



**BWD ELECTRONICS**

**804**

**DC to 10MHz  
OSCILLOSCOPE**

**INSTRUCTION MANUAL**

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**ISSUE 3**





## BWD 804 DC — 10MHz OSCILLOSCOPE

### TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE
1	GENERAL	1
2	SPECIFICATION	1
3	FUNCTION OF CONTROLS	3
4	INITIAL CHECKING	5
5	FIRST TIME OPERATION	6
6	MEASUREMENT OF DIRECT VOLTAGES	7
7	MEASUREMENT OF AC (ALTERNATING) VOLTAGES	8
8	AC-DC INPUT SWITCH	9
9	ISOLATED MEASUREMENTS AC OR DC	9
10	CURRENT MEASUREMENTS AC OR DC	10
11	MEASUREMENTS WITH AN EXTERNAL HORIZONTAL INPUT	10
12	CIRCUIT DESCRIPTION	13
13	ADJUSTMENTS AND MAINTENANCE	17
14	REPLACEMENT PARTS	19
15	GUARANTEE	19
16	PARTS LIST	20

# CAUTION

Input voltage protection of the Model BWD 804 oscilloscope is provided up to:-

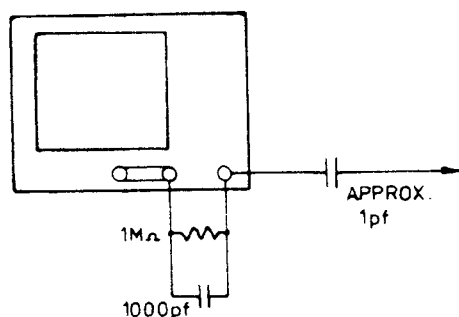
280V RMS, 800V P-P,  $\pm 400V$  DC

Input voltages in excess may cause damage to the input circuitry, which is not covered under the GUARANTEE.

Do not connect directly to high voltage circuits, such as electric fences, ignition systems, TV line outputs, etc.

These high voltages must be reduced to a workable level before coupling into the oscilloscope.

Use only with a high voltage probe having suitable attenuation characteristics such as the BWD P37 for voltages up to 1.5kV. For ignition voltages, electric fences, etc. use a capacitance divider network, similar to the circuit shown below:-





# INSTRUMENT HANDBOOK

## MODEL BWD 804

### 1. GENERAL

Although simple in appearance and operation, the BWD 804 is a calibrated oscilloscope with a wide measurement capability in Voltage, Time, Frequency, Phase & Current.

When required the input terminals can be isolated from the power line ground by removal of a ground link. This enables measurements to be made between voltages not at ground potential up to a limit of  $\pm 400\text{V DC}$ . It may also be used to eliminate ground loops from low level signals. Additionally it prevents accidental connection of a lead from the ground terminal to a live voltage from shorting out equipment - a particularly useful feature in educational areas.

As both vertical and horizontal amplifiers are DC coupled the BWD 804 will measure both DC and AC voltages from the milli volt range to over 400V. If a  $1\Omega$  resistor is placed across the input terminals the current flowing through it when connected into a circuit is displayed on the CRT directly in milli amps or amps.

Time periods from less than  $0.2\mu\text{Sec}$  to 1 Sec, or degrees of phase shift over the range DC to 30kHz are readily measured. Frequency comparison by lissajous figures can extend from zero frequency to beyond 1MHz.

Although the specified bandwidths of the BWD 804 is 10MHz at -3db its amplifier response does in fact extend to well over 25MHz. A chart in the operation section shows how to make measurements over this extended frequency range, together with charts for rise time and phase measurements. A range of high impedance and demodulator probes are available to further extend the measurement ability of your BWD 804. Check the BWD Accessory List.

### 2. SPECIFICATION

- 2.1 CRT: 13cm type 130BUB31 providing a flat 8 x 10cm display.  
EHT: 1.6kV producing a high intensity well focused trace.  
Phosphor: P31 normally supplied. P7 available as Option 04.  
Graticule: 8 x 10cm lines with 2mm subdivisions.

Rise Time reference lines at 10% and 90% also provided.

Graticule is printed on light blue filter or amber for P7 option.

### 2.2 VERTICAL AMPLIFIER

- Sensitivity: 10mV to 50V/cm in 12 calibrated steps of 1,2,5,10 sequence.  
Bandwidth: DC to 10MHz - 3db at all sensitivities referred to 5cm deflection at 50kHz.

## 2.2 VERTICAL AMPLIFIER (Cont'd)

Rise Time:	35 nano seconds over 5cms.
Input Impedance:	1M $\Omega$ in parallel with approximately 30pF to 36pF (Nom. 34pF).
Calibration:	Better than 5% including 10% line variation.
Maximum Input:	Fully protected to $\pm 400V$ from DC to 500kHz at any attenuator setting.
Isolated Input:	Input Common can be isolated by removal of front panel link from chassis and power line ground. Maximum $\pm 400V$ DC.

## 2.3 TIME BASE

Range:	0.2 $\mu$ Sec to 0.1Sec/cm in 5 decade ranges plus additional 0.2 $\mu$ Sec range.
Calibration:	<5% with vernier at Cal.
Vernier:	12:1 continuous control between each range.

## 2.4 TRIGGERING

Internal:	+ or - polarity.
Auto:	Sensitivity >1cm defl. 20Hz to >10MHz.
Level Select:	Sensitivity >1cm deflection 2Hz to >10MHz Level range up to $\pm 4cm$ .
External:	+ Polarity only.
Auto:	Sensitivity >2.0V p-p 15Hz to >10MHz.
Level Select:	>2V p-p 1Hz to >10MHz. Level range 8V p-p.

In Auto operation when no signal is present or repetition rate is below 15Hz, the trace free runs producing a bright base line.

External Trigger Input:	100k $\Omega$ and 10pF approximately. Maximum voltage $\pm 100V$ peak.
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## 2.5 HORIZONTAL AMPLIFIER

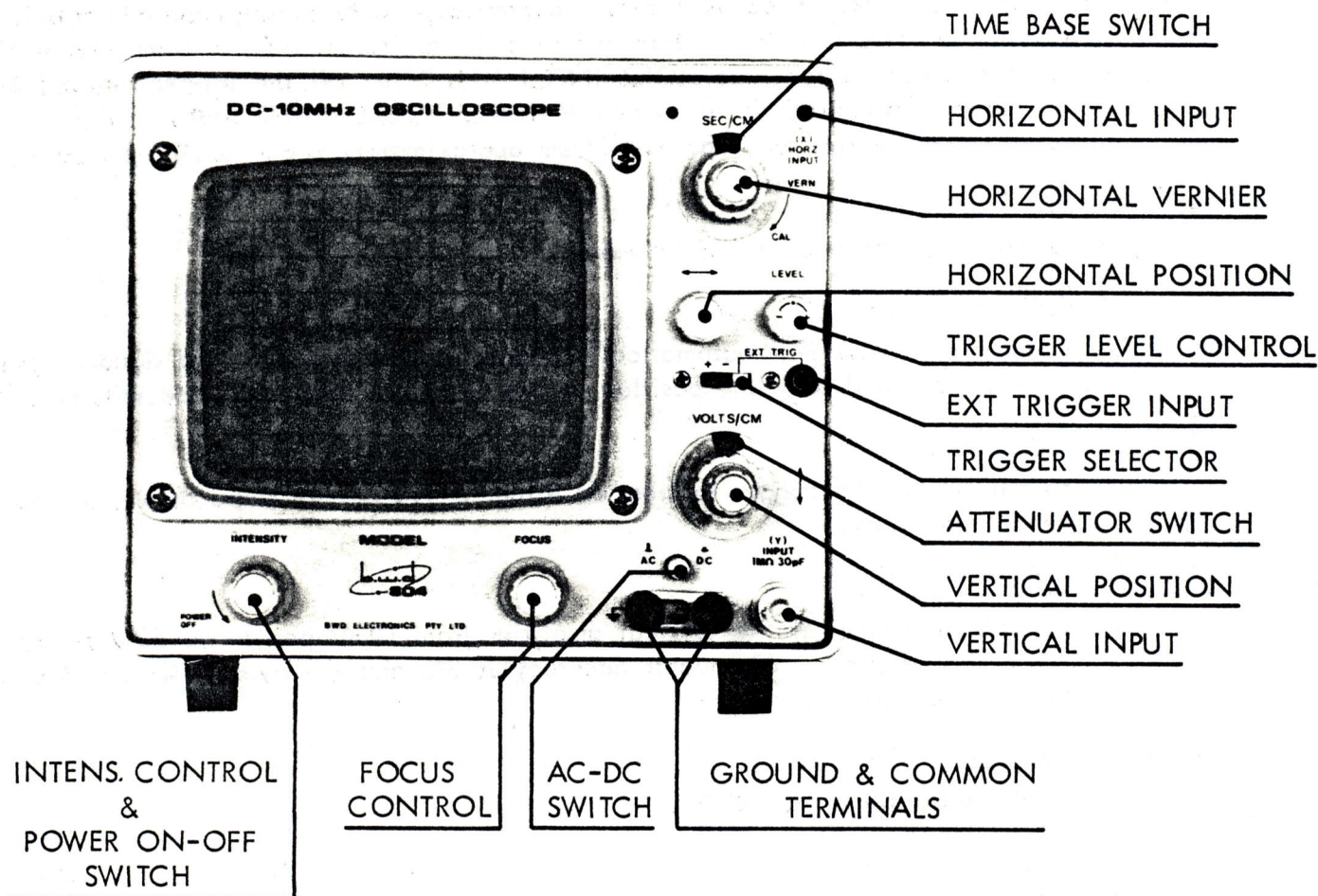
Sensitivity:	Approximately 600mV to 50V/cm continuously variable.
Bandwidth:	DC to 500kHz -3db referred to 6cm deflection at maximum gain.
Input Impedance:	100k $\Omega$ and 20pF approximately.
X-Y Phase Shift:	<3 $^{\circ}$ from DC to 30kHz.

## 2.6 Z MODULATION

Bandwidth:	DC to >2MHz. +5V will blank trace at normal intensity. (TTL compatible).
Maximum Input:	$\pm 50V$ peak.

## 2.7 GENERAL

Tilting Bail:	Fitted with folding tilting bail to raise instrument to a convenient viewing angle.
Power:	100 to 135V and 200 to 265V in two ranges. 48-440Hz 16W.
Dimensions:	185mm high x 205mm wide x 405mm deep overall.
Weight:	5.5kg packed 6.5kg.
Accessories Supplied:	Handbook.



## 3. FUNCTION OF CONTROLS

Front panel controls are grouped for ease of use and are clearly designated. The functions of these controls are described below.

### 3.1 INTENSITY CONTROL & ON-OFF SWITCH

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 maximum.



### 3.2 FOCUS

Controls the sharpness of the trace. May require slight readjustment over the full intensity control range.

### 3.3 TIME/CM (TIME BASE) SWITCH

When the Time Base Vernier Control is turned clockwise to the CAL position, the six time base speeds on this control will be accurate to within 5%. The speeds of 10 and 1mSec. and 100, 10, 1 and 0.2 $\mu$ Sec. represent the fastest speed on each range; anti-clockwise rotation of the Vernier Control will reduce the selected speed over an approximately 12:1 range.

### 3.4 HORIZONTAL VERNIER

Varies the Time Base speed over a 12:1 range to provide a continuously variable rate in conjunction with the TIME/CM switch from 0.1 Sec/cm to 0.2 $\mu$ Sec/cm. When the TIME/CM switch is turned and switched to HORZ INPUT it switches off the internal Time Base, permitting an external signal to be fed into the HORIZONTAL INPUT socket. The Horizontal Vernier now varies the sensitivity from approximately 0.6V to 50V per cm.

### 3.5 HORIZONTAL POSITION

Moves the trace horizontally on the CRT  $\pm 5$ cm.

### 3.6 TRIGGER LEVEL CONTROL

When fully counterclockwise will automatically trigger or free run when no signal is present. Rotation of the control will vary the position on the waveform that the trace will start.

### 3.7 TRIGGER SELECTOR

3 position switch selects the trigger to start on either a +ve or -ve slope or a +ve slope via the external input socket.

### 3.8 VOLTS/CM (ATTENUATOR)

Switch adjusts the sensitivity of the vertical amplifier from 10mV per cm to 50V per cm in a 1,2,5,10 series of steps. Attenuator accuracy is 2% and the overall Oscilloscope accuracy within 5% on any step.

### 3.9 VERTICAL POSITION

Moves the trace vertically on the CRT.

### 3.10 AC-DC SWITCH

The DC position (in) provides direct coupling to the amplifier. The AC position (out) places a capacitor in series with the input to block the DC component.

### 3.11 TERMINALS & SOCKETS

#### a. GROUND AND COMMON TERMINALS

Green and Black terminals. The Black terminal is floating, but may be grounded by a link to the Green terminal. COMMON Black terminal may be taken to  $\pm 400$ V DC with respect to ground.

#### b. VERTICAL INPUT

BNC socket, outer metal shield is connected to the Common Black socket and may be grounded to the chassis via a link between the Green and Black sockets.

### 3.11 TERMINALS & SOCKETS (Cont'd)

#### c. HORIZONTAL INPUT

When the TIME/CM Switch is turned clockwise to X-Y, signals may be fed into this socket to produce a horizontal display, input is DC coupled. An external capacitor must be used if a high voltage DC is present on the signal which causes the trace to be deflected off the screen.

#### d. EXT TRIGGER INPUT

When trigger selector switch is set to EXT, signals from 2 to 100V p-p and within the frequencies specified in para 2.4 can be applied to this socket to trigger the time base.

#### e. Z MODULATION INPUT (Rear Panel)

Input levels as specified in para 2.6 fed into this socket will control the trace intensity. Positive voltages will turn the trace off, negative voltages will increase intensity.

### 4. INITIAL CHECKING

The voltage range for Model BWD 804 is connected for operation between 200 and 270 Volts and fitted with a 3 pin plug when sold within Australia. When exported the voltage range is marked on the label attached to the power cable.

Two voltage ranges are provided, from 100 to 135V or 200 to 270V. They may be changed over by reconnecting links on the transformer as shown in the sketch. This model is fitted with a 3 wire AC power cord in which the GREEN/YELLOW wire must be connected to ground. Failure to do so may pose a shock hazard. Power cord colour coding is as follows:

Line (Active)  
BROWN

Neutral  
BLUE

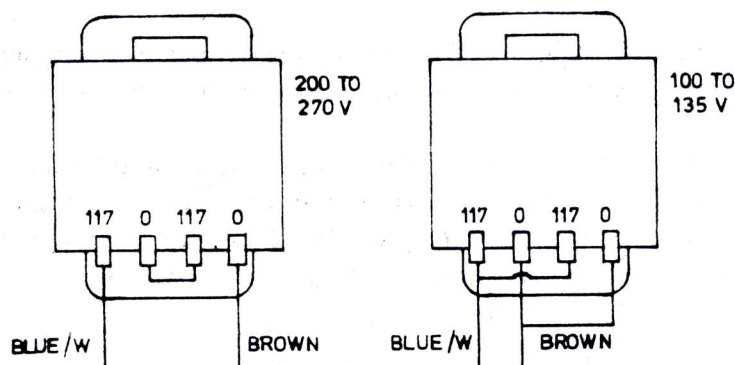
Ground  
GREEN/YELLOW

USA & CANADA ONLY:

Line  
BLACK

Neutral  
WHITE

Ground  
GREEN





## 5. FIRST TIME OPERATION

- 5.1 If you are unfamiliar with an oscilloscope, set the controls as below and follow the steps outlined until each feature is understood.

Intensity:	Off	Focus:	Centre
Time Base:	10mSec	T.B. Vernier:	Cal
Trigger Level:	Auto (ccw)	Trigger Source:	Int +
Horizontal Position:	Centre	Vertical Position:	Centre
Attenuator:	5V	AC-DC Switch:	DC (push in)

- 5.2 Plug instrument into a power line outlet. Switch on by rotating the intensity control about 3/4 turn. A display will appear after a few seconds. Adjust the horizontal and vertical controls to centre the trace and the focus and intensity controls for a sharp bright trace.

If the trace is tilted, correct it with the trace rotation control on the back panel.

- 5.3 Connect either a Probe (BWD P32 or P40) to the BNC input or leads to the Red and Black terminals if fitted. Connect them to a signal source such as a BWD 141 or BWD 160A oscillator, or even to the secondary of a 6.3V or low voltage soldering iron transformer.
- 5.4 When the input probe is connected to the 6.3V source or an oscillator set frequency to 50Hz and 10V p-p output or maximum available, 5 cycles of the input waveform should appear across the screen. Switch the Volts/cm knob to a higher sensitivity, i.e. clockwise. The waveform will increase in height until it deflects off the screen. This is now past maximum usable sensitivity. Turn the Volts/cm switch counter clockwise to reduce the sensitivity. The waveform will reduce in height. When it drops below 0.5cm deflection, it will lose trigger stability. This is the minimum usable sensitivity when a triggered display is required. The most useful range to view a waveform is between 2 and 8cms and the attenuator should be adjusted to provide this when making measurements.
- 5.5 The time base can now be checked. Turn the Time Base Vernier Control counter-clockwise and note how more waveforms appear on the screen as the time base sweeps at a slower speed. When the control is fully counter-clockwise switch the time base switch clockwise to 1mSec/cm. The display will return to the five or six waveforms we started with.

Turn the Vernier Control clockwise towards CAL. The number of waveforms will progressively decrease until only a line sweeping towards the top of the screen is present.

This condition illustrates how the BWD 804 can be used to expand out the leading edge of a waveform to view it in detail or to measure its rise time.

- 5.6 TRIGGER Level and polarity can be checked by setting the time base controls until two waveforms are displayed across the screen. Adjust the attenuator to make the sine waves between 6 and 8cm high. With the trigger source switch to Int + the wave at the left will slope upwards. Change the switch to Int -, the waveform will slope downwards. Return to Int +.



## 5.6 TRIGGER (Cont'd)

Now rotate the Level Select knob clockwise. Trace will at first disappear, then as the control is turned the sine waves will reappear triggered close to the bottom of the waveform. Rotate and notice the trigger point moves up the wave front. When it reaches the top it again disappears. Change the switch to Int- and note how the trigger point runs up and down the falling face of the waveform.

If the input signal to the vertical amplifier is also connected into the EXT TRIG socket the switch can be moved to the EXT position and the AUTO and level select operation checked in the same manner as the internal trigger.

- 5.7 The HORZ INPUT can be checked by feeding the same signal to both the vertical amplifier and the HORZ. INPUT socket. Then turn the time base switch fully clockwise. The time base Vernier control now becomes the Horizontal Sensitivity control. Adjust it until the horizontal deflection is the same as the vertical. Set it to about 6cm. A single line should now be present on the screen sweeping diagonally from top right to bottom left of the screen. Increase the oscillator frequency and note that when the input frequency increases beyond 30kHz the line becomes an ellipse indicating phase shift exists in the oscilloscope between the X & Y inputs. This is the limit for accurate phase measurement but the horizontal amplifier may be used for lissajous figures, etc. to beyond 1MHz.
- 5.8 The use of the AC/DC switch and the ground link are described in Section 6 which outlines methods of measuring waveforms.

6. The following section explains the operation of Model BWD 804 when used to make specific measurements of VOLTAGE, TIME, FREQUENCY, PHASE & CURRENT.

### 6.1 MEASUREMENT OF DIRECT VOLTAGES

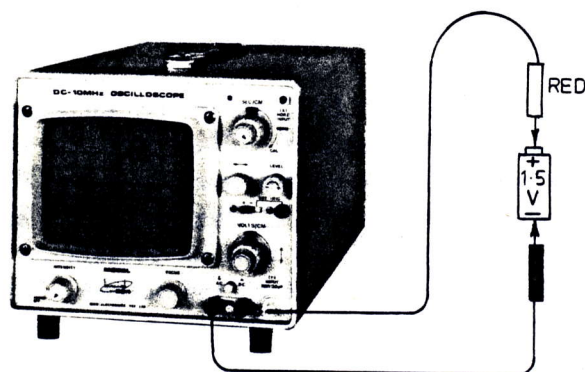
Set the same control positions as for the first time operation, except the attenuator which should be set to 0.5V/cm. Use a 1.5V dry cell for the test and connect the probe ground lead or the black ground prod to the negative end and the probe tip or red prod to the positive end of the battery.

The CRT trace will move up 3cm from the centre line indicating the voltage is positive and  $3 \times 0.5V = 1.5V$ . Now reverse the leads. The trace will move down 3cm indicating the voltage is negative and again  $3cm \times 0.5V = 1.5V$ .

The ability of an oscilloscope to measure both positive and negative DC voltages is particularly useful when measuring power supply rails and AC voltages swinging between them and ground. To enable the maximum signal amplitude to be displayed when DC coupled, the trace may be set at the bottom of the graticule for positive voltage measurements and the top of the graticule for negative voltage measurements.

If the signal deflects the trace off the screen, reduce sensitivity until deflection is within the graticule limits.

- 6.2 NOTE: The  $1\text{M}\Omega$  input resistance of the oscilloscope must be taken into account when measuring high impedance points such as the gate of a FET or similar circuits. A 10:1 probe such as the BWD P32 duo probe will increase the input impedance to  $10\text{M}\Omega$  and so reduce the shunt effect of the oscilloscope input by a factor of 10, although sensitivity is reduced by the same amount.



## 7. MEASUREMENT OF AC (ALTERNATING) VOLTAGES

- 7.1 Set the Attenuator to 50V (if the input voltage is unknown). Connect the probe ground lead or a lead from the COMMON input terminal to the ground side of the signal source and the probe tip or the red lead to the signal. (Model BWD 141 or BWD 160A Oscillators are ideal for initial experiments in this test).

Increase the vertical sensitivity by the VOLTS/CM switch until a display between 2 and 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  $6 \times 0.5 = 3\text{V}$  p-p, to convert to RMS voltage for sine waves - divide the 3V by 2.83, ( $2\sqrt{2}$ ).

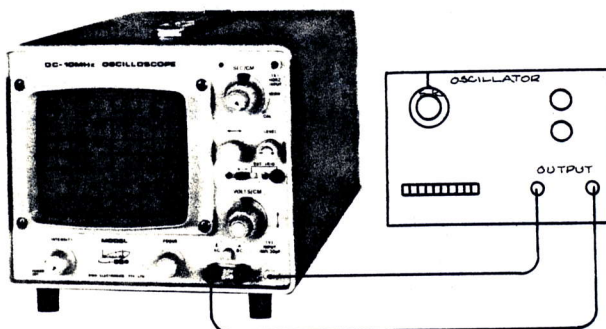
$$\text{e.g. } \frac{3}{2.83} = 1.06\text{V RMS}$$

It is important to remember that oscilloscopes indicate peak to peak voltages, NOT RMS as an AC meter does. To obtain RMS voltages, it is necessary to convert the p-p voltage as shown above.



- 7.2 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 2cm long and the switch is on 100 $\mu$ Sec, then the duration of the waveform is 2 x 100 $\mu$ Sec. The frequency of the displayed waveform can be found by dividing 1 second, which equals 1,000,000 $\mu$ Sec by the waveform duration.

e.g. 
$$\frac{1,000,000\mu\text{Sec}}{200\mu\text{Sec}} = 5000\text{Hz}$$



## 8. AC-DC INPUT SWITCH

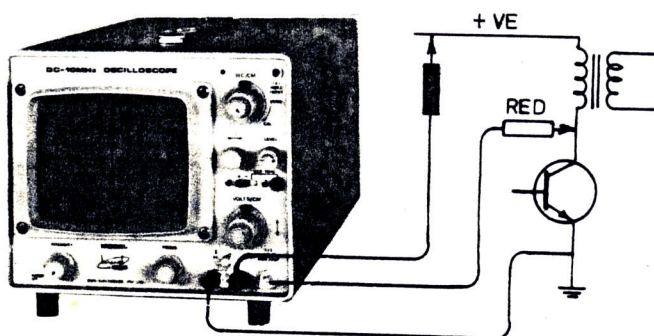
All measurements described under Sections 6 & 7 have been made with the input selector pushed in for DC. If, however it is necessary to measure the amplitude of a low level AC waveform which is superimposed on a high DC voltage the DC component must be removed. By setting the input selector to AC (out position) a 100nF capacitor is placed in series with the input signal and effectively removes the DC voltage and very low frequencies. The amplifier response is now -3db down (0.707 amplitude compared with 1kHz) at 1.6Hz approx. This will produce noticeable tilt on any square wave below 100Hz. To view low frequencies other than sine waves it is necessary therefore to use DC coupling if the waveshape is not to be distorted.

The low frequency response when AC coupled can be extended down by another decade by using a 10:1 high impedance divider probe (BWD P32 or BWD P40) on the input. The -3db point is then 0.16Hz.

## 9. ISOLATED MEASUREMENTS AC OR DC

When the ground link is removed from the Common and Ground terminals the input circuit is isolated from ground, enabling measurements to be made between any two points of a circuit, even if neither is at ground potential.

The COMMON terminal has an impedance to ground of 1.5M $\Omega$  and is shunted by a 100nF capacitor - this must be taken into account if connecting the COMMON to a point of high impedance. Maximum voltage that may be applied to the COMMON terminal is + or - 400V DC.

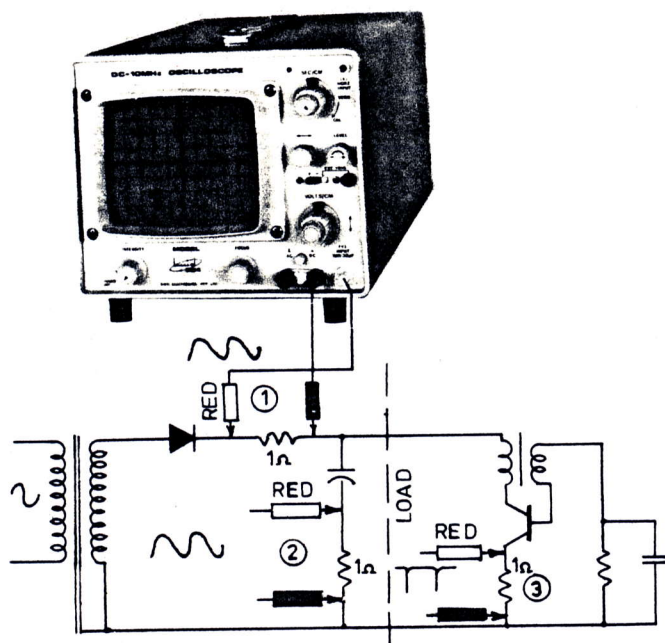




## 10. CURRENT MEASUREMENTS AC OR DC

Another application of the isolated ground is the ability to measure the voltage drop across a known resistor, and by use of Ohms Law, this may be converted to current. With a  $1\Omega$  resistor across the vertical input terminals, the attenuator reads in mA and AMPS directly.

- 10.1 If this resistor is placed in series between a source and load, the Oscilloscope will read the current flowing, both AC & DC in mA or AMPS. e.g. 0.1V on the Attenuator = 0.1A, 0.2V = 0.2A, etc. and unlike a meter will show the actual current waveform - a practical application is the charging current in a filter capacitor of a power supply or the current through a rectifier, etc.



Three examples of resistor placements used to measure current.

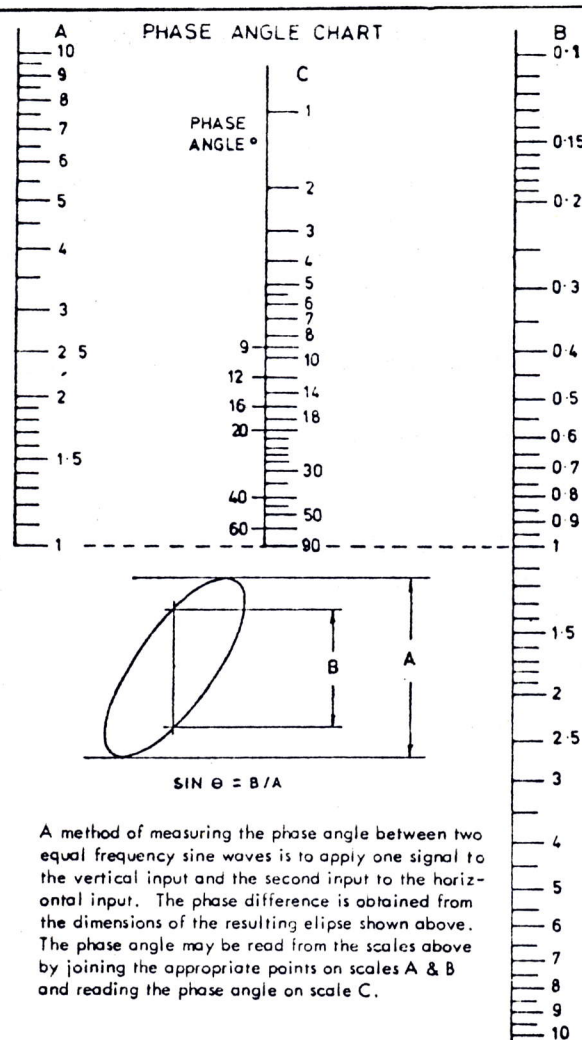
1. Total rectifier current.
2. Capacitor charging current.
3. Transistor emitter current.

## 11. MEASUREMENTS WITH AN EXTERNAL HORIZONTAL INPUT

As the Horiz. input is directly coupled, the CRT display can be used for X-Y plotting over an 8 x 10cm area, phase measurements from DC to  $>30\text{kHz}$  and frequency comparisons with lissajous figures to beyond 1MHz.

- 11.1 Switch the Time Base Switch to X-Y and centre spot. For X-Y plotting first calibrate the Horizontal Amplifier by feeding in 5V p-p waveform and adjusting the HORZ. GAIN until the display equals 5cm long; now set the Vertical Attenuator to 1V/cm. The Oscilloscope has now identical X and Y sensitivities of 1V per cm. (Other ranges can be used with equal or unequal sensitivities, as required).
- 11.2 Remove the calibrating waveform and centre the spot. Positive or negative voltages may now be applied to X and Y inputs and the result plotted on tracing paper placed over the CRT or transferred to a ruled graph paper.
- 11.3 The phase shift in an amplifier or filter network, etc. can be measured from DC to 30kHz using the graph opposite.

## 11. MEASUREMENTS WITH AN EXTERNAL HORIZONTAL INPUT (Cont'd)



A method of measuring the phase angle between two equal frequency sine waves is to apply one signal to the vertical input and the second input to the horizontal input. The phase difference is obtained from the dimensions of the resulting ellipse 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.

Apply a low distortion sine wave to the circuit under test and also to the vertical input of the oscilloscope. Now connect a lead from the output of the circuit or amplifier to the HORZ. INPUT socket. Adjust sensitivities for a display about 6cm long. Vary the test oscillator frequency over the required range and note the variation of the display from a straight line. The width of the ellipse should be measured and using the graph read off the phase angle.

- 11.4 Frequency comparison of one AC source against another may be readily made by feeding one input into the Vertical Amplifier and one into the Horizontal Input. The ratio of one frequency to the other can be determined from the resultant display.
- 11.5 NOTE: Signals should not be fed into the HORZ. INPUT when the time base is in use as this may cause interference with the time base.
- 11.6 EXTENDING THE USABLE CALIBRATED AMPLIFIER RANGE

Although all oscilloscope amplifiers are specified as having a bandwidth of so many megahertz at -3db it does not mean accurate amplitude measurements can be made at the -3db limit. In fact beyond approx. 1/3 of the specified bandwidth the calibration accuracy specification no longer applies. To enable the BWD 804 response to be used at sensitivities well beyond the 1/3 limit the chart below has been devised.

## 11.6 EXTENDING THE USABLE CALIBRATED AMPLIFIER RANGE (Cont'd)

The dotted line indicates the typical frequency response of the amplifier. The solid line indicates the attenuator multiplying factor required at any frequency to 20MHz.

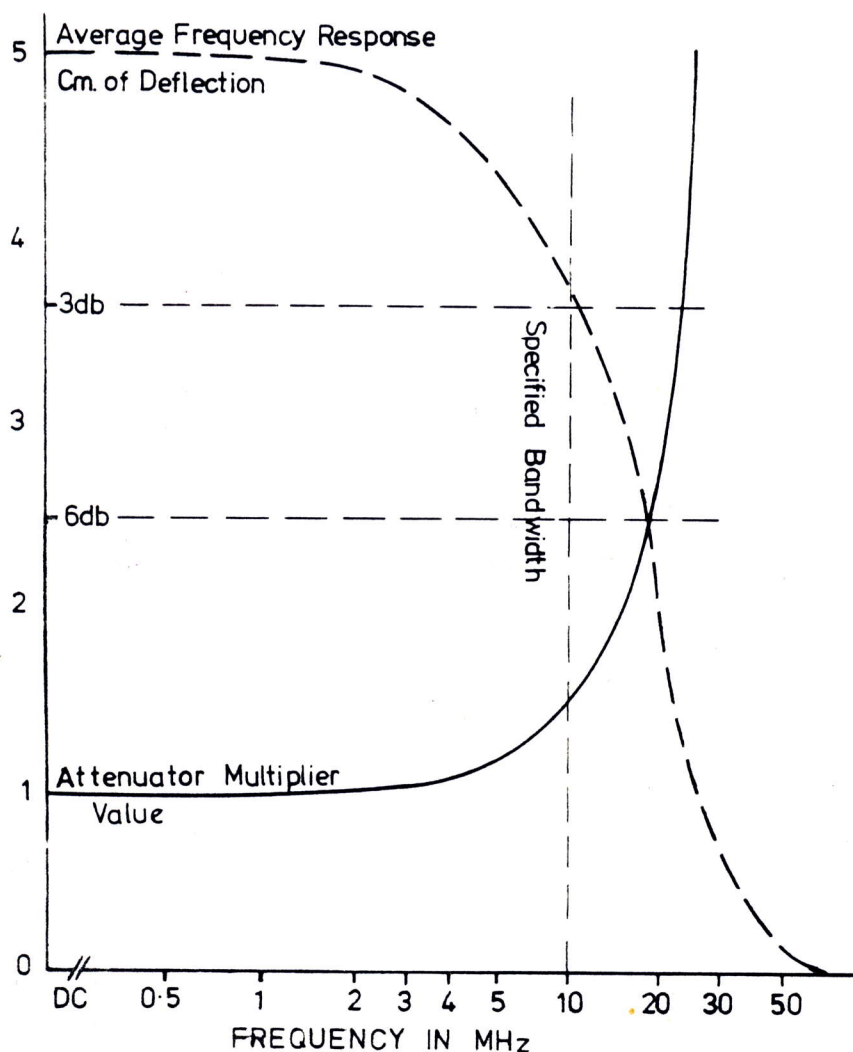
It must be noted the curves can only be approximate as at frequencies above 10MHz the method of picking up the signal and applying it to the oscilloscope can effect its apparent amplitude. With a 10:1 P32 Duo Probe properly grounded by the flying ground lead, measurements can be made to beyond 80MHz so that it will have a negligible effect over the bandwidth range available with a BWD 804 oscilloscope.

- 11.7 NOTE: Max amplitude of signal should NOT exceed the amplitude shown on the response curve, e.g. at 15MHz it should not exceed 2.8cm. Below 4MHz amplitude can be extended to the full 8cm deflection.

EXAMPLE: An input signal at 10MHz produces 3.6cm deflection with the attenuator set to 50mV/cm. Actual amplitude of signal is  $3.6 \times 50 \times \text{Attenuator Multiplier value}$ . At 10MHz Atten. Multiplier value is approx. 1.4 so the amplitude is therefore  $3.6 \times 50 \times 1.4 = 252\text{mV p-p}$ .

NOTE: Max. Deflection curve indicates signal amplitude at 10MHz must be kept below 3.6cm or amplifier overload will occur.

BWD 804 FREQUENCY RESPONSE CHART





## 11.8 Z MODULATION

As the BWD 804 has DC coupled X-Y & Z inputs it can be used as a direct coupled monitor for frequencies from DC to >30kHz with low phase shift between the X-Y & Z inputs.

Z Input impedance is 22k $\Omega$  and is TTL or CMOS compatible in that it requires a positive voltage from 0 to +5V to blank the trace at normal intensity levels. Voltages below 0V will increase the trace intensity. Maximum input to the Z socket is  $\pm 50V$  and must not be exceeded. If an AC coupled input is required an external capacitor must be placed in series with the input signal.

## 12. CIRCUIT DESCRIPTION

NOTE: As the circuit is isolated from ground, all measurements must be made with the ground link in place between Ground and Common terminals on the front panel.

### 12.1 ATTENUATOR

Signals applied to the input terminal are switched straight through to the attenuator in the DC position of S1 or via C1 to block the DC component in the AC position. Switch S2A-D attenuates the input signal in a 1,2,5,10 sequence. Section S2A & B attenuates the signal in a 1,10,100,1000 sequence every third step. Sections S2C and D steps the input in the 1,2,5 sequence. As the two sections are cascaded the result follows a 1,2,5,10 sequence. To maintain constant AC or DC ratio the resistor dividers are paralleled by capacitors, adjusted such that the  $C \times R$  value of the series arm is equal to the  $C \times R$  value of the shunt arm to each step.

### 12.2 VERTICAL AMPLIFIER

(U51 & 62, Q51-54.) The vertical amplifier comprises a balanced FET stage coupled to a wide band I.C. amplifier which in turn drives a cascode CRT deflection amplifier.

U51 dual FET's are the input amplifiers which provide a high impedance for the input signal from the attenuator and a balanced drive for the following stage. Input protection for U51 is provided by reversed biased low leakage diodes D51 and D52. In the event of a positive over-voltage being applied to the input, D51 will conduct into the low impedance of C53 and R60 whilst D2 conducts into C51 with large negative signals.

The zener diode D53 in the sources of U51 changes the amplifier gain in opposition to changes of line voltage to maintain a constant calibration sensitivity irrespective of line voltage variation. To further minimise line effects on the display, U51 is accurately matched for both gain and operating current to virtually eliminate the effects of variations on the DC rails.

Amplifier calibration is adjusted by shunt resistor RV52, whilst positioning voltages are applied from RV51 via R52 and R58 and mixed with the input signal at the junction of U51 drain and the input to U52 amplifier.

## 12.2 VERTICAL AMPLIFIER (Cont'd)

The output cascode stage Q51 to Q54 incorporates high frequency compensation capacitors C55 & 56 located between Q5 and Q6 emitters.

CRT Y - plates are directly coupled to Q51 and Q52 collector loads whilst internal trigger take off is from the collectors of Q53 & 54 via R67 and 77.

## 12.3 TRIGGER CIRCUIT

(Q101, U102 I.C. sections A, B & C.) Signals to trigger the time base are selected by S102 and are then AC coupled to Q101 by C104. Internal +ve trigger is via R77 from Q54, whilst -ve signals arrive via R67 from Q53, Ext signals are attenuated by R101 and C101. Q101 emitter follower drives U102A which is used as an amplifier, stable AC and DC conditions being maintained by R107.

In the AUTO mode S101 is open so the DC voltage on Q101 base is held by the divider RV101, R103 and R104 at its most sensitive condition.

When RV101 is switched out of Auto to Level Select, S101 closes, R103 is shorted out and adjustment of RV101 will change the voltage on Q101 base and hence the trigger level at U102A output.

U102 B & C are connected as a Schmitt Trigger by feedback resistors R109 & 110. In operation a negative signal to pin 9 causes a HI at pins 8 & 5 and a LO at pin 6. This LO is communicated back to pin 9 via R109 & 110 pulling it still more negative. This results in a cumulative action which causes the output on pin 6 to switch rapidly either HI or LO with the input signal.

## 12.4 AUTO CIRCUIT

(Q102, U102D.) Another inverter section U102E is connected to pins 8 & 5 via R111. Its output at pin 10 swings between approx. +4V and +0.2V when a signal is present. This output voltage is rectified by C108, D108, D109 and C109 and applied to the base of Q102 clamp transistor via R112 which controls AUTO operation.

In non-AUTO use, Q102 is held conducting by D107 and R113 connected to -15V through S101 & R104 irrespective of the signals on U102D.

## 12.5 TIME BASE CIRCUIT

(U102 I.C. Sections E & P, U101.) This circuit consists of a Miller Integrator gated by a bistable switch formed by the remaining two inverter gates U102E & 102F. Operation is as follows:

Assume pin 3 of U102E is HI, pins 4 & 1 will be LO and therefore pin 2 will be HI.

Via divider R127 & R128, D102 will conduct biasing pin 2 of U101 on. The output at pin 6 will fall until the junction of R129 & D104 falls below zero volts and pulls D104 into conduction. The negative fall at the output of U101 will continue until the current flowing through D104 pulls D102 negatively and reduces the +ve current through it until it equals the negative charging current supplied to pin 2 of U101 by R120 from RV102A time base Vernier control. The circuit will stabilise in this quiescent state awaiting a trigger pulse to start the time base. When a trigger signal switches pin 6 of U102C LO, the leading edge of the pulse is fed by C106 and diode D105 to pin 3



## 12.5 TIME BASE CIRCUIT (Cont'd)

of the time base bistable. It is driven LO, pins 4 & 1 go HI and 2 switches to LO. R119 communicates this LO back to the input at 3, latching the circuit in this state. The divider R127 & 128 now cuts off D102 and 104 leaving only the charging resistor R120 connected to U101. Current through it pulls the input negatively, causing the output at pin 6 to rise, which is connected to one end of the timing capacitors C119 to C123, thus completing a negative feedback loop around U101.

The negative feedback maintains a constant charging current on the timing capacitors to produce a very linear sweep waveform.

The linear rising time base waveform continues until the junction of R129 & 130 pulls diode D106 into conduction. This pulls pin 3 positive, 4 & 1 go LO, 2 goes HI and R119 feeds back the change to the input to latch it in the HI state. Divider R127 & 128 pulls D102 into conduction and pin 2 of U101 positive, its output falls until D104 again conducts and the circuit is in its quiescent low state awaiting the next trigger signal.

Whilst the time base waveform is being generated pin 4 of U102E I.C. is HI. This pulls diode D103 into conduction and the selected hold off capacitor that is switched into circuit by S103A is charged to approximately +4V. Diode D105 reverse biases and prevents the pull up by D103 from affecting the state of the bistable switch.

At the completion of the sweep waveform when diode D106 resets the bistable to HI, pin 4 falls to LO, D103 disconnects and the hold-off capacitor starts to discharge through R118 & 114.

The fall will continue until a negative trigger pulse fed via C106 can force pin 3 LO and so switch the bistable circuit over to start another trace.

12.6 If a trigger signal is not received to initiate the sweep, the charge on C109 in the AUTO circuit falls to zero so removing the forward bias on Q102 clamp transistor. This enables R114 to pull the junction of R113 & 114 negatively until D105 conducts and latches the bistable over to start another trace.

12.7 When Level Select is in use Q102 clamp transistor is held on by a negative voltage on its base supplied via D107, R113 and R104 from the -15V rail. This holds the bottom end of R114 at almost zero volts and prevents the time base from being initiated until a trigger pulse is received via C106.

## 12.8 BLANKING CIRCUIT

(Transistor Q103). During the retrace period when pin 2 of U102A is HI, Q103 is pulled hard into conduction through D101, causing its collector to fall. When the time base starts, pin 2 goes LO, disconnecting D101, turning off Q103. Its collector rises until the feedback current through R122 stabilises the collector voltage at approx. +65V.

The current through R125 and Z modulation input via R124 are mixed with the blanking waveform at Q103 base and so controls the amplitude of the collector blanking level.

## 12.8 BLANKING CIRCUIT (Cont'd)

In addition to the high speed blanking pulse to the CRT grid it is also necessary to combine it with DC and low frequency blanking. This is achieved by modulating a 20kHz square wave oscillator and demodulating it at the CRT grid. Q201 & 202 are an emitter coupled free running oscillator producing an 80V square wave across R204. The signal passes through R205 to diode clamp D212 which sets the blanking level. Signals from Q103 collector feed directly to the CRT grid via C214 and via D213 to modulate the 20kHz waveform from R205. This is then supplied to the grid via C215 where it is demodulated with respect to the -ve EHT by D215 and mixed with the waveform on C215 by diode D214.

## 12.9 HORIZONTAL AMPLIFIER

(Q104 & 105). Time base and horizontal input waveforms are applied to Q104 base via the divider R138, RV104, R139 and 145. The horizontal positioning voltage on RV105 is taken to the base of Q105 of the amplifier pair. The signals combine across the common emitter load R146 & 137 to produce a balanced drive across R140 and 141 collector loads for the CRT X plates.

Time base calibration is set by RV104 in the amplifier input divider. When switch S103 is turned fully clockwise to the X input position, pin 3 of U101 amplifier is connected to R134 and 135 horizontal input divider. Input sensitivity is adjusted by RV102B.

The other input of U101, pin 2 which is normally connected to the timing components is now joined by S103B to a feedback resistor R132 and 133 with R131 centering resistor to set the amplifier gain to approximately X7 and providing an overall sensitivity of 600mV p-p/cm.

## 12.10 POWER SUPPLIES

EHT. A 500V RMS winding on T201 is voltage doubled by D201-204 to produce -1540V. This is applied to the CRT cathode via RV203 and a divider R217 to RV202 focus control and through R216 to the common line.

+120V Rail. A bridge rectifier D205-206 supplies +125V to C205. The rail is further filtered by R201 and C206. The front panel LED indicator D209 is placed in series with this rail.

+15V Rail. D210 half wave rectifies a 21V AC winding and supplies +22 to C207. R202 & C208 provide additional filtering.

-15V Rail. D211 half wave rectifies 21V AC to supply -23 to C209. R203 & C210 provide additional filtering.

+5V Rail. Current through the vertical output stage and Q51-54 are used to supply the 5V rail which is regulated by D55 zener diode. It is then passed through D54 to filter capacitor C103.

## 12.11 CRT CONTROLS

Intensity is adjusted by RV203 in the CRT cathode whilst focus is set by RV202 in the EHT divider R217, RV202, R216. Astigmatism is preset by RV201 and interplate shield voltage by divider R209 and R210.



### 13. ADJUSTMENTS AND MAINTENANCE

#### W A R N I N G

DANGEROUS VOLTAGES EXIST AT SEVERAL POINTS THROUGHOUT THIS INSTRUMENT. WHEN OPERATING WITH THE COVERS REMOVED, DO NOT TOUCH EXPOSED CONNECTIONS OR COMPONENTS. ALWAYS DISCONNECT THE INSTRUMENT FROM THE POWER OUTLET BEFORE CLEANING, SOLDERING AND REPLACING PARTS.

- 13.1 A number of preset controls are contained in this instrument which may require periodic adjustments to maintain full calibration.

Before removing the top covers, disconnect the instrument from the power line. Turn the instrument over and remove the 4 feet and the two screws holding the handle. Slide off the covers.

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

#### 13.2 ALIGNMENT PROCEDURE

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

Check operation of Time Base and Vernier on each Time Base range.

Turn Time Base switch to HORZ. AMP. Spot should move at least  $\pm 5\text{cm}$  with Horizontal Position.

#### 13.3 GENERAL CHECK OF CONTROLS

- (a) Intensity: Complete control over intensity range.
- (b) Focus: Adjustment available either side.
- (c) Vertical Position: Trace should move completely off screen above and below centre.

#### 13.4 CRT TRACE ALIGNMENT

Feed a 1000Hz sine wave signal into the Vertical Amplifier and adjust waveform for 6cm deflection T.B. to 1mSec. Vernier at Cal.

The astigmatism preset RV201 at the rear centre of the P.C. Board is adjusted in conjunction with the focus control for the best resolution over the entire screen area with intensity adjusted to a high brightness level.

The intensity range preset RV204 at the lower rear corner of the P.C. Board is adjusted so that the Intensity Control when adjusted to max. counterclockwise will extinguish a stationary spot in the centre of the screen (use oscilloscope in X-Y mode).

### 13.5 ATTENUATOR AND CALIBRATION

Test equipment required - 1kHz Square Wave Generator.

Set attenuator to 0.01V, feed in 50mV p-p (1% accuracy) square wave. Adjust RV52 for 5cm display. Vertical amplifier of oscilloscope is now calibrated.

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

<u>Attenuator Setting</u>	<u>Input Voltage</u>	<u>Adjustment for Square Wave</u>
0.01	50mV	-
0.02	100mV	C11
0.05	200mV	C12
0.1	500mV	C4
0.2	1V	C10
0.5	2V	C13
1	5V	C6
2	10V	-
5	20V	-
10	50V	-
20	100V	-
50	100V	-

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

### 13.6 VERTICAL AMPLIFIER

Test equipment required 1MHz Square Wave Generator, less than 30n Sec. rise time and constant amplitude sine wave generator.

Attenuator to 0.1V, input selector to AC, signal input 0.5V p-p 1MHz, T.B. range 0.2 $\mu$ Sec, Vernier to Cal. Check square wave is a good shape. Adjust C55 for best response.

Check bandwidth with a constant amplitude sine wave generator. Adjust deflection for 5cm at 50kHz, display should not drop to less than 3.5cm at 10MHz.

### 13.7 HORIZONTAL AMPLIFIER

Test equipment 1Hz to 1MHz Sine Wave Generator (Model BWD 141). Switch T.B. to Horz Input and turn Vernier control fully clockwise.

Connect oscillator to Horizontal Input. Adjust display for 6cm deflection at 1kHz, increase frequency and note frequency when trace drops to 4.2cm length - it should be above 500kHz.

NOTE: Trace will increase in length to approximately 10cm around 500kHz before falling to 4.2cm at almost 1MHz.

SENSITIVITY: Feed in 1kHz square wave 5V p-p amplitude, trace should be approximately 9cm long at maximum gain and less than 1mm at minimum gain.



### 13.8 X-Y PHASE MEASUREMENT

Turn attenuator to 1V/cm, feed in 6V p-p 1kHz sine wave to both vertical and horizontal inputs. Adjust Horz Vernier for a 45° line on CRT, i.e. equal X-Y sensitivities. Now increase frequency, line should not open in the centre of the wave more than 3mm below 30kHz.

### 13.9 TRIGGER SENSITIVITY

Auto operation. Feed in 50kHz sine wave, time base to 10μSec/cm. Reduce amplitude of input signal until trace ceases to lock. This should be below 0.5cm deflection. Increase deflection to 1cm, increase frequency to 10MHz maintaining 1cm deflection. Trace should lock at all frequencies. To check low frequency trigger use a BWD 141 or BWD 160A oscillator. On AUTO 1cm deflection will trigger to 15Hz. With level select in operation, trigger should be obtained to below 1Hz.

### 13.10 TIME BASE

Test equipment required <1% accuracy generator with 0.1μSec to 0.1Sec output in decade steps. Set Time Base Range to 1mSec, Vernier to Cal. Feed in 1m Sec pulse to amplifier and adjust RV104 (T.B. Cal. top centre of P/C board) to display 1 pulse per cm. Check the following steps with the frequency indicated and if necessary adjust RV104 for a compromise setting to obtain the minimum error at each step.

<u>T.B. Range</u>	<u>Input Frequency</u>	
10mSec	100Hz )	All ranges set by RV42
1mSec	1kHz)	
100μSec	10kHz)	
10μSec	Adjust C121	

Now feed a 1MHz pulse in with T.B. switched to 1μSec, adjust C120 for 1 pulse/cm.

Next switch to 0.2μSec. Adjustment for 1 pulse/2cm is made by twisting C119 trimmer on the T.B. switch.

### 14. REPLACEMENT PARTS

#### 14.1 Spares are normally available direct from the manufacturer.

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 greater than the original component.

#### 14.2 As the policy 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.

### 15. 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 the Guarantee Registration Card which accompanied the instrument, for full details of conditions of warranty.



## 16. PARTS LIST

### 16.1 MANUFACTURERS ABBREVIATIONS

AC	Allied Capacitors Pty. Ltd.
BWD	BWD Electronics Pty. Ltd.
D	Darstan Limited
ERIE	ERIE Electronics Limited
Hitachi	Hitachi Limited
IRH	IRH Components Pty. Ltd.
ITT	ITT Components Group STC Limited
NS	NS Electronics Pty. Ltd.
NSF	NSF Limited
PH	Philips Industries Limited
ROE	Ernst Roederstein GmbH
S	Soanar Electronics Pty. Ltd.
SIEM	Siemens Industries Limited
STE	Stettner Capacitors Limited
TI	Texas Instruments Incorporated

## 16.2 PARTS LIST - MODEL BWD 804

CCT REF	DESCRIPTION			Mfr or Supply	PART NO.
	<u>RESISTORS</u>				
R1	100Ω	1/4W	5%	IRH	GLP
R2	900kΩ	1/4W	1%	IRH	RN 1/4
R3	1MΩ	1/4W	1%	IRH	RN 1/4
R4	111kΩ	1/4W	1%	IRH	RN 1/4
R5	9k1	1/4W	1%	IRH	RN 1/4
R6	1kΩ	1/4W	1%	IRH	RN 1/4
R7	10MΩ	1/4W	5%	PH	VR37
R8	500kΩ	1/4W	1%	IRH	RN 1/4
R9	4M7	1/4W	5%	PH	VR37
R10	1MΩ	1/4W	1%	IRH	RN 1/4
R11	800kΩ	1/4W	1%	IRH	RN 1/4
R12	250kΩ	1/4W	1%	IRH	RN 1/4
R13	270kΩ	1/4W	5%	IRH	GLP
R14	1MΩ	1/4W	1%	ROE	RN 1/4
R15	1M5	1/4W	5%	PH	VR37
R16	1Ω	1/4W	5%	IRH	GLP
R51	68Ω	1/4W	5%	IRH	GLP
R52	3k3	1/4W	5%	IRH	GLP
R53	3k9	1/4W	5%	IRH	GLP
R54	4k7	1/4W	5%	IRH	GLP
R55	3k3	1/4W	5%	IRH	GLP
R56	330Ω	1/4W	5%	IRH	GLP
R57	1kΩ	1/4W	5%	IRH	GLP
R58	3k3	1/4W	5%	IRH	GLP
R59	68Ω	1/4W	5%	IRH	GLP
R60	330Ω	1/4W	5%	IRH	GLP
R61	68Ω	1/4W	5%	IRH	GLP
R62	68Ω	1/4W	5%	IRH	GLP
R63	68Ω	1/4W	5%	IRH	GLP
R64	2k2	1W	5%	IRH	GLI
R65	2k2	1W	5%	IRH	GLI
R66	120Ω	1/4W	5%	IRH	GLP
R67	1kΩ	1/4W	5%	IRH	GLP
R68	120Ω	1/4W	5%	IRH	GLP
R69	330Ω	1/4W	5%	IRH	GLP
R70	120Ω	1/4W	5%	IRH	GLP
R71	33Ω	1/4W	5%	IRH	GLP
R72	120Ω	1/4W	5%	IRH	GLP
R73	2k2	1W	5%	IRH	GLI
R74	2k2	1W	5%	IRH	GLI

# 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION			Mfr or Supply	PART NO.
	RESISTORS (Cont'd)				
R75	2k2	1/4W	5%	IRH	GLP
R76	68Ω	1/4W	5%	IRH	GLP
R77	1kΩ	1/4W	5%	IRH	GLP
R78	82Ω	1/4W	5%	IRH	GLP
R79	33kΩ	1/4W	5%	IRH	GLP
R101	100kΩ	1/4W	5%	IRH	GLP
R102	180kΩ	1/4W	5%	IRH	GLP
R103	820kΩ	1/4W	5%	IRH	GLP
R104	56kΩ	1/4W	5%	IRH	GLP
R105	1kΩ	1/4W	5%	IRH	GLP
R106	Selected on test. Nom. value 1k1			IRH	GLP
R107	56kΩ	1/4W	5%	IRH	GLP
R108	1kΩ	1/4W	5%	IRH	GLP
R109	22kΩ	1/4W	5%	IRH	GLP
R110	22kΩ	1/4W	5%	IRH	GLP
R111	3k3	1/4W	5%	IRH	GLP
R112	100kΩ	1/4W	5%	IRH	GLP
R113	270kΩ	1/4W	5%	IRH	GLP
R114	1k8	1/4W	5%	IRH	GLP
R115	18kΩ	1/4W	5%	IRH	GLP
R116	12kΩ	1/4W	5%	IRH	GLP
R117	560Ω	1/4W	5%	IRH	GLP
R118	1kΩ	1/4W	5%	IRH	GLP
R119	3k9	1/4W	5%	IRH	GLP
R120	2M2	1/4W	5%	PH	VR37
R121	8k2	1/4W	5%	IRH	GLP
R122	100kΩ	1/4W	5%	IRH	GLP
R123	39kΩ	1W	5%	IRH	GL1
R124	22kΩ	1/4W	5%	IRH	GLP
R125	22kΩ	1/4W	5%	IRH	GLP
R126	5k6	1/4W	5%	IRH	GLP
R127	10kΩ	1/4W	5%	IRH	GLP
R128	120kΩ	1/4W	5%	IRH	GLP
R129	5k6	1/4W	5%	IRH	GLP
R130	18kΩ	1/4W	5%	IRH	GLP
R131	120kΩ	1/4W	5%	IRH	GLP
R132	33kΩ	1/4W	5%	IRH	GLP
R133	18k	1/4W	5%	IRH	GLP
R134	100k	1/4W	5%	IRH	GLP
R135	100kΩ	1/4W	5%	IRH	GLP



## 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION			Mfr or Supply	PART NO.
	<u>RESISTORS</u> (Cont'd)				
R136	68Ω	1/4W	5%	IRH	GLP
R137	15k	1/4W	5%	IRH	GLP
R138	8k2	1/4W	5%	IRH	GLP
R139	8k2	1/4W	5%	IRH	GLP
R140	27kΩ	1W	5%	IRH	GL1
R141	27kΩ	1W	5%	IRH	GL1
R142	27k	1/4W	5%	IRH	GLP
R143	68Ω	1/4W	5%	IRH	GLP
R144	330Ω	1/4W	5%	IRH	GLP
R145	3k9	1/4W	5%	IRH	GLP
R146	5k6	1/4W	5%	IRH	GLP
R147	6k8	1/4W	5%	IRH	GLP
R148	1MΩ	1/4W	5%	PH	VR37
R149	4k7	1/4W	5%	IRH	GLP
R150	330kΩ	1/4W	5%	IRH	GLP
R151	1kΩ	1/4W	5%	IRH	GLP
R152	10kΩ	1/4W	5%	IRH	GLP
R153	470Ω	1/4W	5%	IRH	GLP
R154	100kΩ	1/4W	5%	IRH	GLP
R155	2M2	1/4W	5%	PH	VR37
R201	220Ω	1/4W	5%	IRH	GLP
R202	390Ω	1/4W	5%	IRH	GLP
R203	560Ω	1/4W	5%	IRH	GLP
R204	100kΩ	1/4W	5%	IRH	GLP
R205	270kΩ	1/4W	5%	IRH	GLP
R206	15kΩ	1/4W	5%	IRH	GLP
R207	18kΩ	1/4W	5%	IRH	GLP
R208	18kΩ	1/4W	5%	IRH	GLP
R209	100kΩ	1/4W	5%	IRH	GLP
R210	220kΩ	1/4W	5%	IRH	GLP
R211	100kΩ	1/4W	5%	IRH	GLP
R212	82kΩ	1/4W	5%	IRH	GLP
R214	10MΩ	1/4W	5%	PH	VR37
R215	10kΩ	1/4W	5%	IRH	GLP
R216	2M7	1/4W	5%	PH	VR37
R217	390kΩ	1/4W	5%	IRH	GLP
R218	180kΩ	1/4W	5%	IRH	GLP
R219	220kΩ	1/4W	5%	IRH	GLP
R220	33kΩ	1/4W	5%	IRH	GLP
R221	10MΩ	1/4W	5%		
	(Fitted only when V201 is BUB7)			PH	VR37

16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CRT REF	DESCRIPTION					Mfr or Supply	PART NO.
	POTENTIOMETERS						
RV51	1k $\Omega$	Lin Carbon			S	VCU	
RV52	500 $\Omega$	Cermet Preset			S	VTP	
RV53	2k $\Omega$	W.W.			D	P122	
RV101	500k $\Omega$	Lin with DPST Rotary Switch			P1	Series 16	
RV102A/B	100k $\Omega$ +100k $\Omega$	Linear Tandem Carbon			S	VGU	
RV104	10k $\Omega$	Cermet Preset			S	VTP	
RV105	10k $\Omega$	Linear Carbon			S	VMU	
RV201	100k $\Omega$	Cermet Preset			S	VTP	
RV202	1M $\Omega$	Linear Carbon			S	VMU	
RV203	220k $\Omega$	Lin Carbon c/w DPST Switch			PH		
RV204	1M $\Omega$	Cermet Preset			S	VTP	
	CAPACITORS						
C1	100nF	630V	Type NL		S	Type NL	
C2	20pF	5%	630V	NPO	CDS	(May be 2x10pF)	
C3	18pF	10%	630V	NPO	CDS		
C4	2-6pF	Ceramic Trimmer			STE	IOS/06/2-6	
C5	33pF	5%	630V	N750	CDS		

## 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION					Mfr or Supply	PART NO.
	<u>CAPACITORS</u> (Cont'd)						
C6	2-6pF	Ceramic Trimmer				STE	IOS/06/2-6
C7	330pF	5%	400V	(125-600V)	PYS	AC	PYS
C8	3n3	10%	100V			S	Type NL
C9	2p2	± .5pF	630V	NPO	CDS	S	
C10	4-20pF	Ceramic Trimmer				STE	IOS/06/4-20
C11	4-20pF	Ceramic Trimmer				STE	IOS/06/4-20
C12	2-6pF	Ceramic Trimmer				STE	IOS/06/2-6
C13	4-20pF	Ceramic Trimmer				STE	IOS/06/4-20
C14	22pF		630V	N750	CDS	S	
C15	2n2	5%	630V	NPO	CDS	S	
C16	100nF	10%	630V			S	Type NL
C51	22μF		25V	Electro		S	RT
C52	22μF		25V	Electro		S	RT
C53	100nF		63V	HI-K	CDS	S	
C54	100nF		63V	HI-K	CDS	S	
C55	10-60pF	Ceramic Trimmer				STE	IOS/06/10-60
C56	330pF	5%	400V	(125-600V)	PYS	AC	PYS
C57	0.01μF		250V	MPC		SIEM	B32561-A3103-J
C101	3p3	±.5pF	630V	NPO	CDS	S	
C102	100nF		250V	PYE		SIEM	B32561-A3104-J
C103	470μF		6.3V	Electro		PH	
C104	1μF	5%	100V	PYE		SIEM	B32561-A1105-J
C105	220pF	20%	630V	N750	CDS	S	
C106	10pF	10%	630V	NPO	CDS	S	
C107	2n2	5%	630V		CDS	S	
C108	1μF	20%	35V	Ta		S	TAG
C109	2μ2		35V	Ta		S	TAG
C110	4n7	10%	250V	PYE		SIEM	B32560-A3102-K
C111	47nF	10%	100V	Greencap		S	Type NL
C112	0.47μF		35V	Ta		S	TAG
C113	4μ7		35V	Ta		S	TAG
C114	22μF		25V	Ta		S	TAG
C115	47pF	5%	630V	N750	CDS	S	



16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION					Mfr or Supply	PART NO.
	<u>CAPACITORS</u> (Cont'd)						
C116	1nF		250V	PYE		SIEM	B32560-A3102-J
C117	10pF	10%	630V	NPO	CDS	S	
C118	1nF		250V	PYE		SIEM	B32560-A3102-J
C119	Wire Trimmer						
C120	4-20pF	Ceramic Trimmer				STE	IOS/06/4-20
C121	10-40pF	Ceramic Trimmer				STE	IOS/06/10-40
C122	82pF		630V	N750	CDS		
C123	1nF	2%	250V	PYE		SIEM	B32560-A3102
C124	10nF	2%	250V	PYE		SIEM	B32561-A3103
C125	100nF	2%	250V	PYE		SIEM	B32561-A3104
C126	10µF		16V	Ta		S	TAG
C127	18pF	10%	630V	NPO	CDS	S	
C128	3p3		630V	NPO	CDS	S	
C129	1nF		630V	YE	CDS	S	
C130	15pF	10%	630V	NPO	CDS	S	
C201	8µF		450V	Elec		S	RT
C202	8µF		450V	Elec		S	RT
C203	8µF		450V	Elec		S	RT
C204	8µF		450V	Elec		S	RT
C205	40µF		200V	Elec		PH	2222-040-12409
C206	40µF		200V	Elec		PH	2222-040-12409
C207	1000µF		35V	Elec		S	RB
C208	1000µF		35V	Elec		S	RB
C209	1000µF		35V	Elec		S	RB
C210	1000µF		35V	Elec		S	RB
C211	4n7	10%	100V			S	Type N
C212	100nF	5%	250V	PYE		SIEM	B32561-A3104-J
C213	100nF	5%	250V	PYE		SIEM	B32561-A3104-J
C214	10nF		3kV	CDS		ERIE	
C215	1nF		3kV (or 2kV)	CDS		ERIE	
C216	100nF	5%	250V	PYE		SIEM	B32561-A3104-J
C217	68nF	10%	1600V	PYE		ERIE	WD4

## 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION		Mfr or Supply	PART NO.
	<u>DIODES</u>			
D51	IN4148	Diode		IN4148
D52	IN4148	Diode		IN4148
D53	6.2V	Zener	PH	BZX79/6V2
D54	IN4148	Diode		IN4148
D55	5.6V	Zener	PH	BZX79/5V6
D101	IN4148	Diode		IN4148
D102	IN4148	Diode		IN4148
D103	IN4148	Diode		IN4148
D104	IN4148	Diode		IN4148
D105	IN4148	Diode		IN4148
D106	IN4148	Diode		IN4148
D107	IN4148	Diode		IN4148
D108	IN4148	Diode		IN4148
D109	IN4148	Diode		IN4148
D110	IN4148	Diode		IN4148
D201	IN4007	Diode		IN4007
D202	IN4007	Diode		IN4007
D203	IN4007	Diode		IN4007
D204	IN4007	Diode		IN4007
D205	IN4004	Diode		IN4004
D206	IN4004	Diode		IN4004
D207	IN4004	Diode		IN4004
D208	IN4004	Diode		IN4004
D209	Red Light Emitting Diode		TI	TIL209
D210	IN4004	Diode		IN4004
D211	IN4004	Diode		IN4004
D212	IN4148	Diode		IN4148
D213	IN4148	Diode		IN4148
D214	IN4148	Diode		IN4148
D215	IN4148	Diode		IN4148

## 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

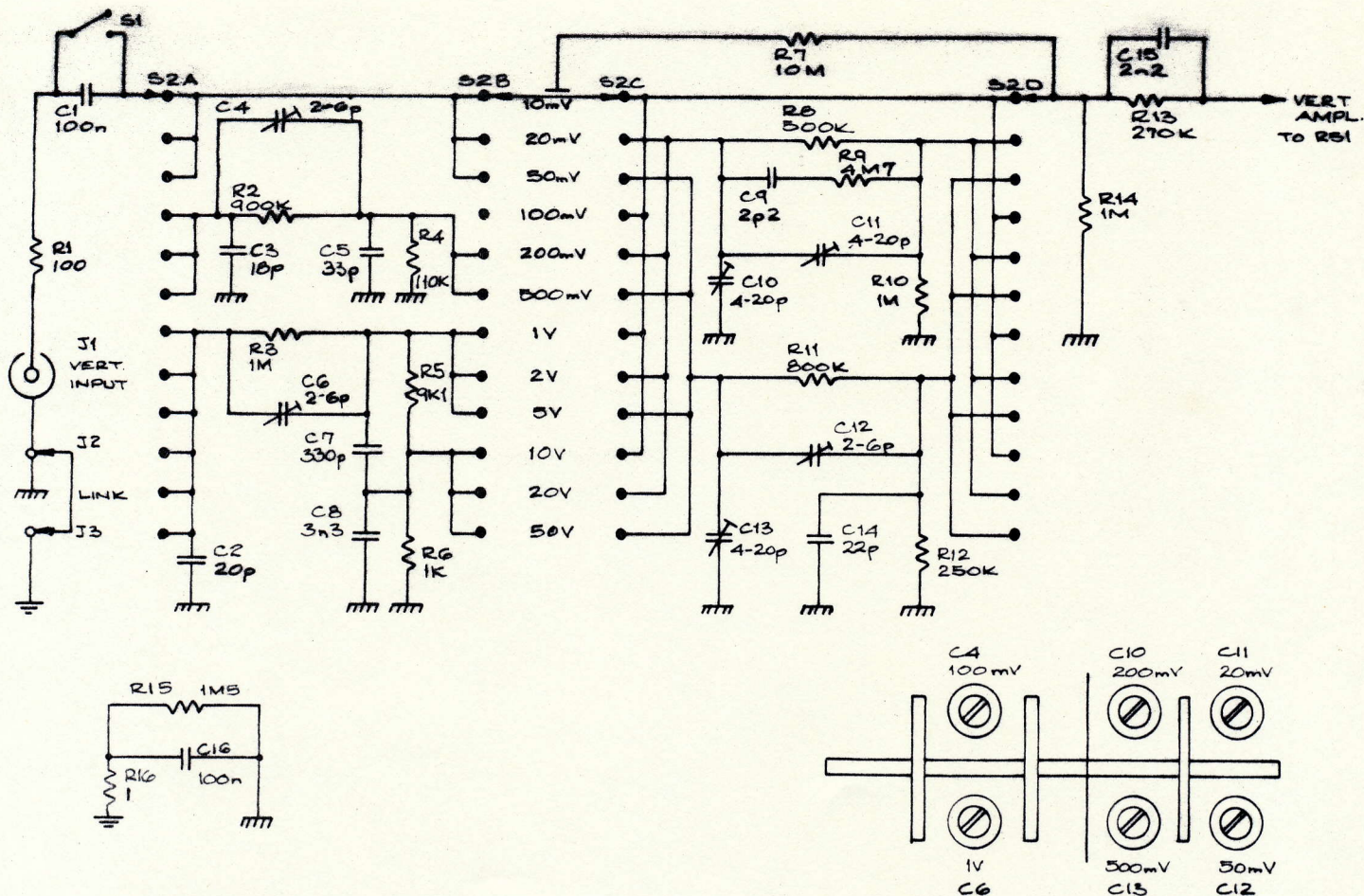
CCT REF	DESCRIPTION	Mfr or Supply	PART NO.
	<u>TRANSISTORS</u>		
Q51	BF459/BF469 Transistor	SIEM	BF469
Q52	BF459/BF469 Transistor	SIEM	BF469
Q53	2N5770 Transistor		2N5770
Q54	2N5770 Transistor		2N5770
Q101	BC547 Transistor	PH	BC547
Q102	PN4121 Transistor	NS	PN4121
Q103	BF459/BF469 Transistor	SIEM	BF469
Q104	BF469/BF337 Transistor	SIEM	BF469
Q105	BF469/BF337 Transistor	SIEM	BF469
Q106	BC547 Transistor	PH	BC547
Q107	BF470 Transistor	SIEM	BF470
Q201	BC547 Transistor		BC547
Q202	BF469 Transistor		BF469
	<u>MISCELLANEOUS</u>		
U51	Dual FET	NS	NPD8303
U52	Operational Amplifier	NS	LM733CN
U101	Operational Amplifier	NS	LF356BN
U102	Hex Inverter		74 LO4



# 16.2 PARTS LIST - MODEL BWD 804 (Cont'd)

CCT REF	DESCRIPTION	Mfr or Supply	PART NO.
TH51	<u>MISCELLANEOUS</u> (Cont'd) Thermistor	ITT	CZ3
V201	Cathode Ray Tube	Hitachi	130 BUB31
L51	Trace Rotation Coil	BWD	090-167-1
T201	Power Transformer	BWD	090-143-1
F201	(Fuse 100mA (235V) (Delay) ( 250mA (117V)		3AG 3AG
S1	Single Section Isostat Switch	NSF	SM2-3
S2A,B, C,D.	3 Deck 12 Pos. Rotary Switch	BWD	100-110-2
S101	SPST Switch (Rotary) Rear of RV101		
S102	3 Pos. 2 Pole Slide Switch	NSF	SM2-3
S103A,B C	2 Deck 7 Pos. Rotary Switch	BWD	100-111-3

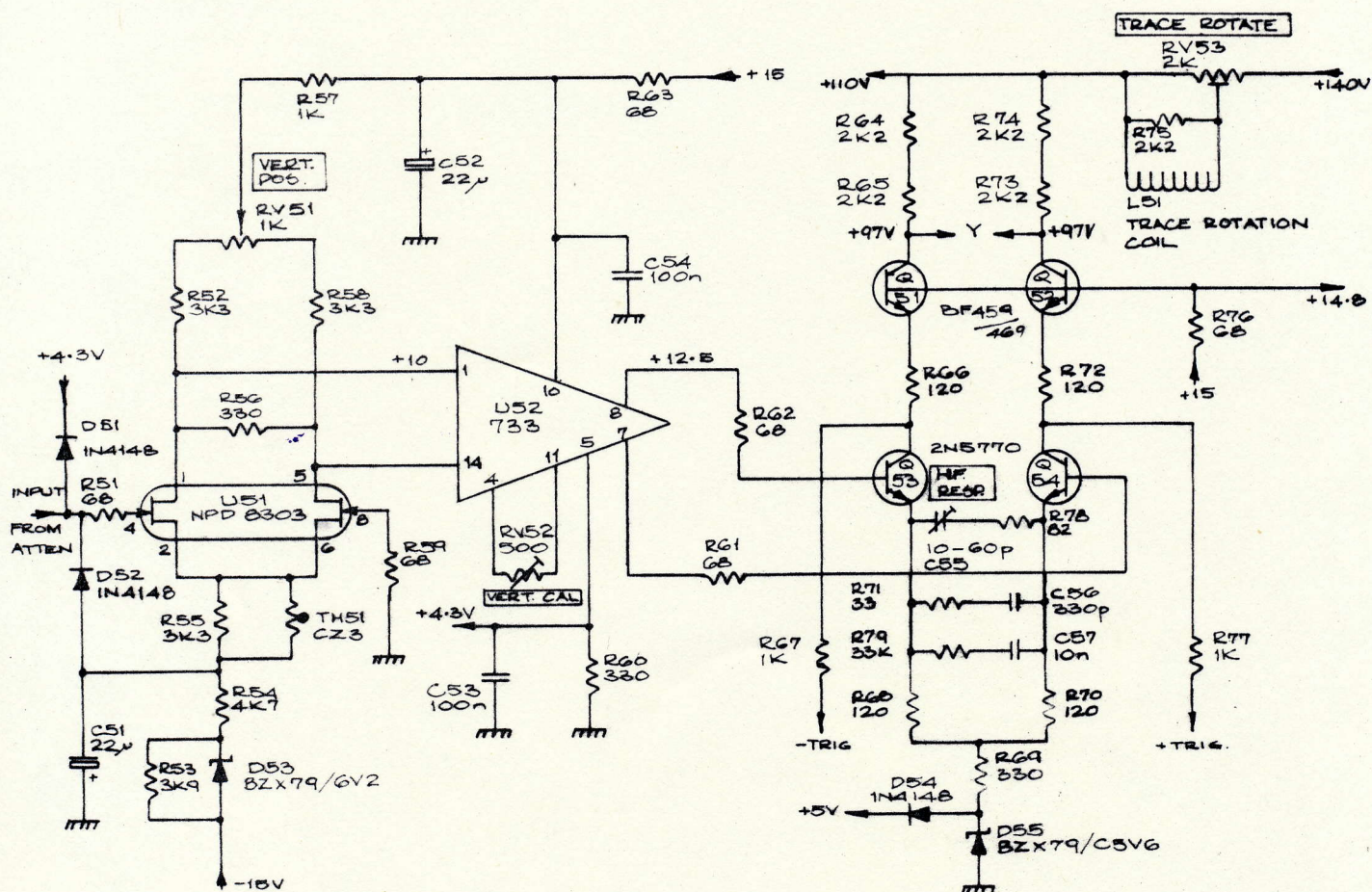




BWD 804

INPUT ATTENUATOR

DRG. No. 1511-3

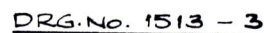


BWD 804

VERTICAL AMPLIFIER

DRG. No. 1512-3







B. W. D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 804

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
All S/No prior to 42130 only	1	12.2.79			
Applicable all issues	2	22.3.79			
42130	3	7.6.79			

Issue	Page	Sect.	Cct.	AMENDMENT
1	24	P/List	1513	RV102 A/B changed from 100k $\Omega$ +100k $\Omega$ to 250k $\Omega$ +250k $\Omega$
1	22	P/List	1513	R121 changed from 12k $\Omega$ to 27k $\Omega$
1	-	-	1513	100k $\Omega$ resistor added from Horz. Input to <del>mm</del> , located on RV102B
2	Caution Note			Last para. P37 was P36
2	2	-		Para 2-2 'Input Impedance' should read: "1M $\Omega$ in parallel with approximately 30pF to 36pF (Nom. 34pF)"
2	22	P/List	1513	R102 changed from 270k $\Omega$ to 180k $\Omega$ R106 selected on test. Nominal value 1k1
2	24	P/List	1511	C3 changed from 15pF to 18pF
2	26	P/List	1513	C130 15pF 10% 630V NPO CDS added in parallel with R146
2			1512	Pins 1 & 14 of U52 reversed on drg. Pin 1 connects to R52 and pin 14 to R58. Also pin numbers of U51 added to circuit. Starting from the gate lead connected to R51 and going clockwise the pin numbers are:- 4, 1, 5, 8, 6, 2.
3	21	P/List	1512	R66 and R72 68 $\Omega$ changed to 120 $\Omega$ .

## BWD Electronics Pty Ltd

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Telex: 35115  
Cables: 'Oscope' Melbourne  
Telephone: 561 2888



## SALES BULLETIN INTERIM SPECIFICATION

BWD 804 Single Trace  
DC to 10MHz Oscilloscope

### GENERAL DETAILS FOR THE 'NEW' BWD 804 OSCILLOSCOPE

An exciting 'NEW' low cost product featuring a DC to 10MHz bandwidth isolated input and DC coupled X, Y and Z inputs.

The DC coupled Z input is TTL compatible and makes it an excellent low cost X-Y-Z monitor. Other applications are in education, industry, (production line testing), servicing and in amateur radio and audio measurements.

Sensitivity 10mV to 50V/cm calibrated and a remarkable 10MHz triggering with polarity and level select and external trigger.

CRT	13cm dia. P31 or P7 phosphor
EHT	1.6kV
Display	8 x 10cm
Z Modulation	Input 22k $\Omega$ DC coupled +5V input for modulation DC to 2MHz
<b>VERTICAL AMP.</b>	
Bandwidth	DC to 10MHz - 3db (5cm ref)
Sensitivity	10mV/cm - 50V/cm
Rise Time	35nSec
Input	1M $\Omega$ & 30pF
Attenuator	1, 2, 5, 10 sequence better than 5% accuracy
Common Line	Isolated to $\pm 400$ V DC

#### TIME BASE

Range	0.2 $\mu$ Sec - 0.1Sec/cm
Calibration	6 decades & 12:1 vernier
Trigger Facilities	Internal $\pm$ , Auto, Level Select External +, Auto, Level Select
Trigger Range	2Hz to >10MHz
Horizontal Amp.	DC to 500kHz 3db 600mV-50V/cm
X-Y Phase Shift	<3 $^{\circ}$ DC to 20kHz
Cal. Accuracy	Better than 5%
Power	100-133 & 200-265V 48-440Hz 15W
Dimensions & Weight	200 x 180 x 410mm 5.4kg Net

  
R. WEST,  
Marketing Manager.



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## Oscilloscope Probe Kit

### Oscilloscope Probe Kit P32

This passive probe incorporates a three position slide switch in the head and has a cable length of 1.2 metres. The specification is as follows:

#### Position x1

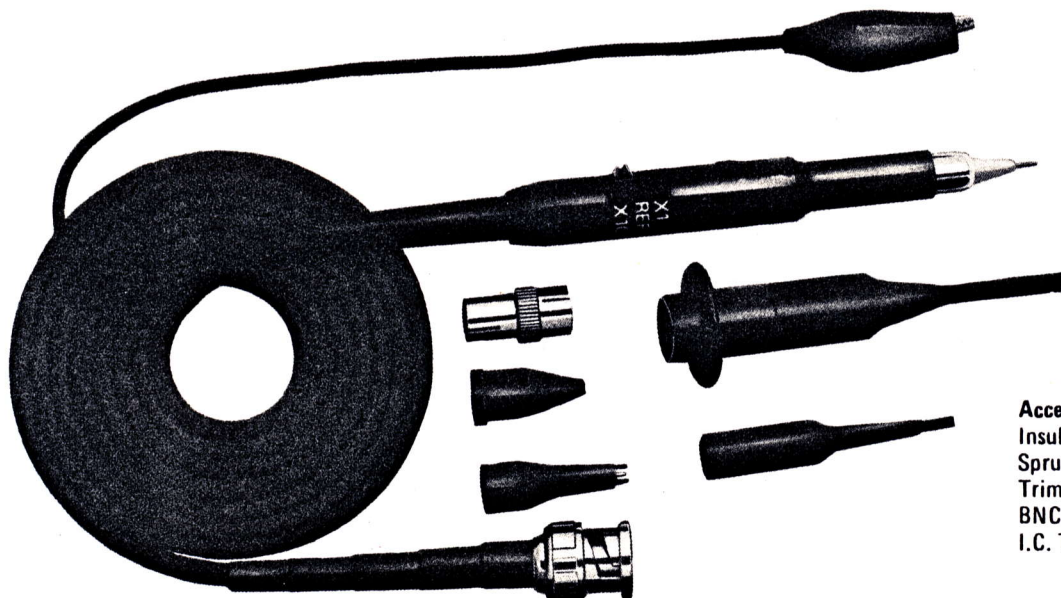
Bandwidth: D.C. to 10MHz  
Input Resistance: 1 M $\Omega$  (oscilloscope input)  
Input Capacity: 40pF. Plus oscilloscope capacity.  
Working Voltage: 600 Volts D.C. (including peak A.C.)

#### Position Ref.

Probe tip grounded via 9 M $\Omega$  resistor, oscilloscope input grounded.

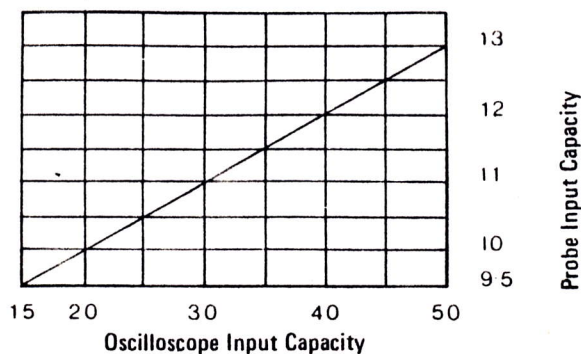
#### Position x10

Bandwidth: D.C. to 100MHz.  
Risetime: 3.5 nanoseconds.  
Input Resistance: 10 M $\Omega$   $\pm$ 2% when used with oscilloscopes with 1 M $\Omega$  input.  
Input Capacity: 10.8pF when used with oscilloscopes which have a 28pF input capacity.  
For other values see graph.  
Compensation Range: 15–50pF.  
Working Voltage: 600 Volts D.C. (including peak A.C.)



#### Accessories Supplied

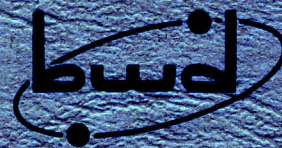
Insulating Tip	Pt.No. 113016
Sprung Hook	Pt No. 120079
Trimmer Tool	Pt No. 113012
BNC Adaptor	Pt No. 100017
I.C. Tip	Pt No. 120091











**BWD ELECTRONICS**

**804**

**DC to 10MHz  
OSCILLOSCOPE**

**INSTRUCTION MANUAL**



1070Hz as the frequency of resonance.

Worth mentioning, is that if this filter is used to back up a crystal or other type of filter in the receiver, the peak frequencies must be tailored to match. This can be done by capacitance adjustment.

When the filter is switched out, a 5 ohm 1 watt series resistor is substituted for the LC circuit. While unnecessary,

this refinement produces about the same attenuation for all frequencies as the filter attenuation at resonance. Switching the filter in will not appreciably affect the signal level at the resonant frequency, but will discriminate against undesired signals and materially reduce noise.

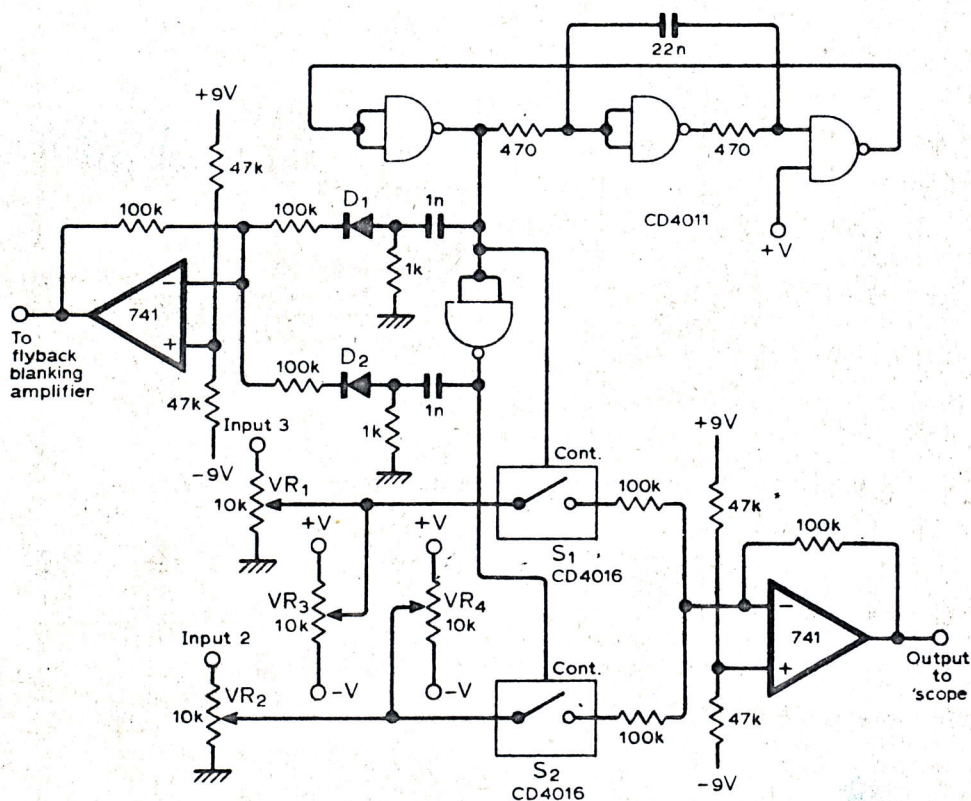
A very low resistance termination is required to make the filter sharp, since

increasing the terminating resistance directly reduces the series circuit Q. The level is adequate for headphones of average sensitivity.

The mechanical arrangement is so unimportant that no layout is included here. Inexpensive to build this filter is a simple device which will improve the selectivity of a receiver without requiring modification of the set in any way. The frequency stability of the receiver however, should be such that the signal remains within the passband of the filter.

(By Frank Noble, W3MT, in "QST".)

## Trace doubler for single beam oscilloscopes

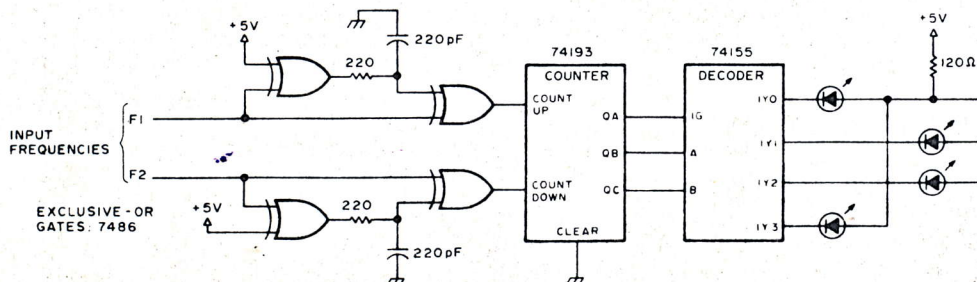


The 4011 forms an astable oscillator with a frequency of 53kHz. Two out-of-phase pulse trains are fed to the 4016 which alternately switches two inputs into the unity gain mixer amplifier. The output of the 741 is then fed to the oscilloscope.

Input levels are controlled by VR1 and VR2, and the position is controlled by VR3 and VR4. The remainder of the circuit is used to blank the beam between sweeps by differentiating the oscillator outputs to produce spikes. Positive spikes are then mixed and inverted by the 741 which drives the flyback blanking amplifier.

(By J. S. Paterson, in "Wireless World".)

## Beat frequency indicator



This circuit uses LEDs to display the beat frequency of two tone oscillators. Only one LED is on at a time, and the apparent rotation of the dot is an exact indication of the beat frequency. When  $f_1$  is greater than  $f_2$ , a dot of light rotates clockwise. When  $f_1$  is less than  $f_2$ , the dot rotates counterclockwise

and when  $f_1$  equals  $f_2$ , there is no rotation. (From "73".)

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