernier control; the waveforms will compress together. Switch the TIME/CM switch to 1mSec and adjust the Vernier to give two complete waveforms on the C.R.T. Turn the TRIGGER LEVEL knob clockwise; the display will disappear, then as the control is turned it will re-appear. Notice how the start of the display moves slowly up the edge of the waveform until it disappears again at the top. Bring the control back to centre and change the + and - trigger switch over to -; the display will change so that the negative or falling slope of the waveform is triggering the display. Rotation of the LEVEL control will again move the triggering point up or down the waveform.

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

4.6 To check the HORZ. INPUT, turn the Time Base Vernier to T.B. OFF (anti-clockwise.) Connect a lead from the CAL socket to the DC HORZ. INPUT socket directly above it. A horizontal line will appear whose length can be varied by the HORZ. GAIN control from approximately 2cm down to less than 3mm. The HORIZONTAL position of the trace can be set by the HORZ. SHIFT control.

4.7 'Z' Modulation - feed in a 1kHz oscillator to the RED rear panel socket market 'Z' Mod. With an input of 6V RMS or ± 10V approx. and the trace at normal brightness level the base line will be intensity modulated. Positive going signals blank the trace whilst negative going signals brighten the trace.

5. MEASUREMENT OF DC (DIRECT) VOLTAGES

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

5.2 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 valve or the gate of F.E.T.'s working with high value loads. Where loading is critical a bwd high impedance probe, type P23, with an input of 10MΩ shunted by 12pF should be used.

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 X 10 input attenuator setting if it is required to re-centre the trace to view a signal superimposed on it.

6. MEASUREMENT OF AN AC (ALTERNATING) VOLTAGE

6.1 Set the DC - AC switch to AC and the Attenuator to 50V (if the input voltage is unknown). Connect a lead from the 'E' (Black) input terminal to the ground (earth) side of the signal to be measured, then connect a lead from the Red input socket to the signal source. (B.W.D. Models 112, 140A or 602 Sine Wave Oscillators are suitable for initial experiments in this test).
Increase the Vertical sensitivity by the VOLTS/CM switch until a display between 2 and, say, 8cm exists. Now adjust the Time Base switch and Vernier to enable the waveform to be readily seen. To measure the voltage of the displayed waveform, measure its overall height in centimetres by the calibrated graticule, then multiply this by the attenuator setting and the result is in Volts p-p e.g. if the display is 6cm high and the attenuator is set to 0.5V, then the amplitude is 6 x 0.5 = 3V peak to peak. To convet to RMS voltage for sine waves, divide the 3V by 2.84, e.g. $\frac{3}{2.84}$ = 1.06V RMS

7. TIME and FREQUENCY MEASUREMENT

7.1 The frequency of the waveform can be found by turning the Time Base Vernier to CAL (clockwise) then switch the TIME/CM switch to a range where the signal can be clearly seen, e.g. if a waveform is 3cm long and the switch is on 100 μSec, then the duration of the waveform is 3 x 100 μSec = 300 μSec. The frequency can be determined by dividing 1 second, i.e. 1,000,000 μSec by the duration of the waveform -

$$\frac{1,000,000}{300} = 3,333\text{Hz}$$

8. MEASUREMENTS WITH AN EXTERNAL HORIZONTAL INPUT

8.1 As the HORZ. INPUT is directly coupled, the C.R.T. display can be used for X - Y plotting over an 8 x 10cm area.
Switch Time Base Vernier to T.B. OFF, centre display and adjust focus and intensity for a fine spot. Positive or negative voltages may now be applied to X and Y inputs and the result plotted on tracing paper placed over the C.R.T. or transferred to a ruled graph paper. AC signals will show phase displays or Lissajous figures. Less than 5° phase shift exists from DC to 10kHz between X and Y inputs.

9. CIRCUIT DESCRIPTION

9.1 VERTICAL AMPLIFIER. Signals applied to the red INPUT terminal are switched straight through to the attenuator in the DC position of S1 or via C1 in the AC position which blocks the DC component. Switch S2A - D attenuates the input signal in a 1, 2, 5, 10 sequence to an amplitude suitable for displaying on the C.R.T. Section S2A and B attenuates the signal in a 1, 10, 100, 1000 sequence every 3rd step. Section S2C and S2D steps the input down in the 1, 2, 5 sequence, therefore the two sections cascaded produce the 1, 2, 5, 10 attenuation steps. To maintain a constant AC to DC attenuation ratio the resistors are bypassed by capacitors adjusted so the the C x R value of the series arm is equal to the C x R shunt arm at each step. Constant input capacitance is maintained by C2 and C3 input shunt capacitors.
R13 is on overload protection resistor bypassed by C15 for AC signal components.
The Vertical Amplifier consists of V1A and B input differential Amplifier, Q1 & Q2 emitter followers inter-stage coupling driving Q3, Q4 and V2 output cascade C.R.T. driver. V1 incorporates voltage compensation in its cathode to stabilise against line changes. Gain is adjusted by RV1 shunt control located between V1A and B anodes. Vertical Shift is applied symetrically to the anodes by R15 and R18 from RV2 front panel shift control. Q1 and Q2 reduce the capacitive loading on the input stage and provide a low impedance drive to Q3 and 4. H.F. compensation of the Amplifier is provided by capacitors C18 and 19; C16 and R29 correct the square wave response.

The C.R.T. Y plates are directly coupled to V2 anodes and internal trigger take off is from V2A anode via R32, C20 R102 divider.

9.2 TRIGGER CIRCUIT Internal or external trigger signals are selected by S3 and applied via C21 and Q5 phase splitter. S4A selects the + or - trigger signal whilst S4B by-passes Q5 emitter in the +ve position to increase H.F. amplification on +ve.
Q6 and 7 form a Schmitt Trigger which generates a precise amplitude fast rise and fall pulse from any input signal large enough to trigger it. Assuming S5A is open the action is as follows: With Q6 conducting its collector will bottom and Q7 will be cut off by the voltage divider across R42, 101, 44, and RV9. A negative going input will cut off Q6, its collector will rise pulling Q7 into conduction producing a negative pulse across its collector load. Q6 and 7 have a common emitter load therefore current through Q7 will hold Q6 cut off until the input signal changes polarity and rises positively reversing the switching action.
When S5A is opened the trigger point of the input waveform is no longer preset by R39 and 40 but can be pulled + or - by the potential on RV8 thus providing level selection of the trigger point on the input waveform.
Trigger sensitivity is set in the AUTO position by RV9 sensitivity preset.

9.3 TIME BASE This circuit consists of Q9 and 10 bi-stable trigger, Q12 source follower driving Q13 Miller integrator and Q14 emitter follower output. Q8 is the AUTO gating transistor and Q11 the blanking generator. Diode D4 gates the Miller stage, D1 and 2 clamp Q9 and 10, D6 sets the trace length and D5 the starting level of the saw tooth waveform.

The operation is as follows:

With S5B closed (trigger Level Select in use).

9.4 Assuming Q9 is conducting, Q10 will be cut off, its collector will rise and D4 will conduct, pulling the gate of Q12 and hence the base of Q13 positive. The collector of Q13 will fall to approximately +3V pulling down Q14 base. At this point diode D6 connected into the emitter load of Q14 passes below zero and starts to conduct reducing the conduction of D4.

9.5 This stabilises in a quiescent state with the trace ready for a trigger input pulse from Q7 via C25. A negative pulse on Q9 base will cause its collector to rise taking Q10 base positive; this causes current to flow through Q10 through the emitter resistor R58, biasing Q9 off further creating a rapid cumulative action in which Q9 cuts off and Q10 saturates. D4 becomes reverse biased, Q12 is left with its gate at - 1.5V approximately and connected through the timing resistor R63, 64 and 65 or RV14 as selected by S6C to a negative potential on RV10 which will endeavour to pull Q12 towards cut-off. However, the timing capacitors selected by S6D are effectively in circuit between the base and collector of the Miller transistor Q13 and will be charged up by the current through the timing resistor.

9.6 Q12 FET source follower presents a high impedance to the charging circuit enabling high value charging resistors to be utilised with small high stability timing capacitors. Q14 emitter follower provides a low output impedance to charge the timing capacitors and drive the output and gating circuits. As Q12 gate and Q13 base fall, Q13 collector rises and via Q14, R68 and C34 a charge is applied to the selected timing capacitor on S6D.

The result of this negative feedback is to linearise the charging rate of the timing capacitor and to produce a positive going sawtooth waveform at the collector of Q13 and via the DC coupling to Q14 where it appears at low impedance at the emitter. The sawtooth continues to rise until the potential at the junction of R70 and R71 reaches approx. 6V, D5 then conducts and charges C28 to 31 and C32 as selected by S6B. It also takes the base of Q9 positive to its emitter potential and continues positively until Q9 conducts causing its collector to fall, cutting off Q10 and at the same time transferring the emitter current from Q10 to Q9. D4 conducts pulling the gate of Q12 positively, Q13 collector falls, rapidly discharging the timing capacitor until Q14 emitter falls sufficiently to cause D6 to conduct to pull D4 back to a quiescent condition and stabilise the circuit condition ready for the next trigger pulse. This will initiate the next trace once the hold-off capacitor C28 - 32 have discharged through R49 and the base current of Q9 and D1 clamps the base of Q9 in its ready state.

9.7 Auto time base operation is obtained when S5B is opened. During the sweep time Q10 is conducting its collector is negative to ground so Q8 whose base is connected via R46 to Q10 collector conducts and clamps R47 at ground potential and discharges the selected capacitor C27 to C30. During the return trace period Q10 ceases to conduct, its collector rises and turns off Q8. The selected Auto capacitor can now charge through the divider R47, 48 and 49. The junction of R47 and 48 drops and if no trigger signal is present to initiate the circuit it will continue negatively until D1 becomes reversed biased pulling down the diode clamp divider causing Q9 to become forward biased thus initiating the time base to produce one sweep. The action is repeated until a trigger pulse is generated to lock the time base.

9.8 Q11 blanking generator is a PNP transistor operating between ground and the -54 rail. It is also switched into conduction when Q10 conducts. R57 is part of Q10 load and current through it pulls Q11 into saturation during the sweep time. During the return trace R56 and the current through R84, 85 Q17, RV7 and R101 in the C.R.T. circuit pulls Q11 collector down until D3 conducts and clamps it at -54V
C.R.T. blanking is obtained by operating Q17 as a high impedance constant current stage with its base held at +9V to the -1390V rail. RV7 and R101 set the current through the stage so that the voltage drops across R84 and 85 equals the -ve EHT Voltage. The collector impedance of Q17 is approx. 4MΩ so 2/3 of the blanking signal is applied to the C.R.T. grid. H.F. bypass is via C57.

9.9 HORIZONTAL AMPLIFIER V3a and b together with Q15 and 16 form a balanced cascade amplifier in which the time base is applied to Q15 base and external horizontal signals to Q16 base. The time base sawtooth waveform is attenuated by R69, C59, R72 divider and superimposed on a horizontal shift voltage taken off RV12A before applying it to Q15 base. Horizontal gain is controlled by RV13X1 preset and RV12B HORZ GAIN control. R75 sets the X 5 magnification limit.

9.10 Input to the HORZ INPUT socket passes via R82 limiter to R81, C58 R80 attenuator to Q16 base. When the time base is not operating S7B opens the horizontal input grounding circuit and S7A open the emitter lead of Q9 and Q10, disconnecting the Time Base and unblanking the C.R.T. via the catching diode D3.

9.11 C.R.T. Negative EHT is obtained by voltage doubling the 550V AC winding by D7 & D8 and capacitors C43, 44, 45, and 46 both doubling and filtering. Blanking is obtained as discussed in para 9.8 whilst intensity is adjusted by RV6 connected in a divider R92 RV6 R91 RV5 (focus control) and R90 across the EHT supply.
Astigmatism is internally preset by RV4.

9.12 POWER SUPPLIES

+50V. A half wave rectified 51V AC winding followed by a three stage filter C53, C52 and C51 supplies all the +50V requirements.

-46V. The same 51V AC winding is also half wave rectified by D12 and followed by C54, 55, and 56 three stage filter for the -ve 46V supply.
The - 54V tapping on the filters used to supply Q9, 10 & 11 in the time base.

+260V. An 82V winding is doubled by D9 and 10, C49 and 50 and added to the +64V rail from D11. A single stage of filtering by R94 C48 is used for the horizontal amplifier and an additional stage R93 C47 for the vertical amplifier supply.

10. ADJUSTMENTS & MAINTENANCE

10.1 A number of preset controls are contained in this instrument which may require periodical adjustments to maintain it is full calibration.

Before removing the top cover disconnect the instrument from the mains. Remove the two screws holding the handle (and 4 screws in the side if fitted) then withdraw the cover. The bottom cover may be removed by unscrewing the feet.

To aid fault finding the voltages present at various points are shown on the circuit.

10.2 Valve replacement will have only a small affect on the calibration of this instrument; however, V1 needs to be reasonably balanced so that the vertical shift control has equal movement either side of centre. If necessary it can be interchanged with V2 or V3.

10.3 bwd 509A ALIGNMENT PROCEDURE

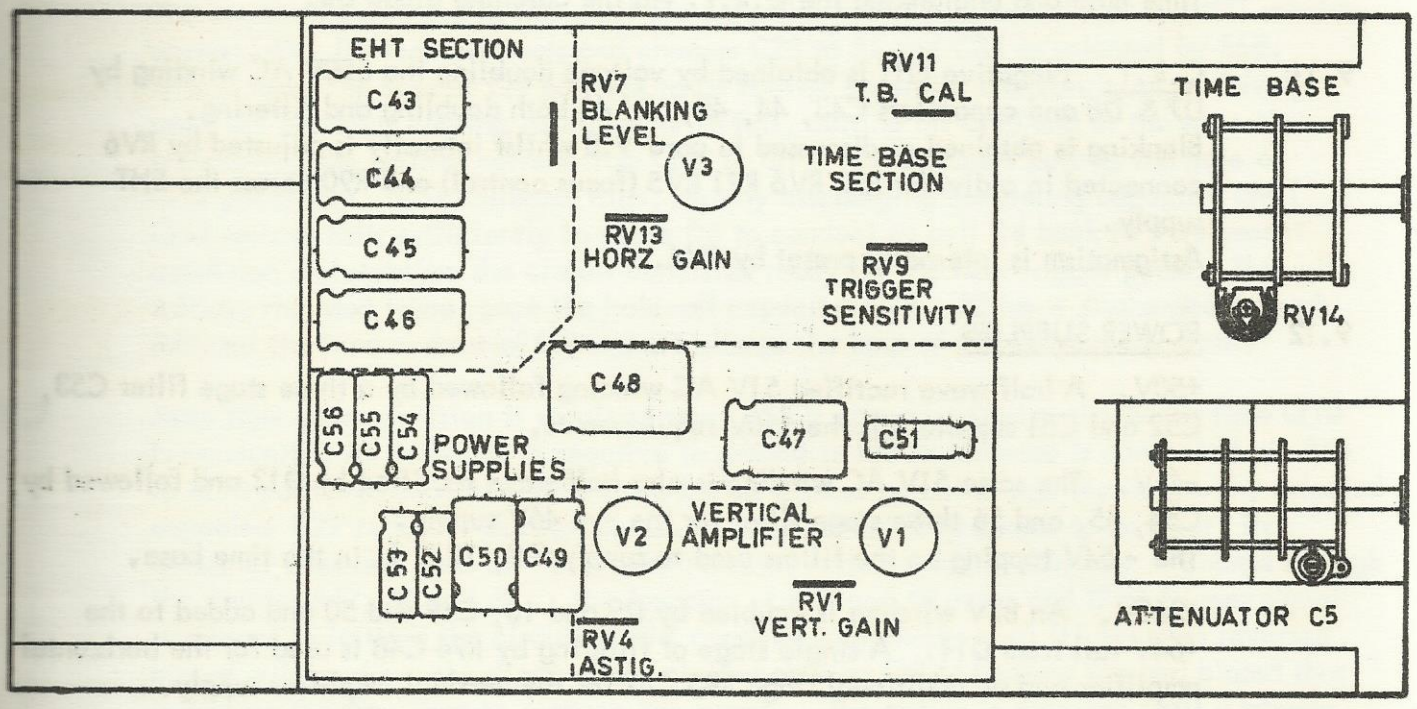
With instrument functioning and trace aligned to graticule, check the following details prior to alignment with Time Base switched to 1mSec.

10.4 ATTEN. to 0.05, centre trace with shift. Turn to 0.1V. If trace moves replace input valve with one free of grid current - type 6ES8.

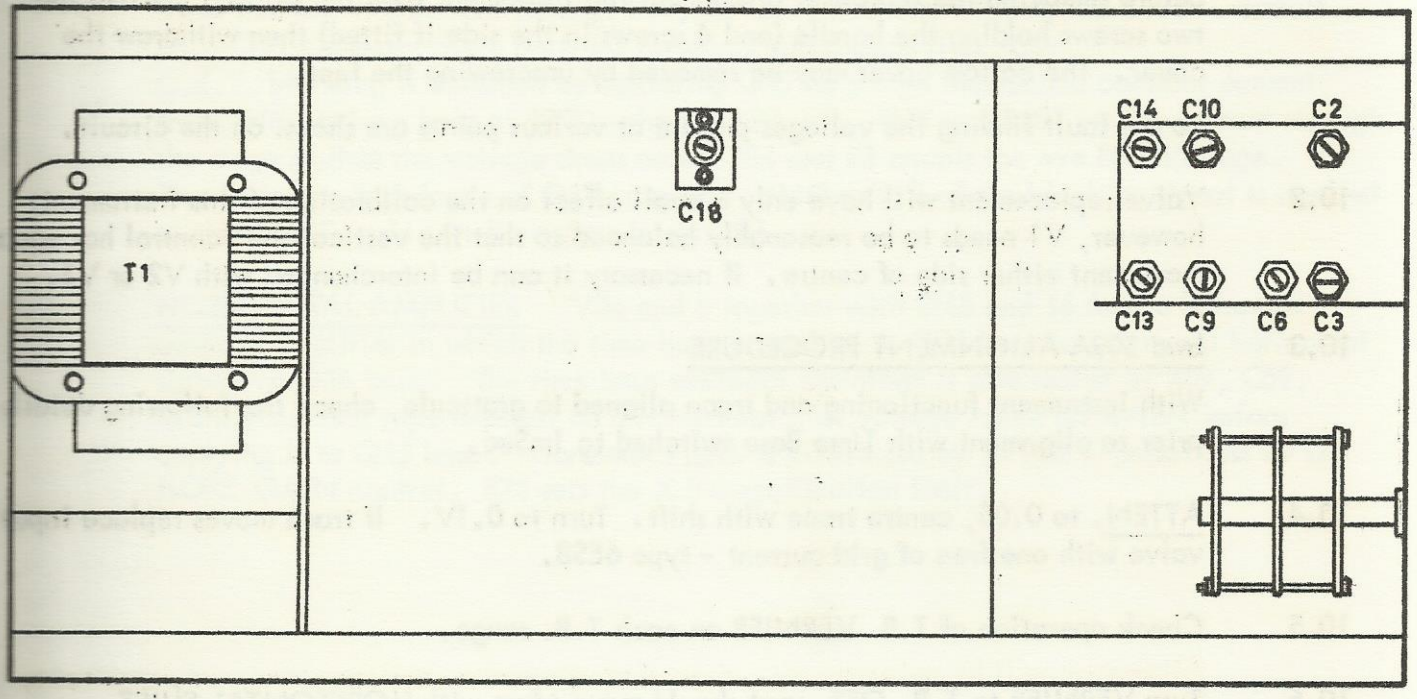
10.5 Check operation of T.B. VERNIER on each T.B. range.

10.6 Turn VERNIER to T.B. OFF, spot should move ±5cm with HORIZONTAL SHIFT.

509A LAYOUT TOP VIEW



BOTTOM VIEW



10.7 General check of controls.

(a)	Intensity:	Complete control over intensity range.
(b)	Focus:	Approx. Centre with movement either side.
(c)	Horz. Gain:	Trace should expand equally either side of centre
(d)	Vert. Shift:	Trace should move completely off screen above and below centre.

10.8 C.R.T. TRACE ALIGNMENT

If a 1,000Hz sine wave signal is available, feed this into the VERTICAL AMPLIFIER and adjust waveform for 6cms. deflection T.B. to 1mSec. VERNIER at CAL. If a square wave is not available use the CAL waveform. T.B. to 10mSec. VERNIER at CAL.

RV4 on L.H. side rear of P/C Board is adjusted in conjunction with the FOCUS control to obtain the best resolution over the entire screen area when intensity is adjusted to max. brightness but without fly back showing.

10.9 ATTENUATOR & CALIBRATION

Test equipment required 2.5kHz Square Wave Generator.

Set attenuator to 0.05V, feed in 200mV p-p (1% accuracy) Square Wave. Adjust RV1 for 4cm display. Vertical amplifier of Oscilloscope is now correctly calibrated.

The following chart indicates the adjustments necessary to fully align the attenuator.

Attenuator Setting	Input Voltage	Adjust for Square Wave	Input Capacitance
0.05V	200mV	-	-
0.1	500mV	C13	-
0.2	1V	C14	-
0.5	2V	C6	C2
1	5V	C9	-
2	10V	C10	-
5	20V	C5	C3
10	50V	-	-
20	100V	-	-
50	100V	-	-
100	100V	-	-

Attenuator will be automatically aligned at attenuator positions where no capacitor is indicated.

10.10 VERTICAL AMPLIFIER

Test equipment required. 250kHz Square Wave Generator, less than 10 nano Sec. rise time.
Attenuator to 0.05V, Input selector to AC, signal input 200mV p-p 250kHz T.B. range 1 μSec, VERNIER to CAL.

Adjust C18 (underside of P/C board) for optimum square wave with minimum over or undershoot.
Check bandwidth, adjust deflection for 4cm at 50kHz, display should not drop to less than 2.8cm at 5MHz.

10.11 HORIZONTAL AMPLIFIER

Test equipment 1Hz to 1MHz Sine Wave Generator. (bwd Model 140A)
Feed in 50kHz sine wave to Vertical Amplifier, Time Base on AUTO at 100 μSec/cm, HORZ.GAIN to x 1, Vernier anticlock with time base operating - not at T.B. OFF, Adjust RV13 (located alongside V3 - do not touch RV7 behind it as this component is at - 1400V to ground) to set trace length to 10.2cm.
Now disconnect oscillator from Vertical input and reconnect to HORZ. INPUT. Adjust display for 6cm deflection at 1kHz, increase frequency and note frequency when trace drops to 4.2cm length - it should be above 250kHz.
Sensitivity: Feed in 1kHz square wave 5V p-p amplitude, trace should be 10cm long at max gain and 2cm long at X1.

10.12 TRIGGER SENSITIVITY

Feed in 50kHz sine wave, time base to 10 μSec/cm, Trigger to AUTO and INT +ve. Reduce amplitude of input signal until trace ceases to lock. Adjust RV9 (centre front of board) for maximum sensitivity of trigger - approx 2 - 3mm display amplitude. Increase display to 1cm deflection increase frequency of input up to 10MHz note trace remains locked both + or -ve selection.
To check low frequency trigger use a bwd 140A oscillator. 1cm deflection will trigger on AUTO to 3Hz. Increase display to 4cm display will now lock to 1Hz.

Trigger Level. Input frequency 1kHz displayed signal 6cm, turn Trigger Level control away from AUTO, trigger point can now be selected over the range ±3cm either + or -

10.13 EXTERNAL AUTO Repeat as in para10.12but with a 1V p-p input to amplifier linked across to EXT trigger socket. Switch to EXT and check trigger lock over specified range. Increase input to 10V p-p check operation of Trigger Level Control.

10.14 TIME BASE Test equipment required crystal controlled generator with 1μSec to 1 Sec output in decade steps. Set Time Base Range to 1mSec, Vernier to CAL. Horizontal gain to X1. Feed in 1mSec pulse to amplifier and adjust RV11 (T.B. CAL front right of P.C. board) to display 1 pulse per cm. Check the following steps with the frequency indicated and if necessary adjust RV11 for a compromise setting to obtain the minimum error at each step.

T.B. Range	Input Frequency
10 µSec	100kHz
100 µSec	10kHz
1mSec	1kHz
10mSec	100Hz
100mSec	10Hz (10% accuracy specified)

Now turn to 1µSec and feed in 1µSec pulses. Adjust RV14 located on Time Base switch for one pulse per cm.
Check trace expands approx. X5 and trace remains linear over sweep length (other than first two cm of highest speed (200 nSec/cm.)

10.15 C.R.T. BLANKING Care is needed in adjustment of RV7 as this is operating at a potential of - 1400V. It is factory adjusted for max. range of the intensity control and should not need adjusting unless the C.R.T. is changed. The adjustment is not critical and should be set with T.B. to 1mSec, AUTO and no input.
INTENSITY control anticlock adjust until trace just disappears.

11. REPLACEMENT PARTS

11.1 Spares are normally available direct from the manufacturer, B.W.D. ELECTRONICS PTY.LTD. When ordering, it is necessary to indicate the serial number of the instrument. If exact replacements are not to hand, locally available alternatives may be used, provided they possess a specification not less than, or physical size not greater than, the original component.

11.2 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 circuits and parts without notice.

12. WARRANTY

12.1 The equipment is guaranteed for a period of twelve (12) months from the date of purchase against faulty materials and workmanship, with the exception of cathode ray tubes, which are covered by their manufacturer's own warranty.

12.2 Please refer to Guarantee Card No....4896....., which accompanied instrument, for full details of conditions of warranty.

13. ACCESSORIES FOR MODEL bwd-509A OSCILLOSCOPES

High Impedance Probe	Type P22/4mm	(10MΩ and 12pF)
Screened Leads with prods	Type P30	(complete with prod and crocodile clip)
Demodulator Probe	Type P35/4mm	(10kHz to 100MHz 30V max.)

Other associated instruments in the BWD range suitable for use with bwd 509A Oscilloscope are:

bwd 112 Sine and Square Wave Generator 20Hz to 1MHz

bwd 140A Sine and Square Wave Generator 1Hz to 1MHz

bwd 602 Combination instrument. Sine and Square Wave Generators 0.5Hz to 500kHz and multiple stabilised power supplies.

For full details regarding the complete range of BWD Instrumentd contact the factory address at the front of this Handbook or your nearest distributor.

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 511, 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
C	Capacitor
cc	Cracked Carbon
c	Carbon
cd	Deposited Carbon
comp	Composition
CDS	Ceramic Disc Capacitor
cer	ceramic
Com	Common
DPST	Double Pole Single Throw
DPDT	Double Pole Double Throw
elec	Electrolytic
F	Farad
f	Fuse
FET	Field Effect Transistor
Ge	Germanium
H	Henry (ies)
H.S.	High Stability
HTC	High Temp Coating
ins	Insulated
kHz	Kilo Hertz = 10^3Hz
KΩ	Kilohm = $10^3\Omega$
L	Inductor
lin	Linear
Log	Logarithmic Taper
m	Milli = 10^{-3}
MHz	Mega Hertz = 10^6Hz
MF	Metal Film
ma	Milli Ampere
MΩ	Meg Ohm = $10^6\Omega$
mfr	Manufacturer
MO	Metal Oxide
MHT	Polyester/Paper Capacitor
MPC	Metalised Polyester Capacitor
Ne	Neon
NPO	Zero temperature co-efficient
nsr	Not separately replaceable
NC	Normally Closed
NO	Normally Open
ns	Nano second
obd	Order by Description
OD	Outside Diameter
p	Peak
pf	pico farad = 10^{-12}F

ABBREVIATIONS CONTINUED

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
S.Shaft	Slotted Shaft
R	Resistor
rot	rotary
R log	Reverse Logarithmic Taper
rms	Root Mean Squared
Se	Selenium
Sl	Slide
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw
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 valve average valve may be shown
**	Special Component, no part number assigned

MANUFACTURER ABBREVIATIONS

AC	Allied Capacitors
AEE	AEE Capacitors
AN	Anodeon
AST	Astronic Imports
AWA	Amalgamated Wireless 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.
AL	Alpha
ARR	Arrow
BWD	B.W.D. Electronics Pty.Ltd.
BL	Belling & Lee Pty.Ltd.
BR	Brentware (Vic.) Pty.Ltd.
CF	Carr Fastener
CAN	Cannon Electrics Pty.Ltd.
CIN	Cinch
D	Ducon Condensor Pty.Ltd.
DAR	Darstan
DIS	Distributors Corporation Pty.Ltd.
ELN	Elna Capacitors (Sonar Elect.P/L)
ETD	Electron Tube Dist.
F	Fairchild Australia Pty.Ltd.
GRA	General Radio Agencies
GES	General Electronic Services
GL	Grelco
HW	Hurtle Webster
HOL	R. G. Holloway
H	Haco Distributors (National)
J	Jabel
MAS	Master Instrument Co. Pty.Ltd.
MUL	Mullard (Aust.) Pty.Ltd.
MOR	Morganite (Aust.) Pty.Ltd.
MSP	Manufacturers Special Products (AWA)
McM	McMurdo (Aust.) Pty.Ltd.
NU	NU VU Pty.Ltd.
NAU	A. G. Naunton Pty.Ltd.
PA	Painton (Aust.) Pty.Ltd.
PAL	Paton Elect. Pty.Ltd.
PI	Piher Resistors (Sonar Electronics)
PW	Precision Windings Pty.Ltd.
PH	Philips Electrical Industries Pty.Ltd.
PL	Plessey Pacific
PV	Peaston Vic.
RP	Radio Parts Pty.Ltd.
RC	Radio Corporation (Electronic Inds.)
RCA	Radio Corporation of America
RHC	R. H. Cunningham
S	Sonic Electronics Pty.Ltd.
STC	Standard Telephones & Cables
SI	Siemens Electrical Industries
SIM	Simonson Pty.Ltd.
SE	Selectronic Components
TR	Trimax Erricson Transformers
TI	Texas Instruments Pty.Ltd.
TH	Thorn Atlas
UC	Union Carbide
W	Wellyn Resistors (Cannon Elec.P/L)
Y	F.L. Yott Pty.Ltd.
Z	Zephyr Prod. Pty.Ltd.

B.W.D. ELECTRONICS PTY. LTD. - PARTS LIST

MODEL bwd-509A

CCT Ref	DESCRIPTION-RESISTORS				Mfr. or Supplies	PART NO.
R1	900KΩ	¼W	1%	HS	ELEC	TR5
R2	990KΩ	¼W	1%	HS	ELEC	TR5
R3	111KΩ	¼W	1%	HS	ELEC	TR5
R4	9.1KΩ	¼W	1%	HS	ELEC	TR5
R5	1KΩ	¼W	1%	HS	ELEC	TR5
R6	750KΩ	¼W	1%	HS	ELEC	TR5
R7	500KΩ	¼W	1%	HS	ELEC	TR5
R8	333KΩ	¼W	1%	HS	ELEC	TR5
R9	1MΩ	¼W	1%	HS	ELEC	TR5
R10	1MΩ	¼W	1%	HS	ELEC	TR5
R11	33Ω	½W	5%	CC	PI	
R12	560Ω	½W	5%	CC	PI	
R13	220KΩ	½W	5%	CC	PI	
R14	82Ω	½W	10%	C	MOR	
R15	100KΩ	½W	5%	CC	PI	
R16	3.3KΩ	½W	5%	CC	PI	
R17	3.3KΩ	½W	5%	CC	PI	
R18	100KΩ	½W	5%	CC	PI	
R19	6.8KΩ	½W	5%	CC	PI	
R20	2.7KΩ	½W	5%	CC	PI	
R21	18KΩ	½W	5%	CC	PI	
R22	47KΩ	½W	5%	CC	PI	
R23	47KΩ	½W	5%	CC	PI	
R24	82Ω	½W	10%	C	MOR	
R25	10KΩ	1W	5%	CC	PI or PH	
R26	10KΩ	1W	5%	CC	PI or PH	
R27	150Ω	½W	5%	CC	PI	
R28	150Ω	½W	5%	CC	PI	
R29	22KΩ	½W	5%	CC	PI	
R30						
R31	2.7KΩ	1W	5%	CC	PI or PH	
R32	470KΩ	½W	5%	CC	PI or PH	
R33	100KΩ	½W	5%	CC	PI or PH	
R34	330KΩ	½W	5%	CC	PI or PH	
R35	220KΩ	½W	5%	CC	PI or PH	
R36	10KΩ	½W	5%	CC	PI or PH	
R37	10KΩ	½W	5%	CC	PI or PH	
R38	100KΩ	½W	5%	CC	PI or PH	
R39	18KΩ	½W	5%	CC	PI or PH	
R40	150KΩ	½W	5%	CC	PI or PH	
R41	820Ω	½W	5%	CC	PI or PH	
R42	10KΩ	½W	5%	CC	PI or PH	

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MODEL bwd-509A

CCT Ref	DESCRIPTION– RESISTORS				Mfr. or Supplies	PART No.
R43	33KΩ	½W	5%	CC	PI or PH	
R44	27KΩ	½W	5%	CC	PI or PH	
R45	3.3KΩ	½W	5%	CC	PI or PH	
R46	33KΩ	½W	5%	CC	PI or PH	
R47	33KΩ	½W	5%	CC	PI or PH	
R48	2.2KΩ	½W	5%	CC	PI or PH	
R49	220KΩ	½W	5%	CC	PI or PH	
R50	6.8KΩ	½W	5%	CC	PI or PH	
R51	220Ω	½W	5%	CC	PI or PH	
R52	47KΩ	½W	5%	CC	PI or PH	
R53	33KΩ	½W	5%	CC	PI or PH	
R54	15KΩ	½W	5%	CC	PI or PH	
R55	120KΩ	½W	5%	CC	PI or PH	
R56	47KΩ	½W	5%	CC	PI or PH	
R57	1KΩ	½W	5%	CC	PI or PH	
R58	22KΩ	½W	5%	CC	PI or PH	
R59	56KΩ	½W	5%	CC	PI or PH	
R60	22KΩ	½W	5%	CC	PI or PH	
R61	33KΩ	½W	5%	CC	PI or PH	
R62	47KΩ	½W	5%	CC	PI or PH	
R63	1.5MΩ	½W	5%	CC	PI	
R64	10MΩ	½W	5%	CC	PI	
R65	3.3MΩ	½W	5%	CC	PI	
R66	33KΩ	½W	5%	CC	PI or PH	
R67	150Ω	½W	5%	CC	PI or PH	
R68	2.7KΩ	½W	5%	CC	PI or PH	
R69	330KΩ	½W	5%	CC	PI or PH	
R70	12KΩ	½W	5%	CC	PI or PH	
R71	18KΩ	½W	5%	CC	PI or PH	
R72	470KΩ	½W	5%	CC	PI or PH	
R73	47KΩ	1W	5%	CC	PI or PH	
R74	22KΩ	½W	5%	CC	PI or PH	
R75	680Ω	½W	5%	CC	PI or PH	
R76	68KΩ	½W	5%	CC	PI or PH	
R77	22KΩ	½W	5%	CC	PI or PH	
R78	47KΩ	1W	5%	CC	PI or PH	
R79	22KΩ	½W	5%	CC	PI or PH	
R80	100KΩ	½W	5%	CC	PI or PH	
R81	56KΩ	½W	5%	CC	PI or PH	
R82	10K	½W	5%	CC	PI or PH	
R83	47KΩ	½W	5%	CC	PI or PH	
R84	1MΩ	1W	5%	CC	PI or PH	
R85	1MΩ	1W	5%	CC	PI or PH	

B.W.D. ELECTRONICS PTY.LTD. - PARTS LIST

MODEL bwd-509A

CCT Ref	DESCRIPTION — RESISTORS	Mfr. or Supplier	PART No.
R86	1MΩ ½W 5% CC	PI or PH	
R87	1MΩ ½W 5% CC	PI or PH	
R88	1MΩ ½W 5% CC	PI or PH	
R89	1MΩ ½W 5% CC	PI or PH	
R90	1.8MΩ 1W 10% CC	PI or PH	
R91	470KΩ ½W 5% CC	PI or PH	
R92	100KΩ ½W 5% CC	PI or PH	
R93	1KΩ 1W 5% CC	PI or PH	
R94	1KΩ 1W 5% CC	PI or PH	
R95	470Ω ½W 5% CC	PI or PH	
R96	680Ω ½W 5% CC	PI or PH	
R97	470Ω ½W 5% CC	PI or PH	
R98	560Ω ½W 5% CC	PI or PH	
R99	1MΩ ½W 5% CC	PI or PH	
R100	3.3K ½W 5% CC	PI or PH	
R101	6.8KΩ ½W 5% CC	PI or PH	
R102	220KΩ ½W 5% CC	PI or PH	
	CAPACITORS		
C1	.1μF 400V 10% PYE	PH	C296AC/A100K
C2	2.20 pF trim	D	CTS2-20
C3	2.20 pF trim	D	CTS2-20
C4	5.6pF 500V ±1pF NPO	D or AC	CDS
C5	.7-3pF trim	PH	C004AA/3E
C6	1-12pF trim	PH	C004CA/12E
C7	470pF 500V MICA 5%	D	MSA
C8	.0047pF 400V 10% PYE	PH	C296AC/A4K7
C9	1-12pF trim	PH	C004CA/12E
C10	2-20pF trim	D	CTS2-20
C11	8.2pF 500V ±1pF NPO	D or AC	CDS
C12	27pF 500V 5% N330	D or AC	CDS
C13	1-12pF trim	PH	C004CA/12E
C14	1-12pF trim	PH	C004CA/12E
C15	.01μF 100V 10% MPC	ELNA	GREENCAP
C16	39pF 500V 5% N750	D or AC	CDS
C17			
C18	20-220pF trim	D	CWO
C19	680pF 630V 10% PYS	AC	TCS610
C20	3.3pF 500V ±½pF NPO	AC or D	CDS
C21	.22 uF 100V 10% MPC	ELNA	GREENCAP
C22	100pF 500V 10% N750	D or AC	CDS
C23	1μF 200V 10% MPC	ELNA	GREENCAP

B.W.D. ELECTRONICS PTY.LTD. - PARTS LIST

MODEL bwd-509A

CCT Ref	DESCRIPTION–CAPACITORS				Mfr. or Supplies	PART No.
C24	22pF	500V	5%	N330	D or AC	CDS
C25	10pF	500V	5%	NPO	D or AC	CDS
C26	22pF	500V	5%	N330	D or AC	CDS
C27	10µF	64V	ELEC		PH	C426AR/H10
C28	.64µF	64V	ELEC		PH	C426AR/H064
C29	.047	160V	10%	PYE	PH	C296AC/47K
C30	.0047	400V	10%	PYE	PH	C296AC/4K7
C31	390pF	630V	10%	PYS	AC	TCS607
C32	220pF	630V	10%	PYS	AC	TCS604
C33	22pF	500V	5%	N330	AC or D	CDS
C34	.01uF	100V	10%	MPC	ELNA	GREENCAP
C35	.1uF	100V	2%	SELECTED MPC	ELNA	GREENCAP
C36	.01uF	100V	2%	SELECTED MPC	ELNA	GREENCAP
C37	.001uF	630V	2%	PYS	AC	TCS412
C38	95pF	500V	5%	N750	AC or D	CDS
C39	100pF	500V	10%	N750	AC or D	CDS
C40	.1uF	100V	10%	MPC	ELNA	GREENCAP
C41	10uF	25V	ELEC		PH	C426AR/F10
C42	.01uF	3KV	CER DISC		D	CDH
C43	8uF	450V	ELEC		ELNA	
C44	8uF	450V	ELEC		ELNA	
C45	8uF	450V	ELEC		ELNA	
C46	8uF	450V	ELEC		ELNA	
C47	16uF	350V	ELEC		ELNA	
C48	32uF	300V	ELEC		D	ET5B
C49	50uF	150V	ELEC		PH	C436AR/K50
C50	50uF	150V	ELEC		PH	C436AR/K50
C51	64uF	64V	ELEC		PH	C437AR/H64
C52	64uF	64V	ELEC		PH	C437AR/H64
C53	64uF	64V	ELEC		PH	C437AR/H64
C54	64uF	64V	ELEC		PH	C437AR/H64
C55	64uF	64V	ELEC		PH	C437AR/H64
C56	64uF	64V	ELEC		PH	C437AR/H64
C57	220pF	2000V	±20%		D	CDH
C58	39pF	500V	5%	N750	AC or D	CDS
C59	10pF	500V	±1pF	NPO	AC or D	CDS
C60	180pF	630V	5%	PYS	AC	TCS603
C61	15pF	500V	5%	N330	AC or D	CDS
C62	3.3pF	500V	±1pF	NPO	AC or D	CDS
C63	5.6pF	500V	±1pF	NPO	AC or D	CDS

B.W.D. ELECTRONICS PTY.LTD. - PARTS LIST

MODEL bwd-509A

CCT Ref	DESCRIPTION – TRANSISTORS				Mfr. or Supplies	PART No.
Q1,2,3,&4	BF194	SI			PH	BF194
Q5,6,7	BC147	SI			PH	BC147
Q9,10,11	BC147	SI			PH	BC147
Q13,14,15	BC147	SI			PH	BC147
Q16,17	BC147	SI			PH	BC147
Q8 & 11	BC157	SI			PH	BC147
Q12	2N3819	SELECTED FET			TI	2N3819
	DIODES					
D1,2,3,	OA91	Ge			PH	OA91
D5,6	OA91	Ge			PH	OA91
D4	IN914	SI			AWV	IN914
D7	K8/25	RECTIFIER	Se		STC	K8/25
D8	K8/25	RECTIFIER	Se		STC	K8/25
D9	EM404 or SD55/4		SI		STC	EM404
D10	EM404 or SD55/4		SI		STC	EM404
D11	EM402 or SD55/4		SI		STC	EM402
D12	EM402 or SD55/4		SI		STC	EM402
	VALVES					
V1	6ES8				PH	6ES8
V2	6ES8				PH	6ES8
V3	6ES8				PH	6ES8
	CRT					
V4	5UP1-F or D13-480GM					
	FUSE					
F1	0.5A QUICK BLOW				Y	3A6
	POTENTIOMETER					
RV1	100K "A"		Preset	C	PH	EO97AC/100K
RV2	500K "A"		Preset	C	ELNA	
RV3						
RV4	100K "A"		Preset	C	PH	EO97AC/100K
RV5	1MΩ "A"			C	ELNA	
RV6	250K "A"	with DPST ROTARY SW			ELNA	
RV7	4.7K "A"		Preset	C	PH	EO97AC/4K7
RV8	250K "A"	with DPST ROTARY SW			ELNA	
RV9	22KΩ "A"		Preset	C	PH	
RV10	250K "A"	with DPST ROTARY SW			ELNA	
RV11	100K "A"		Preset	C	PH	EO97AC/100K
RV12A	100K "A"	REAR SECTION		C	D)	PDU
RV12B	10K "F"	FRONT SECTION		C	D)	PDU
RV13	10K "A"		Preset	C	PH	EO97AC/10K

B.W.D. ELECTRONICS PTY.LTD. - PARTS LIST

MODEL bwd-509A

CCT Ref	DESCRIPTION – POTENTIOMETER	Mfr. or Supplier	PART No.
RV14	220KΩ "A" Preset C	PH	EO97AC/220K
VDR	E299 DD/234	PH	E299 DD/234

MODIFICATION	
ISSUE 1	7-69
ISSUE 2	8-69
ISSUE 3 PRODUCTION	10-69

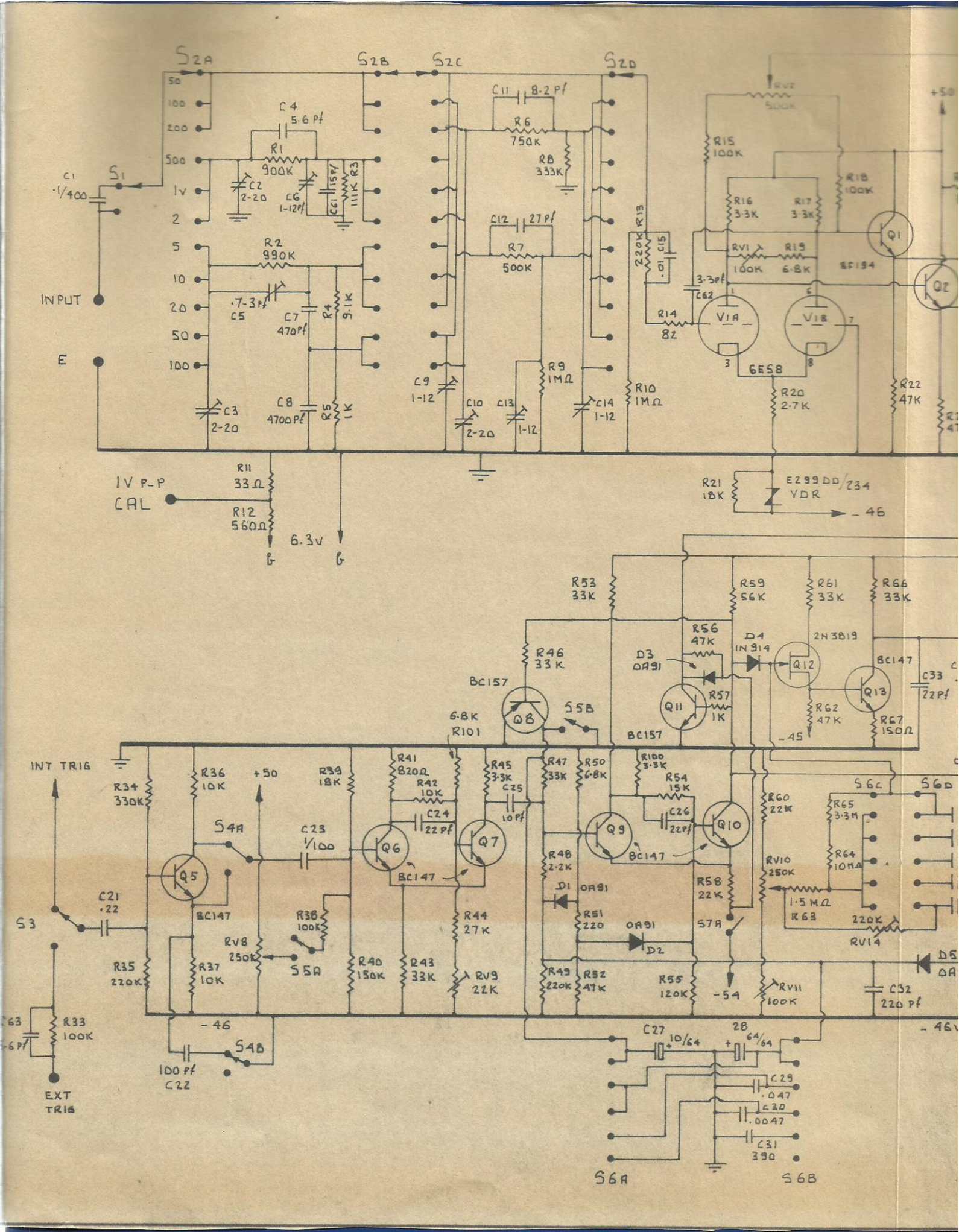
SWITCHES

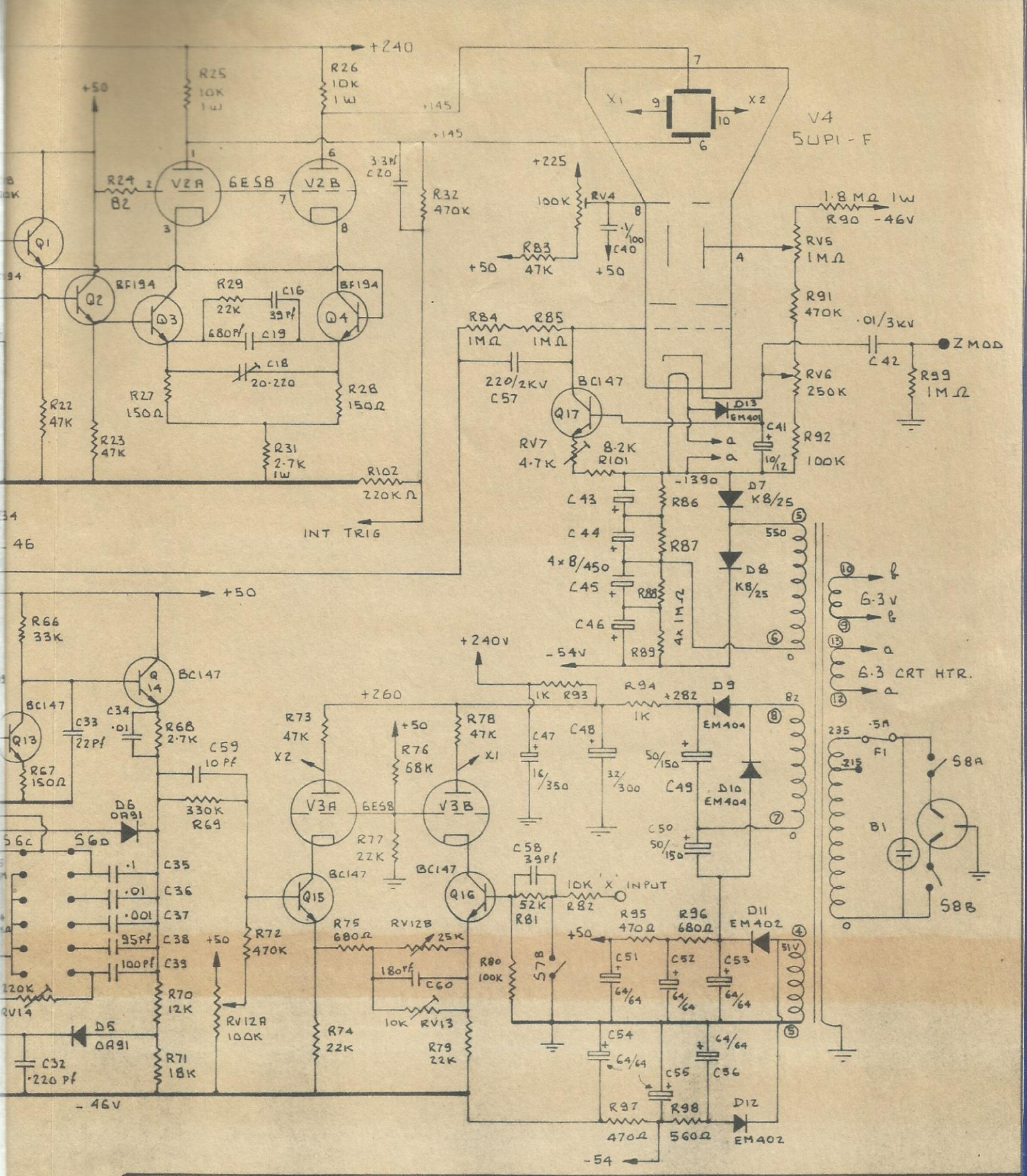
S1 AC-DC INPUT
S2A-D INPUT ATTENUATOR
S3 INT-EXT. TRIGGER
S4A&B + OR − TRIGGER
S5A&B AUTO OR LEVEL SELECT [REAR RV8]
S6A-D TIME BASE RANGE
S7A&B INT-EXT. TIME BASE [REAR RV10]
S8 A&B AC POWER ON-OFF [REAR RV6]

CONTROLS

RV1 VERT GAIN CALIBRATE
RV2 VERT POSITION

RV4 ASTIGMATISM
RV5 FOCUS
RV6 INTENSITY
RV7 BLANKING PRESET
RV8 TRIGGER LEVEL
RV9 TRIGGER PRESET
RV10 TIME BASE VERNIER
RV11 TIME BASE CALIBRATE
RV12A HORIZ. SHIFT
RV12B HORIZ MAGNIFICATION
RV13 HORIZ. " X1 PRESET
RV14 1M SEC TB RANGE CAL.


S2A
S2B
S2C
S2D
50
100
200
500
1V
2
5
10
20
50
100
C1 ·1/400
S1
INPUT
E
C2 2-20
C4 5·6 Pf
R1 900K
C6 1-12pf
C61 15pf
R3 111K
R2 990K
·7-3pf C5
C7 470Pf
R4 9·1K
C3 2-20
C8 4700Pf
R5 1K
C11 8·2 Pf
R6 750K
R8 333K
C12 27Pf
R7 500K
C9 1-12
C10 2-20
C13 1-12
C14 1-12
R9 1MΩ
R10 1MΩ
R13 220K
C15 ·01
R14 8Z
R15 100K
RV2 500K
R16 3·3K
R17 3·3K
R18 100K
RV1 100K
R19 6·8K
3·3pf C62
VIA
VIB
6ES8
Q1
Q2
BF194
R20 2·7K
R22 47K
+50
R11 33Ω
1V P-P CAL
R12 560Ω
6.3V
R21 18K
E299DD/234 VDR
-46
R53 33K
R59 56K
R61 33K
R66 33K
R56 47K
D4 IN914
2N3819
Q12
BC147
C33 22Pf
D3 OA91
R46 33K
BC157
Q8
S5B
6·8K R101
Q11
R57 1K
R62 47K
R67 150Ω
-45
INT TRIG
R34 330K
R36 10K
+50
R39 18K
R41 820Ω
R42 10K
C24 22 pf
R45 3·3K
C25 10Pf
R47 33K
R50 6·8K
R100 3·3K
R54 15K
C26 22pf
S6C
S6D
S4A
C23 1/100
Q5
Q6
Q7
Q9
Q10
BC147
R60 22K
R65 3·3M
R64 10MΩ
RV10 250K
1·5MΩ R63
220K RV14
C21 ·22
S3
R48 2·2K
D1 OA91
R51 220
OA91 D2
S7A
R58 22K
R38 100K
RV8 250K
S5A
R35 220K
R37 10K
R40 150K
R43 33K
R44 27K
RV9 22K
R49 220K
R52 47K
R55 120K
-54
RV11 100K
C32 220 pf
C63 ·6 Pf
R33 100K
EXT TRIG
-46
S4B
100 Pf C22
C27 10/64
28 64/64
C29 ·047
C30 ·0047
C31 390
S6A
S6B



ISSUE	509A	B.W.D. ELECTRONICS P/L MELB. AUSTRALIA	DRG N°
3 / 10-69	DRWN TRACED N.A. CHECKED 20-11-69	MODEL b.w.d 509A 5" OSCILLOSCOPE	779