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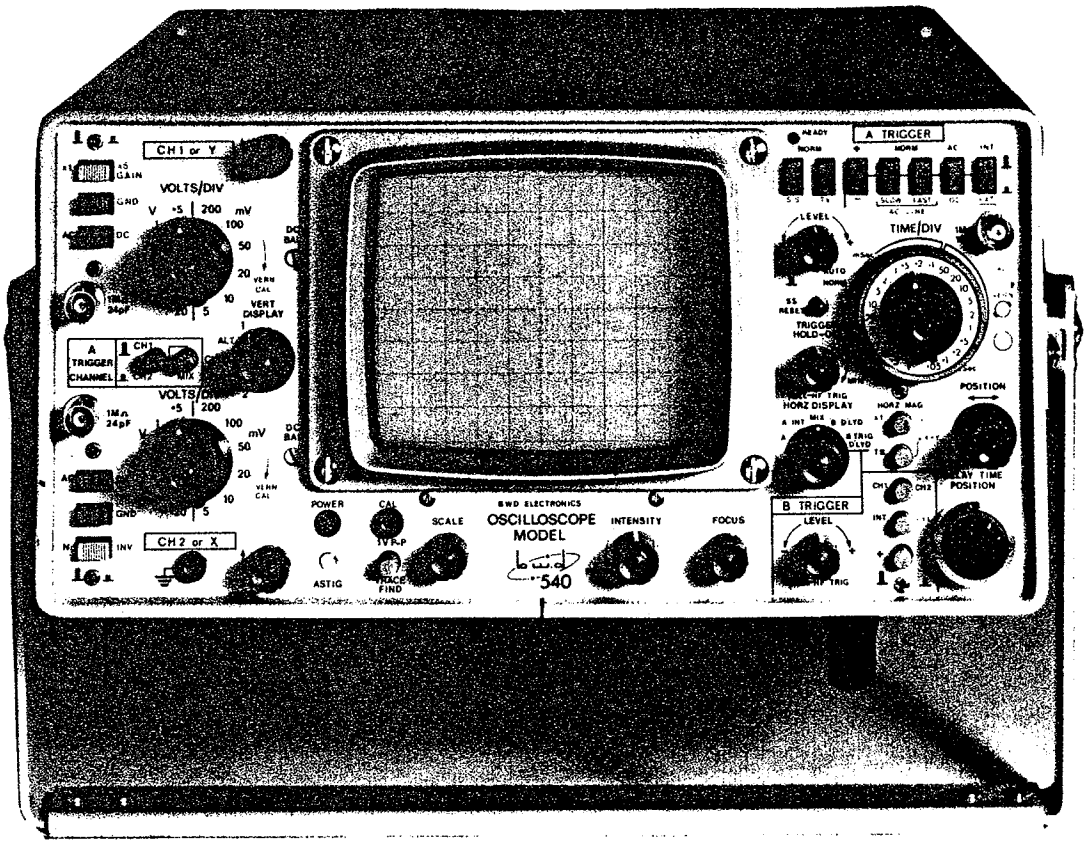
CABLES 'OSCILLOSCOPE'

TELEX AA35115

540

DC to 100MHz OSCILLOSCOPE

ISSUE 15



bwd 540 DUAL TRACE OSCILLOSCOPE

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B.W.D. ELECTRONICS PTY. LTD.

MANUAL CHANGE INFORMATION FOR MODEL BWD 540

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
30000	3	18.3.76			
33300	4	12.4.76			
34600	5	4.8.76			
35610	6	1.11.76			

Issue	Page	Sect.	Cct.	AMENDMENT
3	22	6-16		Lines 1 and 2 should read: - "three types of displays are available to view a waveform delayed in time by the 540 time base.
4	1A	13	1120	ADD R8 10MΩ 10% CC
4	1A	13	1120	ADD R58 10MΩ 10% CC
4	13A	13	1120	ADD C16 3p3 630V ±.5pF NPO CER
4	13A	13	1120	ADD C17 3p3 630V ±.5pF NPO CER
4	13A	13	1120	ADD C67 3p3 630V ±.5pF NPO CER
4	24A	13	1120	ADD S2CR PART OF SR123
4	24A	13	1120	ADD S52CR PART OF SR123
4	1A	13	1120	R4 Changed from 8.2Ω to 10Ω
4	1A	13	1120	R54 Changed from 4.7Ω to 150Ω
4	2A	13	1121	R128 Removed (was from gate Q102 to GND)
4	13A	13	1121	C109 Removed (was from point A to GND)
4	2A	13	1121	R150 Changed from 22Ω to 33Ω
4	2A	13	1121	R151 Changed from 22Ω to 33Ω
4	2A	13	1121	R152 Changed from 33Ω to 22Ω
4	2A	13	1121	R153 Changed from 33Ω to 22Ω
4	21A	13	1121	Q105-Q108 INCL. Changed from 2N5770 to BFY90
4	21A	13	1121	Q145-Q148 INCL. Changed from 2N5770 to BFY90
4	14A	13	1122	C184 Changed from 4p7 to 3p3
4	14A	13	1122	C185 Changed from 4-20pf var. to 3p3 fixed
4	14A	13	1122	ADD C186 1pF 630V 10% NPO CER
4	3A	13	1122	Replace R183 47Ω with a link
4	4A	13	1123	R265 Changed from 2K7 to 2K2
4	4A	13	1123	R266 Changed from 8K2 to 5K6
4	4A	13	1123	R267 Changed from 12K to 10K
4	5A	13	1123	ADD R294, R295 330Ω 1/4W MG IRH RG 1/4
4	14A	13	1123	C252 Changed from 56pF to 68pF
4	14A	13	1123	C253 Changed from 4p7 to 1nF
4	14A	13	1123	C256 Changed from 27pF to 33pF
4	21A	13	1123	Q251, Q252 Changed from 2N5770 to BFY90.
4	5A	13	1124	R320 Changed from 5K6 to 1K0
4	6A	13	1124	R331 Changed from 470Ω to 33Ω
4	6A	13	1124	R332 Changed from 10Ω to 33Ω
4	6A	13	1124	R341 Changed from 1K0 to 470Ω
4	6A	13	1124	ADD R345 2K2 1/4W MG IRH RG 1/4
4	15A	13	1124	C307 Changed from 6p8 to 3p3
4	19A	13	1124	ADD D315 IN4148

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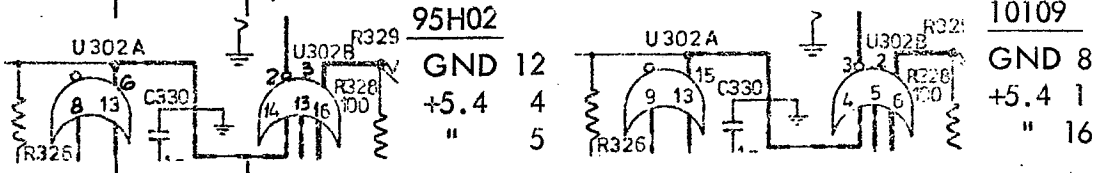
30000	3	18.3.76			
33300	4	12.4.76			
34600	5	4.8.76			
35610	6	1.11.76			

Issue	Page	Sect.	Cct.	AMENDMENT
4	15A	13	1124	C317 Changed from 1n to 10n and re-located (was from wiper of RV304 to GND)
4	5A	13	1124	R309 Changed from 39K to 10K and re-located (was from wiper of RV304 to S251A)
4	-	-	1124	C369 Circuit error only should be 0.68µ
4	23A	13	1124	U302 Changed from 95H02 to 10109. For alternative pin connections refer below:
4	22A	13	1125	Q401 Changed from 2N5770 to 2N3694
4	8A	13	1126	R540 Changed from 8K2 to 10K
4	22A	13	1126	Q504, Q505 Changed from PN4121 to 2N4258
4	23A	13	1127	Q655 Changed from 2N3055 to MJE3055
4	-	-	1127	D660 Reverse connections circuit only
4	-	-	1127	F652 Replaced by link and re-inserted between anode of D658 and Q655 emitter
4	-	-	1127	C651 and C652 -ve leads disconnected from anode of D658 and re-connected to Q655 emitter
4	9A	13	1138	R612 Changed from 220Ω to 560Ω
4	9A	13	1138	R614 Changed from 620Ω to 1K0
4	9A	13	1138	R623 Changed from 6K8 to 15K
5				All circuits re-drawn - no changes.
6	1A	13	1120	R17 Inserted in GND lead of S1A 150Ω 5%
6	1A	13	1120	R67 Inserted in GND lead of S1A 150Ω 5%
6	13A	13	1120	ADD C18 1pF 630V 10% NPO CER
6	13A	13	1120	ADD C68 -1pF 630V 10% NPO CER
6	18A	13	-	Delete D101, D104, D141, D144 IN4148
6	-	-	1121	D101 Replaced by link (was in series with D102 with cathode to point A).
6	-	-	1121	D104 Replaced by link (was in series with D103 with anode to -ve lead of C102).
6	-	-	1121	D141 Replaced by link (was in series with D142 with cathode to point B).
6	-	-	1121	D144 Replaced by link (was in series with D143 with anode to -ve lead of C142).
6	-	-	1121	DC Voltages on bases of Q105, Q106, Q145, Q146 changed from 0V to -0.1V.



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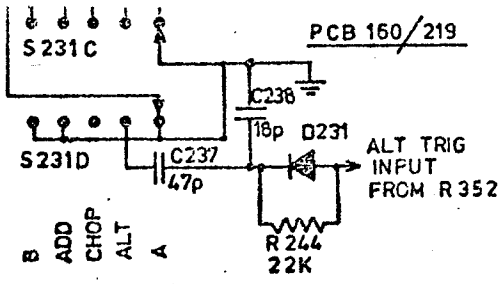
MANUAL CHANGE INFORMATION FOR MODEL BWD 540

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO	ISSUE	DATE
30000	3	18.3.76			
33300	4	12.4.76			
34600	5	4.8.76			
35610	6	1.11.76			

Issue	Page	Sect.	Cct.	AMENDMENT
6	-	-	1121	DC Voltages at (B2) and (B3) changed from +4.3V to +3.9V
6	47	10.4e	-	Line 1 Change 0.2V to -0.1V
6	48	10.4e	-	Line 2 (from top of page) change 4.3V to 3.9V
6	4A	13	1122	ADD R246 150K 5% 1/4W MG IRH RG 1/4
6	4A	13	1122	R231 Changed from 22K to 39K
6	4A	13	1122	R236 Changed from 22K to 39K
6	14A	13	1122	C184 Changed from 4p7 to 3p3
6	4A	13	-	Delete R244 22K
6	14A	13	-	Delete C237 47pF and C238 18pF
6	18A	13	-	Delete D231 IN4148
6	-	-	1122	Remove C238 18pF and R244 22K. Replace with link. D231 and C237 Issue 5. Circuit shown below. 
6	15A	13	1124	ADD C330 1nF 63V HI-K CER
6	9A	13	1127	Delete R671 10KΩ 5% 1W replace with link. (R671 was in series with wire from D664 anode to D607 #1138).
6	8A	13	1138	ADD R608 1K5 5% 1/4W MG IRH RG 1/4
6	9A	13	1138	ADD R625 1K5 5% 1/4W MG IRH RG 1/4
6	9A	13	1138	R621 Changed from 1MΩ to 270KΩ
6	9A	13	1138	R623 Changed from 10K to 12K
6	9A	13	1138	R624 Changed from 10K to 18K
6	-	-	1138	Remove D607 and re-connect with anode to D606 cathode and cathode to +55V.

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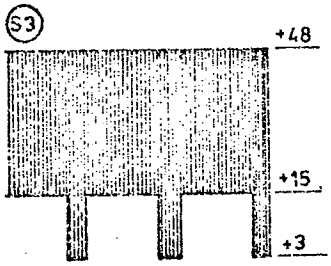
FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
30000	3	18.3.76	36200	8	9.3.77
33300	4	12.4.76	30000	9	23.3.77
34600	5	4.8.76	36811	10	17.5.77
35610	6	1.11.76			
30000	7	24.1.77			

Issue	Page	Sect.	Cct.	AMENDMENT
6	-	-	1138	(S4) Waveform added and (S3) waveform changed from:- 
6	12A	13	1120	C2 changed from 6p8 to 3p3
6	13A	13	1120	C16 changed from 3p3 to 4p7
6	13A	13	1120	C52 changed from 6p8 to 3p3
7	-	-	1124	Circuit error. Join the two 50KΩ sections of R370A-1 as shown (issue 7). Applicable to all previous serial numbers.
8	8A	13	1138	R603 changed from 5K6 to 6K2 1%.
9	6A	13	1124	R370A-1 Pt. No. changed from TF-1 to 010-001
9	7A	13	1125	R450A-G Pt. No. changed from TF-1 to 010-001
9	-	-	1127	Output to D607 (#1138) on T652 changed from Pin 2 to Pin 7 (circuit error - applicable from Serial No. 35610).
10	9A	13	1138	Delete R624 was in parallel with RV601
10			1138	Connect L.H. end of RV601 to ⏚.
10	8A	13	1138	ADD R600 47K 5% 1/4W MG IRH RG 1/4
10	12A	13	1138	ADD RV606 20K Lin. Preset SON VTP
10	17A	13	1138	ADD C609 100nF 63V HI-K CER
10			1138	D607 Cathode was previously connected to +55V
10	11A	13	1122	Delete RV182 200Ω Preset replace with link.
10	7A	13	1126	R504 changed from 18KΩ to 15KΩ
10	8A	13	1126	R510 changed from 6K8 to 5K6
10	40	9		The third paragraph from the top of the page has been changed from:- The rectangular waveform is taken from the DC-DC convert transformer winding that supplies the +55 rail. It is taken through R671 and then clipped on the positive excursion by a 47V zener diode D666. D607 conducts on the positive part of the signal but disconnects the negative going waveform.
10	44	10		Position of RV606 shown in "TOP VIEW"
10	51	10		Description of RV606 adjustment added to end of first paragraph 10.4 (p).

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MANUAL CHANGE INFORMATION FOR MODEL BWD 540

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
36811	10	17.5.77			
37821	11	20.9.77			
38445	12	5.12.77			
39350	13	10.4.78			
Applicable to all instruments	14	29.6.78			

Issue	Page	Sect.	Cct.	AMENDMENT
10	19A	13	1126	D503 changed to D503A and D503B added in series - the type remains unchanged.
10	19A	13	1126	D504 changed to D504A and D504B added in series - the type remains unchanged.
10	19A	13	1126	D506 changed to D506A and D506B added in series - the type remains unchanged.
11			1124	Lead deleted going to S402 c/2 from D313 anode.
11	16A	13	1125	C411 150pF 630V 20% CER removed and replaced with link. Was in series with pin 6 U402F and junction of D407 and R420.
11	7A	13	1125	R420 2K2 5% 1/4W MG removed. Was from ⏚ to anode of D407.
11			1125	Connection from S402 c/2 now goes to R508 #1126. Originally it went to Q309 Base #1124.
11	8A	13	1126	R508 1K2 5% 1/4 MG added.
11	19A	13	1126	D504B removed. Replaced by link. D504A CCT Ref. changed to D504. Type changed from IN4148 to Selected Component.
12	17A	13	1125	R402 33Ω Changed to 68Ω.
12	17A	13	1125	R425 150Ω Changed to 470Ω 5% 1W RG1
13	10A	13	1122	R752 820Ω Removed. Was from base Q751 to gnd.
13	10A	13	1122	R753 15K Changed to 6K8
13			1122	Connection from R751 now to Q204 base. Was to Q201 base.
13			1127	DC Output Socket added to Rear Panel.
13	8A	13	1138	R605 4K7 Changed to 6K2.
13	9A	13	1138	R624 22K (nominal) added. Selected component.
13	23A	13	1138	Q605 BF469 added in series from wiper of RV604 to pin 9.
13			1138	Ground removed from RV601.
14	3A	13	1122	R199 12K Added. Circuit and Parts List omission.
14	14A	13	1122	C204 68pF Added. Circuit and Parts List omission.
14	48	10		Description added to 10-4(g)
14	49	10		Description added to 10-4(h)
14	51	10		Description added to 10-4(m)
14	52	10		"Feed in 50kHz to Ch. 2 and adjust for 6 div. display ...." changed to "Feed in 50kHz to Ch. 1 and Ch. 2 and adjust ...." Sect. 10-4 (q)
14	22A	13	1124	Q311 & Q312 BC547 changed to BC547A.
14	22A	13	1125	Q402 & Q403 2N3694 changed to 2N4249 matched pair.
14	22A	13	1125	Q401 2N3694 changed to BC547A.

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MANUAL CHANGE INFORMATION FOR MODEL BWD 540

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
40800	15	5.10.78			

Issue	Page	Sect.	Cct.	AMENDMENT
15			1124	R332 33Ω replaced by D301 IN4148
15			1124	R348 10K and C322 1p5 removed. Were in series with each other with R348 connected to pin 4 U303B and C322 connected to the cathode of D310.
15	6A	13		R332 removed.
15	6A	13	1124	R327 820Ω added in series with C314.
15	6A	13		R348 removed.
15	15A	13		C322 removed.
15	19A	13	1124	D301 IN4148 added.
15	19A	13	1124	D310 IN4148 changed to IN6263.
15	19A	13	1125	D410 IN4148 changed to IN6263.
15	16A	13	1126	C503 1p5 added across R510.
15	20A	13		D691 TIL209 changed to FLV310
15	4A	13	1122	R230 10kΩ added from pin 10 U231C
15	2	2		Para 2.3: Bandwidth reduced from 2MHz to 1.5MHz.

MODEL BWD 540
100 MHz DUAL TRACE OSCILLOSCOPE

1. INTRODUCTION

The bwd 540 field portable DC to 100MHz 5mV to 20V/div dual channel oscilloscope provides the high performance demanded of a laboratory instrument with the advantage of lightweight and optional battery operation of a portable instrument. The bwd 540 has the features and performance to make accurate measurements with ease. A well laid out panel and a large high intensity 8 x 10 cm CRT simplifies operation learning time and makes for easier operation.

Several features make this oscilloscope unusually versatile. A x5 gain amplifier for Ch. 1 increases the sensitivity to 1mV/div without loosing the dual trace facility that cascade operation via cable patching causes. X-Y operation is phase corrected to give ten times the measuring range than is usually provided. Polarity inversion and a vernier are also included for the X input.

Alternative power input requirements give the 540 a 'go anywhere' low voltage, as operation is possible from AC sources, low voltage DC or an optional battery pack. The battery charger is incorporated as standard and the battery pack may be added at any time, carried separately and the oscilloscope may even be operated remotely from it by an extension cable.

The two time bases feature wide operating range from 5n sec/div down to 5sec/div for the main T.B. and 1 sec/div for the delayed time base. Triggering extends to beyond 100MHz for 1 div deflection and both time bases have individual trigger selection of both source and polarity. Internal trigger take off is taken before the position controls but after the vernier and polarity controls. This ensures the trigger level control setting is always related to the displayed signal amplitude but not its position on the CRT. It also means the Ch. 1 signal output is always proportional to the Ch. 1 display.

An additional trigger facility provided for the main time base is a video sync. separator for stable T.V. line or frame lock. This feature may also be used in communication work to lock modulated RF signals to the modulation envelope. For modulated signals and complex digital words, a variable trigger hold off operates on all time base speeds.

As the 540 is based primarily on standard multi-sourced components, servicing is simplified and component availability is assured.

A range of accessories is available. This includes a low cost switched dual range probe with 1:1,10 :1 and a reference OFF position. Full 100MHz bandwidth is available in the 10:1 position and 20MHz at the 1:1 setting.

A light hood, storage cover, dust cover and the BP3 rechargeable battery pack are also available from B.W.D. Electronics or your nearest supplier.

2. PERFORMANCE - VERTICAL SYSTEM.

2.1 Bandwidth: (5mV to 2V/div). DC to 100MHz-3db referred to 6 div. deflection at 50kHz from 25Ω source with vernier to Cal position.
In ADD mode bandwidth is DC to 100MHz-3db.

(5V to 20V/div) DC to >30MHz-3db referred to 8 div defl. at 50kHz.
AC Coupling <2Hz = 3db or 0.2Hz with 10:1 probe in use.

Bandwidth: Channel 1 only at x5 gain, DC to 30MHz-3db AC coupling <2Hz-3db.

Rise Time: 4n Sec. 10nSec at x5 gain and attenuator steps from 5 to 20V/div. Measured between 10% and 90% points on a 6 div. input.

Sensitivity: (Both Channels) 5mV to 20V/div. in 12 calibrated steps (1-2-5 sequence). Channel 1 only x5 gain 1mV to 4V/div.

Calibration Accuracy: Within 3% at switch settings with Vernier to cal (5% at x5 gain). Uncalibrated Vernier continuously variable between steps, extends range to 50V/div.

Input R & C: 1MΩ within 2% and 26pf within 2pf.

Maximum Input Voltage: 500V (DC + Peak AC) AC component 500V p-p maximum 1kHz or less.

Minimum Undistorted Deflection: >8div at 75MHz. >5.5 div at 100MHz.

2.2 Display Modes: Chan.1, Chan. 2, Alt. Chop, Add. Chopping Frequency: Approx.500kHz.

Delay Line: Permits viewing of leading edge of displayed waveform.

Trace Inversion: Push-push switch enables Channel 2 to be inverted for display convenience or when the two amplifiers are used in the ADD mode to provide a differential input facility.

CMRR (In ADD Mode): At least 20db from DC to 20MHz. Common mode signal amplitude <8div with one vernier adjusted for optimum rejection.

Noise: (Tangentially measured). Full bandwidth all sensitivities 0.05 division x5 gain Channel 1 only. <0.2 div. all sensitivities.

Signal Output: Channel 1 signal is available at a rear panel socket. Output is DC to 25MHz-3db and approx. 25mV/div into 50Ω or 50mV div into 1MΩ.

Cascade Single Channel Operation: Ch.1 output may be coupled into Ch.2 to increase gain to over 500μV/div. Noise is approx. 200μV p-p.

Bandwidth is 2Hz to approximately 20MHz-3db.

2.3 Channel 2 as X Amplifier in X-Y Mode:

Bandwidth: DC to 1.5MHz from 5mV to 50V/div referred to 6 div deflection.

Phase Shift: $<2^{o}$ from DC to 500kHz.

Polarity: Invert switch enables either positive or negative going signals to deflect trace to right.

2.4 HORIZONTAL SYSTEM:

A Time Base, A intensified by B, A & B mixed. B Delayed by A, B trigger delayed by A.

Time Base A: (Main or Delaying)

Sweep Rate: 50nSec to 1 Sec/div in 23 steps of 1-2-5-10 sequence. Maximum sweep speed is 5nSec/div at x10 magnification.

A vernier control covers range between each step and extends range to >5Sec/div.

NOTE: Vernier is operative on 'A' TB only when 'A' is selected. It is operative on 'B' TB in the intensified mixed and delayed modes.

Sweep Accuracy: measured over centre 8 div. of CRT.

x1 Magnification	
+15 to +35°C 3%	0-50°C 5%
x10 Magnification	
(excluding first 20nSec of display)	
+15 to +35°C 5%	0-50°C 6%

Calibrated Sweep Delay:

Delay Time Range: 100nSec to 1Sec.

Delay Time Accuracy: 3% over calibrated range.

Delay Multiplier: 0.5 to 10 x Time/Div setting.

Delay Jitter: 1 in 20,000 of maximum delay time.

Multiplier Linearity: <1% of full scale.

'A' Time Base Sweep Modes:

Mode: Auto (with level select) Non-Auto or Single Sweep with reset button and ready lamp. Ready lamp indicates trace readiness prior to commencement of sweep in all operating modes. Trace free runs in Auto with no trigger signal.

2.5 Time Base 'A' Trigger:

Source: Int. Chan. 1 or 2, or mixed displays, Ext. x1 or Line frequency.

Coupling: AC or DC, Slow, Fast, TV Line TV frame (also operates as a detector for modulated RF waveforms).

Slope: + or - with level select over 8 div. internal or 5V p-p external.

Sensitivity: Internal. 0.3 div defl. DC to >25MHz increasing to 1 div defl. at 100MHz in HF trigger mode.

Signal level requirement increases by x5 in Ch. 1 x5 gain.
In CHOP mode trigger bandwidth extends to not less than 1MHz.

External. 200mV p-p DC to 25MHz increasing to 500mV at 50MHz in gated trigger mode. 200mV p-p at 100MHz in HF trigger mode.

Max. trigger level control 5V p-p (50V p-p with 10:1 probe).

Signal level extends to not less than 1MHz in CHOP mode.

External Input Impedance: 1MΩ and 10pf.

Max. Input Voltage: 500V (DC + Peak AC) AC component 500V p-p maximum.

Video Trigger: <2div of composite waveform to over full screen deflection for line or frame lock.

Trigger Hold Off: Continuously variable. To greater than the selected sweep period above 10mSec/div.

2.6 'B' Time Base (delayed).

Sweep Rate: 50nSec to 0.2Sec/div. in 19 steps of 1-2-10 sequence. An uncalibrated Vernier covers range between steps and extends range to at least 1Sec/div.

Sweep Accuracy: (Measured over centre 8 div. of CRT)

x1 Magnification	
+15 to +35°C 3%	0-50°C 5%
x10 Magnification	
(excluding first 20nSec of display)	
+15 to +35°C 5%	0-50°C 6%

Time Base 'B' Trigger:

Source: Int. Chan.1 or 2 or Ext.

Coupling: Int. & Ext. DC coupled.

Slope: + or - with level select over 8 div. internal or ±2V p-p Ext.

Sensitivity: Int. 1 div 10Hz to 20MHz. 2 div extends range from DC to 40MHz. H.F. trigger increases to 70MHz for 1 div and 100MHz for 2 div deflection in H.F. trigger mode.

Ext. 200mV p-p 10Hz to 25MHz 500mV p-p DC to 40MHz.

H.F. trigger increases to 100MHz for 200mV p-p input in H.F. trigger mode.

Mixed Sweep.

Accuracy: Identical to A & B sweep accuracy excluding 0.5 div of start of main sweep and 0.2 divor 0.1μSec. (whichever is greater) either side of transition from main to delayed sweep.

Note: Transition from A to B sweep is delayed compared to the Time/Div. X multiplier setting until B time base reaches the same voltage as A time base and takes over the display.

Mag: x1 or x10 Horizontal position control fitted with fine and coarse adjustment.

Max. Sweep Speed: 5nSec/div.

Output Waveform: 4mm Sockets located on rear of 540.
(1) Displayed Time Base +1V to +13V 10K source impedance.
(2) A Time Base gate +0.2V to 4V 1kΩ source impedance.
(3) B Time Base gate +0.2V to +4V 1kΩ source impedance.

2.7 GENERAL DETAILS.

CRT: 80 x 100mm rectangular, high beam current gun with mesh PDA.
EHT: 12kV.
Graticule: Internal parallax free with variable illumination. Fitted light blue filter for P31 or amber for P7.
Phosphor: Normally fitted with P31, P7 available as Option 04.
Z Modulation: 2V positive will blank trace at all intensities from DC to >10MHz. Input impedance 4.7KΩ and 10pf. Max input ±30V p-p.

Beam Finder: Push button returns trace to within limits of CRT screen and over rules intensitity setting.

Calibrator: Output, rectangular, positive going from ground, 1kHz frequency approx.

Voltage: 1V p-p.

Accuracy: 1% 15 to 35°C, 2% 0 to 50°C.

Low Voltage Indicator: L.E.D. 'Power On' indicator lamp flashes when DC or battery voltage is below minimum operating level.

Output Waveform: 4mm Sockets located on rear of 540 main frame. (1) Displayed Time Base +1V to 13V 10k source impedance. (2) A Time Base gate +0.2V to +4V 1kΩ source impedance. (3) B Time Base gate +0.2V to +4V 1kΩ source impedance.

Power Requirements.

AC. 98 to 135V and 195 to 270V. Selection by recessed switch accessible through bottom cover. 48 to 440Hz 50 watts max.
DC. 20V to 30V at 1.5 Amps.
Battery Pack (optional) 3 hours per recharge.
Battery charger incorporated in standard instrument. Recharging from AC or 32V DC.

Finish: Grey blue covers, epoxy coated trims and offwhite panels.
Dimensions: 165mm high x 320mm wide x 430mm deep (standard model). Height increases to 223mm with battery pack added.

Weight:	Instrument	9kg.
	Battery Pack	5kg.
Shipping weight:	Instrument	12kg.
	Battery Pack	7kg.
Ordering Code:	Standard model	bwd 540.
	Battery Pack	bwd BP/3

Options: P7 phosphor/05

Environmental.

Specification is met within power supply range shown and from +5°C to +35°C to 80% RH unless otherwise stated. ADD 2% to specification for 0-50°C and 0 to 90% RH.
Storage - 20°C to +70°C.

2.8 BATTERY PACK.

The BP/3 pack may be attached or detached from Model bwd 540 at will. It is fixed by two screws and connects via a plug to the rear panel socket. If desired the battery pack can be carried separately to the oscilloscope and is provided with a handle for this convenience.

Operation via an extension cable from the battery pack is possible when it is necessary to keep instrument weight to a minimum. Recharge time of 14 hours provides approx. 3 hours running time.

2.9 Optional Accessories:

1:1 x 10:1 DuoHead Probe	P32	Dust cover	C16
10:1 200MHz probe kit	P33	Panel storage cover	SC52
Demodulator probe	P35	Oscilloscope trolley	T61
Viewing hood	C44	Cameras-details on request	

External graticule for video applications. See accessory leaflets for full details.

2.10 PROBES.

Two probe sets are available to suit the 540 amplifiers. Both provide full bandwidth operation.

P32 DuoHead Probe: This miniature probe incorporates a 3 position slide switch for 1:1 10:1 and a REF off position. It is supplied with a detachable retractable hook, a fixed point and a BNC adaptor.

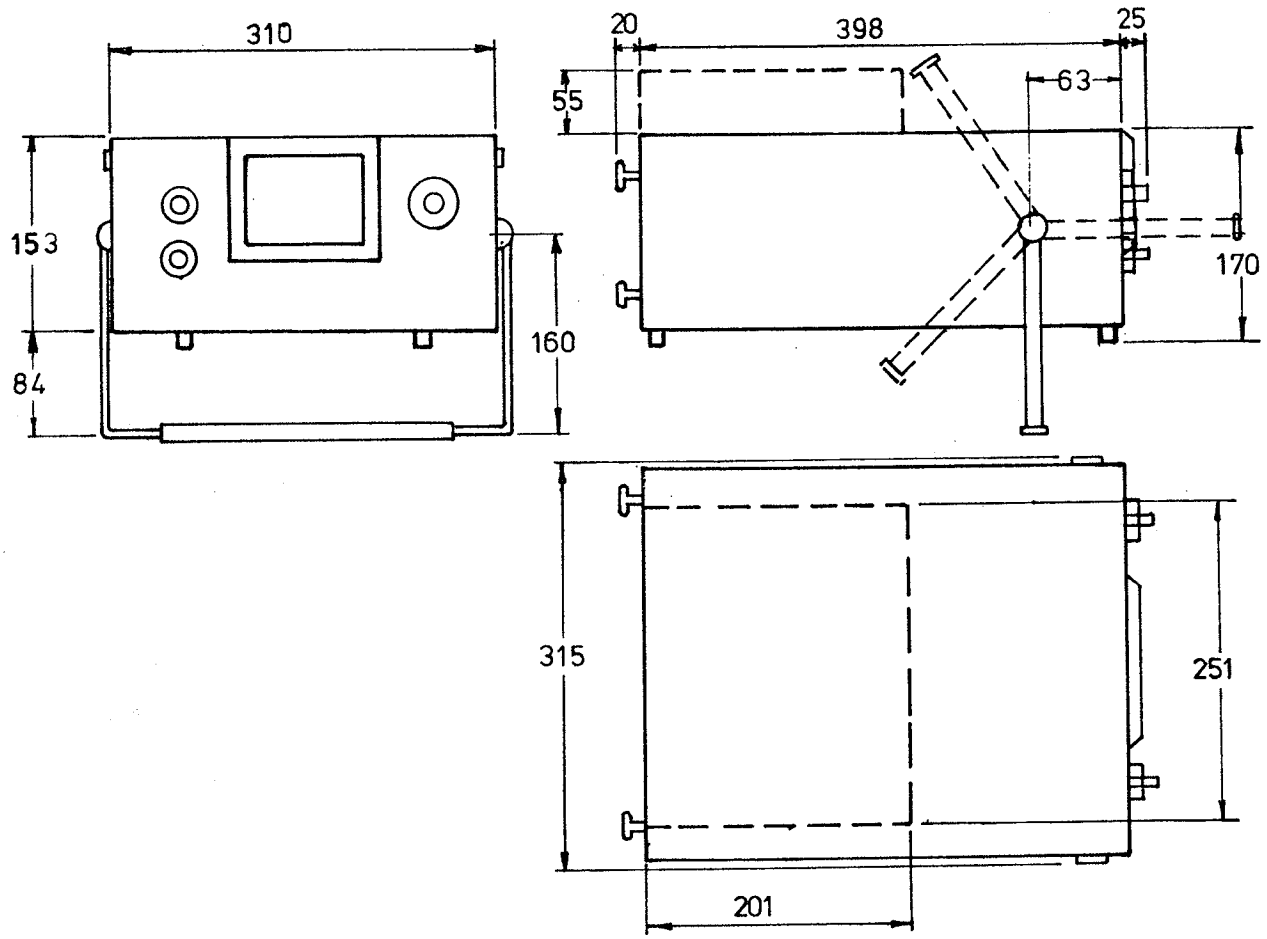
Pulse response in the 10:1 position exhibits approx. 8% overshoot with a 1nSec rise time input.

Input C & R is 11pf and 10MΩ. As a 1:1 probe bandwidth is limited to approx. 20MHz Input C & R is 64pf and 1MΩ.

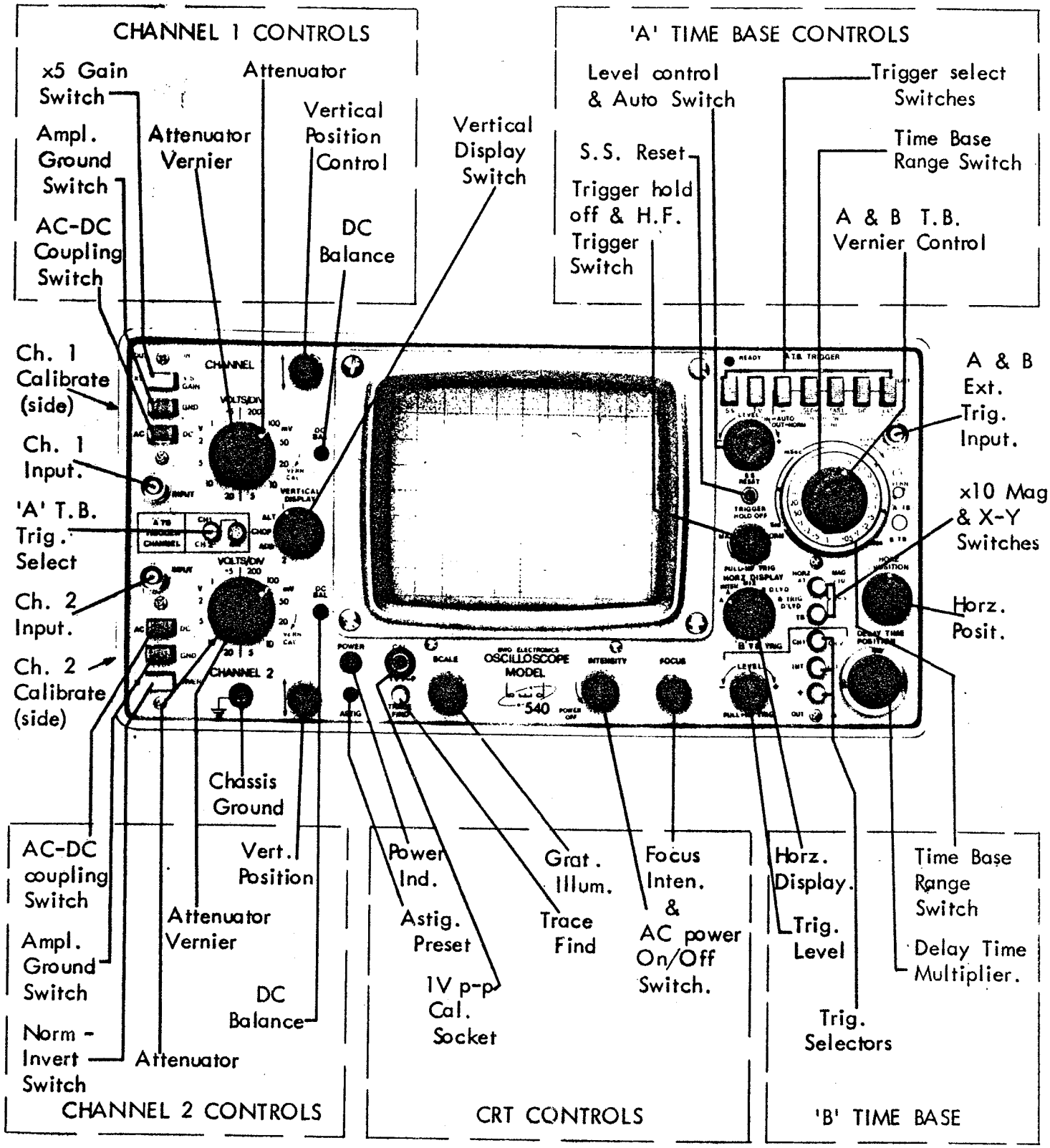
P33 200MHz Probe: This model has detachable 1:1, 10:1 or 100:1 heads plus a demodulator head. With the 10:1 head only bandwidth is 200MHz and pulse response exhibits 4% overshoot with a 1nSec rise time input.

Input C & R is 13pf & 10MΩ. Probe is supplied with detachable miniature hook, point 4mm jack and 10:1 head 1:1 and 100:1 heads are optional extras.

2.11 DIMENSIONS.



LAYOUT OF FRONT PANEL CONTROLS



See page 25 for rear panel layout and Battery Pack connections.

3. FUNCTION OF CONTROLS.

3.1 VERTICAL AMPLIFIER SECTION.

Ch.1 and Ch.2 Volts div. - selects the vertical deflection factor in a 1-2-5 sequence (Vernier control must be in the calibrated detent for the indicated deflection factor) Calibrated accuracy is within 3%.

Vernier - provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/div switch.

↕ - positions the display vertically.

Input Connectors - for application of external signals to the inputs of the vertical amplifier. In the X-Y mode of operation, the signal connected to the Ch.2 connector provides horizontal deflection and the signal connected to the Ch.1 connector provides the vertical deflection. Input impedance is 1 megohm paralleled by approximately 24pf. Minimum bandwidth in the normal mode of operation is DC to 100MHz from 5mV to 2V/div and DC to 30MHz from 5V to 20V/div & x5 gain on Ch.1.

X-axis has a bandwidth in X-Y operation of DC to 2MHz and is compensated to have 2° or less phase difference with relation to the Y axis from DC to 500kHz.

AC, DC and GND Push Buttons - selects the input coupling to the vertical amplifier. In the AC position, signals are capacitively coupled to the vertical amplifier. The DC component of the input signal is blocked. Low frequency -3db point is below 2Hz. In the DC position, all components of the input signal are passed to the input amplifier. In the GND position, the input of the vertical amplifier is disconnected from the input connector and grounded.

Gain x1 or x5 - Push button out gain is 5mV to 20V/div. Button in, gain is increased by x5 on Chan. 1 only to 1mV/div. max.

Invert - Chan. 2 display is inverted when the button is pressed in.

VERTICAL DISPLAY - selects mode of operation for vertical amplifier system.

1. Chan.1 only is displayed. Must also be selected for X-Y operation.

   ALT: Dual trace display of the signals of both channels. Display is switched between channels at the end of each sweep.

   CHOP: Dual trace display of the signals of both channels. Display is switched between channels at a repetition rate of approx. 500kHz.

   ADD: Signals applied to the Ch.1 and Ch.2 input connectors are algebraically added, and the algebraic sum is displayed on the CRT. The INVERT switch in Chan. 2 allows the display to be Ch.1 minus Ch.2 (Normal differential operation).

2. Channel 2 only is displayed.

'A' Trig (Main or Delaying Time Base).

Two push buttons select the required internal trigger source. The right button selects a mixed signal from Ch. 1 and Ch. 2 alternately when pushed in, and either Ch. 1 or Ch. 2 when out. The left button selects Ch. 1 when out and Ch. 2 when in. In the ADD mode it supplies the algebaic addition of Ch. 1 and Ch. 2 trigger signals or Ch. 1 - Ch. 2 with the INVERT switch operated. In the Ch. 1., CHOP & Ch. 2 modes leave the RH button out and select Ch. 1 or Ch. 2 trigger as required.

DC BAL. Preset controls to balance input stage to eliminate trace movement when Vernier controls are operated.

3.2 TIME BASE SECTION.

Two complete time base generators and associated circuits are located within the RH panel section of the bwd 540. Layout and operation of the controls is straight forward and familiarisation will only take a few minutes. The time bases are referred to as A (main) and B (delayed). The time base to provide the CRT display is selected by the five position rotary switch marked HORZ. DISPLAY.

Trigger Select Buttons (in sequence from L to R).

S.S: Trace is normal with button out, immediately it is depressed, the next sweep will latch the circuit and prevent further sweeps from occurring.

Ready Light: Located above S.S. button indicates trace readiness in all sweep modes and when trace has been reset in the S.S. mode and is ready for next trigger signal.

T.V.: Button out coupling is normal. With button depressed TV Frame or line lock is obtained and may be locked by adjustment of level control. Line lock is obtained with all other buttons out, Frame lock with the SLOW button pressed. Trigger polarity corresponds with the polarity of the video waveform.

±: Button out enables the positive or rising slope of the trigger waveform to initiate the time base. With the button in the negative or falling slope triggers the time base.

Slow: Button out, coupling is normal, when pressed in, a CR network attenuates signals above 5kHz. (-3db at 10kHz approx.)

Fast: Button out, coupling is normal, when in, a series capacitor attenuates signals below 10kHz and also eliminates DC coupling.

Line: When both SLOW and FAST buttons are depressed the line frequency powering the oscilloscope is coupled to the trigger circuit to lock the trace. The phase of the line frequency trigger point may be adjusted by the LEVEL control and the ± switch.

NOTE: This facility is inoperative on DC or battery operation.

AC-DC: Button out trigger circuit is AC coupled and approx. - 3db at 10Hz. With button depressed circuit is DC coupled and signals down to DC will trigger the trace.

Int-ext: Button out trigger signal is as selected by A Trig push buttons located between the vertical amplifier attenuators. External signals are selected when the button is pressed.

External Input Socket. External input for both A & B trigger circuits.

Level Control: Selects the precise point on the triggering waveform that initiates the time base trace. Selection is available of the full 8 div. of CRT display or up to 5V pp of external trigger. Larger external signals can be accommodated by a 10:1 probe.

When LEVEL knob is pushed in the time base will free run if a trigger signal is not present or if the control is turned until it is out of the range of the trigger signal.

With the knob out, the automatic base line is eliminated and no trace is present in the absence of a trigger signal.

Time/Div.: Triple concentric knob.

The large outer knob controls B time base range from 50 nano Sec to 0.2sec/div only.

The winged grey knob is the main A time base range and covers the entire range from 50nSec to 1sec/div.

NOTE: The two knobs are interlocked so that B time base range cannot be switched to a slower speed than the A time base to eliminate incorrect displays.

The small red knob doubles for both A & B time base vernier control.

When the HORZ. DISPLAY is set to A it operates as 'A' time base vernier and provides a 5-1 range overlapping each step and extends the range down to approx. 5 sec/div. When the HORZ. DISPLAY switch is turned to the remaining 4 positions the control becomes the B time base vernier providing a 5-1 range and extending the range down to approx. 1sec/div. This method of changeover ensures that the A time base in its delaying mode is always calibrated and the delay period is the selected time/div x the multiplier setting.

Reset.

Push button will reset the time base when the single shot (SS) button is pressed.

Trigger Hold Off/HF Trig Switch. Dual function control.

With the knob pushed in the time base operates in a gated trigger mode to beyond 60MHz. When the knob is pulled out the trigger circuit is switched to HF trigger. This increases the sensitivity to enable signals as low as 0.5 div or 200mV p-p external to lock the trace at >100MHz. HF trigger may be used at all frequencies above 10MHz below this double triggering may occur.

Trigger hold off operates with the knob either in or out.

Fully clockwise in the NORM position, hold off is minimum. Rotation counter clockwise will increase the time base hold off on all 'A' time base ranges and to greater than the selected trace length at all speeds above 10mSec/div.

Display Switch.

A	Normal A time base operation with no delay.
INTEN.	A time base brightened over a selected portion as determined by B time base and the 10 turn Delay Multiplier.
B DL'YD) BY A.)	Only the portion of the trace intensified at the INTEN switch step will be shown on the CRT.
B TRIGGER) DL'YD BY A)	As for previous step but trace will only be initiated by a trigger pulse applied to B time base.

Push Buttons - vertical row.

x1 x10 Mag. Trace length expands x10 when button is depressed.

NORM/X-Y. When the X-Y button and x10 Mag button are both depressed Ch. 2 amplifier is switched to the horizontal amplifier to provide identical X-Y facilities.

B time base Trigger selector buttons.

Ch.1-Ch.2. Ch.1 selected with button OUT. Ch. 2 with button depressed.

INT-EXT. With button OUT Ch. 1 or 2 as selected by the above button is supplied to B time base trigger. EXT signals via the BNC socket above the TB range switch are coupled in when the button is IN.

+ or -. The positive shope of trigger signal initiates the B time base with button OUT. negative slope initiates with button IN.

Level Control/HF Trig. Dual Function Control.

With knob IN B time base is gated and will normally be used for all frequencies to 40MHz. When knob is OUT the trigger sensitivity is increased to provide HF non-gated trigger which extends the range to 100MHz. Level select is always operative in both the gated and HF trigger modes.

Delay Multiplier. Multiplies the TIME/DIV as selected by the A time base switch over the range x 0.5 to x10 providing a delay range from 100nSec to 10Sec.

Horizontal Position. Fine and coarse controls position the trace to display any point along it on the screen.

3.3 CRT CONTROLS.

Intensity/ Power On- Off . Fully anticlock switches AC power to the instrument off - this includes charging current when rear panel switch is in CHARGE position but NOT DC or battery supplies.

Clockwise rotation turns on power and increases trace intensity.

Focus. Adjusts sharpness of trace, control should be set initially in conjunction with the ASTIGMATISM preset for best overall trace sharpness.

Graticule. Adjusts the internal graticule illumination.

Power Indicator. When power input voltage is above minimum necessary for correct calibration light will be on and continuous. If supply voltage falls below correct level - particularly DC or battery the light flashes on and off at a 1 second rate approx.

Cal. 1V p-p. Approx. 1kHz rectangular positive going waveform of 1V p-p amplitude. Rise time is <1uSec into a 10MHz probe.

Ground Socket. 4mm socket for instrument chassis connections.

3.4 REAR PANEL FACILITIES.

Use/Charge switch. Changes the 540 power supplies from normal operating condition when switched to USE to a battery charging condition (and instrument is switched off) in the CHARGE position. Switch must be in USE position for normal operating from AC, DC or battery supplies.

Battery Socket. This takes the battery plug attached to the battery pack. It should not be used for any other purpose if a battery is not attached.

DC Input Terminals. As both terminals are isolated from ground the external DC input may be grounded either side or floating with respect to chassis. The DC input may be floated to a maximum of ±50V from chassis potential.

Beam Rotation Preset. Located below the heat sink. Rotation of control enables the trace to be aligned with the CRT internal graticule.

Ch.1 Signal Out. BNC socket on RH side.

Output is approx. 50mV/div O/C or 25mV/div into 50Ω.

Z Mod. BNC socket. Modulation requires positive input to blank trace, +2V is all that is necessary to turn trace off from normal.

/\/\ Output. 'A' time base output waveform level approx. 0 to + 13 from a 10K source impedance.

A Gate: Waveform coincides with A time base sweep. It is positive going when trace is blended out. Output 0 to + 3V approx. from 1K source.

B Gate: Waveform coincides with the B time base sweep. It is positive going when trace is blended out. Output 0 to +3V from 1K source.

3.5 117 - 235V AC SWITCH.

Located through the bottom cover. Switch may be moved to either position with the aid of a small screwdriver.

4. INITIAL CHECKING.

This section of the Handbook is intended to provide information to allow a user to become familiar with the instrument's power requirements, function of controls and connectors, and also provides some methods of making several measurements of electrical phenomena. Also included is a procedure for checking the instruments calibration.

4.1 OPERATING VOLTAGE. (A.C.) See Section 8 for D.C. and Battery Pack.

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase three-wire system.

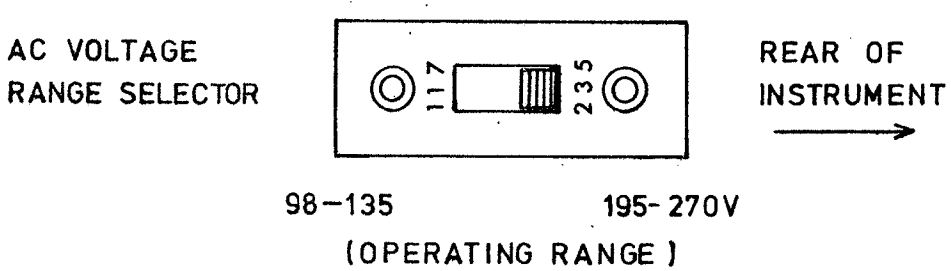
This instrument can be operated from either a 117 - volt or a 235 - volt nominal line voltage source, 48 to 440 hertz. This instrument may be damaged if operated with the line voltage switched to the incorrect position for the line voltage applied. It will also operate from a D.C. Voltage between 20 and 30V, current requirement is 1.5A approx.

The bwd 540 is designed to be used with a three-wire A.C. power system, with the green/yellow wire connected to ground. Failure to complete the ground system may allow the case of this instrument to be elevated above ground potential and pose a shock hazard.

NOTE: Colour-coding of the cord conductors is as follows:-

		(U.S.A. & Canada only)
Line	Brown	Black
Neutral	Blue	White
Safety earth (ground)	Green/yellow stripe	Green

Input selection of A.C. voltage range is made via the slide switch recessed in the underside of the cabinet. Switch dolly must be pushed (with the aid of a screwdriver) towards the voltage range corresponding to the available supply.



5. FIRST TIME OPERATION.

One of the major features of the 540 Oscilloscope is that normal operation is obtained when all push buttons are 'out'. A quick scan over the panel therefore immediately indicates any variation to normal and assists in quick familiarisation with the instrument's operation.

The panel is divided into 3 operating areas.
L.H. side is the vertical section - Channels 1 and 2.
R.H. side is the A & B Time Base section.
Centre are the CRT controls and calibrator.

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

Vertical Amplifiers:

Attenuators	0.2V/div.
Verniers	CAL (clockwise)
Input switches	AC (button OUT)
x1 - x5 gain (Ch.1)	x1 (button OUT)
Norm/Invert (Ch. 2)	Norm (button OUT)
Trigger Select	Ch. 1 (both buttons OUT)

Time Bases:

Trigger buttons	All out.
Trigger level	Centered and pushed in.
Time/div switches	B time base 0.05μ Sec (outer ring) A time base 0.2m Sec (grey knob)
Vernier	CAL (Clockwise)
Trigger Hold Off	Clockwise and pushed in.
Horizontal Display	A time base (counterclock)
Vertical push button	All out.
Horizontal position	Both knobs centred.
B trigger level	Centered and pushed in.
Multiplier	Any setting.

CRT Controls:

Focus	Centered.
Intensity ON/OFF	OFF, fully counter clock.
Graticule	3/4 clockwise rotation.
Astig	Centered or leave as supplied.

5.2 Connect power lead to 48 - 440Hz AC supply or leads to 20 - 30V DC supply and switch instrument on. Turn intensity control to approx. 2 o'clock position, after a few seconds trace will appear. Adjust intensity and focus then position it centrally across screen. If trace is not horizontal, adjust the Trace Alignment preset on rear panel until it aligns with the graticule line.

Turn vernier control of Ch. 1 counter-clockwise, recentre trace with vertical position control, then rotate vernier back to Cal, if trace moves re-centre with DC Bal control. Repeat if necessary to eliminate movement.

Connect a 1:1 probe bwd P32 from the 1V calibrator socket to Ch. 1 input, centre trace. Waveform should be 5 div. high with vernier to cal. If not, adjust calibration at L.H. side of cabinet.

The 1kHz square wave displayed 5 div. high and approx. one waveform per 2 divisions horizontally. Depress the DC button on Ch. 1 amplifier - the trace will rise and the bottom of the waveform will now correspond with the CRT centreline indicating the input signal is a waveform positive going with respect to ground. Depress the GND button on Ch. 1, the trace will disappear then after 0.3 sec. a bright reference base line will appear as the Auto time base operates. The GND switch disconnects the input signal in this condition but grounds the amplifier. Release GND push button and trace will again be standing on the centreline.

Release DC button then rotate position control and note display can be moved off CRT above and below, but without changing the trigger condition as the trigger take-off is ahead of the position control.

5.3 DUAL TRACE OPERATION.

Set Ch. 2 amplifier as for Ch. 1, then switch Vertical Display to 2 and depress Trigger Selector Ch. 2 button.

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

Reduce attenuator settings on both amplifiers to 0.5V/div. then switch Vertical Display to ALT. Two traces will appear which can be positioned above and below CRT centreline.

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

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

Now increase the time base speed, the traces will remain locked tight through to 0.05μ Sec/div. Return time base range to 1m Sec/div again and switch the main frame Vertical Display to CHOP. Trace flicker immediately stops. When the time base frequency is reduced, the two traces appear simultaneously down to the lowest sweep frequency.

Return switch to 1m Sec/div. and then increase time base speed. At speeds around 20μ Sec/div. the waveforms will start to show the individual chopping sections indicating the useful upper limit of CHOP displays.

As been seen, a wise overlap exists where both forms of dual trace display cc used satisfactorily.

With the time base returned to 1m Sec/div. and both attenuators set to 0.5V/div. the traces will be 2 div. high. In this condition set the Vertical Mode to ADD. A single trace will appear with a 4 div. display, i.e. the two traces have been added together. Now press the Invert button on Ch. 2, the waveform will disappear leaving only a line. This is the difference between the two signals or the result when one is subtracted from the other. Applications for this form of measurement are described later. Return switches to ALT and normal.

5.4 TIME BASE OPERATION.

Replace the input signal to Ch. 1 with a 2kHz (approx.) sine wave and adjust attenuator or input for 6 div. display. Time Base to 0.2m Sec/div.

TRIGGER LEVEL.

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

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

T.B. VERNIER.

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

MAGNIFICATION.

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

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

5.5 HORIZONTAL AMPLIFIER.

Identical X-Y

Parallel the 2kHz input sine wave to Ch. 1 and 2, set Vertical Display to 1, press X-Y and x10 Mag. buttons. Ch. 1 will now present the vertical display and Ch. 2 the horizontal. To position the display horizontally use the fine and coarse horizontal position controls.

The horizontal deflection may be reversed in polarity by pressing the INVERT switch. Vernier control between attenuator steps is available for both the vertical and horizontal axis. For zero phase shift between X-Y inputs at low frequencies it is essential to use DC coupling on both channels.

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

Delayed Time Base Operation.

Full details of the three methods of displaying a delayed signal are described on Page 21.

5.6 Z MODULATION.

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

540 NOTE: A positive going signal decreases the trace brightness.
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5.7 AMPLIFIER DC BALANCE.

If trace movement occurs when the vernier control is used, the balance should be reset. Turn the Vernier counterclockwise, recentre with the vertical position control, turn Vernier to CAL, recentre trace with DC BAL preset. Repeat as necessary to eliminate trace movement.

5.8 HIGH IMPEDANCE PROBES.

For high frequency measurements the input loading on circuits particularly capacitance must be kept to minimum levels. The simplest way to achieve this is by use of a high impedance probe which reduces the input signal by a factor of x10 but simultaneously reduces the input capacitance to approx. 12pf and increases the input resistance to 10MΩ. Two types are available for this model. The bwd P32 and the bwd P33 probes. Both will provide full bandwidth operation. The P32 duo head probe has the additional advantage of a switch to provide 1:1 operation and an OFF reference position.

To align a probe, couple it to Channel 1 input jack. Set attenuator to 20mV/div. and time base to 0.2m Sec/div. Place the point of the x10 probe tip on the 1V main frame calibrator socket, a square wave will appear probably with the top and bottom faces tilted in or out. With a small screwdriver supplied, adjust the screw in the side of the probe housing until waveform is square. It will remain correct at all settings.

6. MEASUREMENT OF VOLTAGE AND TIME.

The following sections describe the method of making specific measurements with the 540 Oscilloscope.

Start with controls set as follows:-

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

6.1 MEASUREMENT OF DC (Direct) VOLTAGES.

Press Ch.1 AC-DC switch to DC. For an initial test take a 1½V Dry Cell and set the attenuator to 0.5V. Connect the negative end to the Black socket, set the trace to the centre of the graticule, touch a lead from positive end of the battery to the Ch.1 input socket, the trace will move up 3 div., i.e. 3 x 0.5V ± 1.5V. Now reverse the connections to the battery and note how the trace moves down 3 div. This illustrates how an oscilloscope can display positive or negative voltages or both simultaneously, i.e. when viewing a sine input or square wave.

NOTE: The 1MΩ input impedance of the oscilloscope must be taken into account when measuring high impedance points such as the base of transistors or the gate of FET's working with high value loads.

The DC input facility may be used to measure AC waveforms swinging about a AC voltage, as at the collector of a transistor or the anode of a valve, to check for bias settings or collector limiting, etc. Maximum DC input should not exceed x10 input attenuator setting if it is required to recentre the trace to view a signal superimposed on it. If a higher input impedance is required, use a bwd P32 x 10 probe to increase input to 10MΩ and 12pf.

6.2 MEASUREMENT OF AN AC (Alternating) VOLTAGE

Set the amplifier AC-DC switch to AC and the attenuator to 20V (if the input voltage is unknown). Connect a lead from ground to the ground side of the signal to be measured, then connect a lead from the input socket to the signal source. Bwd oscillators such as models 112B, 141, 160 or 603A oscillators are suitable for initial experiments in this test.

Increase the vertical sensitivity by the Volts/Div. switch until a display between 3 divisions and 8 div. exists. Now adjust the Time Base switch to enable the waveform to be readily seen. To measure the amplitude of a displayed waveform, measure its overall height in divisions against the calibrated graticule, then multiply this by the attenuator setting and the result is in Volts p-p, e.g. if the display is 6 div. high and the attenuator is set at 0.5V, then the amplitude is 6 x 0.5 = 3V peak to peak; to convert to RMS voltage for sine wave, divide the 3V by 2.84, e.g. $\frac{3.00}{2.84}$ = 1.06V rms.

The frequency of a waveform can be found by checking that the Time Base Vernier is turned to Cal (clockwise) then switch the Time/Div. switch to a range where the signal can be clearly seen, e.g. if a waveform is 5 div. long and the switch is at 100μ Sec., then the duration of the waveform is 5 x 100μ Sec. = 500μ Sec. The frequency can be determined by dividing 1 sec., i.e. 1,000,000μ Sec by the duration of the waveform

$$-\frac{1,000,000}{500} = 2,000\text{Hz or } 2\text{kHz}.$$

6.3 INVERTED DISPLAYS.

Where it is required to display a waveform inverted on the CRT feed it into Ch. 2 then push the Invert switch button. All information relating to display and measurement of inverted signals is identical to the normal input details. The calibration and accuracy are as detailed in the specification.

6.4 BALANCED OR DIFFERENTIAL MEASUREMENTS.

AC Measurements:

NOTE: When using the 'Add' facility between Ch. 1 and 2 the following limitations must be considered.

Max. AC or DC Common Mode signal is less than 8 div. deflection, if a larger DC signal exists, it should be eliminated by using AC coupling into the amplifiers.

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

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

The resultant CRT trace is the waveform being developed between the points to which the leads are coupled. Measurement of voltage and time may be made as described previously as the calibration remains constant irrespective of the input facility employed.

The differential input coupling is almost essential when making low level measurements in the millivolt region even when one side of the signal source is grounded. This is because signals generate hum and noise in ground loops and can completely mask the signal. To eliminate this problem, connect the probe from the Ch. 1 socket to the signal to be observed and a probe from the Ch. 2 socket to the nearest ground or common point to the signal on the equipment under test. Hum and noise will be greatly attenuated by this means.

6.5 DIFFERENTIAL DC MEASUREMENTS.

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

The following limits should be observed:-

Differential rejection will only operate if the Common Mode signal to be rejected is < 8 div., e.g. with the attenuator set at 1V/div. the Common Mode signal must not be greater than 8V AC p-p or ± 4V DC, or the input amplifier may be overloaded and the signal will be distorted.

The accuracy of the input attenuator resistors also controls the rejection ratio and the other than 5mV settings may reduce the rejection to only 20-1 which means, in the case of a 100V p-p AC signal, a 5V p-p signal could still appear with the required signal superimposed on it. Adjustment of Ch. 1 or 2 vernier control will reduce the level to the minimum obtainable.

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

6.6 CURRENT MEASUREMENTS AC OR DC.

If a resistor can be included in the ground end of a circuit the voltage drop across it can provide a direct conversion to the current through it by use of Ohms Law. At low currents a 1Ω resistor connected across the vertical input terminal of the amplifier will enable the oscilloscope to read directly in mA or Amps in lieu of mV and Volts. Current through the 1Ω resistor will develop 1mV for every 1 mA flowing and provides the direct conversion for currents to at least 2 Amps. This configuration will read both AC or DC current and unlike an ammeter will show the actual current waveform. Practical applications are the charging currents in a filter capacitor of a power supply or the current through a rectifier, or high speed displays of pulse currents.

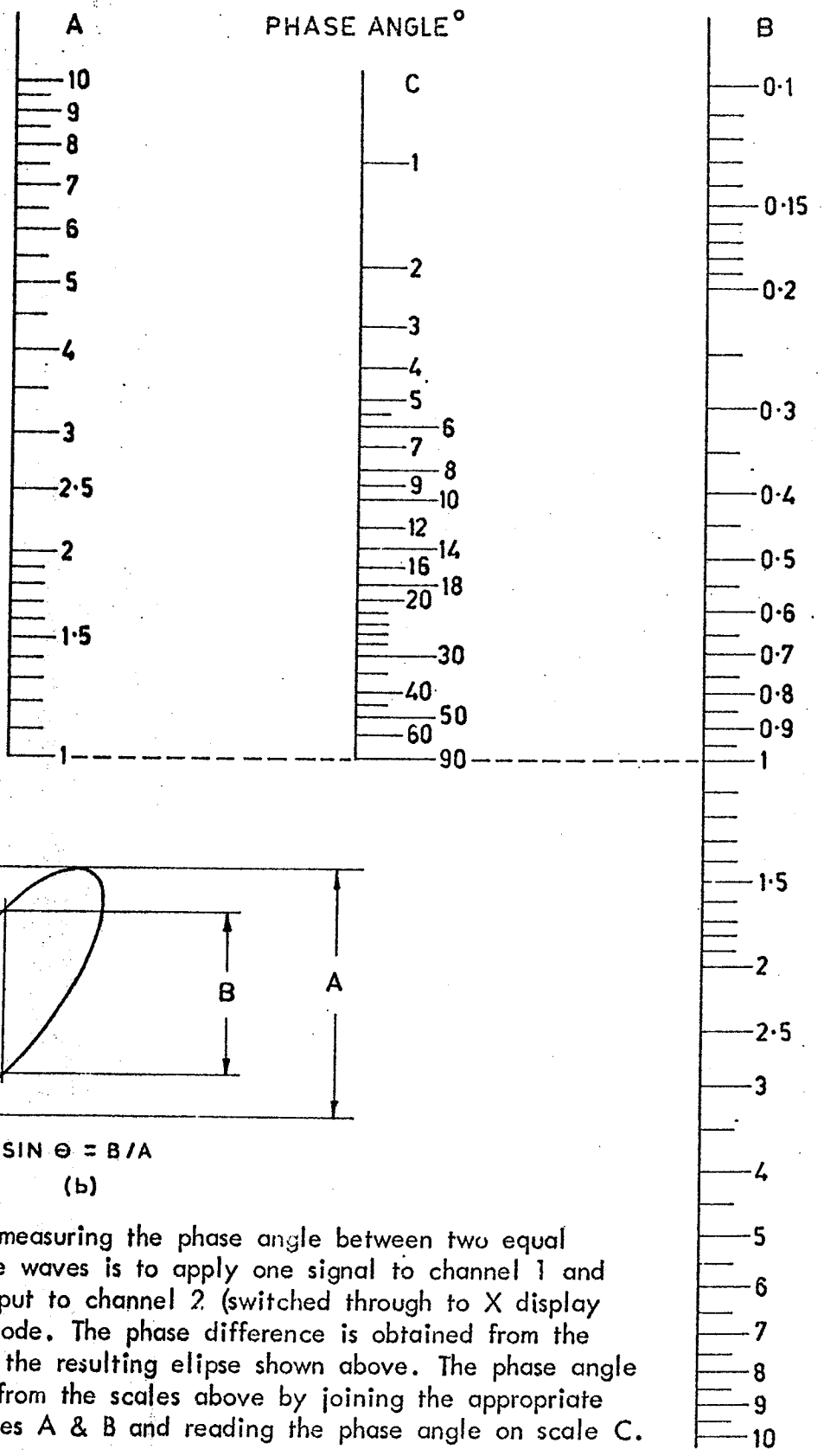
6.7 IDENTICAL X-Y OPERATION.

Start with all buttons out. Then set following controls:-

Vertical Display - Ch. 1. Depress X-Y and x10 Mag. buttons.

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

Cascaded Amplifier Operation (Cont'd.)



SIN Θ = B/A

(b)

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

If zero phase shift exists the line will be straight up to 500kHz. Phase between the two signals can be determined from the chart opposite.

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

6.9 CASCADED AMPLIFIER OPERATION.

When the sensitivity of the vertical amplifier requires to be higher than the direct calibration allows or with the x5 gain of Ch. 1 in use, single channel operation with a sensitivity increase of x10 is available. A patching cable is required and should be connected between the Ch. 1 Output socket on the rear panel and Ch. 2 input.

Irrespective of the input attenuator setting an output of 50mV p-p is present at the Ch. 1 output socket for every 1 div. deflection on the CRT, therefore if Ch. 2 is set to 5mV/div. a gain of x10 will exist between Ch. 1 input and the CRT display from Ch. 2. If less gain than x10 is required, use the x5 gain facility of Ch. 1.

Bandwidth is approx. 2Hz to 25MHz. It is recommended AC coupling be used for Ch. 2 input to minimise trace movement. Select the time base trigger signal from Ch. 2.

6.10 LINE TRIGGER.

To retain a continuously locked display with a constant phase relationship when exploring signals locked to power line frequencies, e.g. in a power supply, or when tracing hum in circuits, push both SLOW and FAST buttons to select Line. Adjustment of the level control and ± switch will provide phase variation of the displayed waveform.

6.11 VIDEO (T.V.) WAVEFORM DISPLAYS.

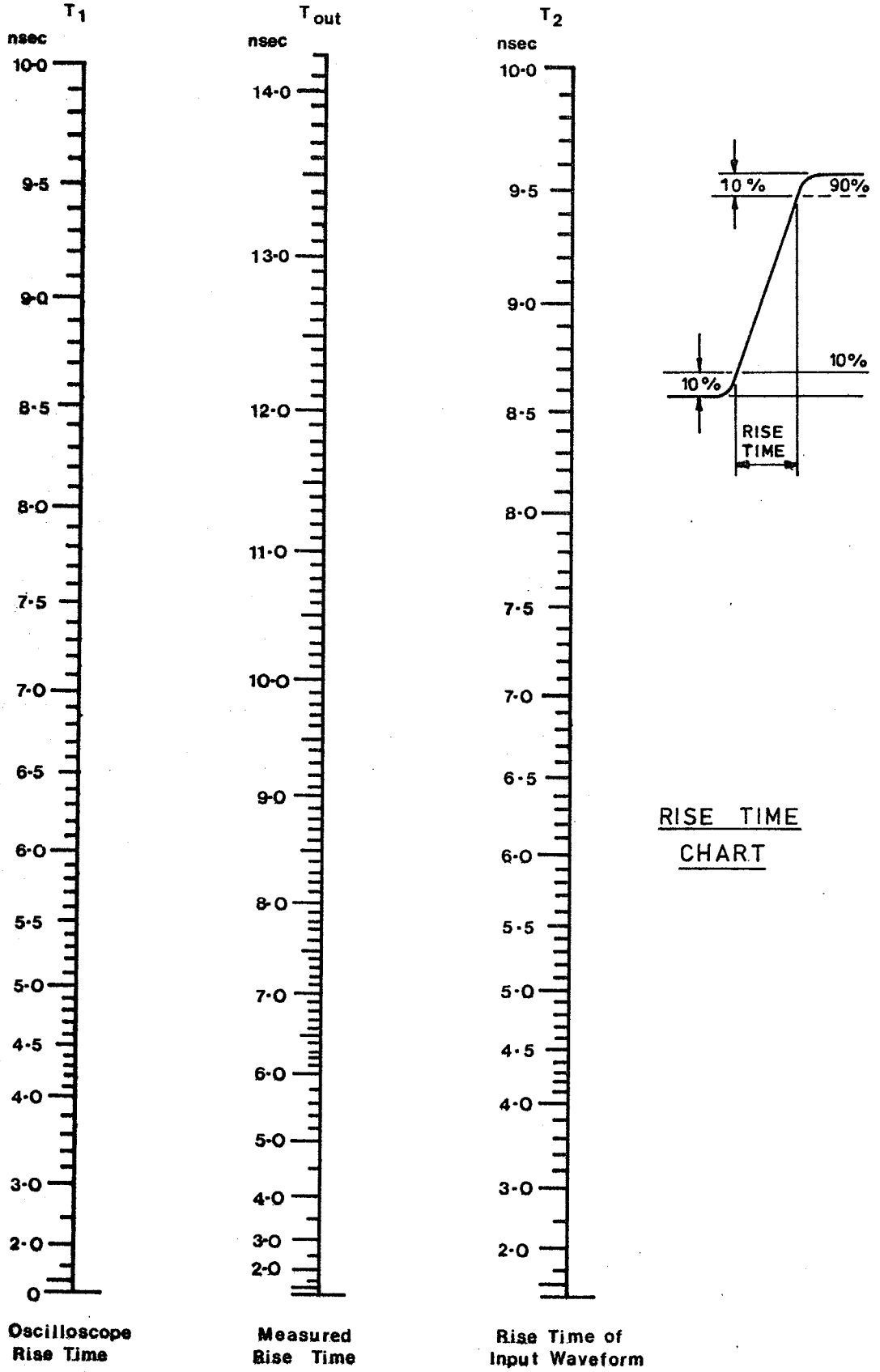
Video signals from closed circuit system, black and white or colour receivers, or TV Studio signals can be locked with complete stability. A composite signal should be a minimum of 2 div. amplitude. Stable lock can be maintained with signal amplitudes from 2 div. to over 8 div.

If the video sync pulses are negative going, select +ve trigger and vice-versa.

To lock to a frame pulse depress the TV and slow buttons then adjust level for a stable lock. If the time base range is increased, the individual equalising pulses and frame pulse serations can be displayed. By utilising the higher speeds and x10 magnification, the lines preceeding the video information containing special test signals can be readily viewed.

To lock to a random line leave the slow button out and adjust the Level control for a stable display.

Where it is required to select a particular line from the video signal, switch HORIZONTAL DISPLAY switch to intensified. With B time base at 10μ Sec. turn the Delay Multiplier 10 turn control until the desired line is intensified, turn display switch to B time base and the selected line will be presented. If the line is unstable select B TRIG DLYD by A then with ± slope selected to suit display polarity, adjust the B. Trig. Level Control to display the line with complete stability.



To use the above chart read the rise time of the displayed waveform on the CRT between its 10% and 90% points. Find the point corresponding to this value on Scale T out. Join this with a straight edge to the value corresponding to the oscilloscope bandwidth on Scale T1, the projection on Scale T2 is the rise time of the input pulse.

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

6.13 AMPLITUDE MODULATED CARRIER DISPLAY.

The TV sync separator can also demodulate amplitude modulated signals - both double and single side band. If an amplitude modulated signal is displayed, select the TV button and + or - slope as required. Adjust the level control to provide a stable lock to modulation frequencies below 5kHz.

6.14 SINGLE SWEEP OPERATION.

This feature is primarily used in conjunction with a camera for recording single waveforms, but can also be used at slow sweep speeds for manually initiating the trace to coincide with other functions. Two modes of operation are available to suit these applications.

For photographic application the Trig. LEVEL knob should be pulled out to Non-Auto and adjusted for correct setting on a similar amplitude waveform. Setting should be slightly away from max. sensitivity to eliminate the possibility of false triggering by noise, hum, etc., which may be present on the input signal.

Next press the SS button, place camera over CRT and open shutter. Apply the input signal which will initiate the time base for one sweep. The trace will then remain blanked out, and latched in a locked-out condition. Release the camera shutter then press the Reset button to release the time base and ready it for the next input signal. The ready condition is indicated by the LED Lamp above the SS button glowing.

Where manual initiation of the time base is required, push the Level knob in for Auto operation. Each time the Reset button is pressed, the trace will immediately sweep across the screen once, and not wait for a trigger pulse to initiate it.

6.15 HIGH FREQUENCY TRIGGERING AND TRIGGER HOLD-OFF.

As trigger frequencies increase above 40MHz better locking and increased sensitivity can be obtained by pulling out the HOLD-OFF knob to the HF TRIG position. Triggering is then available to greater than 100MHz.

Where pulse trains are displayed locking to a specific pulse may be achieved by rotating the Hold-Off control counter clockwise from the NORM position, until the sweep repetition rate corresponds with input signal repetition rate. Trigger hold off operates with the knob in or out. This technique may also be applied to modulated RF displays.

6.16 DISPLAYED TIME BASE OPERATION.

Three types of display are available to view a waveform delayed in time by the 540 time base; there are MIXED, DELAYED SWEEP (B delayed by A) and DELAYED TRIGGER. (B trigger delayed by A).

The horizontal DISPLAY selects the three modes together with A time base only and A intensified by B.

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

With the Delayed Sweep mode no display is presented during the delaying period, but immediately following this period the B time base is displayed. If very long delay periods are involved > 10,000 :1 jitter of the waveform and the inherent jitter of the time base may produce an unstable display in this mode. Stability of the delayed waveform is available, however, when Delayed Trigger is employed.

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

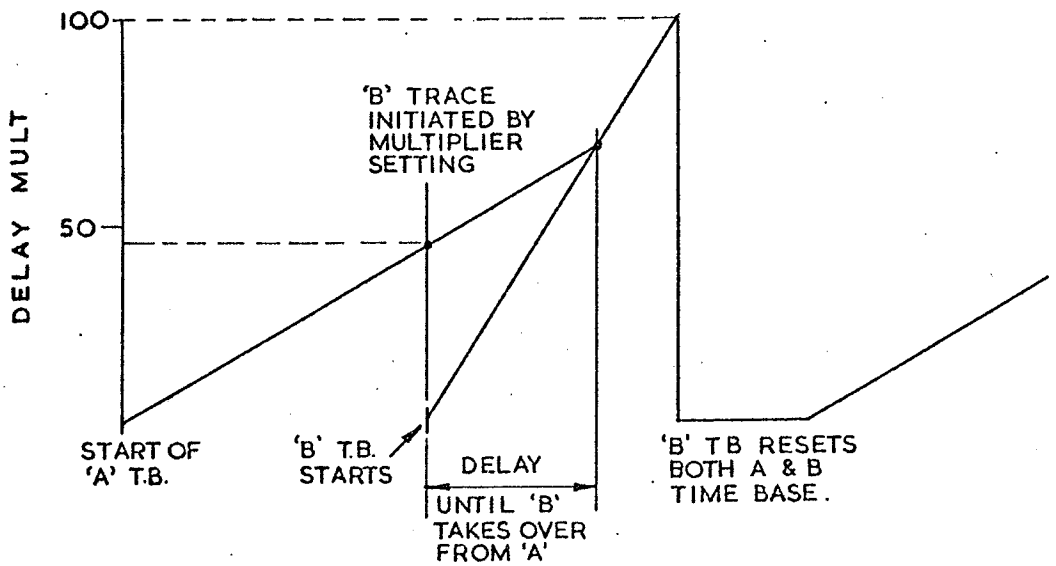
Operating of the delay time base facility is performed as follows:-

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

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

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

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



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

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

6.17 B. TRIG. DELAYED BY A.

The signal to trigger the B time base can be obtained from three sources. It can be selected from either internal channel or from an external source. The three lower push buttons control the source and polarity of the trigger signal. The trigger point on the waveform can be selected by the LEVEL control along side the push buttons. When triggering to frequencies above 20MHz the Level Control can be pulled out to engage the HF trigger facility. This enables signals to 100MHz to be triggered. At the high end care must be taken with the level control as the adjustment is critical.

7. OSCILLOSCOPE OPERATION FROM DC SUPPLIES.

The rear panel terminals for the DC input are isolated from the chassis. This enables supplies grounded either polarity or floating up to 50V from ground to power the 540 oscilloscope. Normal current requirement is approx. 1.5 amps. Input circuit for DC operation is protected against reversed polarity connection and will withstand over-voltage pulses to 40V peak.

NOTE: The front panel Power ON-OFF switches does not disconnect the DC supply. This must be done by removing the supply externally. If both AC and DC supplies are applied simultaneously the source supplying the higher voltage will power the oscilloscope. This would enable a standby DC supply to take over from the AC power in the event of an AC failure.

If the input DC supply falls below minimum operating requirements the front panel lamp will blink on and off to indicate loss of calibration.

8. BP 3 BATTERY PACK OPERATION.

The battery pack attaches to the 540 Oscilloscope by the two rear top cover holding down screws. A three pin plug on a short cable mates with the socket on the rear panel.

Two switches control the battery supply. On the pack itself the switch turns the batteries on or off. When battery operation is NOT required or they are not being charged turn the switch to OFF.

When the batteries are to power the oscilloscope or require charging turn the switch to ON.

The slide switch on the oscilloscope must be left in the USE position for all modes of operation and all power supply sources. It is only switched to CHARGE when required for that purpose. It may be switched from use to charge with power connected without damage.

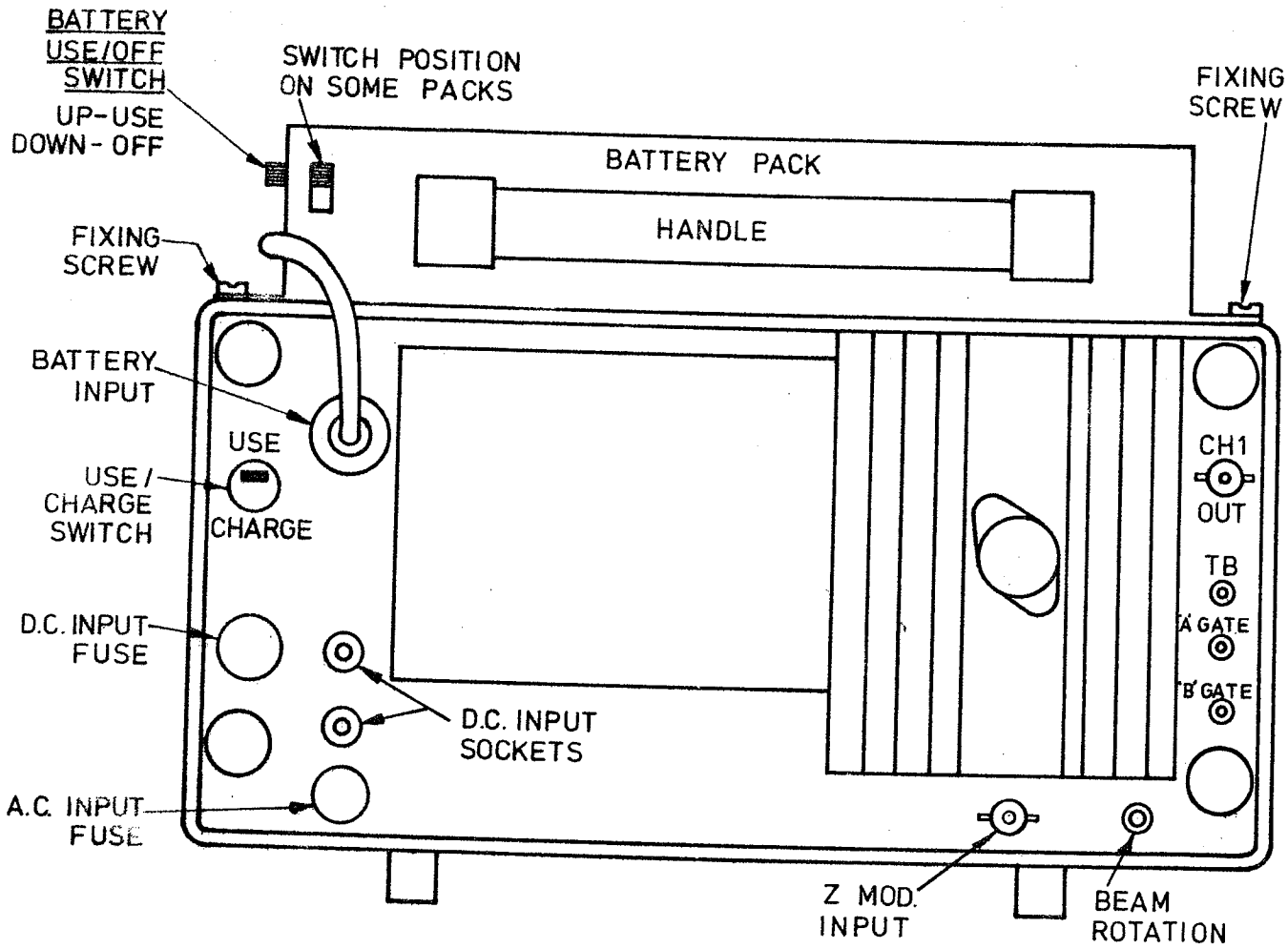
NOTE: The front panel power ON-OFF switch does not disconnect the battery supply, this must be done by the switch on the battery pack itself.

Approximately 14 hours is required to charge the battery pack when it is discharged to minimum operating voltage. A fully charged pack will provide over 3 hours operation. Actual operating time can be affected by temperature and age of batteries.

When the batteries have discharged to their minimum operating condition the front panel light will blink to indicate loss of calibration. Batteries should be recharged and not left on when light is blinking.

For transport purposes the pack may be detached from the oscilloscope and carried separately by the handle provided.

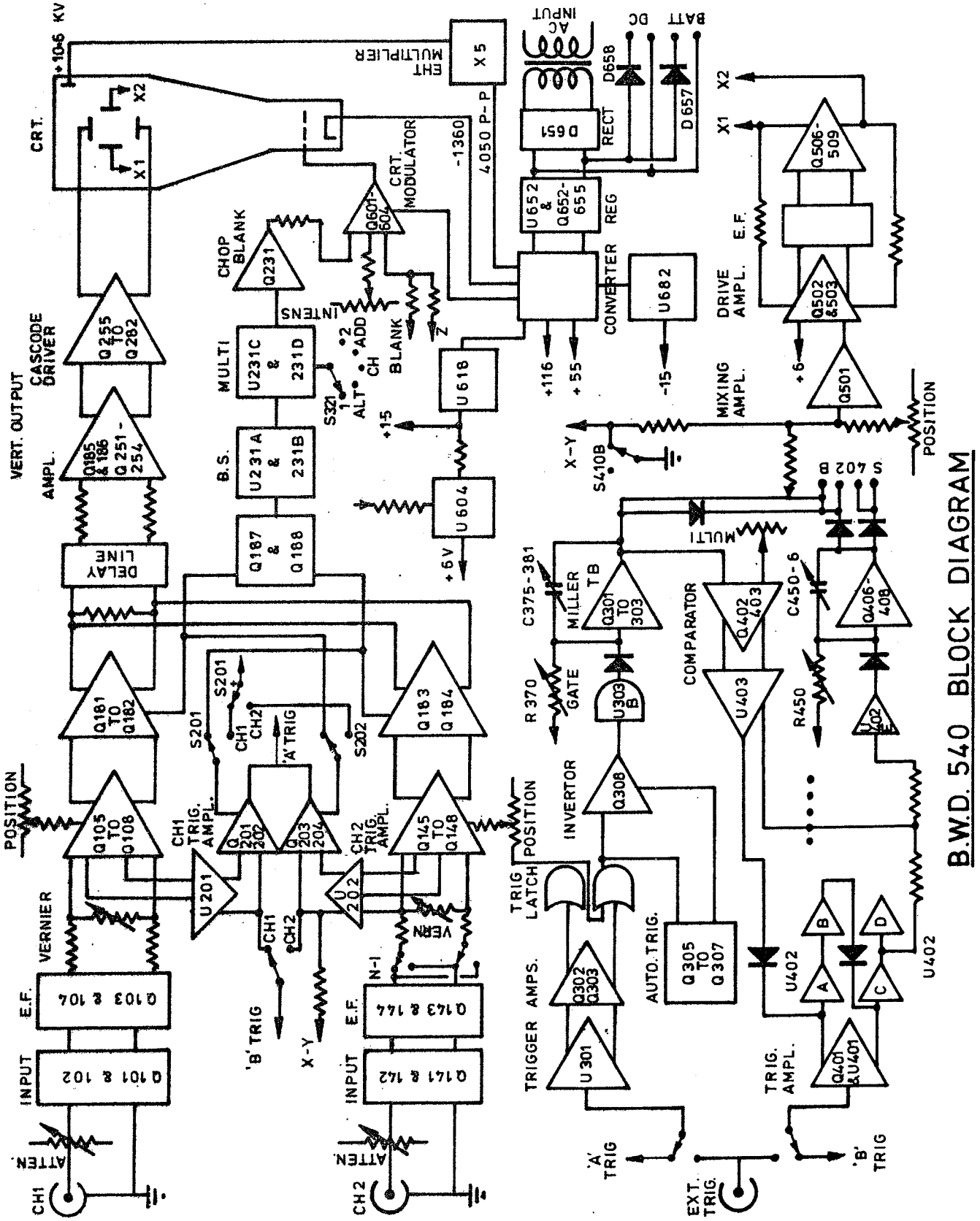
b.w.d. 540 REAR VIEW WITH BATTERY PACK FITTED



CIRCUIT DESCRIPTION

The following circuit descriptions are divided into the categories shown below:

(9.1)	Vertical Amplifiers CH.1	(9.19)	Horizontal Amplifier.	(9.26)	+ and - 15V regulators.
(9.2)	Beam Switched Amplifier.	(9.20)	Z mod and blanking.		
(9.3)	Output Amplifiers.	(9.21)	CRT.	(9.27)	Battery charging
(9.4)	Beam Switch.	(9.22)	Power Supply Input.		
(9.5)	Trigger Amplifiers.	(9.23)	DC Stabiliser.	(9.28)	Calibrator.
(9.6 to 9.18)	Time Base	(9.24)	Low voltage indicator.		
		(9.25	DC-DC Converter.		



9.1 VERTICAL AMPLIFIERS.

Channel 1.

Input signals to the BNC jack are capacitively coupled via C1 & S1A to the attenuator when S1B AC-DC switch is open, or directly when it is closed. When S1A is out (as shown) the input signal passes to S2 attenuator. When the switch is IN, the input is opened whilst the attenuator is grounded. The attenuator S2 comprises 4 sections which are used independently or in series to provide the selected attenuator step.

In the 5mV position no attenuation occurs and the signal passes straight through. At the 10mV setting R10 and R11(together with R15 in parallel) divides the input signal by 2.

Capacitor C10 and C12 divide the signal by 2 at high frequencies to maintain a constant bandwidth.

C11 maintains a constant input capacitance for that step. The 20mV step brings in R12 and R13, (R15 always remains in parallel with the shunt element). This reduces the signal by 4. C13 and C15 compensate for higher frequencies and C14 maintains input capacitance.

At the 50mV setting switch section S2B/R and S2C/F brings R6 and R7 into circuit to provide a x10 attenuation.

This section then remains in circuit and the x2 and x4 networks are sequenced with it to provide 100 and 200mV steps. When 500mV is selected the R6 and R7 section is bypassed and R2 and R5 is switched in by S2A/F and S2B/F to attenuate the signal by x100. This section now remains in circuit on all ranges to 20V/div. The x1, x2 and x4 sections selected by S2D/F and R are cascaded to increase the steps through 1V and 2V. At 5V the x10 section selected by S2B/F and S2C/F is added in to provide x1000 attenuation, which together with the x2 and x4 produces the final 10 and 20V steps.

From the attenuator the signal is taken through R14, R101 & C101 limiting components to Q101 FET source follower. Protection for the input gate is provided by diodes D101 and 102 for positive overload spikes and D103 and 104 for negative overload.

Q101 FET is closely matched to Q102 and provides an identical source impedance to the following stage, electrical and thermal balance necessary for long term display stability. DC balance is set by RV102 the front panel DC BAL preset control. RV101 adjusts the current through the FET's to set the output at +0.7V.

The input FET stage drives a matched pair of emitter followers Q103 and 104 which provide a low impedance to drive the vertical input amplifier and Channel 1 trigger amplifier via R200 and R202. The amplifier gain vernier is placed across the input to Q105 and 106 transistors. R111, 113, 112 and RV103 gain control form a double L network. Variation of RV103 shunt element controls the gain over a 2.5:1 range.

Q105, 106, 107 and 108 are balanced series - shunt feedback pairs. Vertical position control RV104 in the collector circuit of Q105 and 106 varies the current drawn through each side and so superimposes a positioning voltage on the signal voltage. RV105 preset centres the position control range. Channel 1 gain is set by RV106 which is accessible through the side cover. DC operating conditions of the stage are set by RV107. The output from Q107 and 108 passes via R124 and 125 to the beam switching stage Q181 and 182.

540
546

Channel 2.

The attenuator and amplifier circuits are identical to Channel 1 other than the inclusion of the Invert switch S141. This reverses the input signal connections to Q145 and 146. Output from Channel 2 amplifier Q147 and 148 passes via R164 and 165 to the beam switch stage Q183 and 184.

9.2 BEAM SWITCHED AMPLIFIER.

The beam switch stage consists of two balanced amplifiers Q181 and 182 in Channel 1 and Q183 and 184 in Channel 2. Q181 and 184 share one common collector load Q182 and 183 share the other. Therefore if the emitter resistor controlling the current through Q181 and 182 is grounded and Q183 and Q184 emitter resistor is taken to a potential higher than the base voltage (> 5V), channel 1 will supply the signal to the output amplifier and channel 2 will be cut off. If the converse takes place channel 2 will supply the signal and channel 1 will be cut off.

Capacitors C182 and 183 neutralise leakage signals due to stray and feed through capacitance and maintain high isolation between the channels.

If both stages are turned on simultaneously the signals from both channels are mixed as in the ADD mode. As twice the current is drawn when both channels are on, additional current is supplied to the collector load by the vertical display switch section S231A which connects R191 and 192 to the +15V rail.

The collector loads for Q181, 182 and 183, 184 consists of R188 termination resistor and L181 delay line, the resistors R189 and 190 terminating the delay line into the upper cascode pair.

The x5 gain switch S181 in Ch. 1 switches RV181 x5 gain preset into circuit across the emitter resistors of Q181 and 182. The preset is adjusted to decrease the emitter degeneration by a factor of x5 thus increasing the gain by that amount. The stage gain is less than unity at x1, increasing the gain by x5 switch reduces the bandwidth to 30MHz.

The transistor Q181 and 2 (or 183 and 4) and Q185 and 6 are a cascode circuit with delay line between them. They form a series shunt feedback stage with Q257 and 252. The shunt feedback resistors and the following output stage are driven by Q253 and 254 emitter followers to maintain maximum stage bandwidth and output swing.

The common emitter resistor of Q257 and 252, R257 returns to -15V via S501A, beam find switch. When the switch is pressed it opens, and current must now flow through R260, limiting the current and hence the output swing from the stage to such an extent that it will not deflect the trace off the CRT screen.

9.3 OUTPUT STAGE.

The CRT drive is a cascode stage with emitter compensation and a collector T Networks. Final bandwidth compensation is set by the network between Q281 and 282 emitters.

9.4 BEAM SWITCH.

The Beam Switch circuit which turns Q181, Q182 and Q183, 184 on or off consists of a low power TTL quad nand gate U231 and drive transistors Q187 and 188.

Selection of the required Vertical Display is controlled by S231

The first two gates A and B are cross coupled as an edge triggered bistable switch. Gates C and D are coupled by S281C either as a free running multivibrator in the CHOP mode or as a pulse shaper with 2μ Sec delay in the ALT mode.

When the Vertical Display is set to Ch.1 , pin 5 of Gate B is grounded through R237 by S231C. Pin 6 goes HI biasing on Q187 so turning off Channel 1. When 6 is HI, 2 is HI therefore 3 goes LO and turns off Q188 cutting off channel 2. When Q181 and 182 conduct Channel 1 is connected through to the output. When Channel 2 is selected gate A is grounded by S231C and the switching action is reversed.

Alternate operation is as follows. A positive going gate pulse from the time base via C237 is switched by S231D to gate C input . S231C grounds R234 but leaves the second input on pin 10 open. The +ve pulse drives gate C input Hi, its output falls to LO, pulling gate D input LO. In turn, its output rises for approx. 2μ Sec. determined by C233 and R235. When gate D output falls after 2μ Sec. it couples through C231 and C232 to trigger the bistable and change over the channel selected for display.

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

When Chopped mode is selected, R233 is grounded by S231C completing a bistable circuit of gates C and D . The free running frequency is approximately 500kHz which triggers gates A and B, the bistable switch, this in turn switches the channels 1 and 2 on and off. The switching signal to gates A and B is also taken through C235 and R239 differentiator circuit to Q231 PNP chop blanking amplifier. Negative going excursions drive Q231 into conduction during the switching transition and the resultant positive going pulses at the collector are applied via R204 and to the Z modulation amplifier Q601. Also switched in circuit in the chopped mode is resistor R309 which reduces the trigger sensitivity and so eliminates switching transients from the chopping signals from initiating the trigger circuits.

The remaining display facility is ADD. In this condition both channels conduct into the common collector loads. This is performed by grounding gate A via S231C, pin 1 is therefore LO, pin 3 is HI and pulls current through R196 turning Q188 hard on and consequently Ch. 2

Channel 1 drive is however HI and would be turned off so R197 connected to Q187 base is connected to + 15V by S231B. Q187 turns on and provides a current path for Channel 1 which also feeds its signal to the common load.

The additional current drain of the two stages conducting would change the collector voltages so R191 and 192 are connected by S231A to + 15V to provide additional current to the stage and thereby maintaining correct DC Levels.

The +6V DC supply to operate U 231 is obtained by using the series current through the output stage in parallel with a 6V regulator IC located on the delayed time base P.C. Board.

9.5 TRIGGER AMPLIFIERS (CH. 1 and CH. 2).

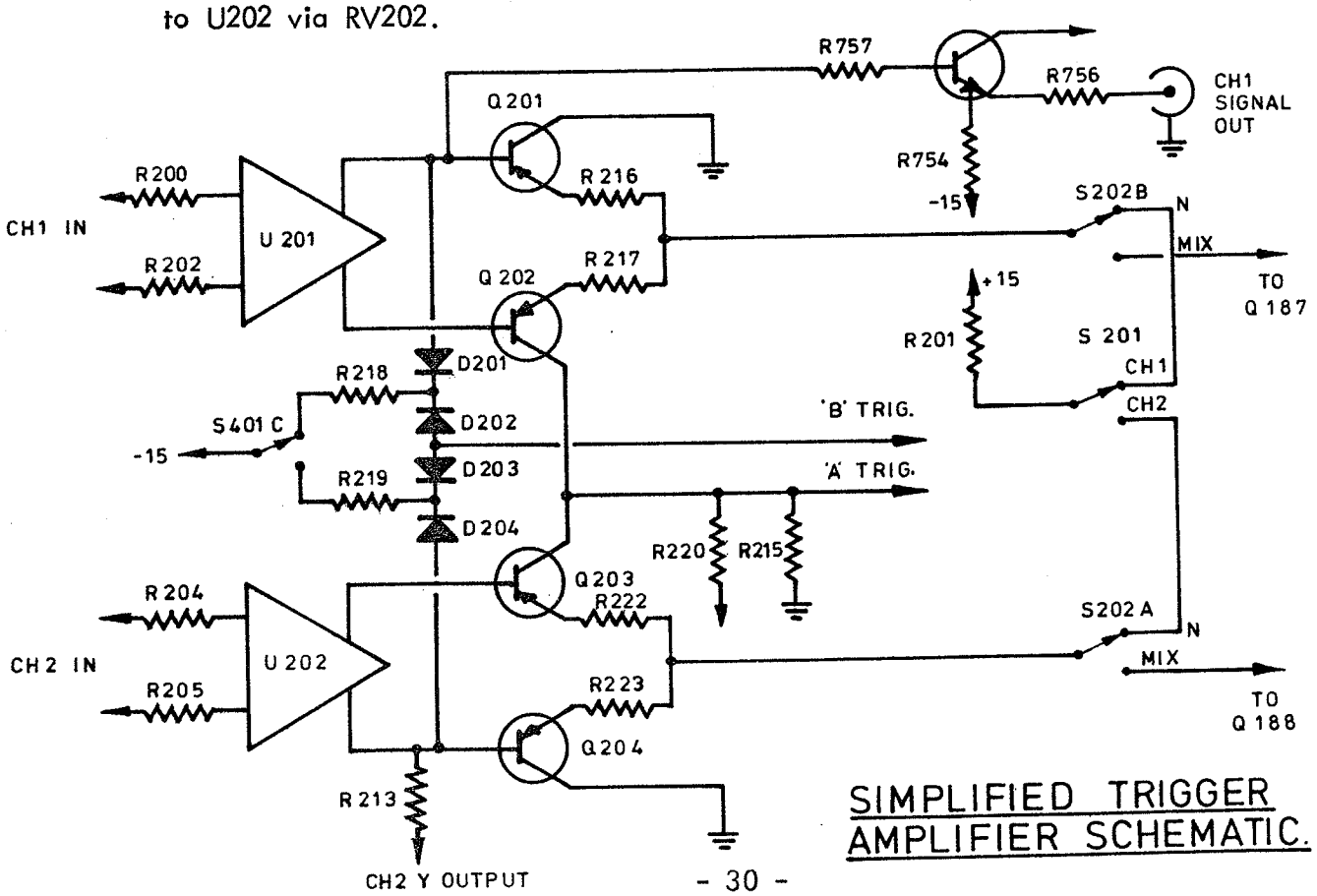
Each channel is directly coupled to its own trigger amplifier via coupling resistors. R200 and 2 to U201 for channel 1 and R204 and 5 to U202 for Channel 2. Each 1C has a gain of approximately x30. The output of U201 and U202 supply two trigger circuits each.

U201 supplies the delayed time base (B) trigger circuits via R211/C205 and D201 and 202 diode gate and to the main time base (A) trigger gating amplifier Q201 directly and via D206/C207 to Q202. D206/C207 are included to prevent Q202 being cut off when the input signal has a high DC offset component. U202 similarly supplies B trigger via R212/C212 and D203 and 4 diode gate. 'A' trigger signals pass directly to Q204 and via D207/C208 to Q203. The channel selected to supply the delayed time base (B) signal is controlled by biasing on either D 201 and 202 via R218 connected to -15V or D203 and 204 via R219 as selected by S401C H. 1 or Ch. 2 switch located on the delayed time base board.

The main time base switching is controlled by S201 Ch. 1 or Ch. 2 selector and S202 individual or mixed selector. S201 and 202 are mounted on the trigger amplifier board on the vertical amplifier board.

When S202 is in the individual position (out) as shown on Drg. 1122, S201 selects the channel to supply the trigger developed across the common collector load R215 by connecting the amplifier emitters to +15V via R201. In the MIX condition S201 is disconnected and instead the collectors of Q187 and 188 are connected to the emitters. When Alternate display is employed Channel 1 and 2 will be switched to supply the trigger signals alternately and simultaneously with the channel being displayed.

Channel 1 amplifier U201 also supplies the Ch. 1 signal output at the rear panel. The signal passes via R751 to Q751 emitter follower which drives the output socket via R756. DC Level adjustments to U201 is set by RV201 and to U202 via RV202.



SIMPLIFIED TRIGGER AMPLIFIER SCHEMATIC.

9.6 TIME BASE CIRCUITS.

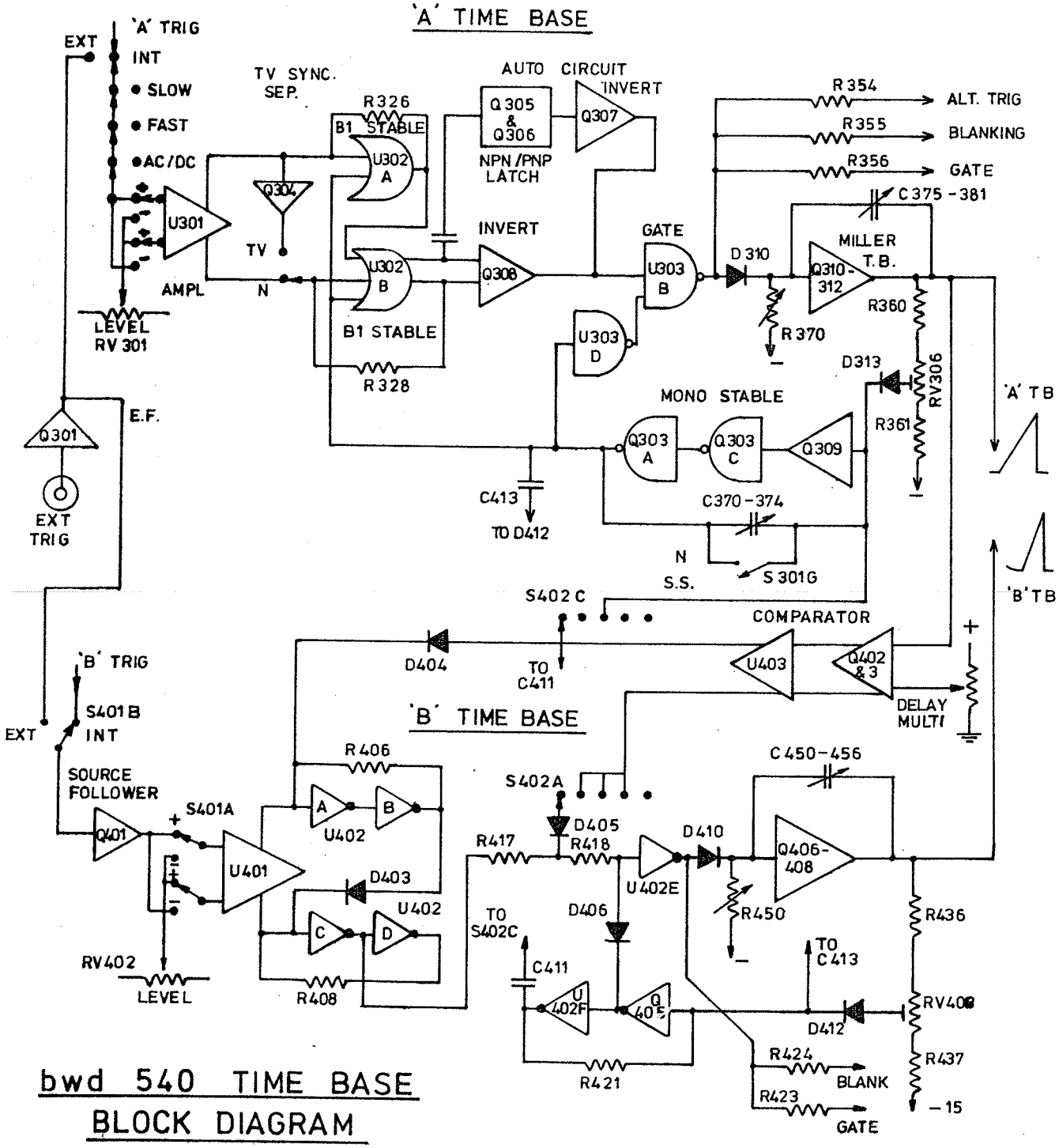
The time base is divided into the following sections and shown in their inter relationship below:-

'A' TIME BASE

(9.7) Trigger Amplifier.
(9.8) TV Trigger selection.
(9.9) Dual Bi-stable trigger.
(9.10) Sweep gating.
(9.11) Sweep Generator.
(9.12) Holf Off.
(9.13) Auto.
(9.14) Single sweep.

'B' TIME BASE

(9.15) Comparator.
(9.16) Trigger Amplifier.
(9.17) TB Gate.
(9.18) Sweep Generator.



bwd 540 TIME BASE BLOCK DIAGRAM

'A' (MAIN OR DELAYING) TIME BASE

9.7 Trigger Amplifier (Drg. 1124).

Signals to trigger the A time base are selected by S301A from either the internal source or via the external trigger input socket and emitter follower Q301.

S301B AC-DC switch places C302 and 303 in series with the signal when AC coupled or it passes directly through when switched to DC. S301C places C304 in series with the signal in the Fast position or connects directly to S301D in the normal position.

S301D selects the path through R308 and C305 when pressed for slow or couples directly to S301E in the normal mode.

S301E + or - polarity selector connects either the trigger signal or the voltage from the level control RV301 via R311, 312 and 313 to the balanced input of U301. Adjustment of DC level setting at the input of U301 is made by RV302 and 303.

The output from U301 is coupled to a balanced transistor pair Q302 and 303. The common emitter load of this pair R320 is taken to RV304 trigger sensitivity preset. Two additional circuits are also connected to RV304 to affect the trigger sensitivity. These are R309 which reduces sensitivity when it is connected to the + 15V rail when S231 Vertical Display switch is turned to the Chopped mode. S305 is the other connection to RV304, this is normally closed for gated trigger operation. It is opened in the HF trig. mode when the Trigger Hold Off knob is pulled out. This increases the trigger sensitivity.

Q302 is directly coupled to U302A bistable trigger whilst Q303 is taken through D304 to U302B. This is to enable the TV sync. separator to be switched into circuit via the diode gates D303, 304 and 305.

9.8 TV TRIGGER SELECTION.

When 301F is switched as shown on drawing 1124, Q304 base is reversed biased by R323 so that an input signal applied via R319 and C311 will not take it into conduction.

When S301F is pressed to select TV, it connects Q304 base to +6V via R322 biasing it into conduction. S301F connects Q302 collectors to via D305 and R321. This reverse biases D304 and prevents any signal on Q303 from triggering U302B.

Negative going video signals applied to Q304 base cause the sync pulses to drive it hard into conduction. This causes Q304 to pull current through R324 collector load. For frame pulses the slow button must be pressed to filter out line pulses but leave the longer frame pulses. The sync. signal cause a negative signal to be developed which biases D303 into conduction.

As U302A latches to the first video component to pass through Q302 after reset, this may be a line or frame pulse, U302B is primed ready to latch when a negative going frame or line pulse pulls D303 into conduction.

9.9 DUAL BI-STABLE TRIGGER.

U302 is an ECL dual OR-NOR gate, each section is connected as a bi-stable trigger by R326 and R328. U302A output is coupled into one input of U302B and both gates have a common input via pin 13. In operation with no input signal and RV304 trigger level adjusted to centre, the collector of Q302 and 303 will be positive to the input level of U302.

The gate input via pin 13 is held LO by IC-303A to which it is connected by R341. When Q302 is pulled into conduction an input signal, pin 8 of U302 is pulled down. Current will flow through R326, a voltage drop develops and the input goes to LO. The output on pin 6 follows and U302 latches in the LO state taking pin 14 of U302B LO also.

When the input trigger signal reverses phase it causes Q303 to conduct, biasing D304 on and pulling current through R328. As pin 16 goes LO, the OR output on 3 will also go LO and latch in. Both triggers are latched to low state and cannot recover until an input to one gate - pin 13 in this case, goes HI when it is reset during the hold off period.

9.10 SWEEP GATING.

As the OR output goes low the NOR output on pin 2 goes HI. This voltage difference is applied across the emitter base junction of Q308 inverter driver stage.

The collector load of Q308 is R339 and R340.

When Q308 emitter base junction is reversed biased it is non conducting and U303B NAND gate will have one input level LO by R340. This will result in the output on pin 6 being HI. Five circuits are activated by U303B output.

(1) Alternate trigger initiated by U302B going HI via R354.
(2) Unblanking of the CRT is switched by the output going LO, via R355.
(3) The gate output is taken through R356 to the rear panel socket.
(4) The Ready light LED is gated between U303B and U303A outputs via R349 and 342.
(5) The sweep circuit is gated on and off via R351 and diode D310.

9.11 SWEEP GENERATOR.

A positive going sawtooth waveform is generated by a Miller feedback circuit consisting of Q310 FET source follower, Q311 Miller integrator followed by Q312 emitter follower.

When U303B output is HI, D310 is biased on and pulls Q310 gate positive. This pulls Q311 into conduction and its collector falls. Q312 follows and its emitter falls until D309 connected between D310 and Q312 emitter is pulled into conduction. Current will now flow through R351, D309, R360, RV306 and R361 to -15V which reduces the voltage on D310, on Q310 gate and hence on Q311 base. Conduction reduces in Q311, its collector rises slightly and Q312 follows until a quiescent condition is reached where the forward bias on D311 is just equalled by the reverse bias via D309 and the divider to -15V. When RV305 is correctly set this will be +1V at the emitter of Q312 and pin 7 of the A and B time base P.C. Board interconnecting socket.

The arrival of a trigger signal at U302 will cause it to latch as previously described and the outputs on pins 2 and 3 will reverse, biasing Q308 hard into conduction. The junction of R339 and R340 will be pulled positively, gate input 4 of U303 will HI (assume gate 5 is HI), output will drop to LO and D310 will become reversed biased.

The Miller circuit is now left with the gate of Q310 taken to a negative voltage as determined by the timing resistor R370 selected by S304D wafter of the Time/Div. range switch and the setting of RV472 vernier control.

Q310 gate will therefore be pulled negatively, however a timing capacitor as selected by S304E is also connected to Q310 gate and via the switch back to Q312 emitter.

The fall at Q310 gate is amplifier and inverted by Q311 at its collector and is followed by Q312 and so coupled to the timing capacitor. The effect of this large amount of negative feedback is to linearise the waveform resulting in less than 0.2% non-lineaity at the generator output over most of the timing range.

The timing capacitors are changed over the lower ranges every sixth step which represents two decades of timing change. The 1,2,5, 10 timing changes are produced by resistors selected by S304D wafer. The highest speeds have individual preset capacitors to enable stray capacitance etc., to be compensated by capacitor adjustment.

The sweep voltage continues to rise at the output of Q312 until the take off point on RV306 in its emitter load rises to + 1.4V. D313 and Q309 now conduct to initiate the trace termination switching.

9.12 HOLD OFF CIRCUIT.

U303 A and C gates and Q309 are cross coupled as a mono-stable. C370 - 374 with C321 in parallel as selected by S304C set the time of the mono stable period. When Q309 conducts at the positive excusion of the trace it pulls U303C input HI, its output becomes HI, U303A input follows and its output in turn falls to LO.

This is coupled through C321 and any parallel capacitor on S304C to pull Q309 input HI via D311, this latches U303C output to a high state until C321 etc., discharges through R353. This period of time is selected to be longer than the Miller integrator takes to discharge the timing capacitor and to settle to in a quiescent condition.

Hold off capacitors selected by S304C wafer are changed to suit the timing capacitors and to minimise lost time during hold off at higher frequencies.

The switching signals generated by U303A and C are used as follows:

From pin 3 of U303A, the output pulse is coupled by R341 to pin 13 of U302A and B dual Bi-stable trigger. This positive output pulse unlatches U302 and holds it until the delay period is complete. Q308 becomes reversed biased and pin 4 of U302B falls to low, the circuit is then in readiness for the next input trigger signal.

The HI output from U303A (pin 3) during hold off is inverted by U303D, causing U303B output to go HI, D310 is forced into conduction. Q310 gate goes positive, its source follows taking Q311 base positive. It conducts causing its collecta to fall rapidly. Q312 follows and the selected timing capacitor C375- C381 is discharged through the low impedance path of U303B, R351 and D309 in series going to +4.5V and R360, RV306 and R361 in series connected to - 15V. The discharge is halted when D309 conducts as previously described.

At the end of the hold-off period U303A goes LO and U303B output goes HI, but as pin 4 of U303B is now low U303B remains with its output on pin 6 HI, until the time base is initiated by the U302 latching, Q308 conducting and switching U303B output from HI to LO thus disconnecting D310 and allowing the sweep circuit to start.

The LED Ready Light on the front panel is connected between U303B output and U303A output. A voltage only appears across it when U303B is HI - between sweeps and when U303A is LO after the hold off period, i.e. the period when the time base is ready, awaiting a trigger signal.

9.13 AUTO CIRCUIT.

Q305, 306 and 307 are responsible for the auto action. When the level control RV304 is pushed in S302 is opened leaving capacitor C318 charged to +15V. It proceeds to discharge through R334 and if U302B trigger gate is not switched by an incoming trigger signal it will continue to discharge until D306 conducts. This in turn will cause Q307 to conduct and draw current through R347 pulling pin 4 of U303B HI, its output drops to LO and the time base is initiated and will continue to free run til U302B latches. When this occurs a trigger pulse is fed via C314 to Q306 base. It conducts, pulls Q305 base positive, Q305 conducts and pulls Q306 base negative and the two transistors latch together and charge C318 towards the +15 rail. When the capacitor is charged the current through Q306 is insufficient to hold Q305 in conduction so the latch releases and C318 again discharges until another trigger pulse latches Q305 and 306, and the action is repeated.

If trigger signals continue to switch Q305 into conduction C318 will remain charged and Q307 will remain non-conducting, however, in the absence of trigger signals Q305 will not conduct, C318 will discharge within 0.3 seconds approximately, Q307 will conduct and via R347 will pull input 4 of gate U303B to its high state irrespective of the action of Q308 and initiate the next time base sweep.

At the end of the trace when the reset circuit next operates U303B output will only be switched to HI by the hold-off circuit via U303D and immediately it completes its task both inputs to U303B will be HI , its output will fall and a sweep will be initiated. A free running trace results not locked to any trigger signal and will continue to do so until trigger signals again switch U302 and hence Q305 into conduction to recharge C318 to bias Q307 off.

Another output of U302A gate is taken via R342 to C413 on the delayed time base board to reset the B time base hold off gate.

9.14 SINGLE SWEEP

Single sweep operation of A time base is obtained by shorting out C321 and all other hold off capacitors by S301G/A, converting U303A and C from a mono stable to bi-stable. When this circuit is latched by Q309 conducting at the end of the sweep period no further sweep can occur until the circuit is unlatched by depressing the reset button S303. This places C329 across the input of Q309. The charging current which will flow into C329 will pull Q309 base to a low state. U303C output will rise and unlatch the bi-stable circuit in readiness for the next sweep.

9.15 B TIME BASE

Comparator.

The point on the trace at which B time base fires is set by Q402 and Q403 and U403 comparator. This circuit is a high gain differential amplifier which feeds comparator I.C U403.

The sweep waveform from Q312 emitter is connected to Q402 whilst the comparison voltage across RV405 Delay Multiplier is fed to Q403.

When the Horizontal Display switch is in position 'A' only, Q404 will be pulled hard into conduction by its base resistor R430 being taken to -15V by switch S402B. This causes Q404 to saturate and pull the base of Q403 up to almost + 15V, it will therefore remain conducting irrespective of the input to Q402. When S402 isswitched to all other positions Q404 is turned off and Q404 and 403 are free to conduct.

In the quiescent condition when A time base is blanked out awaiting a trigger signal Q402 will be cut off and Q403 will be conducting. Pin 4 of U403 will be negative to pin 3 and the TTL compatible ouputs will be HI at pin 11 and LO at pin 9. The HI output on 11 will pull D404 into conduction and hold the input of U402A HI in the reset condition. The LO output on 9 will reverse bias diode D405.

The circuit will remain in this condition until the comparator is switched over by the A time base signal.

9.16 TRIGGER AMPLIFIERS AND BI-STABLE LATCH.

Input signals are selected by S401B from an external or the internal source. Q401 emitter follower presents a low output impedance for signals driving U401 differential amplifier and also provides a DC voltage shift which is adjusted by RV401.

S401A selects the input polarity by coupling the signal input and level select voltage to either pin 1 or 14.

The outputs of U401 are taken through diodes D401 and 402 to direct coupled Hex Inverter gates connected as latching schmitt triggers.

As the B time base trigger is only required for the B trigger delayed by A mode it is rendered inoperative in all other conditions by disconnecting the negative voltage supply to IC D401. This prevents U401 being able to pull enough current through D401 and D402 to latch the bi-stable circuits.

The action of the circuit is as follows: Assuming pins 1 and 13 are HI. With the arrival os a positive going signal on Pin 1 of U401 the amplifier will conduct pulling pin 1 low via D401. Pin 2 and 3 will become HI causing the output at 4 to switch to LO. This signal is communicated by R406 to Pin 1 pulling it LO thus latching the circuit in a LO state. The second pair of inverter gates C and D have been held by diode 403 which prevented current through D402 changing the state of gates C and D.

However once pin 4 switches to LO, D403 is disconnected leaving gates C and D free to be controlled by U401 and D402. The following half cycle of the trigger waveform will cause pin 7 to rise and through the differential action at the IC amplifier, will cause pin 8 to fall and make D402 conduct. The same sequence of events will follow. Pin 13 will go towards LO, 12 and 11 will go HI, Pin 10 will be LO and via R408 the inputpin will be pulled LO thus latching the circuit in the LO state.

The trigger circuit will remain in this state until it is reset by a pulse from the comparator via D404 at the end of the sweep. As can be seen the trigger circuit also forms the time base gate and consequently reduces the delay time in initiating the saw tooth sweep down to a few nano seconds. Trigger bandwidth is increased by the very high speed switching inherent in the TTL inverter gates. Increase sensitivity is obtained when switch S403 is remove closed in the HF trigger mode when the Level control RV402 is pulled out.

Output from the latching trigger circuit is taken from Pin 12 and drives another section of the same IC gate U402E via two resistors R417 and 418. The resistors are used to inject the signal from the comparator and from D406 to terminate the sweep.

9.17 GATING CIRCUITS

S402A wafer of the Horizontal Display selects the mode of triggering the B time base. As shown in drg. 1125, S402 is switched to A time base and Q404 is held on by R430 preventing B time base from operating.

The next position of S402 (INTEN) connects diode D405 from the output of U403 comparator to the junction of R417 and 418. Q404 base is released from the -15V rail allowing Q403 base to fall to the voltage on RV405 Delay Multiplier potentiometer.

When the A time base sweep voltage applied to Q402 base rises to the potential on Q403 base, Q402 will become reversed biased, D408 will disconnect, Q403 will conduct and its collector will rise above ground potential. U403 comparator input to pin 4 will rise above 3 switching the outputs on 9 and 11. The output on 11 will have no effect but the change from LO to HI on 9 will make D405 conduct and via R418 cause U402E input to rise, its output will go to LO to initiate the B time base. D410 is disconnected permitting Q406, 407 and 408 Miller circuit to sweep. As B time base is running faster than A the B sweep will terminate before A.

9.18 SWEEP GENERATOR.

The voltage on RV408 controls the end of the sweep when it rises to + 1.4V and biases Q405 into conduction. This pulls input 5 of U402F LO its output rises and pulls the base of Q405 positive, and latches the bi-stable circuit. D406 conducts and pulls input 9 LO, a HI appears on 8 which via R422 pulls D410 into conduction. The gate of source follower Q406 is driven positively, this pulls Q407 hard into conduction by the direct coupling of RV407 from Q406 source. Q407 collector falls, Q406 emitter follower falls until D411 conducts. During the return trace the timing capacitors are selected by S304B are discharged by the current flowing in D410, R422 and R436, RV408 and R437, the CR value determining the fall time of the circuit.

When the emitter of Q408 falls to approx. + 3V D411 conducts and current flows through R422. D411, R436, RV402 and R437 to -15V and will continue to flow until D410 is pulled to a lower conduction level and a stable quiescent state is reached.

The output of U402E is also connected to the unblanking circuits via R424 and D475 diode to S402A/1. S402B/1 applied -15V through R474 to pre-bias the 'B' unblanking waveform negatively with respect to 'A' unblanking level.

The resultant unblanking pulse fed out to the Z modulation amplifiers causes an increase in trace intensity during the period of the B time base, producing a display with an intensified section.

In this position of S402 only the A time base sweep waveform is selected by S402B/1 via D471. The bi-stable latch U402F and Q405 is reset at the start of the next A sweep by a negative pulse from U303A via R342 and C413 to Q405 base.

The third position of S402 selects MIXED display. S402B/1 disconnects B intensified unblanking but sweep signals from both A and B time bases are connected to the horizontal amplifier by S402B/1 via diodes D472 and D473.

The gating circuit is identical to the Intensified condition in that the B time base is initiated when the comparator switches and U402E output goes LO. Once B time base is initiated the sweep waveform on Q408 emitter will appear on D473 anode and take it positive.

D472 is already conducting as A time base output sweeps positively towards +13V. At a point in time determined by the setting of the Delay Multiplier and the B time base range setting the signal on D473 will rise positively to D472 thus cutting off the sweep from A time base and feeding B time base through to the output amplifier instead.

The resultant display is that the slower A time base appears on the left hand side of the display followed by the higher speed B time base. See sketch on Page 23.

At the end of the B sweep the output of Q405 is fed to U402E to end the sweep and then the output of U402F via C411, D407 and 402C/2 to the base of Q309 to end the A sweep also. If the Delay Multiplier is set near the maximum delay and there is little difference between A and B sweep speeds, A time base may finish first in which case U303A gates Q405 via C413 to end both time bases.

The fourth step of S402 is B time base delayed by A. The only difference introduced by the switches is that only B sweep is selected by S402B/1 and B unblanking only by S402A/1. Therefore no display will be present on the CRT until B time base starts when unblanking the CRT displays B sweep only.

The final position of S402 is B trigger delayed by A. Two changes to the switching occur. U402E is not pulled into conduction by U403A, instead diode D404 releases U402 and allows the trigger signal generated by the 'B' trigger circuit U401 and U402 to pull U402E input HI. This causes its output to go LO and start the B sweep. S402B/2 connects R410 directly to -15V thus bringing the trigger circuit into operation.

Initiating of B time base by a trigger input can only take place when U402 clamp voltage via D404 is removed. This only occurs when U403 comparator output on 11 goes to its LO state. As pin 7 of U401 will normally be in a LO state U402 A and B will latch in to a LO when D404 disconnects thus releasing D403 leaving U402 C and D latch ready to switch on receiving the next trigger signal when the outputs of U401 will reverse, pin 7 will go HI and 8 will drop to LO.

9.19 HORIZONTAL AMPLIFIER.

This circuit consits of a shunt feedback input stage Q501 driving a balanced stage Q502, 503 followed by emitter followers Q504, 505 which drive the complementary output pairs Q506, 507 and Q508, 509 with overall feedback around the balanced amplifier. Six inputs are taken to Q501 base in addition to the collector to base feedback resistor R513 which converts Q501 to a current input stage stage with very low input impedance. These are the 'X' input via R501, fine and coarse position controls, via R502 and 503, trace centering voltages via R504 and 505 and the time base input via R510 and RV506.

The time base signals are selected by S402B/1 Horizontal Display switch and applied to Q501. Horizontal position control voltages from RV504A and B are mixed with the sweep waveform along with the centering voltages from R504 and 505. The latter resistor is disconnected when the X-Y latter is pressed. X input signals are shorted to ground by S401B when the time base is used but opened in the X-Y mode. C501 across the X input line corrects the phase of the signal to match the vertical channel which is delayed approx. 100 n Sec by the delay line.

The inverted signal at Q501 collector drives the base of Q502. Q503 base is returned to +6V via R518 and 517 to provide DC balance. The emitter resistors of Q502 and 503 are the negative feedback resistors R521 and 527 from the driver stage. The amount of feedback and hence the stage gain is set by R516 shunt resistor in the X1 mag. position and R515. with RV505 in series are switched in parallel with R516 at x10 mag. Whilst Q502 is a base driver stage with emitter feedback, Q503 is emitter driven via R516 and 515/RV505.

Drive signals for the output are developed across collector hoods R522 and 523 with RV508 balanced control between them. Current through the stage is set by RV507 under normal conditions but when S501A Beam Find button is pressed RV507 is opened and a reduced current flows through R 540 to restrict the horizontal deflection to within screen limits.

Emitter followers Q504 and 505 provide a low impedance drive for the output stages.

Q506 and 507 are a PNP-NPN complementary stage driving the X2 plate. Like wise Q508 and 509 drive the X1 plate. Both run at a quiescent current of approx. 5mA which is set by R530, 529, 531 and 520 for the X2 stage and R538, 536, 542 and 528 for the X1 stage.

If a positive going input is applied to Q507 to turn it on, Q506 which receives at high frequencies the same drive signal via C514 will be turned off. Thus reducing the load and assisting Q507 in charging the capacitor load formed by the deflection plates. In a similar manner negative going signals will turn Q507 off and Q506 on when the X2 plate is being driven positively. The drive signals to Q508 and 509 are similar to the X2 stage described.

Diodes D503 and 506 prevents the output stages being driven into positive saturation whilst D504 and 505 prevent Q507 saturating. Output limiting is also set by D501 and 502.

Trace linearity is adjusted by C508, C510 and RV507.

9.20 Z MODULATION AND BLANKING

The Z modulation stage consists of Q601 common base input stage which presents a low input impedance to the six input signals available to modulate the CRT trace. Output signals developed across collector load R607 are applied through diode D601 to Q602 emitter follower and mixed with the feedback signal via R611 from the output stage. The complementary pair output stage Q603 and 604 operate at a quiescent current of approx. 5mA as set by R614, 609 and 610 around Q603.

During the return trace the output of Q603 and 604 is held low to blank the CRT. The negative going unblanking pulse from S402A/1 switch deck is fed to Q601 via R602.

This increases the current in Q601 and produces a negative fall at its collector. Q602 emitter falls cutting of Q604 and pulling Q603 hard on. The high frequency component of the waveform is capacitively coupled to the CRT grid via C606.

The DC component of the CRT grid drive is developed by modulating a 22kHz rectangular waveform and then demodulating it at the CRT cathode.

The rectangular waveform is taken from the DC-DC converter transformer winding that supplies the +117V rail. It is taken through R621 and then clipped on the positive excursion by D607. RV606 sets the clipping level providing an intensity range control. D606 isolates the switching waveform from the Z modulation amplifier output. It controls the amplitude of signal present at the junction of D606 and 607. The more positive the output of the amplifier the smaller the signal amplitude with respect to ground.

When the modulated waveforms are coupled by C607 to the CRT cathode they are DC restored by D605 and then coupled through D604 and R620 to be combined with the AC coupled component at the CRT grid.

9.21 CRT.

The cathode ray tube is operated with an overall potential of 12KV. The cathode supply from a half wave rectifier D672 followed by a two section RC filter C663, R615 and C605. The PDA voltage is supplied by a 5 stage multiplier through a C and R filter consisting of R622 and the capacity of the screened cable used to provide the final connection to the P.D.A. connector.

CRT focus by RV602 and astignation correction by RV604 are front panel controls whilst RV603 geometry preset is internal on the rear P.C. board near the CRT socket.

9.22 POWER SUPPLIES

The power supply system in the 540 Oscilloscope is designed to provide operation from either AC or DC power sources on a rechargeable battery.

POWER INPUT

AC input passes first to the power switch on the Intensity control then to the 117 - 235V changeover switch located on the transformer bracket. The transformer T651 has secondary windings consists of a main winding supplying a bridge rectifier D651 and two 6.9V windings. One supplies the graticule lights and the line voltage for the time base trigger via R672. The other winding forms an extension with the main winding to increase the supply for battery charging.

Rectifier D651 operation is self evident when the USE/CHARGE switch is in USE however when 'charge' is selected the bottom pair of diodes C and D in D651 become reversed biased and D655 and 656 become the lower half of the bridge circuit. D656 is switched by S652A to be in 'parallel' with C and D655 is switched by S652B in 'parallel' with D. The rectified output of either supply is filtered by C652 and C653. The external DC supply input is connected in at this point via D658 which isolates the input if it is below the rectified AC input and also prevents a reversed voltage from damaging the circuit. In a similar manner the battery is connected in via D657. It must be switched off by the battery pack switch when it is not required to operate the oscilloscope.

* Serial No's below 33291 only.

9.23 DC STABILISER.

The rectified AC or DC supplies are stabilised at 17. 5V by the regulator, U651, inverter drive stage Q652 and 653, emitter follower driver Q654 and series pass transistor Q655.

The 1C U651 is connected across the stabilised output, the reference voltage connects to the Inverting input whilst the Non-Inverting input picks up a voltage on the divider chain R655, RV651 and R656 connected across the stabilised output via switch S652A. Output voltage is adjusted by RV651. When S652 is switched to Charge, R656 is disconnected leaving D673, R657 and R652 to set the output voltage in conjunction with RV651 and R655 at 28V.

The output control voltage from U651 developed across R658 is applied to Q652 where it is inverted at the collector across R659 and connected to the base of emitter follower Q654. This stage in turn drives the series pass transistor Q655.

9.24 LOW VOLTAGE INDICATOR.

Q658 base drive is obtained from the divider R666 and R665 across Q655 and under normal operation Q658 is held in conduction pulling its collector up to the negative unregulated rail . This in turn via R662 pulls pin 3 non inverting input of U652op. amp negatively. The output at 6 follows and the front panel LED D691 lights by the current flowing through it via R670. If the unregulated input drops to less than 1.2V across Q655, Q658 becomes reversed biased allowing its collector to fall and pin 3 takes up a voltage set by divider R663, 664 and R669. The inverting input is connected back to the output through R668 and has capacitor C657 returned to the positive rail. If the output is latched negatively C657 will be charged negatively until it rises above pin 3 voltage. The 1C output will suddenly invert and settle near the positive rail. C663 will be charged in the opposite direction and when it reaches the voltage on pin 3 the state will be reversed. The front panel LED will be switched on and off by U652 at an approx. 1 sec rate until the correct input voltage is restored.

9.25 DC - DC CONVERTER .

All the DC supplies required by the oscilloscope are supplied through a DC to DC converter consisting of Q656 and 657 with transformer T652.

The push pull primary has separate feedback windings for Q656 and 657 and a starting base feed resistor R661. Both the base feed resistor and the centre tap of the collector winding is taken to S652A Use/Charge switch to the positive (0V) rail in the Use position. When Charge is selected the converter supply is disconnected.

The multiple secondary windings are rectified by high speed diodes to supply low and HI voltage windings and EHT. The CRT heater supply is not rectified. In the event of a short circuit on any rail the converter will turn off or squegg audibly.

The CRT modulator voltage is taken from the 55V rail ahead of D664, passed through R671 and then applied to the blanking circuit.

9.26 + AND -15V REGULATORS.

Additional filtering and regulation is provided for the + and -15V rails by regulator 1C's U681 and U682. Output voltage is adjusted by RV681 from the +15V and RV682 for the -15V rail. An additional CR filter R681/C681 is incorporated in the +117V rail to reduce ripple level.

9.27 BATTERY CHARGING.

With S652 switched to charge, the unregulated supply is +34V approx. The regulated supply is set by RV652 to +28V and is applied via D659 and then through R651 to the battery. Q651 has its base and emitter connected across R651 so that any current flow that causes more than 0.6 to 0.7V to appear across R651 will cause Q651 to conduct. It will pull the voltage at the inverting input of U651 negatively, reducing the output voltage of the regulator until the charging current is reduced to just maintain Q651 in conduction. A constant current is maintained to charge the battery until its own internal impedance reduces the current demand as it becomes fully charged.

9.28 CALIBRATOR.

Q701 and Q702 comprise a free running emitter coupled multivibrator operating at approximately 1kHz. The output voltage across R706 is limited in a positive direction (when Q702 cuts off) by the divider action of D701, R706 and RV701, the output calibration control. In a negative direction Q702 pulls the collector below ground, but D701 cuts off and the output signal swings between ground and approximately + 1.8V. 1V p-p output level is set by RV701.

10. ALIGNMENT AND MAINTENANCE.

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

1. Non operating.
2. Check input supply.
3. Check 117 - 235V input range switch.
4. Check fuses.
5. Check USE/CHARGE switch. Switch to USE.
6. Panel indicator OFF. Check through regulator.
7. Panel indicator ON. Audible buzzing indicates converter is overloaded.
8. Remove rear panel check 22kHz signal on rear panel transistors.
9. Check all voltage rails + 6 Red/White wire, +15 Yellow - 15 Violet, +116 Red.
10. Press trace find and check vertical and horizontal position.

A. TB OK. NO VERTICAL.

Switch to Ch. 1 if still faulty, Check Ch. 2

B. If one Ch. faulty check that input stage for unbalanced amplifier stages.

NOTE: Input FETS and transistors must be replaced as matched pairs in vertical amplifiers.

C. Check DC BAL adjust as on P25.

D. Both faulty check, delay line for O/C.

E. Check output drive stages for balance.

F. If correct through to deflection plates, check CRT.

i. VERTICAL OK. NO TIME BASE

Make sure Horz. Display switch is in 'A' only position and LEVEL knob is pushed in for AUTO.

ii. Press X-Y button only. Spot should be present and Horizontal position should move spot.

iii. If faulty check Horizontal Amp.

iv. If okay, check time base.

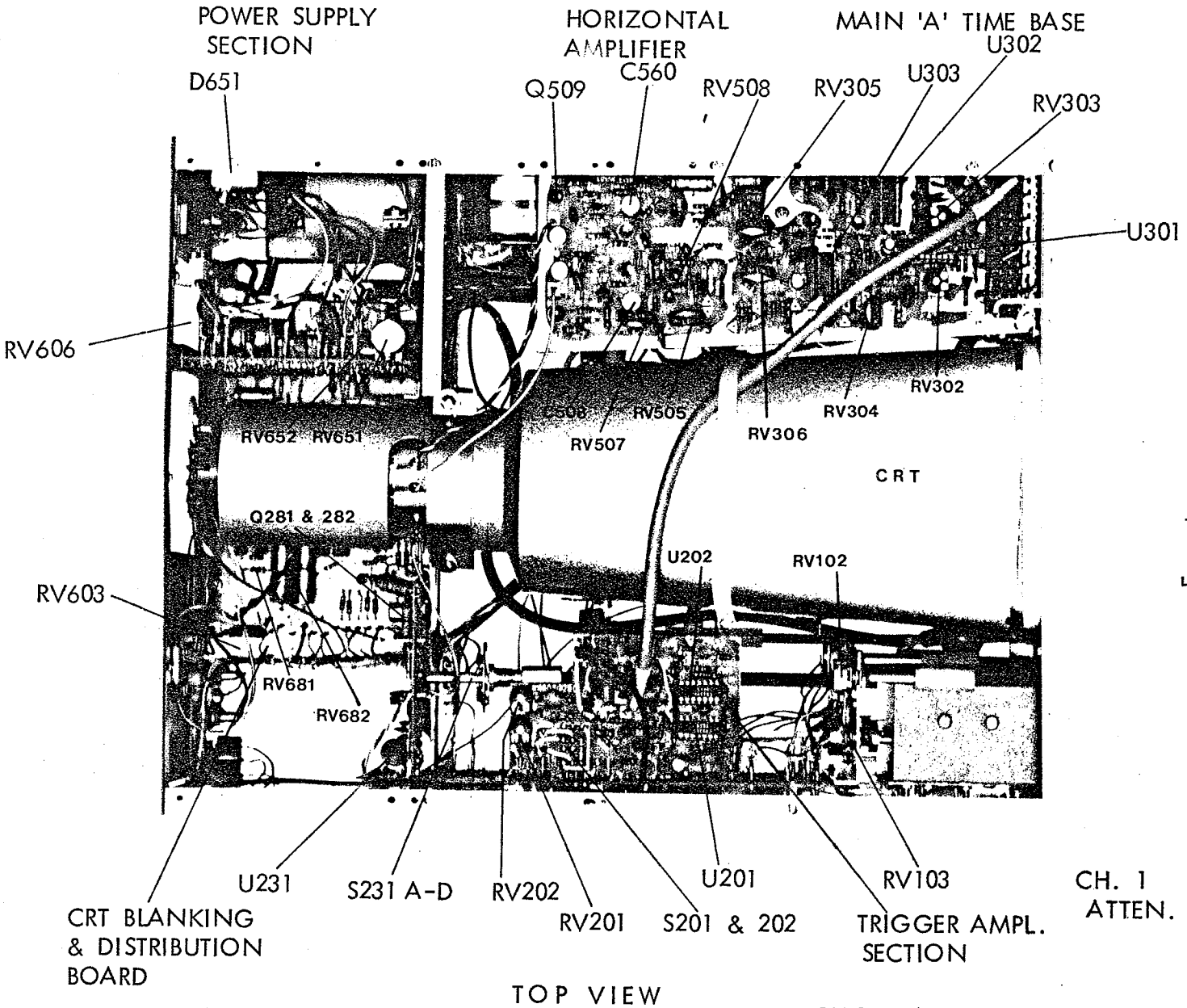
v. 'A' time base okay No. B. T.B. check comparator outputs when switched to INTENSIFIED.

vi. If okay, check B time base circuit.

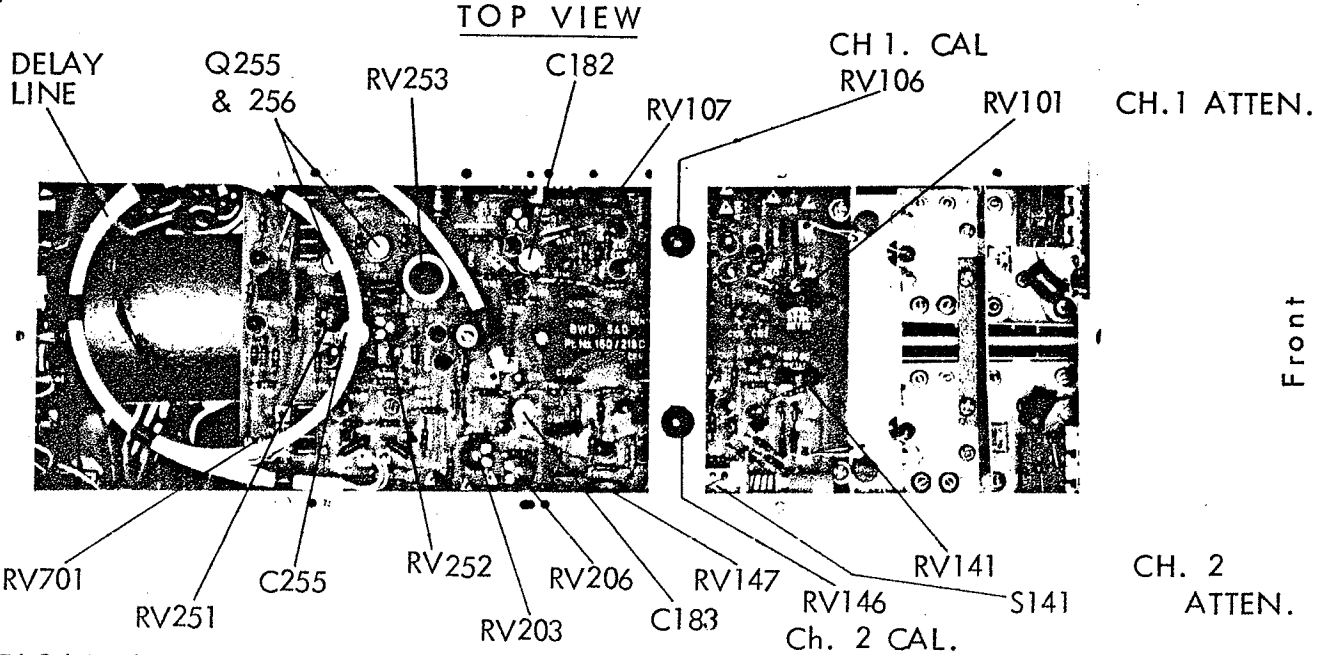
POWER SUPPLY

If faults are located in power supply board, it may be unplugged and slipped out of frame for access to all components. Short circuits to output of converter will cause circuit to shut down or emit an audible sound which indicates a fault condition.

bwd 540 COMPONENT LAYOUT

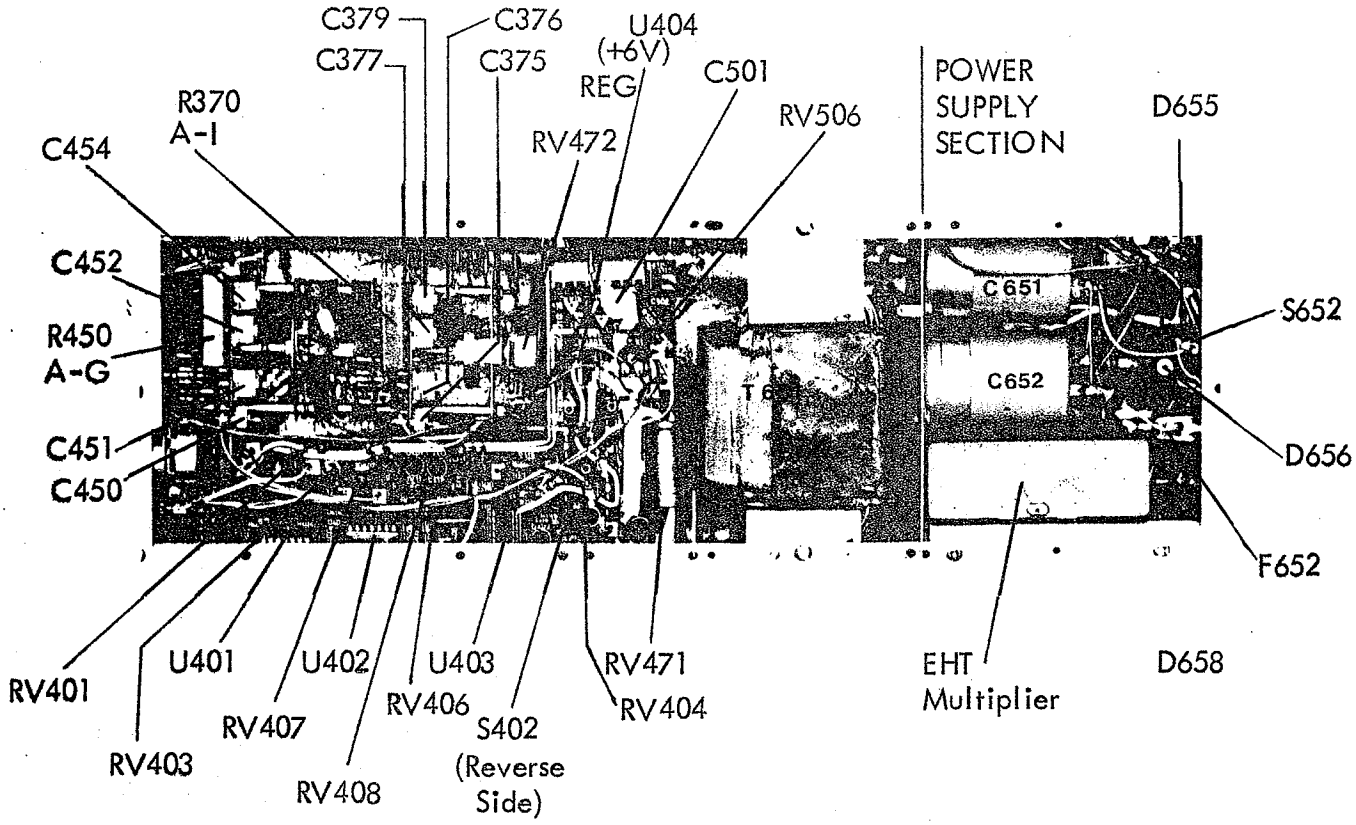


TOP VIEW

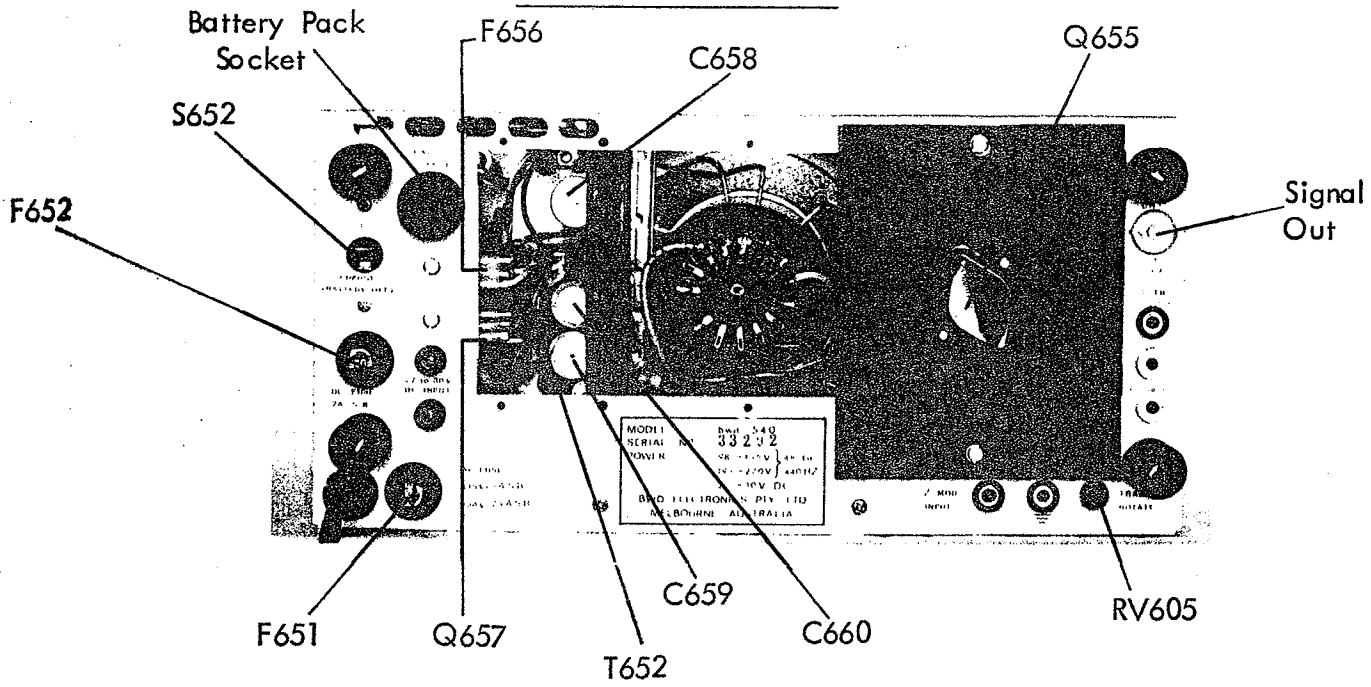


VERTICAL AMPLIFIER SECTION - L.H. SIDE VIEW

bwd 540 COMPONENT LAYOUT



L.H. SIDE VIEW



REAR VIEW

10.3 ALIGNMENT AND MAINTENANCE

The following details cover almost the entire factory alignment procedure, and will therefore allow realignment of any section following a component replacement or periodical recalibration. Only the section required for the service being performed should be followed, do not re-set other controls.

NOTE: To assist in checking voltages and tracing leads the following wire colours have been adopted:-

-15V Violet, ground - black, + 6V red/white,

+15V Yellow, + 116V red.

A.C. Power Line (before on/off switch) Brown - active, blue - neutral and yellow/green - ground.

A.C. Power after on/off switch. Brown/white and blue/white.

In the power supply/rectifier compartment at the rear red is positive (0V on circuit) and blue is negative (usually between -18V and -32V). All D.C. Measurements should be made with a 20,000 Ω/V meter or a DVM with > 10MΩ input impedance.

Oscilloscope waveforms are obtained using a 10:1 high impedance probe. Power line ripple can be checked with a 1:1 probe but in each case the ground lead must be used to minimise noise or interference.

To remove covers to obtain access, first remove all forms of power source from the instrument. The top cover is removed by unscrewing the two rear side screws and the front top screws. It is then pulled to the rear and upwards.

The bottom cover is removed by unscrewing the four feet and lifting off.

The rear panel slides from behind the heat sink when the four fixing screws are removed.

Internal shields are detached by removing the holding screws.

TEST EQUIPMENT

The following instruments are required for a full alignment. For most servicing requirements a meter, oscilloscope and signal source are sufficient.

Voltage Calibration from 5mV to 200V p-p at 1kHz. Square Wave output accuracy > 0.2%. Time Calibrator from 1Hz to 100MHz accuracy > 0.1%. 1 nano second rise time square wave 250mV p-p 1MHz rep. rate.

(All above instruments are available in a Bradley Model 192 Oscilloscope Calibrator). Low frequency oscillator 1Hz to 1MHz. (bwd 141 and 160 generators). generators). H.F. generator 50kHz to 100MHz constant amplitude output (Tek 191).
H.F. generator to 150MHz for trigger check. Oscilloscope 1mV to 20V/div sensitivity, time base to 100n Sec/div and triggering to > 50 MHz (bwd 540 or bwd 525).

10.4 ALIGNMENT AND CALIBRATION.

1. Power supplies. The converter type supply in the bwd 540 has a major advantage over multiple regulated supplies in that it will turn off all rails if a short or heavy load is placed across a rail or even between rails.

Under certain conditions it will squeg and emit a buzzing sound giving audible warning of a faulty condition.

(a) Initial resistance check, values shown are approximate +6V rail 600Ω, + 15V 400Ω, - 15 400Ω, +70 800Ω, +116 800Ω, - 1360V O/C. Across input filter capacitor 6K8. Red DC input terminal to chassis 10KΩ. Across a/c input 40Ω (235V) 20Ω (117V).

(b) Remove sockets on two MJE 3055 transistors on rear panel. Set USE/CHARGE switch to USE. Connect AC power input to a variable voltage transformer and increase input to 50V AC (235V input) 25V (117V input). Voltage a/c main filter cap approx. 6.5V. Approx. 5.5V across C 656 on Power Supply board.

Increase input to 100V AC (235) or 50V (117) voltages should increase to 12.5 and 12.2 respectively. Increase input to 200V (or 100V) and set voltage a/c C656 to 17.4V by RV651 at top of power supply board. 17.4V should remain constant to 270V AC (235V) or 125V (117V) input.

NOTE:

All above measurements can be made WRT the Red DC input terminal on rear panel which is the OV rail of the power supply, but is isolated (via 10K) from the chassis.

(c) Return input voltage to 0, switch to CHARGE. Follow above procedure.

AC input 50V. 9V a/c filter. 8.5V a/c C656
AC input 200V set RV652, For 29.5V a/c open circuit.

Check voltage remains constant up to 270V input. Connect a 1000Ω 1W resistor a/c battery socket pins and finally adjust RV 651 for 28V a/c the 1K resistor.

(d) Return AC input to 0V. Refit sockets on MJE 3055 transistors. Switch to USE. Connect an oscilloscope input to one MJE 3055 collector. Set scope attenuator to 0.5V/div, use 10:1 probe and TB set to 50μ Sec/div.

Increases AC input, at approx. 90V (235) or 45V (117) a trapesoidal waveform should appear on monitoring oscilloscope 3 div. high and 1 div./waveform.

Check all DC rails to verify diode and regulator operation.

+6V = 3V, +15V = 3.5V, =15V = 4.2V, +55V = +30, +117V = +55,
CRT cathode = -650V.

Continue increasing AC input and check each 50V (25V) that rails remain in step with each other. At 200V AC input (100V) + 55V should be correct. Set +15V by RV681 and -15V by RV682, located on rear lower P.C. Board. Check all voltages (other than P.D.A. which requires a special probe) and that converter signal is approx. 22kHz and 35V p-p on MJE 3055 collector.

VERTICAL INPUT AMPLIFIER.

(e) Set RV101 and RV141 at front of board for -0.1 between chassis and connections to Vernier controls. Set front panel DC balance control for zero volts across vernier control - control to CAL.

Check balance exists at each stage in each input amplifier, then adjust RV107 for 3.9V average to chassis on R124 and 125 and RV147 for 3.9V on R164 and 165.

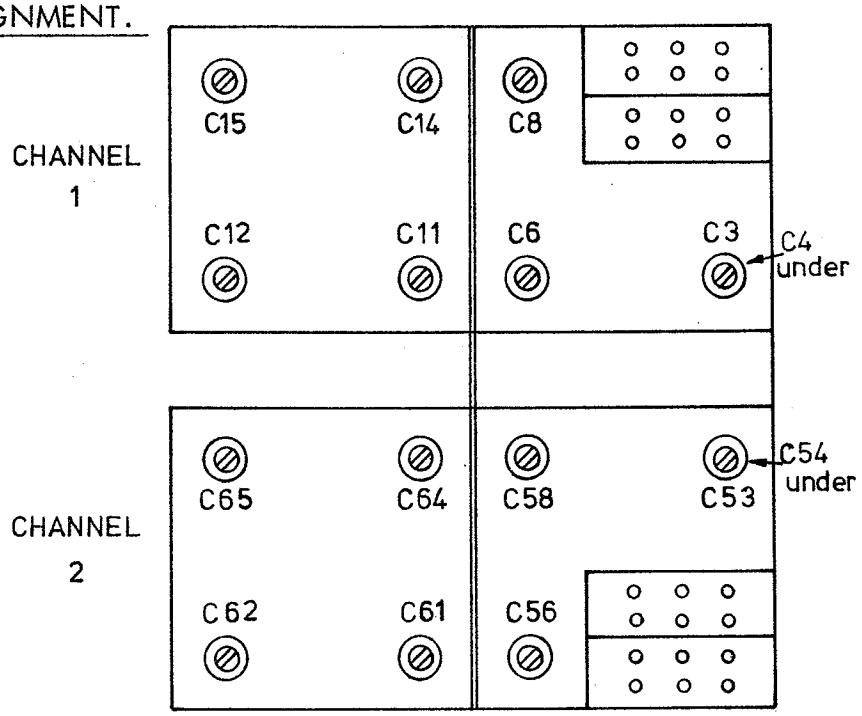
(f) VERTICAL OUTPUT AMPLIFIER.

Switch Vertical Display to Ch. 1 then check voltages through stages compared to circuit and finally set Q281 and 282 output stage collectors to +39V with RV253 average to chassis. Use position control to equalise voltages. Set RV105 to equalise trace movement above and below centre by position control .

Check channel 2 then centre trace by RV145.DC Balance is set by turning the vernier control counterclock, centre with position, turn vernier to CAL, recentre with DC bal, repeat as necessary.

(g) ATTENUATOR ALIGNMENT.

ATTENUATOR LAYOUT



Attenuator Step	Input Voltage	Response Adjustment		Input Capacitor Adj.	
		Ch. 1	Ch. 2	Ch. 1	Ch. 2
5mV	20mV	None	None	None	None
10mV	50mV	C12	C62	None	None
20mV	100mV	C15	C65	None	None
50mV	200mV	C8	C58	C6	C56
100mV	500mV	C11	C61	None	None
200mV	1V	C14	C64	None	None
.5V	2V	C4*	C54 *	C3	C53
1V	5V	None	None	None	None
2V	10V	None	None	None	None
5V	20V	None	None	None	None
10V	50V	None	None	None	None
20V	100V	None	None	None	None

*The slugs of C3 and C53 should be removed completely and an insulated adjustment tool used to set C4 and C54. C3 and C53 can now be replaced and set as described on page 49.

Two methods of input capacitance alignment are available as detailed below:-

(i) Measure input capacitance with instrument operating at 20mV attenuator setting, then adjust C6 (C56) at 50mV/div and C3 (C53) at 0.5V/div to equalise the input capacitance to the 20mV setting.

(ii) Connect a x10 probe (bwd P32) to the input socket. Set attenuator to 20mV, couple probe to a calibrator with 1V, 1kHz output, adjust probe compensation for optimum square wave. Now turn attenuator to 50mV step, increase input to 2V and adjust C6 (C56) for clean wave free of under or overshoot. Repeat at .5V with 20V input, adjust C3 and C53 for clean square wave.

(h) VERTICAL AMPLIFIER ALIGNMENT.

Select Ch. 1 set atten. at 50mV, Vernier to CAL. Set calibration with a 200mV 1% 1kHz square wave. Remove cal. signal and apply a 1MHz square wave with <1n Sec rise time. Set time base to 100mSec/div and square wave amplitude to produce 6 divs. vertical deflection.

RV252 affects the flatness along the top of the waveform and should be set first. R257 should be adjusted until the trace oscillates, then turn back slightly to eliminate oscillation but to leave a fast leading edge. C255 with RV251 controls the sharpness of the leading edge. RV281 and C282 control the shape for the best overall response to obtain widest bandwidth with minimum overshoot and ringing.

Change input from Ch. 1 to Ch. 2 and check result. Bandwidth should be measured by setting level to 6 div. deflec. at 50kHz or less and noting response does not fall below 4.2 div. at 100MHz at the 5mV attenuator sensitivity setting.

A small variation to equalise the response between channels can be made by adjustment of RV182 which compensates Ch. 2 amplifier.

(i) TIME BASE SECTION.

Switch Horz. Display to 'A'. 'A' T.B. range switch to 1mSec (leave 'B' T.B. range switch at .1μ Sec). Push LEVEL select into AUTO and turn fully clockwise. If time base is present proceed as next paragraph. If time base is not available, check voltage at R331 is + 4.7V and Q307 collector is ≈ +6V. Check voltages in accordance with circuits to find fault.

Time base output can be monitored on the second pin from the rear of the 8 pin interconnecting plug. With time base operating set bottom of waveform to +1V by RV305 and top of waveform at + 13V by RV306. The signal on the last pin of the plug should be approx. 80mV pp and the collectors of Q506 and 507 should swing about 80V pp on each.

(j) TRIGGER CIRCUIT.

Connect a DC coupled oscilloscope to co-ax cable output socket on top of trigger P.C. board attached to rear of main vert amplifier board. Select Ch. 1 trig - no input to amplifier. Set Ch. 1 trace to approx. screen centre. Adjust voltage displayed on monitor scope to zero by RV201. Switch trigger select button to Ch. 2, set voltage to zero by RV202.

Remove oscilloscope probe from co-ax connector, reconnect to Pin 1 of U301 (μA733) on time base board. With ALL trig select buttons out, set voltage on pin 1 to zero with RV303 along side the I.C. Change probe to pin 14 of U301, press ± button to - . Set voltage to zero with RV302. Next apply a 50kHz sine wave to Ch. 1, 4 div. amplitude, select Ch. 1 trigger and +ve polarity. Pull LEVEL knob OUT to non-Auto. With T.B. to 10μ Sec/div lock to signal. Verify operation of level control and ± switch - ensure Trigger Hold Off knob is clockwise and pushed IN. Remove input to Ch. 1 then adjust RV304 so that trace just fails to trigger at any position of LEVEL knob or ± button.

Reconnect input signal, reduce level to 3mm, it must be possible to still lock. Increase signal to 8 div. with amplifier vernier to CAL. Level select should operate over full range with either + or - selected.

(k) TIME BASE 'A' ALIGNMENT.

Set grey range knob to 1m Sec/div. Vernier to cal. Adjust RV506 (located near interconnecting plug and socket on vertical board (B time base) for a trace length of 10.8 div.

Apply 1m Sec timing pulse to Ch. 1 adjusted for say 3 div. deflection lock for a stable display. Adjust RV471 (bottom rear of vertical board) for 1 pulse/div.

Check calibration down to 1 sec/div. with appropriate timing pulses.

Turn range switch to 10μ Sec/div. adjust C379 on rear T.B. switch section for 1 pulse/div. with a 10μ Sec (100kHz) pulse input. Adjust following capacitors for remaining steps with appropriate input pulses.

.2μ S - C377, 0.1μSec - C376, 0.05μ Sec - C375.

(l) X10 MAGNIFIER.

Return T.B. to 1m Sec/div. Push X10 MAG button. Apply 0.1m Sec (10kHz) timing pulse. Adjust RV505 for 1 pulse/div. Reduce input timing pulse to 5mSec (2kHz). Position centre pulse on CRT centre line. Return to 1X MAG, adjust RV508 to centre pulse. Repeat until no movement occurs betwen X1 and X10 MAG. Next adjust RV503 for equal shift movement either side of centre.

Increase input pulse to 0.1μ Sec and T.B. to 1μ Sec. Adjust RV507 for best linearity over entire magnified trace. Increase input to 100MHz - pull out Trigger Hold Off knob to HF Trig for stable lock. Turn to 50μ S/div. and set C507, 51- and RV507 for best overal calibration/linearity over the top time base ranges.

(m) 'B' TIME BASE

Time Base Settings 'A' 1m Sec, 'B' 0.1 m Sec, X1 Mag and Multiplier on 5.

Turn Horz. Display to INTENSIFIED. Monitor B time base output at emitter of Q408. Adjust RV407 for start of sawtooth at +1V and top of waveform at + 13.5V by RV408.

Set start of intensified trace to align with first graticule line. Increase speed of B time base to 1μSec. Turn Delay Multiplier to 1.0. Align start of intensified section with No. 1 graticule line by RV406 on vertical board. Turn multi to 9.0, set with RV404 to align start of intensified portion on the 9th graticule line. Repeat if necessary to obtain correct setting and tracking.

Now turn Horz. Display to B. Delayed and Delay Time Position to 1. Turn 'A' to 2m Sec and 'B' to 1m Sec. Display a 1m Sec pulse, set first pulse against 0 graticule line with Delay Time Position. Adjust for calibration with RV407.

NOTE:

If calibration is more than 5% out before adjusting RV407 the FET'S Q310 in A T.B. and Q406 are not a matched pair and should be changed. A time base will require recalibrating if Q310 is changed.

Check calibration down to .2 sec/div. keeping the A time base range one or two steps slower than the B range. Now bring B T.B. lock to 10μ Sec (A on back 50μS). With 10μ Sec input adjust C454 or front time base switch section for calibration. Check following steps with appropriate input and adjust for calibration. 0.2μ Sec - C452, 0.1μ Sec C451, 0.05μ Sec C450.

(n) MIX DISPLAY.

Turn Display switch back to MIX to verify operation of this facility. No calibration is required.

(o) DELAY TRIGGER.

Set oscilloscope up as follows:-

Ch. 1 input 50kHz, 4 div. deflec. A time base .2m Sec/div., B TB 10μ Sec/div., Horz. Display to B trig delay by A, Delay Multi 5.0, B trigger to + and external.

Set voltage on wiper of RV401 to -2.5V with B level control centered. Next adjust sensitivity control RV403 so that trace put fails to free run when level control is turned with either ± polarity selected. Switch B trigger to Internal. Check trigger operation with Level Control. Control range should extend from below 0.5 div. to over 8 div. display for either + or - selection.

(p) Z MOD AND UNBLANKING AMPLIFIER.

Return Horz. display to A only. turn TB to 50 n Sec, display a 1MHz square wave or pulse. Trace brightness should be even across the trace at all intensity settings. Slight variation of the twisted wire capacitor on the underside of the bottom rear P.C. board will adjust the brightness to ensure leading edge of display is well defined. With the Intensity control knob pointer set to the first 'N' of INTENSITY, adjust RV606 for visual extinction.

Z Mod can be checked by feeding in a signal of 4V pp centred about ground into a vertical amplifier and the Z mod input. The top half of each waveform will be blanked out.

It will be noted that a phase difference occurs at frequencies above 3 or 4MHz due to the inclusion of the delay line in the vertical amplifier circuit. On the bwd 540 the phase delay is less than most oscilloscopes due to the shortness of the delay line.

(q) X-Y OPERATION.

Feed in 50kHz to Ch. 1 and Ch. 2 and adjust for 6 div. display with Vernier to CAL. Centre trace on screen, then select Ch. 1 for Vert. Display and press X-Y button. Centre trace horizontally by RV203. Without moving the horz. position control, press X10 mag. button, recentre trace with RV203 and set trace length to 6 div by RV204 (both controls on Vertical Amplifier board).

Now select Ch. 2 for vertical display to produce a 45^{o} line on CRT. Increase input frequency to 500kHz. Adjust C501 on B time base board for a straight line display.

(r) X5 CH. 1 GAIN.

Set Ch. 1 attenuator to 50mV/div. feed in 50mV p-p 1kHz square Wave. Press X5 gain button. Adjust RV181 for 5 div. display.

(s) CALIBRATOR.

Check calibration of Ch. 1 on 200mV range. Adjust Ch. 1 CAL preset if necessary for exact calibration. Connect a 1:1 probe from Ch. 1 to CAL socket. Set RV701 for 5 div. deflection.

(t) All other specification details can be checked by application of appropriate signal as required by the specification.

11. REPLACEMENT PARTS

Spares are normally available from the manufacturer, B.W.D. Electronics Pty. Ltd. When ordering, it is necessary to indicate the Model No. and Serial No. of the instrument. If exact replacements are not to hand, locally available alternatives may be used, provided they possess a specification not less than, or physical size not greater than the original components.

As the policy of B.W.D. Electronics Pty. Ltd., is one of continuing research and development, the Company reserves the right to supply the latest equipment and make amendments to circuit and parts without notice.

12. GUARANTEE

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

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

13. REPLACEMENT PARTS

13.1 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.

13.2 Ordering - Please quote Model Type No., e.g. bwd 540 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	U	Integrated circuit.
E	Misc. Elect. Part	Q	Transistor	V	Valve
F	Fuse	R	Resistor	VDR	Voltage Dependent Resistor.

ABBREVIATIONS

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

COMPONENT ABBREVIATIONS (Cont'd)

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

13.3 MANUFACTURERS ABBREVIATIONS

AB	A.B. Electronics U.K.
AEE	AEE Capacitors
AWA	Amalgamated Wireless of Aust.
A/C	Allied Capacitor
AMP	Aircraft Marine Products (Aust.) Pty. Limited
AR	A & R Transformers
AWV	Amalgamated Wireless Valve Co.
ACA	Amplifier Co. of Aust.
ALPS	Alps Electric Co. Limited.
BWD	B.W.D. Electronics Pty. Limited.
Bourne	Bourns Inc.
BR	Brentware (Vic.) Pty. Ltd.
BU	Bulgin
CF	Carr Fastener
CAN	Cannon Electrics Pty. Ltd.
CUN	R.H. Cunningham
DAR	Darston
ELNA	Elna Capacitors (Sonar Elec) Pty. Ltd.
ERIE	Erie Products Inc.
F	Fairchild Australia Pty. Ltd.
GRA	General Radio Agencies
GE	General Electric (USA)
GEC	General Electric Co. (U.K.)
GES	General Electronic Services
HW	Hurtle Webster
HOL	R.G. Holloway
H	Haco Distributors (National)
IRH	IRH Components Pty. Limited.
ITT	International Telephone & Telec.
J	Jobel
McH	McKenzie & Holland (Westinghouse)
MAS	Master Instrument Co. Pty. Ltd.
MOR	Morganite (Aust.) Pty. Ltd.
MSP	Manufacturers Special Products (AWA)
McM	McMurdo (Aust.) Pty. Ltd.
MOT	Motorola
NU	Nu Vu Pty. Limited.
NAU	A.G. Naunton Pty. Ltd.
NS	National Semiconductors
PA	Painton
PAL	Paton Elect. Pty. Ltd.
PI	Piher Resistors (Sonar Electronics)
PH	Philips Electrical Industries Pty. Ltd.
PL	Plessey Pacific
PRO	Procel
PV	Peaston Vic.
RCA	Radio Corporation of America.
STC	Standard Telephone & Cables
SI	Siemens Electrical Industries
SIM	Simonson Pty. Ltd.
SE	Selectronic Components
SON	Sonar Electronics
STET	Stettner Capacitors Limited.
TI	Texas Instruments Pty. Ltd.
TH	Thorn Atlas
V	Varo Semiconductor Inc.
W	Wellyn Resistors (Cannon Elec P/L)
WH	Westinghouse
Z	Zephyr Prod. Pty. Ltd.

13.4 PARTS LIST - MODEL BWD 540

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R1	33Ω	5%	1/4W	MG	IRH	RG 1/4
R2	990KΩ	1%	"	HS	IRH	
R3	56Ω	5%	"	MG	IRH	RG 1/4
R4	150Ω	5%	"	MG	IRH	RG 1/4
R5	10.1KΩ	1%	"	HS	IRH	
R6	900K	1%	"	HS	IRH	
R7	111K	1%	"	HS	IRH	
R8	10MΩ	10%	"	CC		
R9	47Ω	5%	"	MG	IRH	RG 1/4
R10	100K	1%	"	HS	IRH	
R11	1MΩ	1%	"	HS	IRH	
R12	750KΩ	1%	"	HS	IRH	
R13	333KΩ	1%	"	HS	IRH	
R14	33Ω	5%	"	MG	IRH	RG 1/4
R15	1MΩ	1%	"	HS	IRH	
R16	47Ω	5%	"	MG	IRH	RG 1/4
R17	150Ω	5%	"	MG	IRH	RG 1/4
R51	33Ω	5%	1/4W	MG	IRH	RG 1/4
R52	990KΩ	1%	"	HS	IRH	
R53	56Ω	5%	"	MG	IRH	RG 1/4
R54	10Ω	5%	"	MG	IRH	RG 1/4
R55	10.1KΩ	1%	"	HS	IRH	
R56	900KΩ	1%	"	HS	IRH	
R57	111KΩ	1%	"	HS	IRH	
R58	10MΩ	10%	"	CC		
R59	47Ω	5%	"	MG	IRH	RG 1/4
R60	500K	1%	"	HS	IRH	
R61	1MΩ	1%	"	HS	IRH	
R62	750KΩ	1%	"	HS	IRH	
R63	333KΩ	1%	"	HS	IRH	
R64	33Ω	5%	"	MG	IRH	R6 1/4
R65	1MΩ	1%	"	HS	IRH	
R66	47Ω	5%	"	MG	IRH	RG 1/4
R67	150Ω	5%	"	MG	IRH	RG 1/4
R101	200KΩ	5%	"	MG	IRH	RG 1/4
R102	10Ω	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R103	100Ω	5%	1/4W	MG	IRH	RG 1/4
R104	33Ω	5%	"	MG	IRH	RG 1/4
R105						
R106	2.7KΩ	5%	"	MG	IRH	RG 1/4
R107	2.7KΩ	5%	"	MG	IRH	RG 1/4
R108	390Ω	5%	"	MG	IRH	RG 1/4
R109	2.7KΩ	5%	"	MG	IRH	RG 1/4
R110	2.7KΩ	5%	"	MG	IRH	RG 1/4
R111	33Ω	5%	"	MG	IRH	RG 1/4
R112	47Ω	5%	"	MG	IRH	RG 1/4
R113	33Ω	5%	"	MG	IRH	RG 1/4
R114						
R115	6K8	5%	"	MG	IRH	RG 1/4
R116	6K8	5%	"	MG	IRH	RG 1/4
R117	2K2	5%	"	MG	IRH	RG 1/4
R118	2K2	5%	"	MG	IRH	RG 1/4
R119	560Ω	5%	"	MG	IRH	RG 1/4
R120	560Ω	5%	"	MG	IRH	RG 1/4
R121	150Ω	5%	"	MG	IRH	RG 1/4'
R122	150Ω	5%	"	MG	IRH	RG 1/4
R123	750Ω	2%	"	MG	IRH	RG 1/4
R124	22Ω	5%	"	MG	IRH	RG 1/4
R125	22Ω	5%	"	MG	IRH	RG 1/4
R126	270Ω	5%	"	MG	IRH	RG 1/4
R127	10Ω	5%	"	MG	IRH	RG 1/4
R128						
R129						
R141	220KΩ	5%	"	MG	IRH	RG 1/4
R142	100Ω	5%	"	MG	IRH	RG 1/4
R143	10Ω	5%	"	MG	IRH	RG 1/4
R144	33Ω	5%	"	MG	IRH	RG 1/4
R145	2.7KΩ	5%	"	MG	IRH	RG 1/4
R146	2.7KΩ	5%	"	MG	IRH	RG 1/4
R147	2.7KΩ	5%	"	MG	IRH	RG 1/4
R148	2.7KΩ	5%	"	MG	IRH	RG 1/4
R149	390Ω	5%	"	MG	IRH	RG 1/4
R150	33Ω	5%	"	MG	IRH	RG 1/4
R151	33Ω	5%	"	MG	IRH	RG 1/4
R152	22Ω	5%	"	MG	IRH	RG 1/4
R153	22Ω	5%	"	MG	IRH	RG 1/4
R154	6K8	5%	"	MG	IRH	RG 1/4
R155	6K8	5%	"	MG	IRH	RG 1/4
R156	2K2	5%	"	MG	IRH	RG 1/4
R157	2K2	5%	"	MG	IRH	RG 1/4
R158	560Ω	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg. or Supply	PART NO. OR ALTERNATIVE
R159	560Ω	5%	1/4W	MG	IRH	RG 1/4
R160	150Ω	5%	"	MG	IRH	RG 1/4
R161	150Ω	5%	"	MG	IRH	RG 1/4
R162	750Ω	2%	"	MG	IRH	RG 1/4
R163	10Ω	5%	"	MG	IRH	RG 1/4
R164	22Ω	5%	"	MG	IRH	RG 1/4
R165	22Ω	5%	"	MG	IRH	RG 1/4
R166	8.2KΩ	5%	"	MG	IRH	RG 1/4
R167	8.2KΩ	5%	"	MG	IRH	RG 1/4
R168	270Ω	5%	"	MG	IRH	RG 1/4
R169						
R181	56Ω	5%	"	MG	IRH	RG 1/4
R182	56Ω	5%	"	MG	IRH	RG 1/4
R183	470Ω	5%	"	MG	IRH	RG 1/4
R184	150Ω	5%	"	MG	IRH	RG 1/4
R185	56Ω	5%	"	MG	IRH	RG 1/4
R186	56Ω	5%	"	MG	IRH	RG 1/4
R187	150Ω	5%	"	MG	IRH	RG 1/4
R188	150Ω	5%	"	MG	IRH	RG 1/4
R189	75Ω	1%	"	MG	IRH	RG 1/4
R190	75Ω	1%	"	MG	IRH	RG 1/4
R191	1.5KΩ	5%	"	MG	IRH	RG 1/4
R192	1.5KΩ	5%	"	MG	IRH	RG 1/4
R193	68Ω	5%	"	MG	IRH	RG 1/4
R194	1.2KΩ	5%	"	MG	IRH	RG 1/4
R195	1.2KΩ	5%	"	MG	IRH	RG 1/4
R196	3.9KΩ	5%	"	MG	IRH	RG 1/4
R197	3.9KΩ	5%	"	MG	IRH	RG 1/4
R198	3.9KΩ	5%	"	MG	IRH	RG 1/4
R199	12KΩ	5%	"	MG	IRH	RG 1/4
R200	100Ω	5%	"	MG	IRH	RG 1/4
R201	1.2KΩ	5%	"	MG	IRH	RG 1/4
R202	100Ω	5%	"	MG	IRH	RG 1/4
R203	220Ω	5%	"	MG	IRH	RG 1/4
R204	100Ω	5%	"	MG	IRH	RG 1/4
R205	100Ω	5%	"	MG	IRH	RG 1/4
R206	220Ω	5%	"	MG	IRH	RG 1/4
R207	33Ω	5%	"	MG	IRH	RG 1/4
R208	47KΩ	5%	"	MG	IRH	RG 1/4
R209	47KΩ	5%	"	MG	IRH	RG 1/4
R210	33Ω	5%	"	MG	IRH	RG 1/4
R211	1KΩ	5%	"	MG	IRH	RG 1/4
R212	1KΩ	5%	"	MG	IRH	RG 1/4
R213	1.5KΩ	5%	"	MG	IRH	RG 1/4
R214	4.7KΩ	5%	"	MG	IRH	RG 1/4
R215	270Ω	5%	"	MG	IRH	RG 1/4
R216	100Ω	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R217	100Ω	5%	1/4W	MG	IRH	RG 1/4
R218	4.7KΩ	5%	"	MG	IRH	RG 1/4
R219	4.7KΩ	5%	"	MG	IRH	RG 1/4
R220	3.3KΩ	5%	"	MG	IRH	RG 1/4
R222	100Ω	5%	"	MG	IRH	RG 1/4
R223	100Ω	5%	"	MG	IRH	RG 1/4
R224	4.7KΩ	5%	"	MG	IRH	RG 1/4
R225	4.7KΩ	5%	"	MG	IRH	RG 1/4
R226						
R227						
R228						
R229						
R230	10kΩ	5%	"	MG	IRH	RG 1/4
R231	39KΩ	5%	"	MG	IRH	RG 1/4
R232	100Ω	5%	"	MG	IRH	RG 1/4
R233	12KΩ	5%	"	MG	IRH	RG 1/4
R234	8.2KΩ	5%	"	MG	IRH	RG 1/4
R235	22KΩ	5%	"	MG	IRH	RG 1/4
R236	39KΩ	5%	"	MG	IRH	RG 1/4
R237	100Ω	5%	"	MG	IRH	RG 1/4
R238	6.8KΩ	5%	"	MG	IRH	RG 1/4
R239	3.9KΩ	5%	"	MG	IRH	RG 1/4
R240	3.3KΩ	5%	"	MG	IRH	RG 1/4
R241	47Ω	5%	"	MG	IRH	RG 1/4
R242	56KΩ	5%	"	MG	IRH	RG 1/4
R243	100Ω	5%	"	MG	IRH	RG 1/4
R244						
R245	120K	5%	"	MG	IRH	RG 1/4
R246	150K	5%	"	MG	IRH	RG 1/4
R250						
R251	2.7KΩ	5%	"	MG	IRH	RG 1/4
R252	2.7KΩ	5%	"	MG	IRH	RG 1/4
R253	330Ω	5%	"	MG	IRH	RG 1/4
R254	330Ω	5%	"	MG	IRH	RG 1/4
R255	680Ω	5%	"	MG	IRH	RG 1/4
R256	680Ω	5%	"	MG	IRH	RG 1/4
R257	1.8KΩ	5%	"	MG	IRH	RG 1/4
R258	10Ω	5%	"	MG	IRH	RG 1/4
R259	10Ω	5%	"	MG	IRH	RG 1/4
R260	8.2KΩ	5%	"	MG	IRH	RG 1/4
R261	68Ω	5%	"	MG	IRH	RG 1/4
R262	68Ω	5%	"	MG	IRH	RG 1/4
R263	47Ω	5%	"	MG	IRH	RG 1/4
R264	47Ω	5%	"	MG	IRH	RG 1/4
R265	2K2	5%	"	MG	IRH	RG 1/4
R266	5K6	5%	"	MG	IRH	RG 1/4
R267	10K	5%	"	MG	IRH	RG 1/4
R268						
R269						

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R270	10Ω	5%	1/4W	MG	IRH	RG 1/4
R271	220Ω	5%	1W	MG	IRH	RG1
R280						
R281						
R282						
R283	15Ω	5%	1/4W	MG	IRH	RG 1/4
R284	15Ω	5%	"	MG	IRH	RG 1/4
R285	4.7KΩ	5%	"	MG	IRH	RG 1/4
R286	8.2KΩ	5%	1W	MG	IRH	RG1
R287	270Ω	5%	1W	MG	IRH	RG1
R288	220Ω	5%	1W	MG	IRH	RG1
R289	220Ω	5%	1W	MG	IRH	RG1
R290	270Ω	5%	1W	MG	IRH	RG1
R291	15KΩ	5%	1/4W	MG	IRH	RG 1/4
R292	18KΩ	5%	1/4W	MG	IRH	RG 1/4
R293	33KΩ	5%	1/4W	MG	IRH	RG 1/4
R294	330Ω	5%	1/4W	MG	IRH	RG 1/4
R295	330Ω	5%	1/4W	MG	IRH	RG 1/4
R296						
R297						
R298						
R299						
R300						
R301	680KΩ	5%	1/4W	MG	IRH	RG 1/4
R302	390KΩ	5%	"	MG	IRH	RG 1/4
R303	470KΩ	5%	"	MG	IRH	RG 1/4
R304	33Ω	5%	"	MG	IRH	RG 1/4
R305	10KΩ	5%	"	MG	IRH	RG 1/4
R306	270Ω	5%	"	MG	IRH	RG 1/4
R307	10KΩ	5%	"	MG	IRH	RG 1/4
R308	3.3KΩ	5%	"	MG	IRH	RG 1/4
R309	10K	5%	"	MG	IRH	RG 1/4
R310						
R311	VDR TYPE E299 DE/P226				PH	2322-553-226-1
R312	1KΩ	5%	"	MG	IRH	RG 1/4
R313	10Ω	5%	"	MG	IRH	RG 1/4
R314	270KΩ	5%	"	MG	IRH	RG 1/4
R315	270KΩ	5%	"	MG	IRH	RG 1/4
R316	150Ω	5%	"	MG	IRH	RG 1/4
R317	33Ω	5%	"	MG	IRH	RG 1/4
R318	33Ω	5%	"	MG	IRH	RG 1/4
R319	10KΩ	5%	"	MG	IRH	RG 1/4
R320	1K	5%	"	MG	IRH	RG 1/4
R321	470Ω	5%	"	MG	IRH	RG 1/4
R322	470KΩ	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R323	470KΩ	5%	1/4W	MG	IRH	RG 1/4
R324	2.2KΩ	5%	"	MG	IRH	RG 1/4
R325	1KΩ	5%	"	MG	IRH	RG 1/4
R326	100Ω	5%	"	MG	IRH	RG 1/4
R327	820Ω	5%	"	MG	IRH	RG 1/4
R328	100Ω	5%	"	MG	IRH	RG 1/4
R329	180Ω	5%	"	MG	IRH	RG 1/4
R330	470Ω	5%	"	MG	IRH	RG 1/4
R331	33Ω	5%	"	MG	IRH	RG 1/4
R332						
R333	33KΩ	5%	"	MG	IRH	RG 1/4
R334	56KΩ	5%	"	MG	IRH	RG 1/4
R335	1KΩ	5%	"	MG	IRH	RG 1/4
R336	1KΩ	5%	"	MG	IRH	RG 1/4
R337	1KΩ	5%	"	MG	IRH	RG 1/4
R338	10Ω	5%	"	MG	IRH	RG 1/4
R339	330Ω	5%	"	MG	IRH	RG 1/4
R340	680Ω	5%	"	MG	IRH	RG 1/4
R341	470Ω	5%	"	MG	IRH	RG 1/4
R342	100Ω	5%	"	MG	IRH	RG 1/4
R343	100Ω	5%	"	MG	IRH	RG 1/4
R344	680Ω	5%	"	MG	IRH	RG 1/4
R345	2K2	5%	"	MG	IRH	RG 1/4
R346	68KΩ	5%	"	MG	IRH	RG 1/4
R347	1KΩ	5%	"	MG	IRH	RG 1/4
R348						
R349	820Ω	5%	"	MG	IRH	RG 1/4
R350	10KΩ	5%	"	MG	IRH	RG 1/4
R351	2.2KΩ	5%	"	MG	IRH	RG 1/4
R352	150Ω	5%	"	MG	IRH	RG 1/4
R353	39KΩ	5%	"	MG	IRH	RG 1/4
R354	1KΩ	5%	"	MG	IRH	RG 1/4
R355	470Ω	5%	"	MG	IRH	RG 1/4
R356	1KΩ	5%	"	MG	IRH	RG 1/4
R357	8.2KΩ	5%	"	MG	IRH	RG 1/4
R358	150Ω	5%	"	MG	IRH	RG 1/4
R359	68KΩ	5%	"	MG	IRH	RG 1/4
R360	3.3KΩ	5%	"	MG	IRH	RG 1/4
R361	5.6KΩ	5%	"	MG	IRH	RG 1/4
R362	10Ω	5%	"	MG	IRH	RG 1/4
R363	10KΩ	5%	"	MG	IRH	RG 1/4
R364	33KΩ	5%	"	MG	IRH	RG 1/4
R368	33Ω	5%	"	MG	IRH	RG 1/4
R370A - I	Network resistor				bwd	010-001

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R400						
R401	22KΩ	5%	1/4W	MG	IRH	RG 1/4
R402	68Ω	5%	"	MG	IRH	RG 1/4
R403	3.3KΩ	5%	"	MG	IRH	RG 1/4
R404	100Ω	5%	"	MG	IRH	RG 1/4
R405	470Ω	5%	"	MG	IRH	RG 1/4
R406	820Ω	5%	"	MG	IRH	RG 1/4
R407	120Ω	5%	"	MG	IRH	RG 1/4
R408	820Ω	5%	"	MG	IRH	RG 1/4
R409	470Ω	5%	"	MG	IRH	RG 1/4
R410	150Ω	5%	"	MG	IRH	RG 1/4
R411	2.2KΩ	5%	"	MG	IRH	RG 1/4
R412	39KΩ	5%	"	MG	IRH	RG 1/4
R413	15KΩ	5%	"	MG	IRH	RG 1/4
R414	10Ω	5%	"	MG	IRH	RG 1/4
R415	10Ω	5%	"	MG	IRH	RG 1/4
R416	100KΩ	5%	"	MG	IRH	RG 1/4
R417	330Ω	5%	"	MG	IRH	RG 1/4
R418	330Ω	5%	"	MG	IRH	RG 1/4
R419	6.8K	5%	"	MG	IRH	RG 1/4
R420						
R421	15KΩ	5%	"	MG	IRH	RG 1/4
R422	2.2KΩ	5%	"	MG	IRH	RG 1/4
R423	1KΩ	5%	"	MG	IRH	RG 1/4
R424	1KΩ	5%	"	MG	IRH	RG 1/4
R425	470Ω	5%	1W	MG	IRH	RG 1
R426	82KΩ	5%	"	MG	IRH	RG 1/4
R427	33KΩ	5%	"	MG	IRH	RG 1/4
R428	2.2KΩ	5%	"	MG	IRH	RG 1/4
R429	150Ω	5%	"	MG	IRH	RG 1/4
R430	68KΩ	5%	"	MG	IRH	RG 1/4
R431	4.7KΩ	5%	"	MG	IRH	RG 1/4
R432	150Ω	5%	"	MG	IRH	RG 1/4
R433	8.2KΩ	5%	"	MG	IRH	RG 1/4
R434	68KΩ	5%	"	MG	IRH	RG 1/4
R435	150Ω	5%	"	MG	IRH	RG 1/4
R436	3.9KΩ	5%	"	MG	IRH	RG 1/4
R437	5.6KΩ	5%	"	MG	IRH	RG 1/4
R438	6.8K	5%	"	MG	IRH	RG 1/4
R450A-G	Network Resistors				BWD	010-001
R471	33Ω	5%	"	MG	IRH	RG 1/4
R472	6.8KΩ	5%	"	MG	IRH	RG 1/4
R473	1KΩ	5%	"	MG	IRH	RG 1/4
R474	10KΩ	5%	"	MG	IRH	RG 1/4
R501	3.3KΩ	5%	"	MG	IRH	RG 1/4
R502	15KΩ	5%	"	MG	IRH	RG 1/4
R503	150KΩ	5%	"	MG	IRH	RG 1/4
R504	15KΩ	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R505	22KΩ	5%	1/4W	MG	IRH	RG 1/4
R506						
R507						
R508	1K2	5%	"	"		
R509	22KΩ	5%	"	MG	IRH	RG 1/4
R510	5K6	5%	"	MG	IRH	RG 1/4
R511	33Ω	5%	"	MG	IRH	RG 1/4
R512	1.5KΩ	5%	"	MG	IRH	RG 1/4
R513	5.6KΩ	5%	"	MG	IRH	RG 1/4
R514	33Ω	5%	"	MG	IRH	RG 1/4
R515	270Ω	5%	"	MG	IRH	RG 1/4
R516	3.3KΩ	5%	"	MG	IRH	RG 1/4
R517	33Ω	5%	"	MG	IRH	RG 1/4
R518	100Ω	5%	"	MG	IRH	RG 1/4
R519	10Ω	5%	"	MG	IRH	RG 1/4
R520	36KΩ	5%	"	MG	IRH	RG 1/4
R521	27KΩ	5%	"	MG	IRH	RG 1/4
R522	1KΩ	5%	"	MG	IRH	RG 1/4
R523	1KΩ	5%	"	MG	IRH	RG 1/4
R524	68KΩ	5%	"	MG	IRH	RG 1/4
R525	5.6KΩ	5%	"	MG	IRH	RG 1/4
R526	68Ω	5%	"	MG	IRH	RG 1/4
R527	27KΩ	5%	"	MG	IRH	RG 1/4
R528	2K7Ω	5%	"	MG	IRH	RG 1/4
R529	1.5KΩ	5%	"	MG	IRH	RG 1/4
R530	470Ω	5%	"	MG	IRH	RG 1/4
R531	2.7KΩ	5%	"	MG	IRH	RG 1/4
R532	1Ω	5%	"	MG	IRH	RG 1/4
R533	1KΩ	5%	"	MG	IRH	RG 1/4
R534	2.7KΩ	5%	"	MG	IRH	RG 1/4
R535	1Ω	5%	"	MG	IRH	RG 1/4
R536	1KΩ	5%	"	MG	IRH	RG 1/4
R537	470Ω	5%	"	MG	IRH	RG 1/4
R538	2K7	5%	"	MG	IRH	RG 1/4
R539	10Ω	5%	"	MG	IRH	RG 1/4
R540	10K	5%	"	MG	IRH	RG 1/4
R541	560Ω	5%	"	MG	IRH	RG 1/4
R542	36KΩ	1 or 2%	"	MG	IRH	RG 1/4
R600	47K	5%	"	MG	IRH	RG 1/4
R601	15K	5%	"	MG	IRH	RG 1/4
R602	1KΩ	5%	"	MG	IRH	RG 1/4
R603	6K2	1%	"	MG	IRH	RG 1/4
R604	4.7KΩ	5%	"	MG	IRH	RG 1/4
R605	6K2	5%	"	MG	IRH	RG 1/4
R606	47Ω	5%	"	MG	IRH	RG 1/4
R607	6.8KΩ	5%	"	MG	IRH	RG 1/4
R608	1K5	5%	"	MG	IRH	RG 1/4

PARTS LIST MODEL BWD 540 (continued)

CCF Ref.	DESCRIPTION	Mfg or Supply	PART NO. OR ALTERNATIVE
RV181	50Ω Lin Preset	PI	PT 10V
RV182			
RV201	25KΩ Lin Preset	PI	PT 10V
RV202	25KΩ Lin Preset	PI	PT 10V
RV203	5KΩ Lin Preset	PI	PT 10V
RV204	5KΩ Lin Preset	PI	PT 10V
RV251	500Ω Lin Preset	SON	VTP
RV252	1KΩ Lin Preset	PI	PT 10V
RV253	100Ω Lin Preset WW	DAR	P109/6
RV281	100Ω Lin Preset	PI	PT 10V
RV301	10KΩ Lin Carbon Push-Pull switch pot	ALPS	VM13A-5M3121 (S10KB)
RV302	10KΩ Lin Preset	PI	PT 10V
RV303	10KΩ Lin Preset	PI	PT 10V
RV304	5K Lin Preset	SON	VTP
RV305	2K Lin Preset	SON	VTP
RV306	1K Lin Preset	PI	PT 15H
RV307	10KΩ Lin Carbon Push-Pull switch pot	ALPS	VM13A-5M3121 (S10KB)
RV401	1KΩ Lin Preset	PI	PT 15H
RV402	10KΩ Lin Push-Pull switch pot	ALPS	VM13A-5M3121 (S10KB)
RV403	500Ω Lin Preset	PI	PT 15H
RV404	5KΩ Lin Preset	SON	VTP
RV405	10KΩ Lin 10 turn pot WW	Bourne	3507
RV406	1KΩ Lin Preset	SON	VTP
RV407	2KΩ Lin Preset	SON	VTP
RV408	1K Lin Preset	PI	PT 15H
RV471	5KΩ Lin Preset	SON	VTP
RV472	10KΩ Lin Preset	PI	PT 15H
RV501			
RV502			

CCF Ref.	DESCRIPTION					Mfg or Supply	PART NO. OR ALTERNATIVE
RV503	20KΩ	Lin	Preset			PI	PT 15H
RV504	10KA/100KA	Dual Concentric pot				IRH	CT 45
RV505	100Ω	Lin	Preset			PI	PT 15H
RV506	2KΩ	Lin	Preset			SON	VTP
RV507	1KΩ	Lin	Preset			PI	PT 15H
RV508	200Ω	Lin	Preset			PI	PT 15H
RV601	10KΩ	Lin	Carbon rotary switch pot			PH	
RV602	2.5MΩ	Lin	Carbon			ELNA	
RV603	500KΩ	Lin	Preset			PI	PT 15H
RV604	100KΩ	Lin	Preset			PI	PT 15H
RV605	5K	Lin	WW			DAR	P122
RV606	20K	Lin	Preset			SON	VTP
RV651	1KΩ	Lin	Preset			SON	VTP
RV652	2KΩ	Lin	Preset			PI	PT 15H
RV681	1KΩ	Lin	Preset			PI	PT 15H
RV682	1KΩ	Lin	Preset			PI	PT 15H
RV691	50Ω	Lin	W.W.			DAR	P121
RV701	2KΩ	Lin	Preset			SON	VTP
	CAPACITORS.						
C1	0.1μF	630V	10%		PYE	ELNA	TYPE N
C2	3p3	630V	±.5pf	NPO	CER		
C3	1-12pF	Trim			CER	PH	2222/801/20008
C4	0.5 -3pF	Trim			CER	PH	2222/801/96003
C5	220pF	Button Mica capacitor				ERIE	654 - 017
C6	1-12pF	Trim			CER	PH	2222/801/20008
C7	3.3pF	630V	±.25pf	NPO	CER		
C8	1-12pf	Trim			CER	PH	2222/801/20008
C9	6.8pF	630V	±.5pf	NPO	CER		
C10	10pF	630V	± 1pf	NPO	CER		
C11	0.5-3pf	Trim			CER	PH	2222/801/96003
C12	0.5-3pF	Trim					

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R609	10KΩ	5%	1/4W	MG	IRH	RG 1/4
R610	18KΩ	5%	"	MG	IRH	RG 1/4
R611	27KΩ	5%	"	MG	IRH	RG 1/4
R612	560Ω	5%	"	MG	IRH	RG 1/4
R613	2.2KΩ	5%	"	MG	IRH	RG 1/4
R614	1KΩ	5%	"	MG	IRH	RG 1/4
R615	6.8KΩ	5%	"	MG	IRH	RG 1/4
R616	8.2MΩ	5%	1W	MG	IRH	RG 1/4
R617	1.5MΩ	5%	1/4W	MG	IRH	RG 1/4
R618	10MΩ	5%	"	MG	IRH	RG 1/4
R619	10KΩ	5%	"	MG	IRH	RG 1/4
R620	33K	5%	"	MG	IRH	RG 1/4
R621	270K	5%	"	MG	IRH	RG 1/4
R622	820K	5%	1W	MG	IRH	RG 1/4
R623	12K	5%	1/4W	MG	IRH	RG 1/4
R624	22K(Nom.Val)		Selected			
R625	1K5	5%	1/4W	MG	IRH	RG 1/4
R651	0.5Ω	5%	1W	WW	Merlin	
R652	1KΩ	5%	1/4W	MG	IRH	RG 1/4
R653	3.3KΩ	5%	"	MG	IRH	RG 1/4
R654	1KΩ	5%	"	MG	IRH	RG 1/4
R655	3.3KΩ	5%	"	MG	IRH	RG 1/4
R656	4.7KΩ	5%	"	MG	IRH	RG 1/4
R657	560Ω	5%	"	MG	IRH	RG 1/4
R658	4.7KΩ	5%	"	MG	IRH	RG 1/4
R659	1KΩ	5%	"	MG	IRH	RG 1/4
R660	1.8KΩ	5%	"	MG	IRH	RG 1/4
R661	4.70Ω	5%	"	MG	IRH	RG 1/4
R662	4.7KΩ	5%	"	MG	IRH	RG 1/4
R663	330KΩ	5%	"	MG	IRH	RG 1/4
R664	330KΩ	5%	"	MG	IRH	RG 1/4
R665	5.6KΩ	5%	"	MG	IRH	RG 1/4
R666	4.7KΩ	5%	"	MG	IRH	RG 1/4
R667	27Ω	5%	"	MG	IRH	RG 1/4
R668	100KΩ	5%	"	MG	IRH	RG 1/4
R669	39KΩ	5%	"	MG	IRH	RG 1/4
R670	1.5KΩ	5%	"	MG	IRH	RG 1/4
R671	10KΩ	5%	1W	MG	IRH	RG1
R672	6K8	5%	1/4W	MG	IRH	RG 1/4
R673	120KΩ	5%	"	MG	IRH	RG 1/4
R674						
R675	120K	5%	"	MG	IRH	RG 1/4
R681	33Ω	5%	"	MG	IRH	RG 1/4
R682	10KΩ	5%	"	MG	IRH	RG 1/4
R683	4.7KΩ	5%	"	MG	IRH	RG 1/4
R684	1.8KΩ	5%	"	MG	IRH	RG 1/4
R685	12KΩ	5%	"	MG	IRH	RG 1/4
R686	1Ω	5%	"	MG	IRH	RG 1/4

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
R687	1Ω	5%	1/4W	MG	IRH	RG 1/4
R688						
R689	10Ω	5%	"	MG	IRH	RG 1/4
R691	10Ω	5%	"	MG	IRH	RG 1/4
R701	8.2KΩ	5%	"	MG	IRH	RG 1/4
R702	22KΩ	5%	"	MG	IRH	RG 1/4
R703	27KΩ	5%	"	MG	IRH	RG 1/4
R704	270KΩ	5%	"	MG	IRH	RG 1/4
R705	33KΩ	5%	"	MG	IRH	RG 1/4
R706	22KΩ	5%	"	MG	IRH	RG 1/4
R707	22KΩ	5%	"	MG	IRH	RG 1/4
R708						
R751	1KΩ	5%	"	MG	IRH	RG 1/4
R752						
R753	6K8	5%	"	MG	IRH	RG 1/4
R754	3.3KΩ	5%	"	MG	IRH	RG 1/4
R755	33Ω	5%	"	MG	IRH	RG 1/4
R756	56Ω	5%	"	MG	IRH	RG 1/4
	POTENTIOMETERS.					
RV101	2KΩ	Lin	Preset		PI	PT 15H
RV102	500Ω	Lin.	Carbon		IRH	CTS 200
RV103	5KΩ	Lin	Carbon		IRH	CTS 200
RV104	10K	Lin	Carbon		SON	VMU
RV105	500Ω	Lin	Preset		SON	VTP
RV106	100Ω	Lin	Preset		SON	VTP
RV107	200Ω	Lin	Preset		PI	PT 15H
RV141	2KΩ	Lin	Preset		PI	PT 15H
RV142	500Ω	Lin	Carbon		IRH	CTS 200
RV143	5KΩ	Lin	Carbon		IRH	CTS 200
RV144	10K	Lin	Carbon		SON	VMU
RV145	500Ω	Lin	Preset		SON	VTP
RV146	100Ω	Lin	Preset		SON	VTP
RV147	200Ω	Lin	Preset		PI	PT 15H

CCF Ref.	DESCRIPTION					Mfg. or Supply	PART NO. OR ALTERNATIVE
C13	4.7pF	630V	±.5pf	NPO	CER		
C14	0.5-3pF	Trim			CER	PH	2222/801/96003
C15	1-12pF	Trim			CER	PH	2222/801/20008
C16	4p7	630V	±.5pf	NPO	CER		
C17	3p3	630V	±.5pf	NPO	CER		
C18	1pf	630V	±10%	NPO	CER		
C51	0.1µF	630V	10%		PYE	ELNA	TYPE N
C52	3p3	630V	±.5pf	NPO	CER		
C53	1-12pF	Trim			CER	PH	2222/801/20008
C54	0.5-3pF	Trim			CER	PH	2222/801/96003
C55	220pF	Button mica capacitor				ERIE	654 - 017
C56	1-12pF	Trim			CER	PH	2222/801/20008
C57	3.3pF	630V	±.25pf	NPO	CER		
C58	1-12pF	Trim			CER	PH	2222/801/20008
C59	6.8pF	630V	±.5pf	NPO	CER		
C60	10pF	630V	± 1pf	NPO	CER		
C61	0.5-3pF	Trim			CER	PH	2222/801/96003
C62	0.5 -3pF	Trim			CER	PH	2222/801/96003
C63	4.7pF	630V	±.5pf	NPO	CER		
C64	0.5-3pF	Trim			CER		2222/801/96003
C65	1-12pF	Trim			CER		2222/801/20008
C67	3p3	630V	±.5pf	NPO	CER		
C68	1pF	630V	±10%	NPO	CER		
C101	2.2nF	630V	20%		CER		
C102	10µF	16V			TA	GES/ ITT	TAD/TAG
C103	10µF	16V			TA	"	TAD/TAG
C104	18pF	630V	±5%	NPO	CER		
C105	10µF	16V			TA	GES/ ITT	TAD/TAG
C106	100nF	63V		HI -K	CER		
C107	100nF	63V		HI -K	CER		
C108	1nF	630V	10%		CER		
C109							
C141	2.2nF	630V	20%		CER		
C142	10µF	16V			TA	"	TAD/TAG
C143	10µF	16V			TA	"	TAD/TAG
C144	100nF	63V		HI-K	CER		
C145	22pF	630V	5%	NPO	CER		
C146	100nF	63V		HI-K	CER		
C147	100nF	63V		HI-K	CER		
C148							

CCF Ref.	DESCRIPTION					Mfg or Supply	PART NO OR ALTERNATIVE
C182	1-5pF	Trim			PYS	PH	2222-808-00004
C183	1-5pF	Trim			PYS	PH	2222-808-00004
C184	3p3	630V	10%	NPO	CER		
C185	3p3	630V	10%	NPO	CER		
C186	1pf	630V	10%	NPO	CER		
C201	100nF	63V		HI-K	CER		
C202	100nF	63V		HI-K	CER		
C203	100nF	63V		HI-K	CER		
C204	68pF	630V	5%	NPO	CER		
C205	10nF	630V	±1pF	NPO	CER		
C206	22µF	16V			TA	GES/ ITT	TAD/TAG
C207	22µF	16V			TA	"	TAD/TAG
C208	22µF	16V			TA	"	TAD/TAG
C209	100nF	63V		HI-K	CER		
C210							
C211							
C212	10pF	630V	±1pF	NPO	CER		
C231	10pF	630V	5%	NPO	CER		
C232	18pF	630V	5%	NPO	CER		
C233	18pF	630V	5%	NPO	CER		
C234	18pF	630V	5%	NPO	CER		
C235	18pF	630V	5%	NPO	CER		
C236	100nF	63V		HI-K	CER		
C237							
C238							
C251	100nF	63V		HI-K	CER		
C252	68pF	630V	5%	NPO	CER		
C253	1nF	10%	100V		PYE	ELNA	TYPE N
C254	10pF	630V	5%	NPO	CER		
C255	4-20pF	Trim			CER	STET	10S-06-4-20
C256	33pF	630V	5%	NPO	CER		
C257	47nF	100V	10%		PYE	ELNA	TYPE N
C258	100nF	63V		HI-K	CDS		
C259	100µF	10V			ELEC	PH	2222-015-14101
C260	100nF	63V		HI-K	CER		
C281	22pF	630V	5%	NPO	CER		

CCF Ref.	DESCRIPTION					Mfg or Supply	PART NO. OR ALTERNATIVE
C282	4-20pF				CER	STET	105-06-4-20
C301	1.5pF	500V	±.25pF	NPO	CER		
C302	4.7µF	35V			TA	GES/ ITT	TAD/TAG
C303	4.7µF	35V			TA	"	TAD/TAG
C304	1nF	630V	10%		CER		
C305	10nF	63V		HI-K	CER		
C306	6.8pF	630V					
C307	3p3	500V	±.25pF		CER		
C308	100nF	63V		HI-K	CER		
C309	100nF	63V		HI-K	CER		
C310	100nF	63V		HI-K	CER		
C311	0.1µF	100V	10%		PYE	ELNA	TYPE N
C312	100nF	63V		HI-K	CER		
C313	100nF	63V		HI-K	CER		
C314	56pF	500V	5%	N750	CER		
C315	100µF	10V		Electro		PH	2222-015-14101
C316	10nF	63V		HI-K	CER		
C317	10nF	630V	10%		CER		
C318	4.7µF	35V			Ta	GES/ ITT	TAD/TAG
C319	150µF	16V			Elec	PH	2222-015-15151
C320	220pF	630V	20%		CER		
C321	680pF	630V	20%		CER		
C322							
C323	33pF	630V	5%	N750	CER		
C324	68pF	630V	5%	N750	CER		
C325	100nF	63V		HI-K	CER		
C326	150µF	16V			Elec	PH	2222-016-15151
C327	100nF	63V		HI-K	CER		
C328	100nF	63V		HI-K	CER		
C329	10µF	16V			TA	GES/ ITT	TAD/TAG
C330	1nF	63V		HI-K	CER		
C369	0.68µF	16V			TA	"	TAD/TAG
C370	10µF	16V			TA	"	TAD/TAG
C371	390pF	630V	5%		PYS	A/C	
C372	680pF	630V	5%		PYS	A/C	
C373	3.3nF	100V	5%		PYE	ELNA	TYPE N
C374	100nF	100V	5%		PYE	ELNA	TYPE N
C375	2-10pF	Trim			PYS	PH	2222-808-00005
C376	4-20pF	Trim			CER	STET	10S-06-4-20
C378	10-40pF	Trim			CER	"	10S-06-10-40
C379	10-40pF	Trim			CER	"	10S.06-10-40

CCF	DESCRIPTION					Mfg or Supply	PART NO. OR ALTERNATIVE
C380	10nF	250V	1%		PYE	SI	B32541
C381	1µF	100V	1%		PYE	SI	B32541
C401	10nF	63V		HI-K	CER		
C402	100nF	63V		HI-K	CER		
C403	10µF	16V			TA	GES/	TAD/TAG
C404	10µF	16V			TA	"	
C405	10µF	16V			TA	"	TAD/TAG
C406	100nF	63V		HI-K	CER		
C407	22pF	500V	5%	N330	CER		
C408	100nF	63V		HI-K	CER		
C409	330pF	630V	20%		CER		
C410	33pF	630V	5%	N750	CER		
C411							
C412	10pF	500V	10%	NPO	CER		
C413	150pF	630V	20%		CER		
C414	10µF	16V			TA	GES/ ITT	TAD/TAG
C415	33pF	630V	5%	N750	CER		
C416	68pF	630V	5%	N750	CER		
C417	10µF	16V			TA	"	TAD/TAG
C418							
C419							
C450	2-10pF	Trim			PYS	PH	2222-808-00005
C451	4-20pF	Trim			CER	STET	10S-06-4-20
C452	10-40pF	Trim			CER	STET	10S-06-10-40
C453	68pF	630V	5%	N750	CER		
C454	10-40pF	Trim			CER	STET	10S-06-10-40
C455	10nF	250V	1%		PYE		
C456	1µF	100V	1%		PYE	SI	B38541
C471	1000µF	16V			Elec	PH	2222-017-15102
C500							
C501	10-40pF	Trim			CER		10S-06-10-40
C502	100nF	63V		HI-K	CER		
C503	1pF	630V	±.1pF	NPD	CDS		
C504	150µF	16V			Elec	PH	2222-016-15151
C505	2p2	630V	±.25pf	NPO	CER		
C506	10µF	16V			TA	GES/ ITT	TAD/TAG

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
C507	10µF	16V		TA	GES/ ITT	TAD/TAG
C508	1-5pF	Trim		PYS		2222-808-00004
C509	1.5pF	630V	±.25pf NPO	CER		
C510	1-5pF	Trim		PYS		2222-803-00004
C511	1.5pF	630V	±.25pf NPO	CER		
C512	10nF	630V		PYE	ELNA	TYPE N
C513	100nF	100V		PYE	ELNA	TYPE N
C514	2.2nF	630V	20%	CER		
C515	470pF	630V	20%	CER		
C516	100nF	63V	HI-K	CER		
C601	100nF	63V	HI-K	CER		
C602	1nF	630V	10%	CER		
C603	10nF	630V	10%	PYE	ELNA	TYPE N
C604	33nF	1600V	Polycarb			2222-341-81333
C605	33nF	1600V	Polycarb		PH	2222-341-81333
C606	10nF	2500V		CER		
C607	1nF	2000V		CER		
C608	100nF	630V	10%	PYE	ELNA	TYPE N
C609	100nF	63V	HI-K	CER		
C649	10nF	260V	AC	MP	AEE	PME271M510
C650	10nF	260V	AC	MP	AEE	PME271M510
C651	2500µF	63V		Elec	ELNA	TYPE RG
C652	2500µF	63V		Elec	ELNA	TYPE RG
C653						
C654	1nF	630V		CER	ELNA	TYPE N
C655	100µF	25V		Elec	PH	2222-016-16101
C656	680µF	40V		Elec	PH	2222-017-17681
C657	1µF	35V		TA	GES/ ITT	TAD/TAG
C658	100µF	25V		Elec	"	TAD/TAG
C659	100µF	63V		Elec	PH	2222-017-18101
*C659	80/100	100V		Elec	PH	Serial No. below 33299
C660	50µF	150V		Elec	PH	2222-040-11509
C661	220µF	25V		Elec	PH	2222-017-16221
C662	220µF	25V		Elec	PH	2222-017-16221
C663	10nF	2500V		CER		
C665	1µF	250V		PYE	SI	B32541

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO. OR ALTERNATIVE
C681	12.5µF	150V		Elec	PH	2222-040-11139
C682	330µF	16V		Elec	PH	2222-017-15331
C683	330µF	16V		Elec	PH	2222-017-15331
C684	100nF	100V	10%	PYE	ELNA	TYPE N
C685	100nF	100V	10%	PYE	ELNA	TYPE N
C686	100µF	25V		Elec	PH	2222-016-16101
C687	100µF	25V		Elec	PH	2222-016-16101
C688	68µF	63V		Elec	PH	2222-017-18689
C701	100nF	100V	10%	PYE	ELNA	TYPE N
	SEMICONDUCTORS					
D101						
D102	Diode			Si		FD300/IN3595
D103	Diode			Si		FD300/IN3595
D104						
D141						
D142	Diode			Si		FD300/IN3595
D143	Diode			Si		FD300/IN3595
D144						
D181	Diode			Si		IN4148
D182	Diode			Si		IN4148
D201	Diode			Si		IN4148
D202	Diode			Si		IN4148
D203	Diode			Si		IN4148
D204	Diode			Si		IN4148
D205	Zener diode			Si	PH	BZX79/C11V
D206	Diode			Ge	PH	OA90
D207	Diode			Ge	PH	OA90
D231						

CCF Ref.	DESCRIPTION	Mfg or Supply	PART NO. OR ALTERNATIVE
D301	Diode Si		IN4148
D302	Zener Diode Si	PH	BZY79/C10V
D303	Diode Si		IN4148
D304	Diode Si		IN4148
D305	Diode Si		IN4148
D306	Diode Si		IN4148
D307	Diode Si		IN4148
D308	LED	TI	TIL209
D309	Diode Si		IN4148
D310	Diode Si		IN6263
D311	Diode Si		IN4148
D312	Diode Si		IN4148
D313	Diode Si		IN4148
D314			
D315	Diode Si		IN4148
D401	Diode Si		IN4148
D402	Diode Si		IN4148
D403	Diode Si		IN4148
D404	Diode Si		IN4148
D405	Diode Si		IN4148
D406	Diode Si		IN4148
D407	Diode Si		IN4148
D408	Diode Si		IN4148
D409	Diode Si		IN4148
D410	Diode Si		IN6263
D411	Diode Si		IN4148
D412	Diode Si		IN4148
D471	Diode Si		IN4148
D472	Diode Si		IN4148
D473	Diode Si		IN4148
D474	Diode Si		IN4148
D475	Diode Si		IN4148
D501	Diode Si		IN4148
D502	Diode Si		IN4148
D503A&B	Diode Si		IN4148
D504	Diode Si		Selected Component
D505	Diode Si		IN4148
D506A&B	Diode Si		IN4148

CCF Ref.	DESCRIPTION		Mfg or Supply	PART NO.	OR ALTERNATIVE
D601	Diode	Si		IN4148	
D602	Diode	Si		IN4148	
D603					
D604	Diode	Si		IN4148	
D605	Diode	Si		IN4148	
D606	Diode	Si		IN4148	
D607	Diode	Si		IN4148	
D608	Diode	Si		IN4148	
D651A-D	Bridge Rectifier	Si	VARO	VJ448	
D655	Diode	Si	MOT	MR501	or MR752
D656	Diode	Si	MOT	MR501	or MR752
D657	Diode	Si	MOT	MR501	or MR752
D658	Diode	Si	MOT	MR501	or MR752
D659	Diode	Si	MOT	MR501	or MR752
D660	Diode	Si		IN4148	
D661	Diode	Si		IN4148	
D662	Diode	Si	PH	BY206	or A114D
D663	Diode	Si	PH	BY206	or A114D
D664	Diode	Si	PH	BY206	or A114D
D665	Diode	Si	PH	BY206	or A114D
D666	Zener diode) required SN° Below	Si	PH	BZX70C47V	
D667	Diode) 33299 Only	Si		IN4148	
D668	Diode	Si		BAX12	
D669	Diode	Si		BAX12	
D670	Diode	Si		BAX12	
D671	Diode	Si	PH	BAX12	
D672	Diode	Si	PH	BY187	
D673	Zener Diode	Si	PH	BZX79/C15V	
D674	Zener Diode)required only	Si		BZY88/C3V3	
D675	Zener Diode)on S.No. Below 33299.	Si		BZX70/C12V	
D691	LED		F	FLV310	
D701	Diode	Si		IN4148	

CCF Ref.	DESCRIPTION		Mfg or Supply	PART NO.	OR ALTERNATIVE
Q101	F.E.T.) selected pair	Si	N S	MPF106	gain < 50)
Q102	F.E.T.)	Si	N S	MPF106	current 8)
Q103	Transistor) matched pair	Si	N S	2N5770	
Q104	Transistor)	Si	N S	2N5770	
Q105	Transistor) matched pair	Si	PH	BFY90	
Q106	Transistor)	Si	PH	BFY90	
Q107	Transistor) matched pair	Si	PH	BFY90	
Q108	Transistor)	Si	PH	BFY90	
Q141	F.E.T.) Selected pair	Si	N S	MPF106	as Q101&102
Q142	F.E.T.)	Si	N S	MPF106	
Q143	Transistor) matched pair	Si	N S	2N5770	
Q144	Transistor)	Si	N S	2N5770	
Q145	Transistor) matched pair	Si	PH	BFY90	
Q146	Transistor)	Si	PH	BFY90	
Q147	Transistor) matched pair	Si	PH	BFY90	
Q148	Transistor)	Si	PH	BFY90	
Q181	Transistor) matched pair	Si	N S	2N5770	
Q182	Transistor)	Si	N S	2N5770	
Q183	Transistor) matched pair	Si	N S	2N5770	
Q184	Transistor)				
Q185	Transistor) matched pair	Si	N S	2N5770	
Q186	Transistor)	Si	N S	2N5770	
Q187	Transistor	Si	N S	2N5769	
Q188	Transistor	Si	N S	2N5769	
Q201	Transistor	Si	F	2N4258	
Q202	Transistor	Si	F	2N4258	
Q203	Transistor	Si	F	2N4258	
Q204	Transistor	Si	F	2N4258	
Q205					
Q231	Transistor	Si	F	PN4121	
Q251	Transistor) matched pair	Si	PH	BFY90	
Q252	Transistor)	Si	PH	BFY90	

CCF Ref.	DESCRIPTION				Mfg or Supply	PART NO.	OR ALTERNATIVE
Q253	Transistor)	matched pair		Si	N.S	2N5770	
Q254	Transistor)			Si	N.S	2N5770	
Q255	Transistor)	matched pair		Si	PH	BFW17A	or BFW16A
Q256	Transistor)			Si	PH	BFW17A	or BFW16A
Q281	Transistor)	matched pair		Si	ITT	TT3118	or 2N3118
Q282	Transistor)			Si	ITT	TT3118	or 2N3118
Q301	Transistor		NPN	Si	PH	BC547	
Q302	Transistor		NPN	Si	N.S	2N5769	
Q303	Transistor		NPN	Si	"	2N5769	
Q304	Transistor		NPN	Si	PH	BC547	
Q305	Transistor		NPN	Si	PH	BC547	
Q306	Transistor		PNP	Si	N.S	PN3645	
Q307	Transistor		PNP	Si	N.S	PN4121	
Q308	Transistor		PNP	Si	N.S	PN4121	
Q309	Transistor		NPN	Si	N.S	2N5769	
Q310	F.E.T.			Si	NS	MPF106	Matched with Q406
Q311	Transistor		NPN	Si	PH	BC547A	
Q312	Transistor		NPN	Si	PH	BC547A	
Q401	Transistor		NPN	Si	N.S	BC547A	
Q402	Transistor		PNP	Si	N.S)	2N4249	Matched Pair
Q403	Transistor		PNP	Si	N.S)		
Q404	Transistor		PNP	Si	N.S	PN3645	
Q405	Transistor		NPN	Si	PH	BC547	
Q406	F.E.T.			Si	NS	MPF106	Matched with Q310.
Q407	Transistor		NPN	Si	PH	BC547	
Q408	Transistor		NPN	Si	PH	BC547	
Q471	Transistor		PNP		NS	PN3645	
Q501	Transistor		NPN	Si	PH	BC547	
Q502	Transistor		PNP	Si	N.S	2N4258	
Q503	Transistor		PNP	Si	N.S	2N4258	
Q504	Transistor		PNP	Si	N.S	2N4258	
Q505	Transistor		PNP	Si	N.S	2N4258	

CCF Ref.	DESCRIPTION			Mfg or Supply	PART NO. OR ALTERNATIVE
Q506	Transistor	PNP	Si	N S	PN4888
Q507	Transistor	NPN	Si	PH	BF337
Q508	Transistor	NPN	Si	PH	BF337
Q509	Transistor	PNP	Si	N S	PN4888
Q601	Transistor	NPN	Si	PH	BC547
Q602	Transistor	NPN	Si	PH	BC547
Q603	Transistor	PNP	Si	N S	2 N3645
Q604	Transistor	NPN	Si	PH	BC547
Q605	Transistor	NPN	Si	PH	BF469
Q651	Transistor	NPN	Si	PH	BC547
Q652	Transistor	PNP	Si	N S	PN3645
Q653	Transistor	PNP	Si	N S	PN3645
Q654	Transistor	NPN	Si	PH	BD137
Q655	Transistor	NPN	Si	MOT	MJE3055
Q656	Transistor	NPN	Si	MOT	MJE3055
Q657	Transistor	NPN	Si	MOT	MJE3055
Q658	Transistor	NPN	Si	PH	BC547
Q701	Transistor		Si	PH	BC547
Q702	Transistor		Si	PH	BC547
Q751	Transistor		Si	NS	2N5770
U201	Integrated circuit		Si	NS	LM733
U202	Integrated circuit		Si	NS	LM733
U231	Integrated circuit		Si	NS	74L00
U301	Integrated circuit		Si	NS	LM733
U302	Integrated circuit		Si	F	MC10109P
U303	Integrated circuit		Si	N S	7400

CCF Ref.	DESCRIPTION		Mfg or Supply	PART NO. OR ALTERNATIVE
U401	Integrated circuit	Si	NS	LM733
U402	Integrated circuit	Si	NS	74S04
U403	Integrated circuit	Si	NS	LM361
U404	Integrated circuit	Si	NS	LM340T
U651	Integrated circuit	Si	N S	LM723
U652	Integrated circuit	Si	NS	LM741C
U681	Integrated circuit	Si	F	78MG
U682	Integrated circuit	Si	F	79MG
	SWITCHES			
S1	3 Section isostat switch		McM	bwd SR118A
S2	4 Deck mini 12 post. 4 pole deck		AB	bwd SR123
S51	3 Section isostat switch		McM	bwd SR118A
S52	4 Deck mini 12 post. 4 pole deck		AB	bwd SR123
S141	Isostat switch 1 section		McM	SR 80
S181	Isostat switch 1 section		McM	SR 80
S201) S202)	Isostat switch 2 section		McM	SR 84
S231	2 pol. 5 pos. 2 Deck Type F		MSP	bwd AK 52265
S301	Isostat switch 7 section		McM	bwd SR116
S302	Rear RV301			
S303	Push button Bulgin		CUN	MS16
S304	Mini 24 switch triple concentric			bwd SR101B
S305	Rear RV307			
S401	Isostat switch 5 section		McM	bwd SR117A
S402	3 Deck, 5 pos. 2 pole Type F		MSP	bwd SR119

CCF Ref.	DESCRIPTION	Mfg or Supply	PART NO. OR ALTERNATIVE
S501	Isostat switch 1 section.	McM	bwd SR125.
S651	Rear RV601		
S652	Slide switch AWA	AWA	62556-56003-004
S653	2 Pol. 2 pos. slide sw.	AWA	70/78
	MISCELLANEOUS		
T651	Power Transformer	BWD	T137A
T652	Converter transformer	BWD	T138B
	EHT MULTIPLYER	VARO	MH1001A
B691	LES 6.3V 100mA Lamps		
B692	LES 6.3V 100mA Lamps		

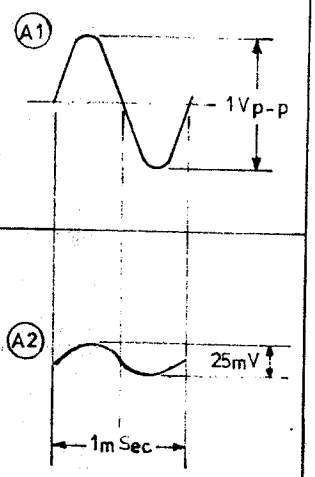
R	1 – 15 51 – 65
C	1 – 15 51 – 65
Q	—
D	—

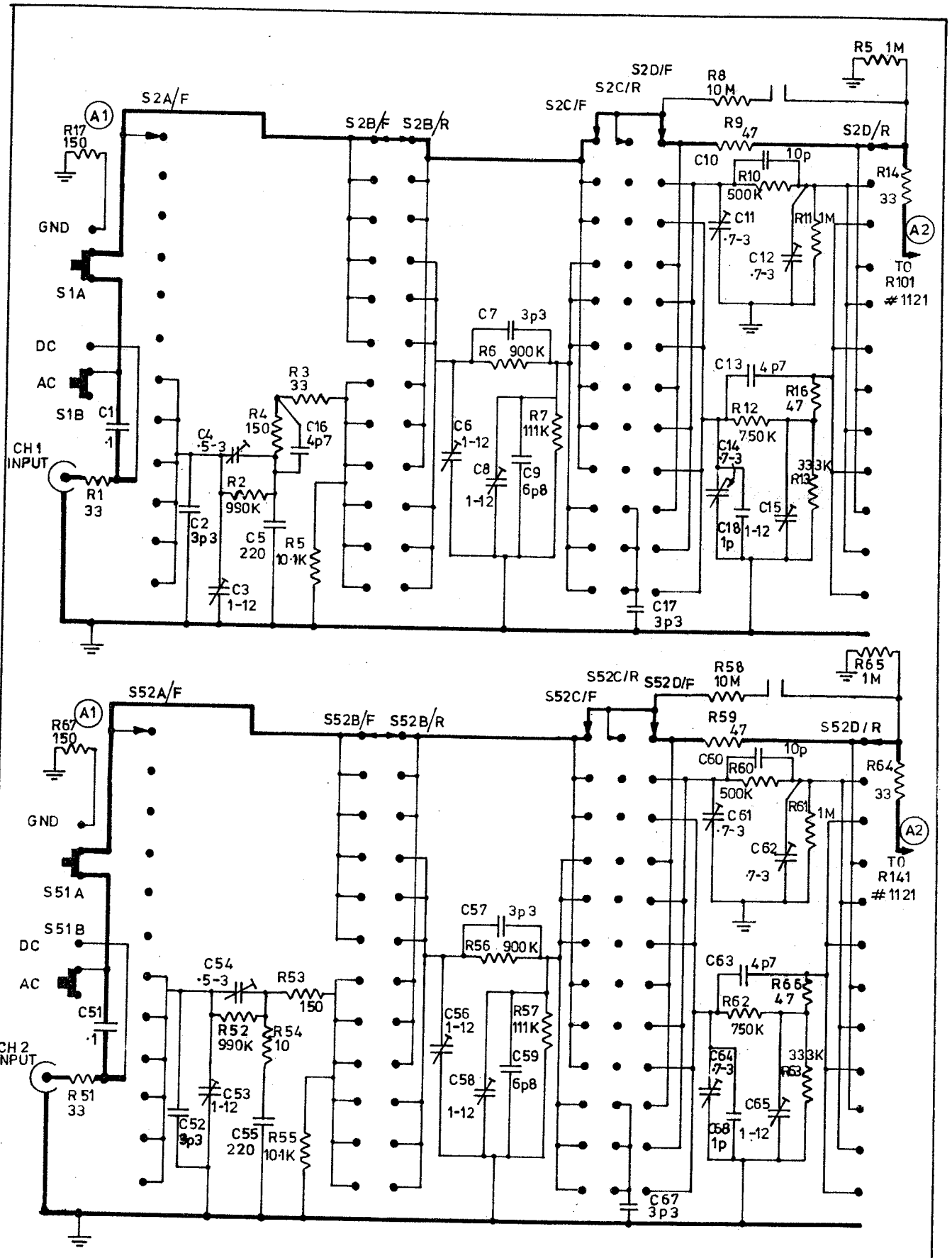
SWITCHES

S1A	NORM – GROUND
S1B	AC - DC
S2A – D	CH. 1 ATTENUATOR
S51A	NORM - GROUND
S51B	AC – DC
S52A – D	CH. 2 ATTENUATOR

WAVEFORMS

INPUT 1V p-p
ATTEN 200mV/div





NOTE:- COMPONENTS MAY VARY FROM THOSE DESIGNATED DUE TO AVAILABILITY OR TO OPTIMISE PERFORMANCE.

DRAWN	JB
TRACED	DEW
CHECKED	BKT
DATE	10-75

INPUT ATTENUATORS
BWD 540

DRG. Nº 1120

R
101-128
141-167

C
101-109
141-147

Q
101-108
141-148

D
101-104
141-144

SWITCHES

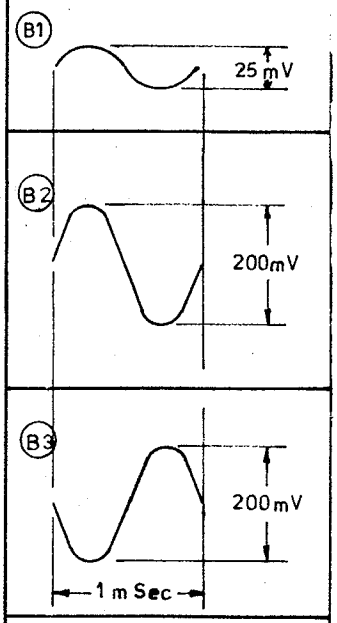
S 141	NORM INVERT CH 2

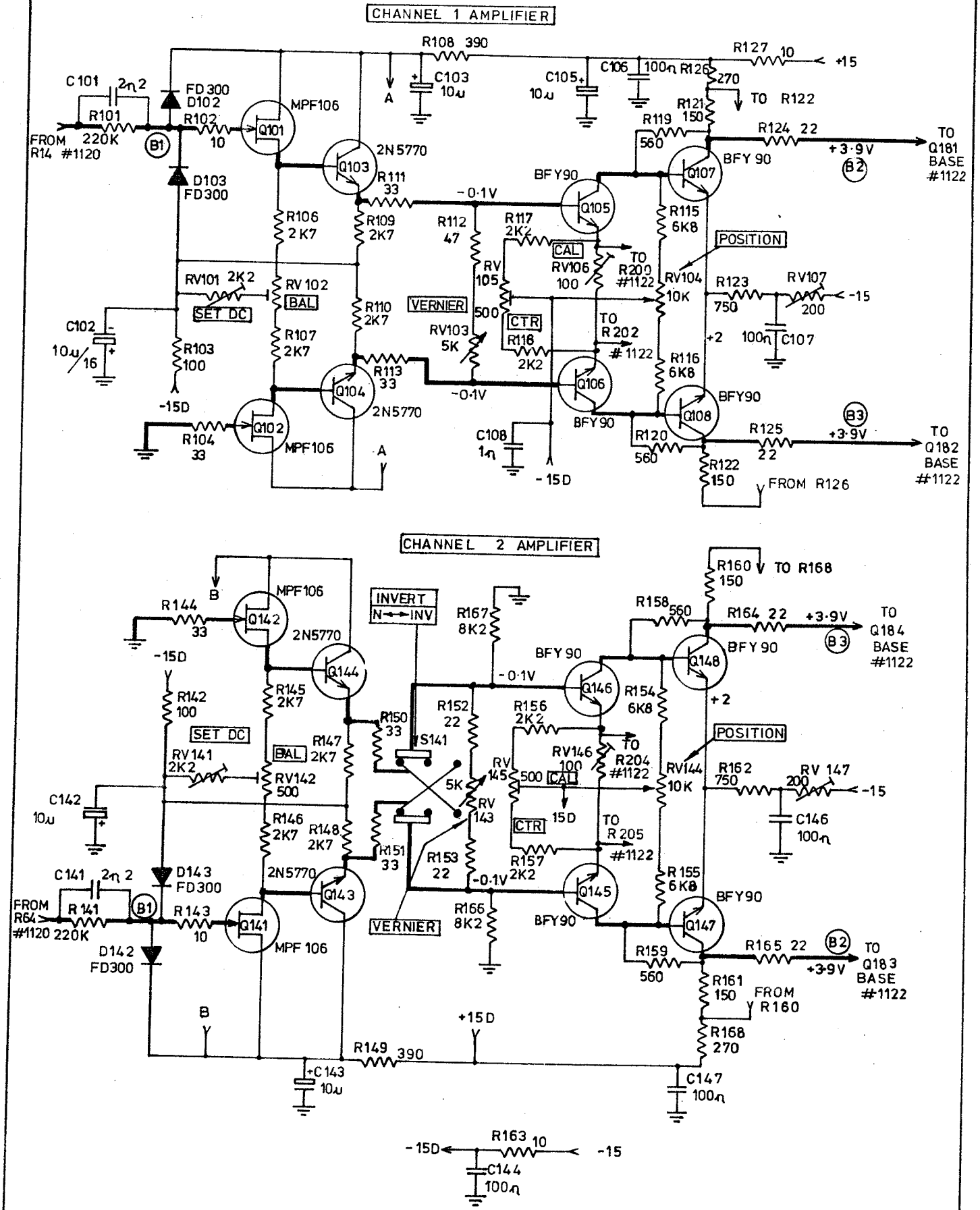
CONTROLS

RV 101	SET DC LEVEL CH1
RV 102	DC BALANCE CH1
RV 103	ATTEN. VERNIER CH1
RV 104	POSITION CH1
RV 105	POSITION CENTERING CH1
RV 106	CALIBRATE GAIN CH1
RV 107	OUTPUT DC LEVEL CH1
RV 141	SET DC LEVEL CH2
RV 142	DC BALANCE CH2
RV 143	ATTEN. VERNIER CH2
RV 144	POSITION CH2
RV 145	POSITION CENTERING CH2
RV 146	CALIBRATE GAIN CH2
RV 147	OUTPUT DC LEVEL CH2

WAVEFORMS

INPUT 1V p-p 1KHz
ATTENS 200mV div
VERNIER CAL





PCB 160/218

	DRAWN J.B	VERTICAL INPUT AMPLIFIERS 540	DRG.Nº 1121
	TRACED D.E.W.		
	CHECKED BAT		
10-78	DATE 8-74		

R
181-199
201-228
231-245

C
181-185
201-208
231-238

Q
181-188
201-205
231

D
182-3
201-205
231

SWITCHES

S181 X1 - X5 GAIN

S231A-D VERT. DISPLAY
S201 TRIG. SELECT CH1 OR 2
S202A&B 'A' TRIG. SELECT CH1/2 OR MIX

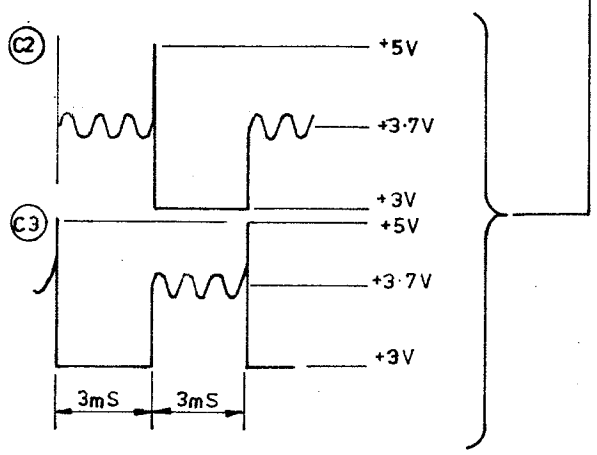
CONTROLS

RV 181 SET X5 GAIN

RV 201 CH1 TRIG DC LEVEL
RV 202 CH2 TRIG DC LEVEL
RV 203 'X' CENTERING
RV 204 'X' CALIBRATION

I.C.'s

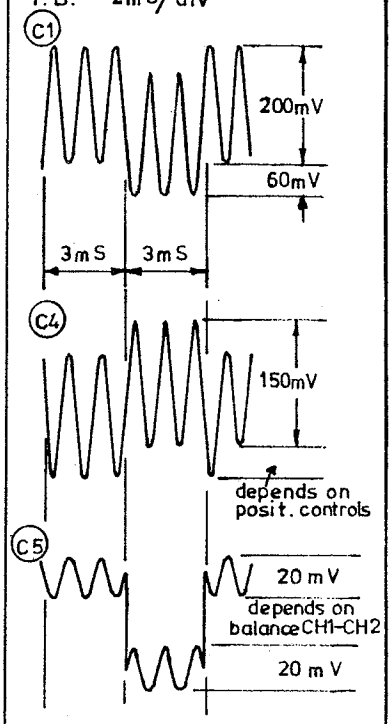
U 201 LM 733
U 202 LM 733
U 231 74L00



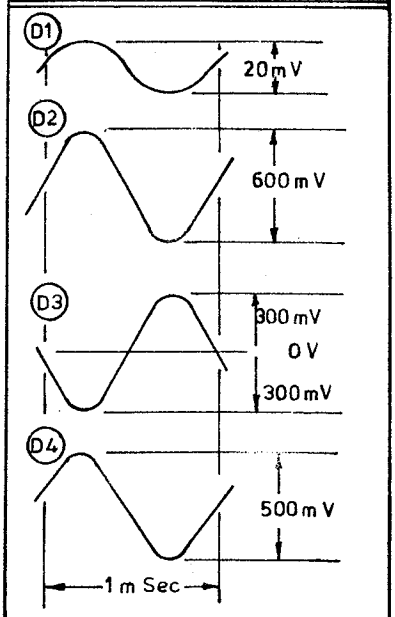
VERT. AMPLIFIER

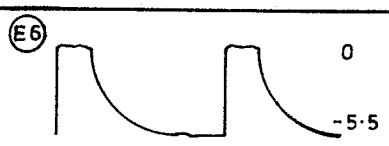
WAVEFORMS

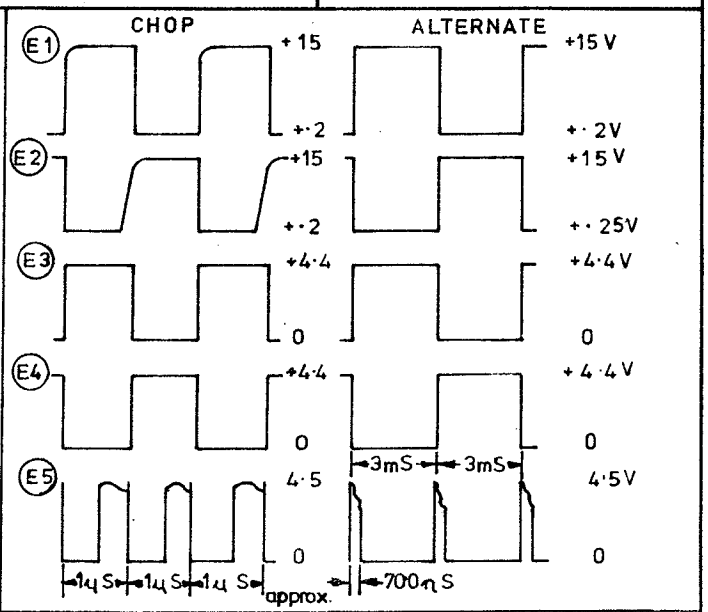
INPUT AS DRG. No. 1121
DISPLAY CHOPPED
T.B. 2mS/div

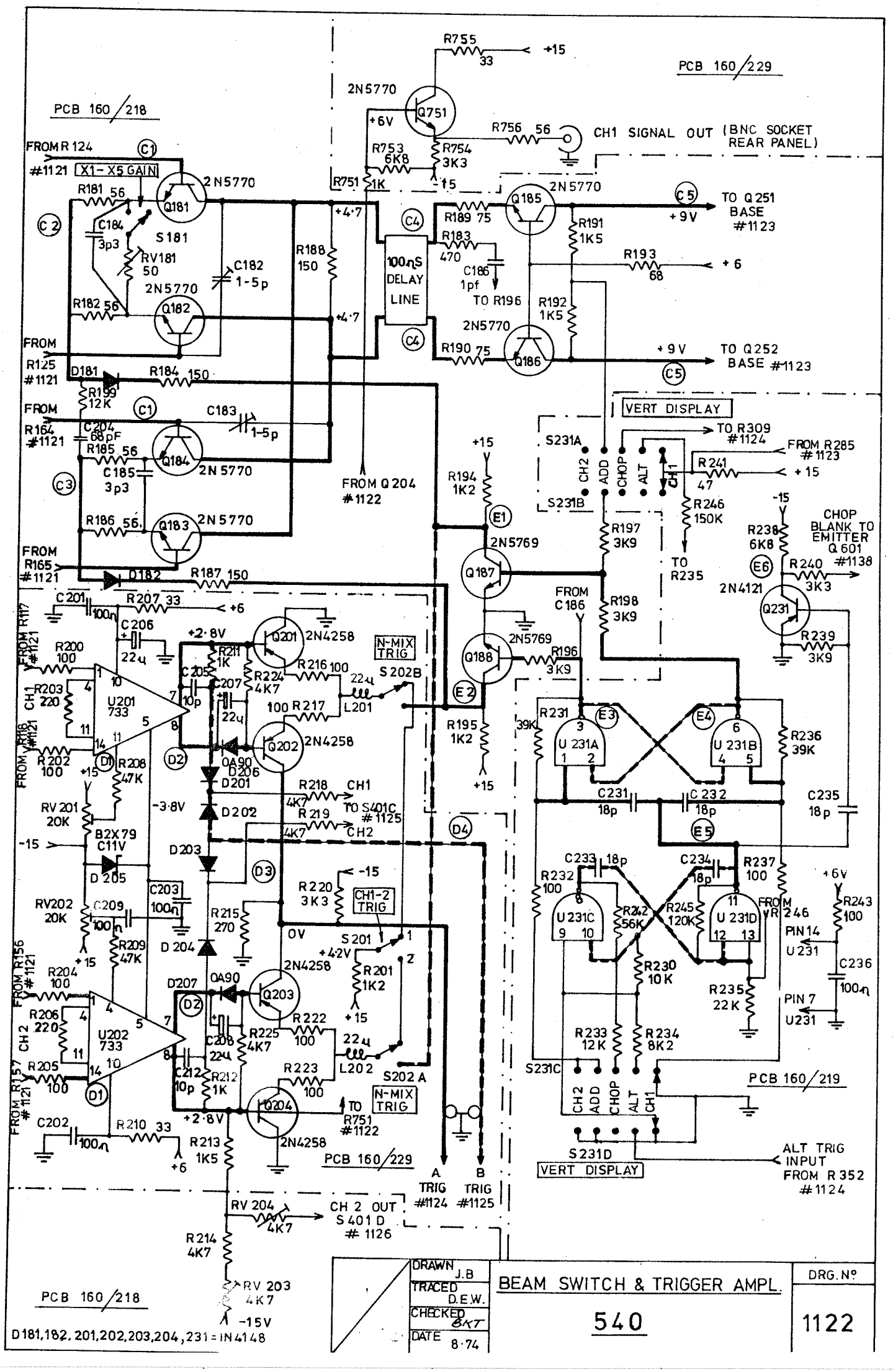


TRIGGER AMPLIFIER








PCB 160/218
PCB 160/229
PCB 160/219
FROM R124 #1121
X1-X5 GAIN
2N5770
Q181
Q182
Q183
Q184
Q185
Q186
Q751
R755 33
+15
+6V
R756 56
CH1 SIGNAL OUT (BNC SOCKET REAR PANEL)
R753 6K8
R754 3K3
R751 1K
S181
RV181 50
C182 1-5p
C184 3p3
C185 3p3
C186 1pf
TO R196
R181 56
R182 56
R183 470
R184 150
R185 56
R186 56
R187 150
R188 150
R189 75
R190 75
R191 1K5
R192 1K5
R193 68
+9V
TO Q251 BASE #1123
TO Q252 BASE #1123
+6
+4·7
100nS DELAY LINE
C4
C5
D181
D182
R199 12K
C183 1-5p
C204 68pF
FROM R125 #1121
FROM R164 #1121
FROM R165 #1121
FROM Q204 #1122
VERT DISPLAY
S231A
S231B
CH2
ADD
CHOP
ALT
CH1
TO R309 #1124
FROM R285 #1123
R241 47
R246 150K
TO R235
R194 1K2
R197 3K9
R198 3K9
R196 3K9
R195 1K2
2N5769
Q187
Q188
E1
E2
E3
E4
E5
E6
CHOP BLANK TO EMITTER Q601 #1138
R238 6K8
R240 3K3
2N4121
Q231
R239 3K9
FROM C186
C201 100n
R207 33
C206 22µ
+2·8V
Q201 2N4258
R211 1K
R216 100
N-MIX TRIG
S202B
C205 10p
C207 22µ
R224 4K7
100 R217
L201
Q202 2N4258
D206 OA90
D201
D202
D203
D204
-3·8V
R218 CH1
4K7
TO S401C #1125
R219 CH2
4K7
D4
D3
D2
D1
R200 100
R203 220
R202 100
R208 47K
RV201 20K
B2X79 C11V
D205
R220 3K3
CH1-2 TRIG
C203 100n
RV202 20K
C209 100n
R209 47K
R215 270
OV
S201
+42V
R201 1K2
R204 100
R206 220
R205 100
C208 22µ
R225 4K7
R222 100
R223 100
L202
S202A
C212 10p
R212 1K
C202 100n
R210 33
R213 1K5
+6
TO R751 #1122
RV 204 4K7
CH 2 OUT S 401 D # 1126
R214 4K7
RV 203 4K7
-15V
A TRIG #1124
B TRIG #1125
R231 39K
R236 39K
U 231A
U 231B
C231 18p
C232 18p
C235 18p
C233 18p
C234 18p
R232 100
R237 100
R242 56K
R245 120K
U 231C
U 231D
R230 10K
R235 22K
R233 12K
R234 8K2
R243 100
C236 100n
PIN 14 U 231
PIN 7 U 231
FROM R246
+6V
S231C
S231D
VERT DISPLAY
ALT TRIG INPUT FROM R 352 #1124
D181,182,201,202,203,204,231 = IN4148
DRAWN J.B
TRACED D.E.W.
CHECKED BKT
DATE 8·74
BEAM SWITCH & TRIGGER AMPL.
540
DRG. Nº
1122

R
251-271
281-295
701-707

C
251-260
281-282
701-

Q
251-256
281-282
701-702

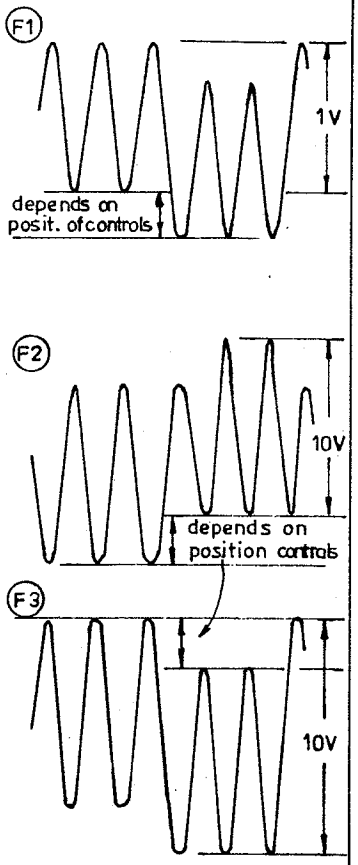
D
281-282
701

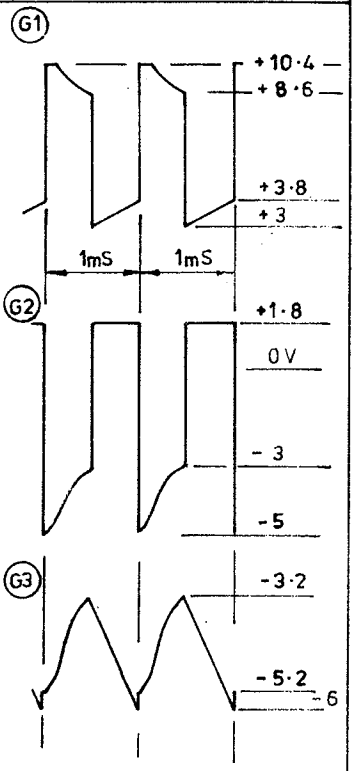
CONTROLS

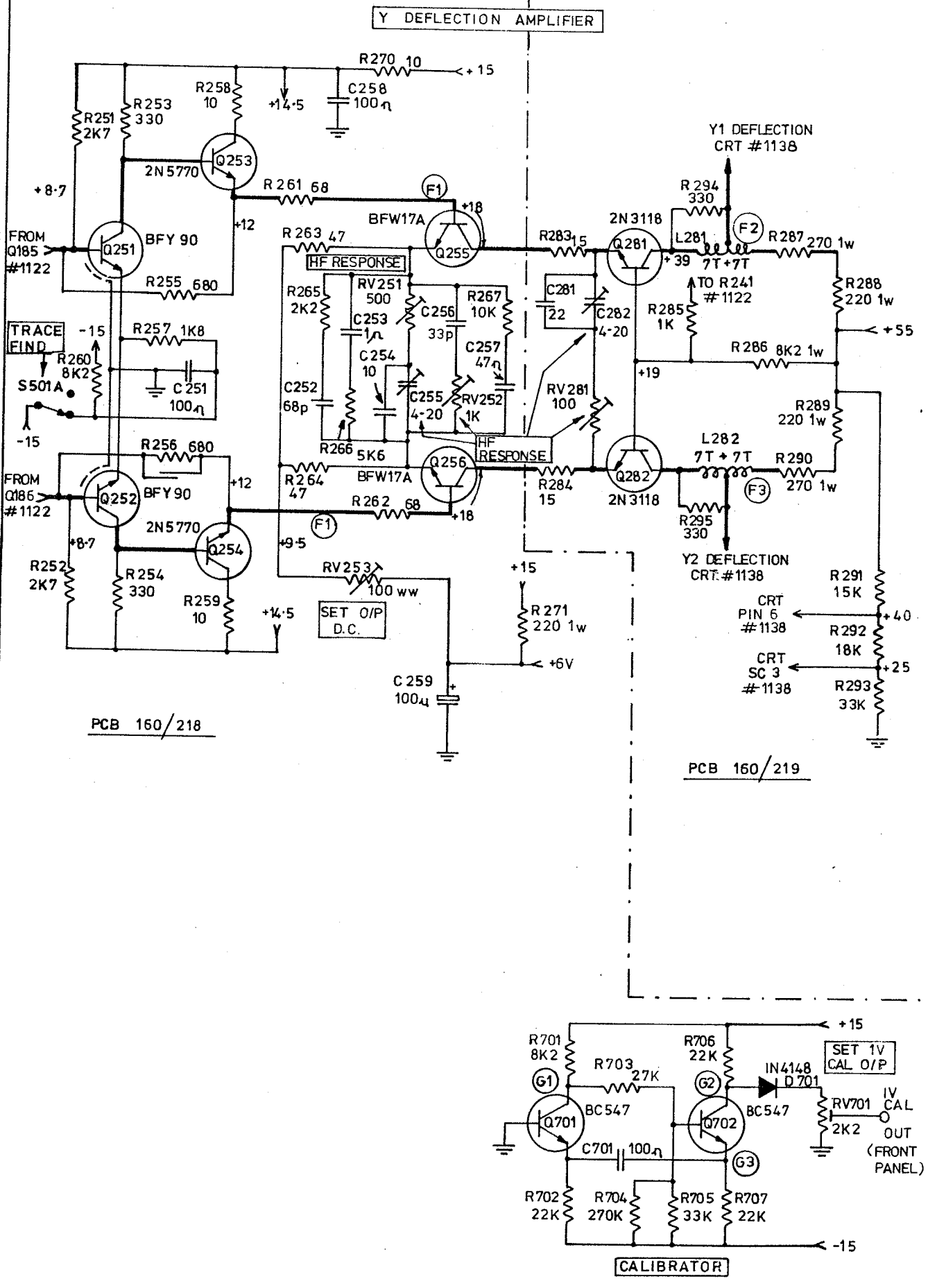
RV 251	SET HF RESPONSE
RV 252	SET HF RESPONSE
RV 253	SET OUTPUT DC LEVEL
RV 281	SET HF RESPONSE
RV 701	SET 1V P-P CAL OUTPUT
S501A	TRACE FIND

WAVEFORMS

INPUT & SETTINGS
AS ON DRG. No 1121







	DRAWN J.B	OUTPUT AMPL. & CALIBRATOR	DRG Nº
	TRACED D.E.W.	540	1123
	CHECKED BKT		
	DATE 10-75		

R 301-368 370A-1
C 301-329 370-381
Q 301-312
D 301-314

SWITCHES

S301A	INT-EXT TRIG SOURCE
S301B	AC-DC TRIG COUPLING
S301C	FAST-NORM TRIG COUPLING
S301D	SLOW-NORM TRIG COUPLING
S301E	+ OR − TRIG SLOPE
S301F	NORM/TV SELECT
S301G	S.S - NORM TRIGGER
S302	AUTO/NORMAL (REAR RV301)
S303	S.S. RESET
S304C-E	'A' T.B. RANGE SWITCH
S305	HF TRIGGER (OPEN)

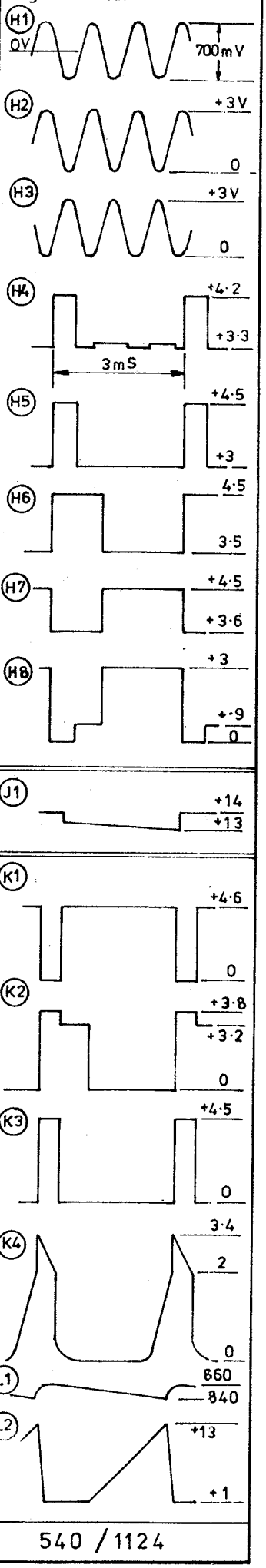
CONTROLS

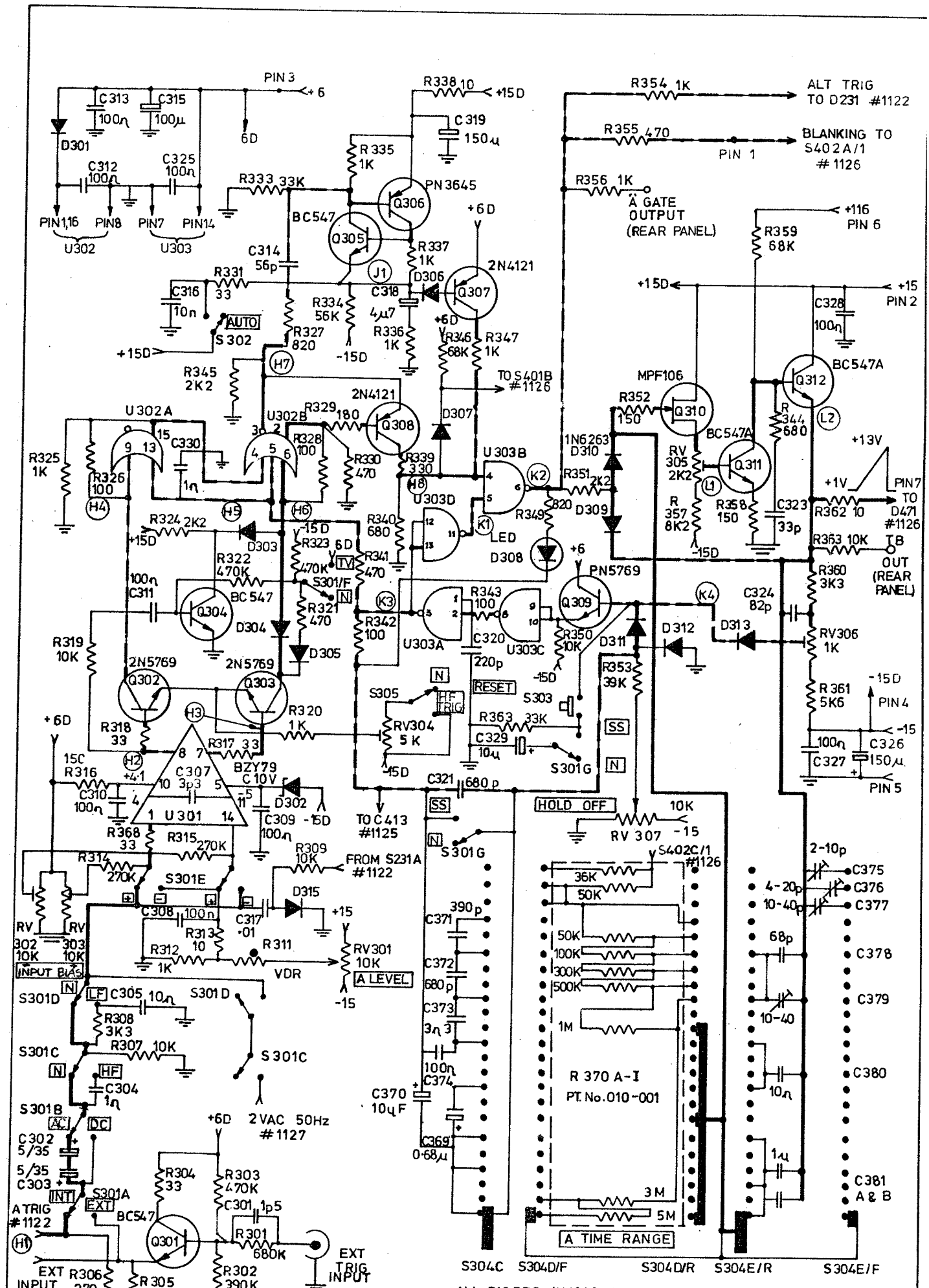
RV 301	LEVEL SELECT (TRIG)
RV 302	-INPUT BIAS CURRENT U301
RV 303	+INPUT BIAS CURRENT U301
RV 304	TRIGGER SENSITIVITY
RV 305	SWEEP START LEVEL
RV 306	SWEEP FINISH LEVEL
RV 307	TRIGGER HOLD OFF

U 301	μA733 AMPL
U 302	10109 ECL
U 303	7400 TTL

WAVEFORMS

INPUT AS DRG. No. 1121
T.B to ·2mS/div. ver.cal. signal locked.





DRAWN J.B.	MAIN (A) TIME BASE	DRG. No.
TRACED D.E.W.	540	1124
CHECKED BKT		
DATE 10.75		

R
401-439
450A-G

C
401-417
450-456

D
401-411

Q
401-408

SWITCHES

S304A & B	'B' TB RANGE
S401B	INT-EXT TRIG
S401A	+ OR - TRIG POLARITY
S401C	CH1 OR 2 TRIG SELECT
S402A & B	HORZ DISPLAY SWITCH

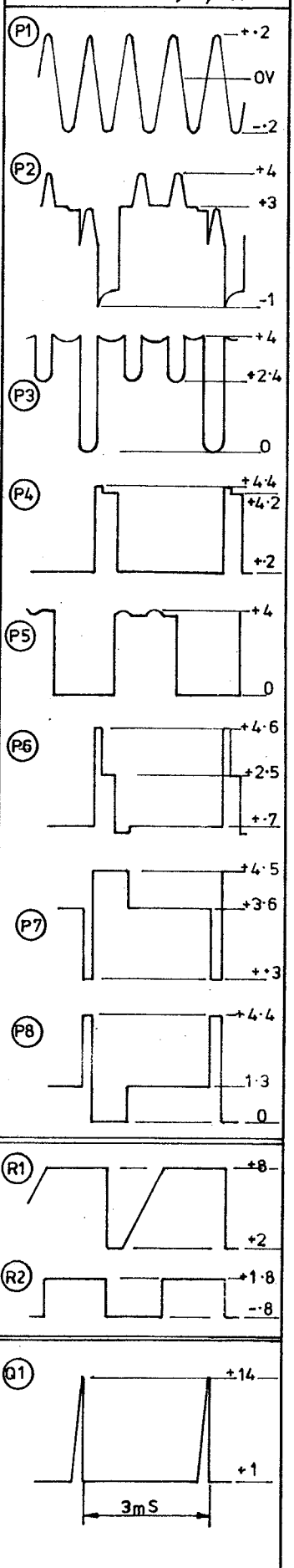
CONTROLS

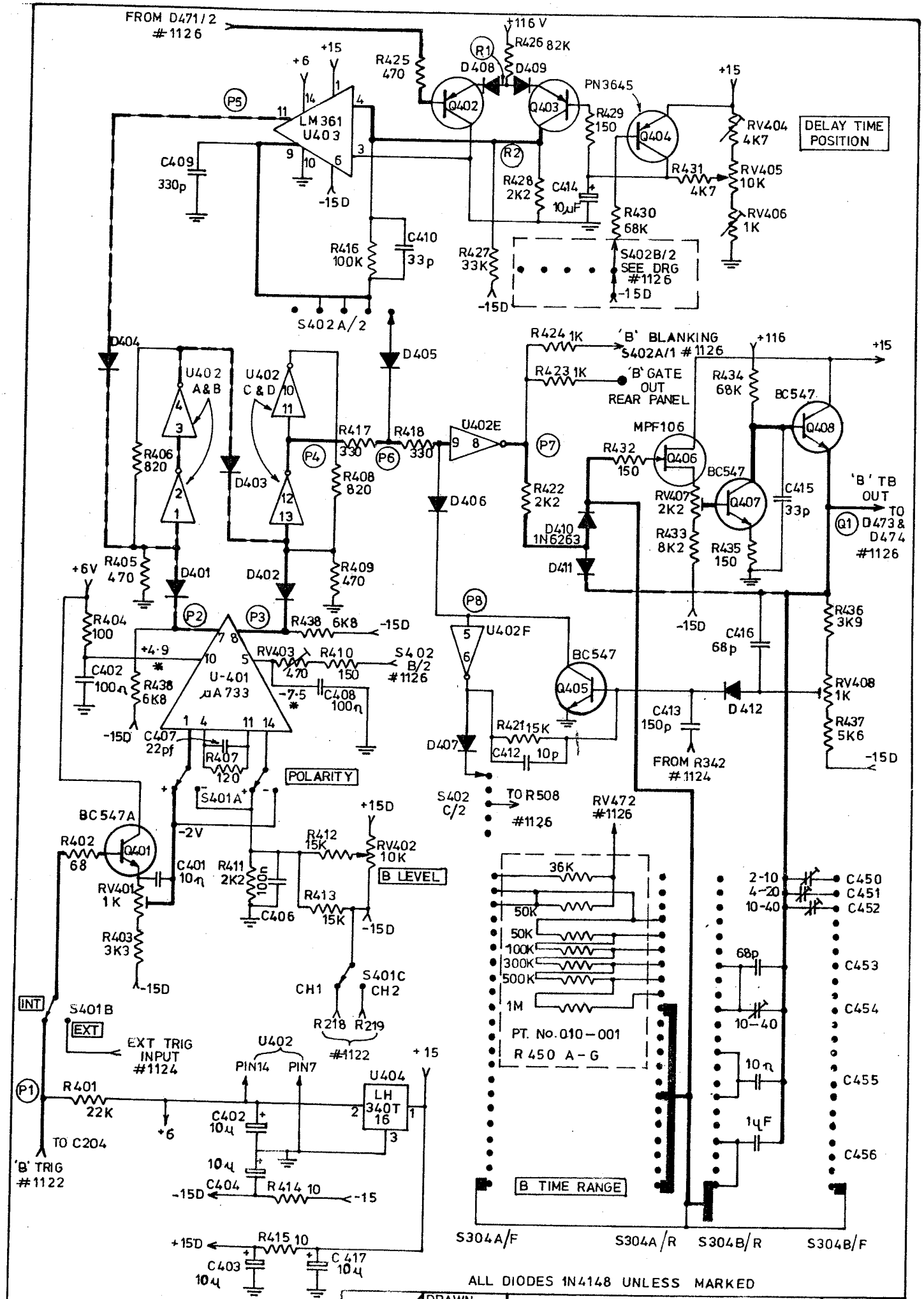
RV401	TRIG DC LEVEL
RV402	TRIG LEVEL CONTROL
RV403	TRIG SENSITIVITY
RV404	SET DELAY X 9
RV405	DELAY TIME POSITION
RV406	SET DELAY X 1
RV407	SET TB CAL
RV408	SET TB FINISH

U401	733 AMPLIFIER
U402A-F	74S04 TTL
U403	LM 361 COMPARATOR
U404	LM 340T 6V REGULATOR

WAVEFORMS

SETTINGS AS FOR DRG. 1124 WITH HORZ DISPLAY TO B TRIG DELAYED MULTIPLIER TO 5 DLYD TB TO 10µS/div




FROM D471/2 #1126
+116 V
R426 82K
R425 470
D408
D409
Q402
Q403
PN3645
Q404
+15
+6
LM361 U403
C409 330p
-15D
R428 2K2
C414 10µF
R429 150
R431 4K7
RV404 4K7
RV405 10K
RV406 1K
R430 68K
DELAY TIME POSITION
R427 33K
R416 100K
C410 33p
S402B/2 SEE DRG #1126
S402A/2
D404
D405
U402 A&B
U402 C&D
R406 820
R408 820
D403
R417 330
R418 330
U402E
R424 1K
'B' BLANKING S402A/1 #1126
R423 1K
'B' GATE OUT REAR PANEL
R434 68K
BC547 Q408
MPF106 Q406
R432 150
RV407 2K2
BC547 Q407
C415 33p
'B' TB OUT TO Q1 D473 & D474 #1126
R433 8K2
R435 150
R422 2K2
D406
D410 1N6263
D411
R405 470
D401
D402
R409 470
+6V
R404 100
C402 100n
R438 6K8
U-401 µA733
RV403 470
R410 150
S402 B/2 #1126
C408 100n
C407 22pf
R407 120
POLARITY
S401A
U402F
BC547 Q405
C416 68p
R436 3K9
RV408 1K
R437 5K6
D412
C413 150p
FROM R342 #1124
R421 15K
C412 10p
D407
S402 C/2
TO R508 #1126
RV472 #1126
BC547A Q401
R402 68
C401 10n
RV401 1K
R403 3K3
R412 15K
RV402 10K
B LEVEL
R411 2K2
C406
R413 15K
S401C
CH1
CH2
R218
R219
#1122
INT
S401B
EXT
EXT TRIG INPUT #1124
U402 PIN14 PIN7
U404 LH 340T 16
R401 22K
TO C204
'B' TRIG #1122
C402 10µ
C404 10µ
R414 10
R415 10
C403 10µ
C417 10µ
36K
50K
50K
100K
300K
500K
1M
PT. No. 010-001 R 450 A-G
B TIME RANGE
2-10
4-20
10-40
C450
C451
C452
68p
C453
10-40
C454
10n
C455
1µF
C456
S304A/F
S304A/R
S304B/R
S304B/F
ALL DIODES 1N4148 UNLESS MARKED
* WHEN SWITCHED TO D'LYD TRIGGER
DRAWN J.B.
TRACED D.E.W.
CHECKED BKT
DATE 10-75
'B' TIME BASE
540
DRG.No
1125

R
501 - 542
471 - 474

C
501 - 516
471

D
501 - 506
471 - 475

Q
501 - 509
471

SWITCHES

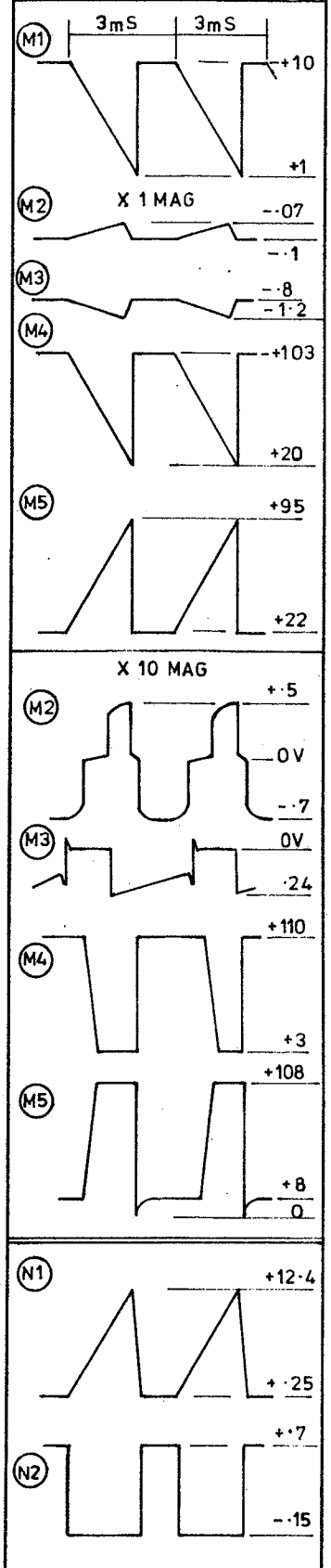
S 401E	X1 - X10 MAG
S 401D	TB - XY DISPLAY
S402 A - C	HORZ DISPLAY SELECTOR
S501A	TRACE FIND

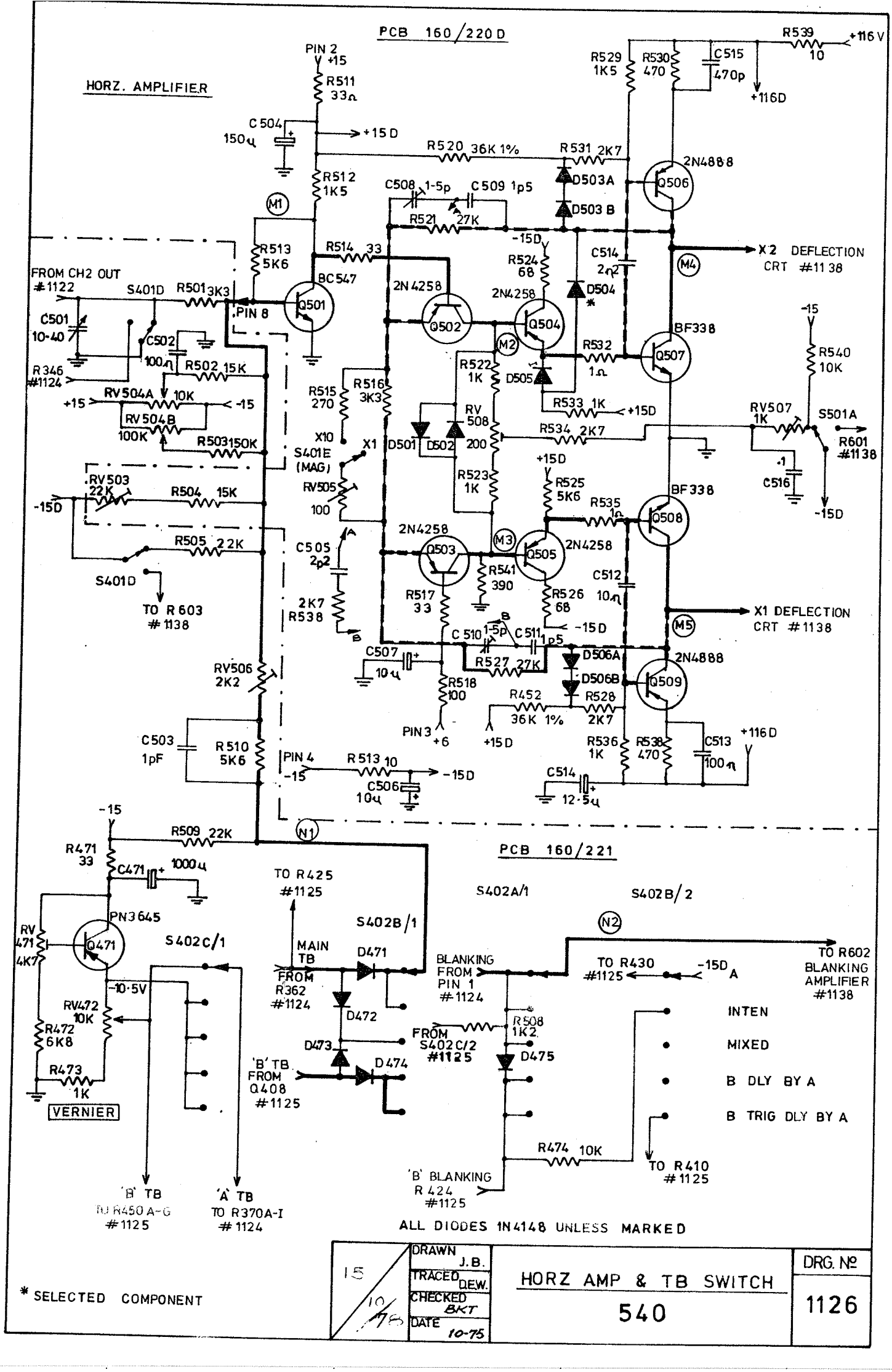
CONTROLS

RV 472	T.B. VERNIER (A&B T.B.)
RV 501	T.B. CAL
RV 503	HORZ CENTERING
RV 504 A& B	HORZ POSITION
RV 505	X10 MAG CAL
RV 506	X1 SWEEP WIDTH
RV 507	DC LEVEL SET
RV 508	AMPL. BALANCE

WAVEFORMS

ALL SETTINGS AS ON DRG. N° 1124




PCB 160/220D
HORZ. AMPLIFIER
PIN 2 +15
R511 33Ω
C504 150µ
+15D
R520 36K 1%
R531 2K7
R529 1K5
R530 470
C515 470p
R539 10
+116V
+116D
2N4888
Q506
D503A
D503B
C508 1-5p
C509 1p5
R521 27K
-15D
R512 1K5
M1
R513 5K6
R514 33
BC547
Q501
FROM CH2 OUT #1122
S401D
R501 3K3
PIN 8
C501 10-40
C502 100n
R502 15K
R346 #1124
RV504A 10K
RV504B 100K
R503 150K
+15
-15
R516 3K3
R515 270
X10
X1
S401E (MAG)
RV505 100
D501
D502
RV 508 200
R522 1K
D505
R532 1Ω
R533 1K
+15D
2N4258
Q502
Q504
R524 68
D504
C514 2n2
M4
X2 DEFLECTION CRT #1138
BF338
Q507
R540 10K
RV507 1K
S501A
R601 #1138
C516 .1
-15D
M2
R534 2K7
R523 1K
R525 5K6
R535 1Ω
Q508
RV503 22K
R504 15K
R505 22K
S401D
TO R603 #1138
C505 2p2
2K7 R538
2N4258
Q503
Q505
M3
R541 390
R517 33
R526 68
C512 10n
X1 DEFLECTION CRT #1138
M5
C510 1-5p
C511 1p5
C507 10µ
R527 27K
D506A
D506B
2N4888
Q509
RV506 2K2
R518 100
R452 36K 1%
R528 2K7
PIN 3 +6
+15D
C503 1pF
R510 5K6
PIN 4 -15
R513 10
C506 10µ
R536 1K
R538 470
C513 100n
+116D
C514 12·5µ
N1
PCB 160/221
R509 22K
R471 33
C471 1000µ
TO R425 #1125
S402A/1
S402B/2
S402B/1
N2
PN3645
Q471
RV 471 4K7
S402C/1
MAIN TB FROM R362 #1124
D471
BLANKING FROM PIN 1 #1124
TO R430 #1125
-15D A
TO R602 BLANKING AMPLIFIER #1138
-10·5V
RV472 10K
R472 6K8
R473 1K
VERNIER
D472
D473
D474
'B' TB FROM Q408 #1125
FROM S402C/2 #1125
R508 1K2
D475
INTEN
MIXED
B DLY BY A
B TRIG DLY BY A
R474 10K
TO R410 #1125
'B' BLANKING R424 #1125
'B' TB TO R450A-G #1125
'A' TB TO R370A-I #1124
ALL DIODES 1N4148 UNLESS MARKED
* SELECTED COMPONENT
DRAWN J.B.
TRACED DEW.
CHECKED BKT
DATE 10-75
15/10/75
HORZ AMP & TB SWITCH
540
DRG. Nº
1126

R
651–675
681–689
691

C
651 – 665
681 – 689

Q
651 – 657

D
651–675
691

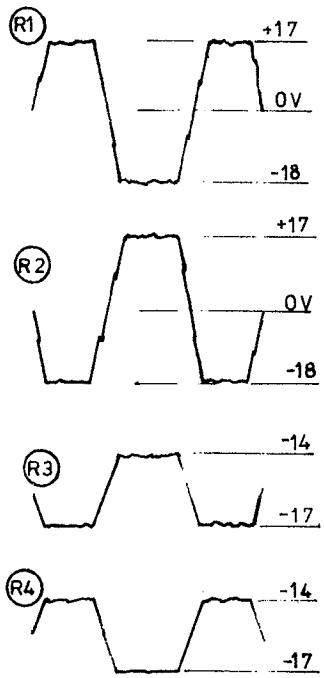
SWITCHES

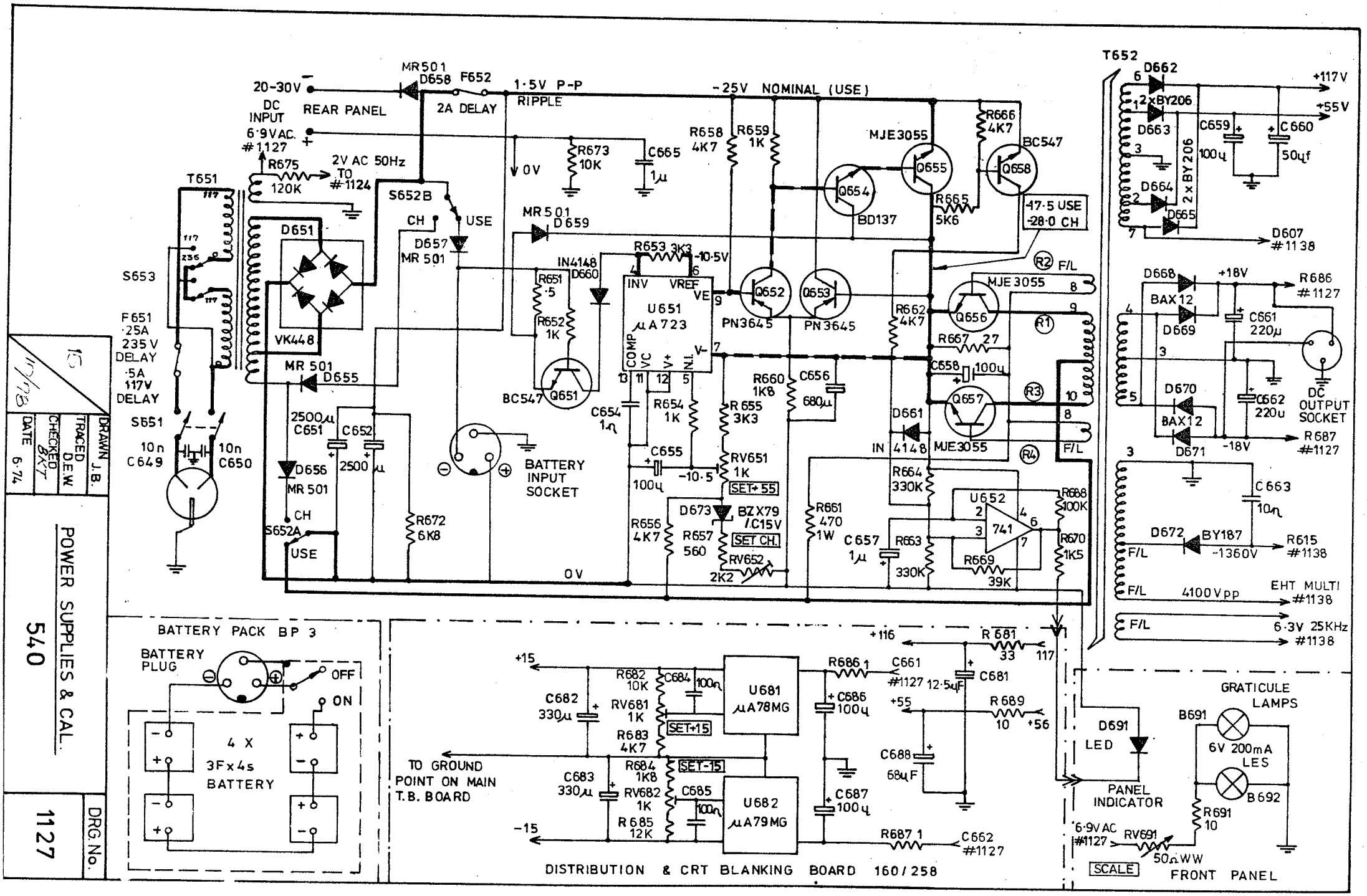
S 651 A & B	POWER ON-OFF
S 652 A & B	USE - CHARGE
S 653 A & B	AC VOLTS

CONTROLS

R V 651	SET D C (+55V RAIL)
R V 652	SET BATTERY CHARGE
RV 681	SET +15V OUTPUT
R V 682	SET -15V OUTPUT
R V 691	SCALE ILLUMINATION

WAVEFORMS




20-30V DC INPUT REAR PANEL
6·9VAC. #1127
2V AC 50Hz TO #1124
MR501 D658 F652
2A DELAY
1·5V P-P RIPPLE
-25V NOMINAL (USE)
0V
T651
S653
F651 ·25A 235V DELAY
·5A 117V DELAY
S651
10n C649
10n C650
D651
VK448
MR 501 D655
2500µ C651
C652 2500µ
D656 MR 501
CH S652A USE
R672 6K8
S652B CH USE
D657 MR 501
MR 501 D659
BATTERY INPUT SOCKET
R673 10K
C665 1µ
R658 4K7
R659 1K
MJE3055 Q655
Q654 BD137
BC547 Q658
R666 4K7
R665 5K6
-17·5 USE
-28·0 CH
R653 3K3
-10·5V
IN4148 D660
R651 ·5
R652 1K
BC547 Q651
U651 µA723
INV VREF VC V+ V- NI COMP VE
PN3645 Q652
PN3645 Q653
R662 4K7
MJE 3055 Q656
R667 27
C658 100µ
Q657 MJE3055
R660 1K8
C656 680µ
D661 IN 4148
C654 1n
R654 1K
R655 3K3
C655 100µ
-10·5
RV651 1K SET+55
D673 BZX79 /C15V
SET CH.
RV652 2K2
R656 4K7
R657 560
R661 470 1W
R664 330K
U652 741
R668 100K
R670 1K5
C657 1µ
R663 330K
R669 39K
R1 R2 R3 R4 F/L
T652
D662 +117V
2xBY206 +55V
D663
C659 100µ
C660 50µf
D664
2 x BY206
D665
D607 #1138
D668 +18V
BAX12
D669
C661 220µ
R686 #1127
DC OUTPUT SOCKET
D670
C662 220u
BAX12
D671 -18V
R687 #1127
C663 10n
D672 BY187 -1360V
R615 #1138
F/L 4100Vpp EHT MULTI #1138
F/L 6·3V 25KHz #1138
BATTERY PACK BP 3
BATTERY PLUG
OFF ON
4 X 3Fx4s BATTERY
+116
R681 33 117
+15
R682 10K
C684 100n
C682 330µ
RV681 1K SET+15
R683 4K7
U681 µA78MG
R686 1
C661 #1127 12·5µF
C681
+C686 100µ
+55
R689 10 +56
C688 68µF
TO GROUND POINT ON MAIN T.B. BOARD
C683 330µ
R684 1K8 SET-15
RV682 1K
C685 100n
R685 12K
U682 µA79MG
C687 100µ
-15
R687 1
C662 #1127
DISTRIBUTION & CRT BLANKING BOARD 160/258
D691 LED
PANEL INDICATOR
GRATICULE LAMPS
B691 6V 200mA LES
B692
R691 10
6·9VAC #1127
RV691 50ΩWW
SCALE
FRONT PANEL
DRAWN J.B.
TRACED D.E.W.
CHECKED BKT
DATE 6·74
POWER SUPPLIES & CAL.
540
1127
DRG. No.

R
601 - 623

C
601 - 609

Q
601 - 604

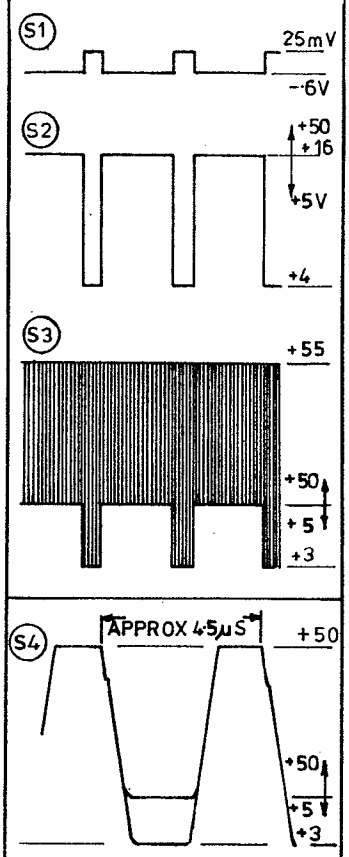
D
601 - 608

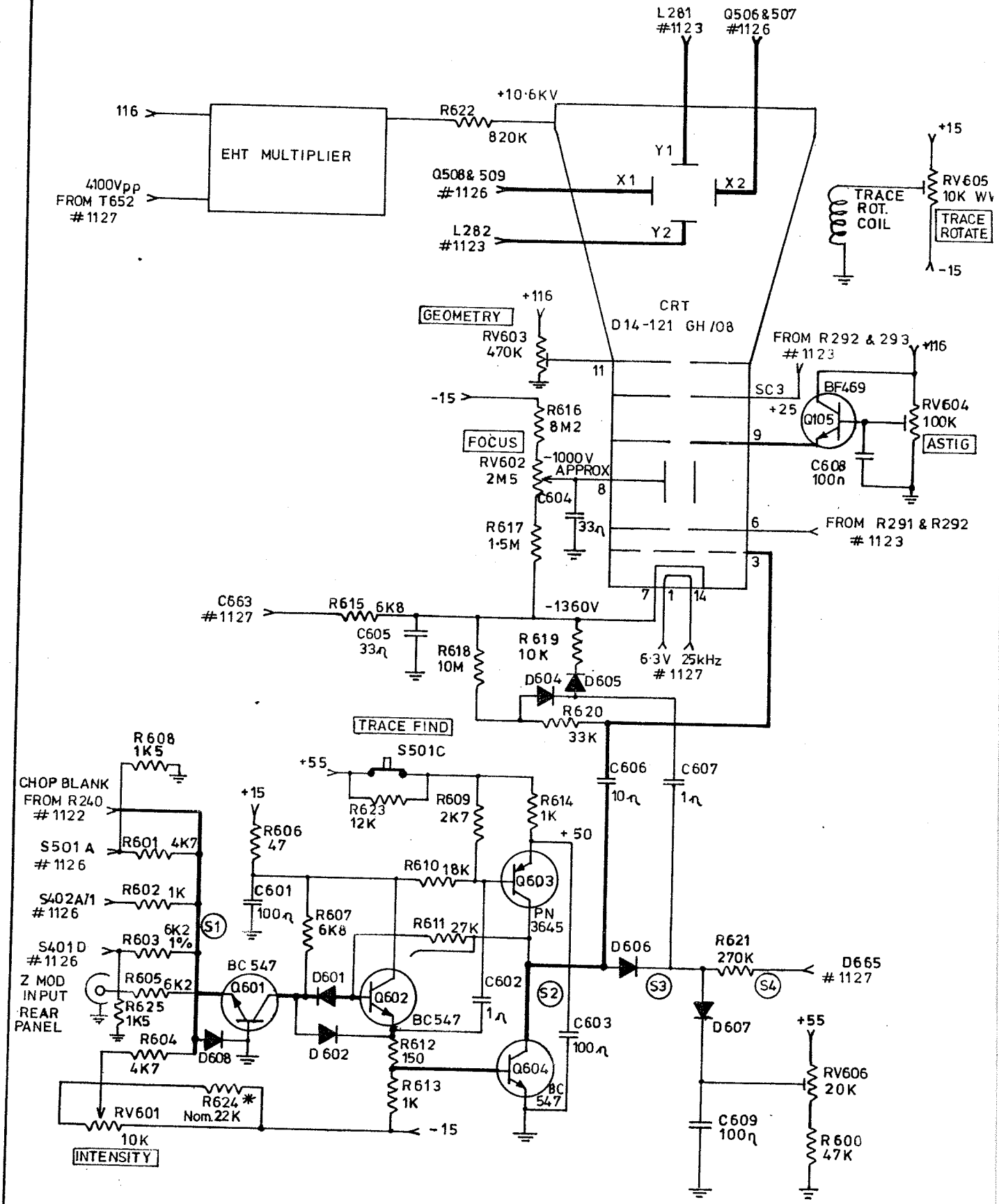
CONTROLS

RV 601	INTENSITY
RV 602	FOCUS
RV 603	GEOMETRY
RV 604	ASTIGMATISM
RV 605	TRACE ROTATE
RV 606	INTENSITY RANGE
S501C	TRACE FIND

WAVEFORMS

INPUT & SETTINGS AS DRGS. 1121 & 1124





ALL DIODES IN4148 UNLESS OTHERWISE STATED

* SELECTED COMPONENT

15 / 10 / 77	DRAWN J.B.	CRT BLANKING & PDA SUPPLY	DRG. No.
	TRACED D.E.W.		
	CHECKED BKT	540	1138
	DATE 10.75		