TELEQUIPMENT

PLUG-IN AMPLIFIER

TYPE CD

MANUAL

APPENDIX CD

TYPE CD VERTICAL AMPLIFIER - HIGH-GAIN DELAY

GENERAL

The Type CD amplifier combines the advantages of an ultra-high gain amplifier and a general purpose amplifier.

The four ranges available are as follows:

x1	DC - 15MHz at 100mV/cm
x10	DC - 800kHz at 10mV/cm
x100	3Hz - 75kHz at 1mV/cm
x1,000	3Hz - 75kHz at 100μV/cm

A switched attenuator network and variable gain control provide continuous coverage from 100μV/cm to approximately 125V/cm.

Direct coupling is used in the main amplifier but the preamplifier is AC-coupled. The circuit uses both valves and transistors; when plugged into a D53 framework, a balanced 200ns delay line is automatically connected to provide signal delay.

Special care has been taken in the high gain preamplifier to minimise both hum and noise, and on open circuit but shielded input, the total hum and noise content should not exceed 30μV peak to peak.

TECHNICAL DATA

Gain	x1	x10	x100	x1,000
3dB bandwidth	DC - 15MHz	DC - 800kHz	3Hz - 75kHz	3Hz - 75kHz
10 - 90% risetime	23ns	440ns	4.7μs	4.7μs
Sensitivity	0.1-50V/cm	10mV - 5V/cm	1 - 500mV/cm	0.1-50mV/cm

070-0958-00

Attenuator accuracy	$\pm$ 5%
Maximum Y deflection	6cm within bandwidth
Signal delay	200ns

OPERATION

Volts/cm Switch

This nine-position switch inserts a series of frequency compensated attenuators between the coaxial INPUT socket and the main amplifier. If the gain of the amplifier is calibrated, direct readings of input voltages may be obtained. The 1 volt calibration squarewave should measure 5 cm vertically with the VOLTS/CM switch set to 0.2V/cm; if not, adjust SET GAIN x1.

Variable Gain Control

The VARIABLE gain control is mounted concentrically with the VOLTS/CM switch and varies the gain of the amplifier to cover the range between the VOLTS/CM switch positions. The amplifier gain is only calibrated when VARIABLE is fully clockwise.

Input Selector Switch

This switch will normally be used in the AC x1 position, in which a blocking capacitor removes the DC component of the input signal. The time constant of the input circuit in this position is such that the response is 3dB down at 3Hz, which, whilst adequate for most purposes, may prove critical in some applications. (For example, in the AC positions, the 50Hz calibration waveform acquires a pronounced tilt). If a longer time constant is required, an external blocking capacitor must be used, with a value suitably greater than 0.1µF and the input switch set to DC.

The DC position is also used if it is specifically desired to include the DC component of the input waveform to be measured.

In the ACx100 position an AC-coupled preamplifier is switched into circuit; the bandwidth is limited to 3Hz - 75kHz. The switch position can be used with the x1/x10 gain switch in either position, the basic sensitivity being either 1mV/cm or 100μV/cm.

x1/x10 Y Gain Switch

This switch changes the gain of the Y amplifier, the normal (x1) sensitivity being multiplied by 10 when the x10 position is selected. The calibration of the VOLTS/CM switch applies only in the x1 position and should be divided by ten in the x10 position. Trace shift on switching between x1 and x10 is corrected by use of DC BAL as described in the Recalibration section.

Adjustment of Probe Trimmer

This adjustment is best carried out with a squarewave of about 1kHz. Connect the probe lead to the INPUT socket and apply the probe tip to the output of the squarewave generator. Adjust controls to display a few cycles of squarewave of about 5cm in amplitude and adjust the probe trimmer to give square corners and a flat top to the displayed waveform.

In the Type HZ1 probe, the trimmer has a screwdriver adjustment through a hole in the probe body.

To compensate the Type GE81000, slacken the narrower of the two knurled rings at the oscilloscope end of the probe lead, then rotate the adjacent broader ring until correct compensation is obtained. Retighten the narrower locking ring, taking care that the setting of the other ring is not disturbed.

CIRCUIT DESCRIPTION

It will be seen from the circuit diagrams that the amplifier consists of three sections:

(a) A high gain preamplifier
(b) An input attenuator network
(c) A balanced DC-coupled amplifier

High Gain Preamplifier

The preamplifier uses a double-triode valve. With S1 in the ACx100 position, the input signal is taken via blocking capacitor C2 to the grid of V1a. This valve is run at low anode current and voltage to minimise noise and drift. The amplified signal at the anode is resistance-capacity coupled to V1b. This valve, the second amplifying stage, is operated with some undecoupled cathode resistance, thus providing negative feedback to improve the signal handling capability. The variable resistor RV8 is used to set the gain to x100.

The preamplifier output is taken from the anode of V1b to the attenuator, via the DC blocking capacitor C6 and the input selector switch. This switch has three positions, marked ACx100, ACx1 and DC respectively. In the ACx100 position, the input signal passes through the preamplifier to the attenuator. In the ACx1 position the preamplifier is by-passed and the signal is taken via the DC blocking capacitor C1 to the input attenuator switch. In the DC position the signal is taken directly to this switch.

The high tension supply to the preamplifier is buffered against mains voltage fluctuations by means of the zener diode MR1. Further smoothing is obtained by R9, C7 while the valve heater is supplied with DC from a main frame LT supply.

The Input Attenuator (Volts/cm Switch)

The input attenuator consists of four frequency compensated resistance dividers, which are used singly or in series, to give nine division ratios. The first section has ratios of 1:1, 1:10, 1:100; the second, ratios of 1:1, 1:2, 1:5.

The Vertical Deflection Amplifier

The signal from the attenuator is fed into the control grid of V31. V31 and V32 form a cathode-coupled pair. The cathodes are coupled through RV38 the VARIABLE gain control and RV39 the SET GAIN x1 control. The cathode currents are supplied through cathode resistors R33, R42 and RV41. RV41 is a DC balance control and is adjusted so that there is no trace shift as VARIABLE is rotated. The network R36, R37, C30 maintains the input capacity of V31 constant despite changes in gain and shift.

A negative supply of 12.6 volts is available to provide the valve current and the shift voltage. The shift is applied to the grid of V32 via the attenuator R56, R57. The HT supply to the anodes of V31, V32 is obtained from the common cathode resistor of the output cathode followers V32a and b, hence the cathode current of the input stage is part of the cathode current of the output stage and a saving in total HT current is effected.

Signals from V31, V32 anodes are coupled to the bases of emitter followers TR30, TR31.

The output from the emitter followers drives the bases of TR34, TR35 and also, via attenuator networks R49, R53, C32 and R48, R52, C31, the bases of TR32, TR33.

TR32, TR33 form an emitter-coupled amplifier, to amplify the sync signals. The outputs at the collectors are taken to the output sync contacts for connection to the time base. The output DC levels are adjusted to be equal and approximately at earth potential by RV55.

Transistors TR34, TR35 form another emitter-coupled pair and provide the termination and frequency compensation for the balanced signal delay line. R66, RV67, R68, C35, 36, 37 & 38, between the emitters, provide middle and high frequency compensation. A floating supply of 12 volts developed across C39a provides a high-current low-voltage supply for the TR34, TR35 stage.

Transistor TR36 is used to maintain the currents through TR34, TR35 constant, despite fluctuations of input DC voltages, and it also provides through R88, a DC path for the base currents of TR34, TR35.

The output of TR34 & 35, after a delay of 200ns, is taken to the grids of V33a and b, a cathode-coupled output stage. High frequency compensation is effected by L32, L33 in the anode circuits. The output is coupled via cathode followers V34a and b to the Y plate connections.

In the x10 position of the Y GAIN switch, R58 is added in the shift voltage attenuator, and the anode loads of V31 and 32 are increased to increase the gain ten times.

RECALIBRATION

The vertical amplifier should be located in the lower compartment of the oscilloscope, both side covers removed and the delay line box swung back on its hinge so as to provide access to preset controls on both sides of the amplifier.

Set Gain and Balance Controls and Sync Output Level

Set Volts/cm to 0.1, Y GAIN to x1, INPUT to DC, and VARIABLE to Cal.

Centre the trace with Y SHIFT. Switch Y GAIN to x10 and recentre the trace with DC BAL.

Repeat the above procedure until switching from x1 to x10 produces no trace shift.

With Y GAIN on x10, rotate VARIABLE fully anti-clockwise and recentre the trace with RV41. Turn VARIABLE fully clockwise and recentre the trace with DC BAL. Repeat until rotation of VARIABLE produces no trace shift.

Check there is still no trace movement when operating the Y GAIN switch. Leave switch in x1 position.

Set the trace to the centre of the screen with Y SHIFT and adjust RV55 so that the voltage between the sync output contacts is zero.

Feed in a 0.5V peak to peak 1kHz square wave on the 0.1V/cm range and adjust SET GAIN x1 to give 5cm deflection. Reduce the input to 50mVp-p, switch to x10 and adjust RV60 to give 5cm of deflection. Switch back to x1 gain.

Reduce the input to 5mVp-p, switch to ACx100 and 0.1V/cm. Adjust RV8 to give 5cm deflection.

Input Attenuator

The eight trimmer capacitors of the VOLTS/CM switch are accessible for adjustment when the right-hand side cover is removed from the instrument. They are situated at the front of the amplifier in two parallel rows of four, separated by a metal screen. Plate CD shows the position of each trimmer.

In order to carry out attenuator adjustment a squarewave generator is required, giving a frequency of approximately 1kHz; its output must be variable between 0.5V and 100V. The rise time of the squarewave need not be particularly fast, but it must have good, flat tops and bottoms. The adjustment procedure is as follows:-

Connect the squarewave generator to the INPUT socket and adjust its output to approximately 0.5V.

Set the input attenuator to 0.1 volt/cm. Adjust the sweep controls to display three cycles of the square wave on the screen.

Adjust each capacitor in turn, to give square corners to the waveform. The VOLTS/CM switch and squarewave generator should be set as shown in the table below.

Volts/cm	Squarewave Vp-p	Capacitor to be Adjusted
0.2	1	C19
0.5	2.5	C23
1	5	C12
2	10	C16
5	25	C17
10	50	C13

When this procedure is correctly carried out, the 20 and 50 volts/cm ranges are automatically correct.

Adjustments for Using Probe

The capacitors C8 and C9 affect compensation only when a high impedance probe is in use. To adjust them proceed as follows:

Remove the squarewave generator output from the input socket and plug in the probe. Connect the probe tip to the generator output.

Set the input attenuator to 0.1V/cm and the squarewave generator output to approximately 500mV.

Adjust the probe trimmer to give a flat top to the squarewave.

Switch the input attenuator to the 1V/cm range. Readjust the squarewave generator output to 5V, and adjust C8. Set the input attenuator to the 10V/cm range, the generator output to 50V, and adjust C9. All other ranges will automatically be correct.

High Frequency Compensation

This should not be attempted unless a square wave generator capable of producing an accurate square wave at 100kHz to 1MHz with a risetime of not more than 5 nanoseconds is available. It must also be absolutely free from ring or overshoot. The HF compensation circuits are very stable, and unless such a generator is available, it is best not to attempt any readjustment.

If such a generator is available, the following procedure should be adopted.

Feed in a 1MHz squarewave, on the 0.1V/cm range, via a correctly terminated cable, and adjust the amplitude to produce a display of about 3cm.

Set C38 to minimum capacity, as shown by maximum undershoot, and adjust RV67 for best response without ripples.

Adjust L32, L33 by equal amounts to obtain the fastest possible rise time consistent with no overshoot.

Adjust L30, L31 by equal amounts to obtain the fastest possible rise time consistent with no overshoot.

Adjust C38 for the best corner, resetting RV67 if necessary.

Bandwidth should be greater than 15MHz at -3dB.

Bandwidth on x10 should be greater than 800kHz at -3dB.

Bandwidth on ACx100 should be 3Hz to 75kHz.

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R1	319-0031-01	1M	HS	1	$\frac{1}{4}$
R2	316-0101-01	100	C		
R3	319-0088-00	68k	HS	1	$\frac{1}{4}$
R4	316-0152-01	1.5k	C		
R5	316-0105-01	1M	C		
R6	316-0101-01	100	C		
R7	316-0473-01	47k	C		
RV8	311-0755-00	5k	CP	30	0.1
R9	316-0152-01	1.5k	C		
R10	316-0180-01	18	C		
R11	316-0180-01	18	C		
R12	316-0153-01	15k	C		
R13	319-0005-01	900k	HS	1	$\frac{1}{4}$
R14	319-0119-00	990k	HS	1	$\frac{1}{4}$
R15	319-0096-00	111k	HS	1	$\frac{1}{4}$
R16	319-0120-00	10.1k	HS	1	$\frac{1}{4}$
R17	319-0112-00	500k	HS	1	$\frac{1}{4}$
R18	319-0118-00	800k	HS	1	$\frac{1}{4}$
R19	319-0031-01	1M	HS	1	$\frac{1}{4}$
R20	316-0101-01	100	C		
R22	319-0103-00	250k	HS	1	$\frac{1}{4}$
R23	319-0031-01	1M	HS	1	$\frac{1}{4}$
R24	316-0104-01	100k	C		
R25	316-0180-01	18	C		
R30	316-0101-01	100	C		
R31	319-0117-00	8.2k	HS	1	$\frac{1}{4}$
R32	319-0116-00	750	HS	1	$\frac{1}{4}$
R33	316-0102-01	1k	C		
R34	316-0152-01	1.5k	C		
R35	302-0273-01	27k	C	10	$\frac{1}{2}$
R36	316-0122-01	1.2k	C		
R37	316-0182-01	1.8k	C		
RV38	311-0726-00	500	CV	20	$\frac{1}{4}$
RV39	311-0723-00	500	CP	20	$\frac{1}{4}$
R40	316-0101-01	100	C		
RV41	311-0721-00	500	CP	20	$\frac{1}{4}$

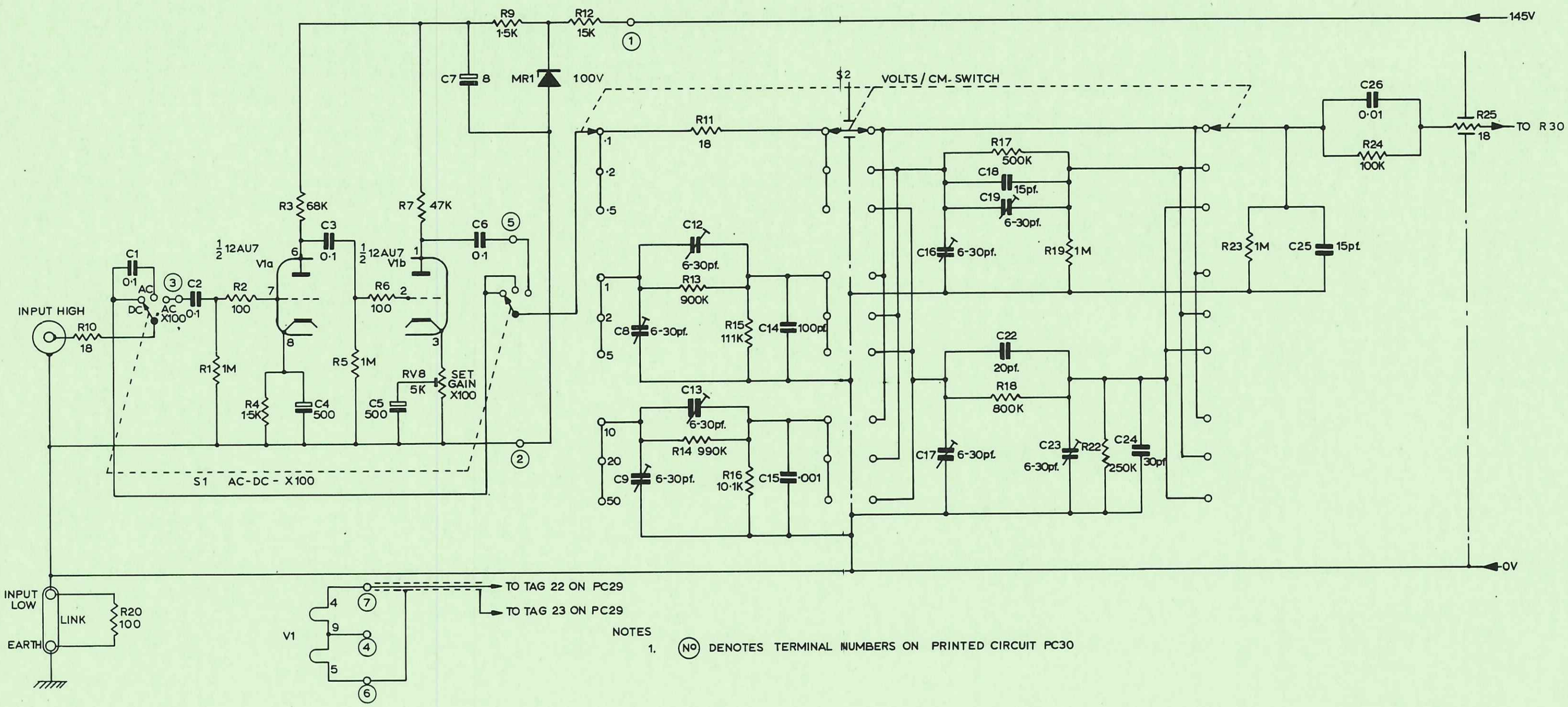
Carbon resistors are 10% $\frac{1}{4}$W unless otherwise shown

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R42	316-0102-01	1k	C		
R43	316-0101-01	100	C		
R44	319-0116-00	750	HS	1	$\frac{1}{4}$
R45	319-0117-00	8.2k	HS	1	$\frac{1}{4}$
R46	307-0148-00	820	MO	5	$1\frac{1}{2}$
R47	316-0271-01	270	C		
R48	307-0147-00	8.2k	MO	5	$1\frac{1}{2}$
R49	307-0147-00	8.2k	MO	5	$1\frac{1}{2}$
R50	316-0101-01	100	C		
R51	302-0273-01	27k	C	10	$\frac{1}{2}$
R52	319-0091-00	1.5k	HS	1	$\frac{1}{4}$
R53	319-0091-00	1.5k	HS	1	$\frac{1}{4}$
R54	316-0152-01	1.5k	C		
RV55	311-0715-00	150	CP	30	0.1
R56	316-0224-01	220k	C		
R57	316-0124-01	120k	C		
R58	316-0225-01	2.2M	C		
R59	316-0125-01	1.2M	C		
RV60	311-0804-00	500k	CP	30	0.1
R61	316-0684-01	680k	C		
RV62	311-0779-00	100k	CV	20	$\frac{1}{4}$
RV63	311-0783-00	100k	CP	20	$\frac{1}{4}$
R64	319-0093-00	100	HS	1	$\frac{1}{4}$
R65	316-0271-01	270	C		
R66	316-0102-01	1k	C		
RV67	311-0722-00	500	CP	30	0.1
R68	316-0471-01	470	C		
R69	316-0390-01	39	C		
R71	316-0390-01	39	C		
R72	316-0271-01	270	C		
R73	319-0093-00	100	HS	1	$\frac{1}{4}$
R74	316-0102-01	1k	C		
R75	316-0152-01	1.5k	C		
R76	319-0093-00	100	HS	1	$\frac{1}{4}$
R77	319-0093-00	100	HS	1	$\frac{1}{4}$
R78	316-0101-01	100	C		
R79	316-0101-01	100	C		
R81	307-0141-00	2.7k	MO	5	$1\frac{1}{2}$

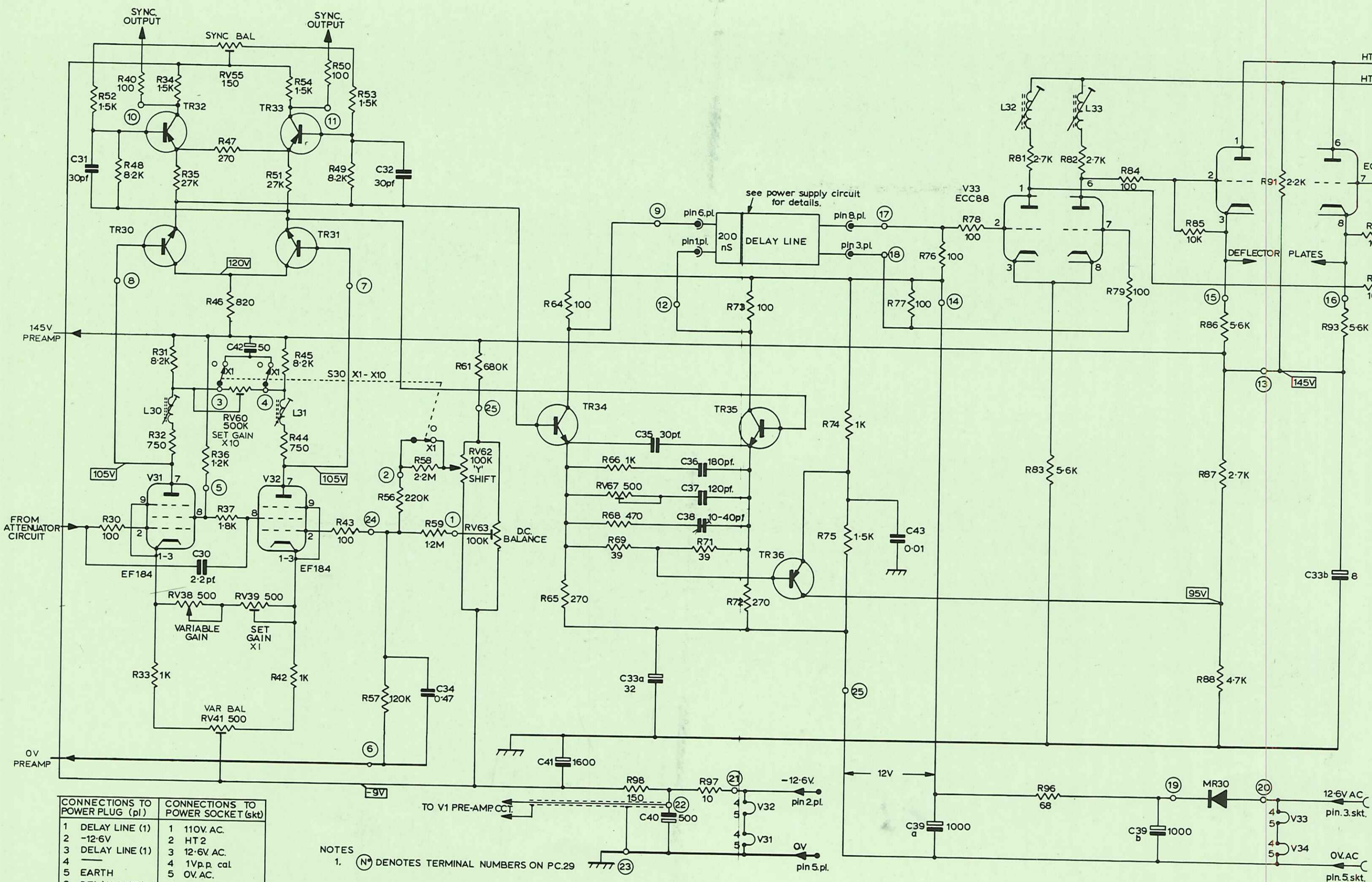
Cct. ref.	Part number	Value	Description	Tol. %	Rating
R82	307-0141-00	2.7k	MO	5	$1\frac{1}{2}$
R83	307-0168-00	5.6k	MO	5	$3\frac{1}{4}$
R84	316-0101-01	100	C		
R85	316-0103-01	10k	C		
R86	307-0143-00	5.6k	MO	5	$1\frac{1}{2}$
R87	307-0141-00	2.7k	MO	5	$1\frac{1}{2}$
R88	307-0166-00	4.7k	MO	5	$3\frac{1}{4}$
R91	307-0165-00	2.2k	MO	5	$3\frac{1}{4}$
R93	307-0143-00	5.6k	MO	5	$1\frac{1}{2}$
R94	316-0103-01	10k	C		
R95	316-0101-01	100	C		
R96	316-0680-01	68	C		
R97	302-0100-01	10	C	10	$\frac{1}{2}$
R98	316-0151-01	150	C		
C1	285-0772-00	0.1	PE	10	400
C2	285-0773-00	0.1	PE	20	400
C3	285-0796-00	0.1	PE	20	250
C4	290-0341-00	500	E		3
C5	290-0341-00	500	E		3
C6	285-0796-00	0.1	PE	20	250
C7	290-0113-01	8	E		150
C8	281-0137-00	6-30p	CT		350
C9	281-0137-00	6-30p	CT		350
C12	281-0137-00	6-30p	CT		350
C13	281-0137-00	6-30p	CT		350
C14	285-0854-00	100p	PS	2p	350
C15	285-0850-00	1,000p	PS	5	125
C16	281-0137-00	6-30p	CT		350
C17	281-0137-00	6-30p	CT		350
C18	285-0842-00	15p	PS	1p	350
C19	281-0137-00	6-30p	CT		350
C22	285-0867-00	20p	PS	1p	350
C23	281-0137-00	6-30p	CT		350
C24	285-0843-00	30p	PS	2p	350
C25	285-0842-00	15p	PS	1p	350
C26	285-0769-00	0.01	PE	20	400
C30	281-0676-00	2.2p	CER	0.1p	500

Cct. ref.	Part number	Value	Description	Tol. %	Rating
C31	285-0843-00	30p	PS	2p	350
C32	285-0843-00	30p	PS	2p	350
C33a)	290-0346-00	(32)	E (32 + 8)		200
C33b)		(8)			
C34	285-0779-00	0.47		20	100
C35	285-0843-00	30p	PS	2p	350
C36	285-0872-00	180p	PS	2	350
C37	283-0661-00	120p	SM	5	750
C38	281-0132-00	10-40p	CT		500
C39a)	290-0384-00	(1,000)	E (1,000 + 1,000)		18
C39b)		(1,000)			
C40	290-0387-00	500	E		18
C41	290-0344-00	1,600	E		10
C42	290-0343-00	50	E		40
C43	285-0790-00	0.01	PE	20	125
L30	114-0264-00	1.5-3.3μH	Variable inductor		
L31	114-0264-00	1.5-3.3μH	Variable inductor		
L32	114-0252-00	9.1-20μH	Variable inductor		
L33	114-0252-00	9.1-20μH	Variable inductor		
MR1	152-0344-00	100V	Si zener	10	0.33W
MR30	152-0339-00	50V	Si rectifier		0.5A
S1	260-0929-00		Rotary (3-position)		
S2	260-0953-00		Rotary (9-position)		
S30	260-0955-00		Slide (2-position)		
TR30	151-0242-00		SPS2506 Motorola Si		
TR31	151-0242-00		SPS2506 Motorola Si		
TR32	151-0244-00		2N3702 Texas Si		
TR33	151-0244-00		2N3702 Texas Si		
TR34	151-0246-00		BSY95A CSF Si		
TR35	151-0246-00		BSY95A CSF Si		
TR36	151-0243-00		ACY22 Mullard Ge		

Cct. ref.	Part number	Description
V1	154-0041-05	ECC82/12AU7
V31	154-0535-00	EF184/6EJ7
V32	154-0535-00	EF184/6EJ7
V33	154-0187-01	ECC88/6DJ8
V34	154-0187-01	ECC88/6DJ8



ATTENUATOR & PRE AMP TYPE CD FIG 3·9

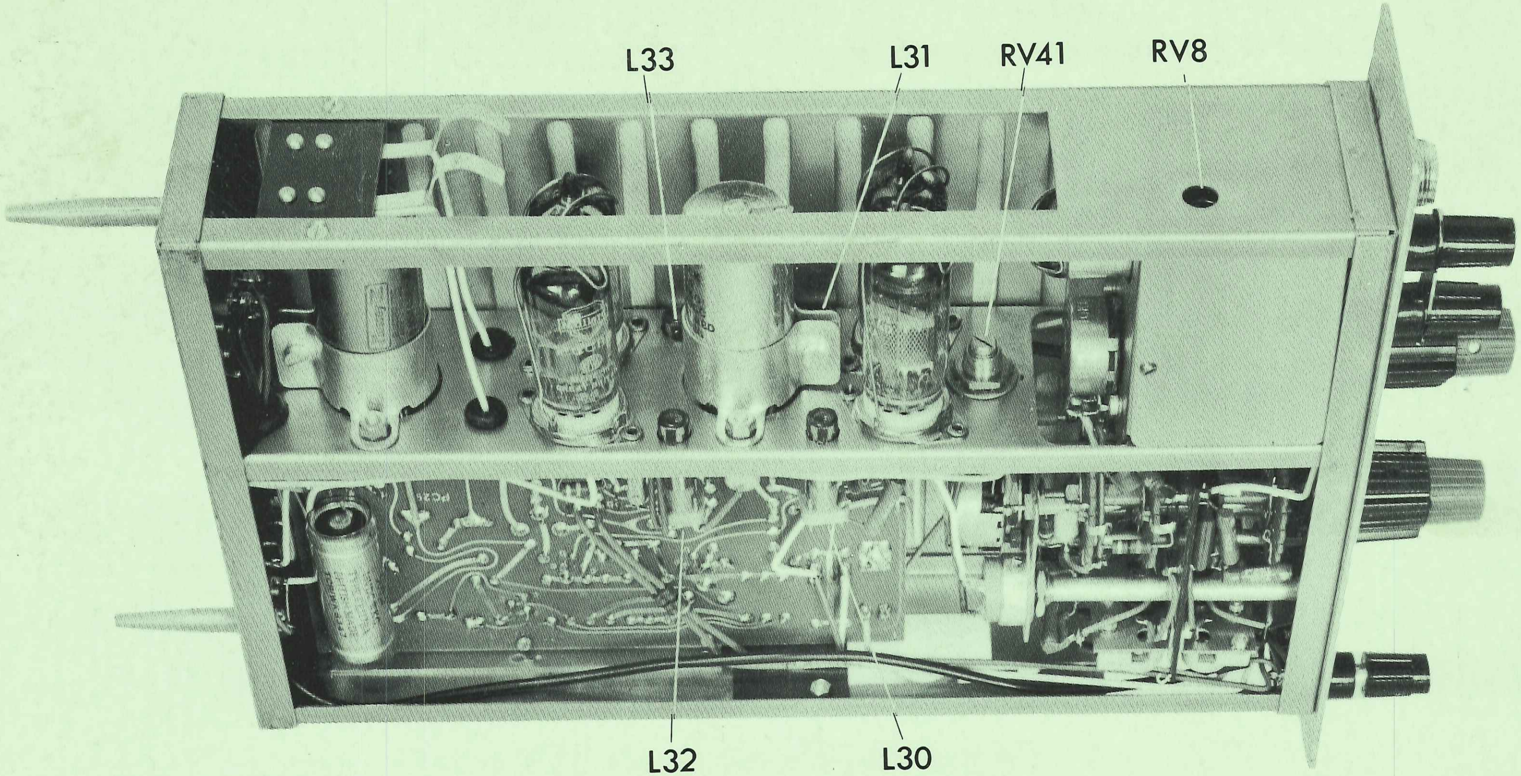


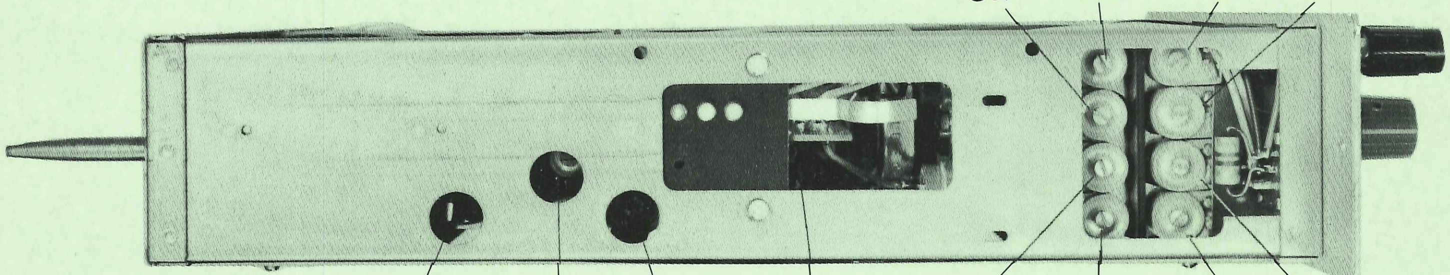
CONNECTIONS TO POWER PLUG (pl)	CONNECTIONS TO POWER SOCKET (skt)
1 DELAY LINE (1)	1 110V. AC.
2 -12·6V	2 HT2
3 DELAY LINE (1)	3 12·6V. AC.
4 ——	4 1Vp.p. cal.
5 EARTH	5 0V. AC.
6 DELAY LINE (2)	6 110V. AC.
7 -100V	7 HT1
8 DELAY LINE (2)	8 6·3V. AC.

NOTES
1. (N°) DENOTES TERMINAL NUMBERS ON P.C.29

AMPLIFIER TYPE CD

FIG 3·10





PRESET CONTROLS AMPLIFIER. TYPE.CD.

PLATE CD