TELEQUIPMENT

PLUG-IN AMPLIFIER

TYPE JD

All TelequipmenT instruments are subject to continuous development and improvement, consequently this instrument may incorporate minor changes in detail from the information contained herein.

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TYPE JD VERTICAL AMPLIFIER - HIGH-GAIN WIDEBAND DELAY

GENERAL

The Type JD plug-in is a four-range amplifier offering a continuous coverage of sensitivities from 100μV to approximately 125V/cm on a.c. and 10mV to approximately 125V/cm on d.c.

The amplifier may only be used in the 53 series of oscilloscope.

The built-in signal delay of 200ns enables the leading edge of a fast-rise pulse to be clearly observed.

TECHNICAL DATA

Sensitivity, approximate 3dB bandwidth and risetime.

Input coupling	Y gain	Calibrated sensitivity per cm ± 5%	Bandwidth	Risetime
DC	x1	100mV-50V	d.c.-25MHz	14ns
	x10	10mV-5V	d.c.-10MHz	35ns
AC	x1	100mV-50V	3Hz-25MHz	14ns
	x10	10mV-5V	3Hz-10MHz	35ns
ACx100	x1	1mV-500mV	5Hz-100kHz	3.5μs
	x10	100μV -50mV	5Hz-100kHz	3.5μs

Maximum input (via 400V capacitor a.c. coupled)	
DC & AC	400Vp
ACx100	50mVp-p before limiting
Signal delay	200ns
Hum and noise	
Short-circuited input	30μVp-p or better
Open-circuited but shielded input	100μVp-p or better

Overall dimensions approx.		
Height	6 cm	$2\frac{1}{2}$ in
Width	20 cm	$7\frac{3}{4}$ in
Depth	35 cm	$13\frac{3}{4}$ in
Net weight approx.	1.25 kg	$2\frac{3}{4}$ lb

OPERATION

Input

The outer of the UHF socket and the LOW terminal are not connected directly to chassis but through a 100ohm resistor. In most applications this resistor may be shorted-out by the plated earthing link, but where multiple-earth paths introduce problems, reference should be made to the General Description section of the main-frame manual.

Input selector switch

ACx100 In this setting a two-stage low-noise preamplifier, with a gain of 100 and a bandwidth of 100kHz is switched into circuit before the input attenuator; either the x1 or x10 Y GAIN switch settings may be used in conjunction. Since the maximum input signal handling capacity of the preamplifier, before limiting occurs, is 50mVp-p, it is recommended that, for signals in excess of this, the AC or DC input switch settings should be used. A 5cm display is obtainable from a 50mV signal on AC or DC with VOLTS/CM at 0.1 and Y GAIN at x10.

AC Except for inputs below 50mVp-p, when the ACx100 facility may be used as noted above, the AC position will be found usually more convenient than DC. This avoids frequent resetting of the shift control due to changes in d.c. level of input signals.

DC This position should be used for d.c. voltage measurement and for displaying low-frequency signals when the input time-constant on AC is inadequate to prevent waveform distortion. If d.c. blocking at very low frequencies is desired, the signal should be fed through an external capacitor, greater than 0.1µF, with the switch set at DC.

Y shift

This control positions the display in the vertical axis of the CRT.

Volts/cm

A setting should be chosen to produce a convenient amplitude of display. With the variable control fully clockwise at CAL the calibrations, which relate to the x1 Y gain setting on AC or DC, are accurate to within ± 5%.

Variable

Amplifier gain may be reduced by a factor of up to 2.5:1 or greater, from the calibrated setting, by anti-clockwise rotation of this control. Volts/cm calibrations are only valid when VARIABLE is fully clockwise.

Y gain

The x1 or x10 setting should be selected as appropriate for the amplitude of the signal to be observed. The volts/cm indications should be divided by 10 in the x10 gain condition and further divided by 100 in the ACx100 condition.

Amplifier d.c. balance and x1 gain may be readily checked as follows:-

Check d.c. balance: In x1 gain condition and with no input signal, centre trace with Y SHIFT. Switch to x10 and recentre trace with DC BAL. Repeat until no trace shift occurs when switching between x1 and x10.

Check x1 gain: Select x1 gain, DC input and 0.2V/cm. Link CAL 1Vp-p and INPUT and adjust SET GAIN for a 5cm display. If there is insufficient range of adjustment, refer to Recalibration section.

Adjustment of probe trimmer

This adjustment is best carried out with a squarewave of about 1kHz. Connect the probe lead to the plug-in 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

Preamplifier and attenuator - Figure JD1

In the ACx100 position of S1, the input signal is passed via blocking capacitor C1 to the gate of TR1, an n-channel field-effect transistor. MR1 & 2 protect TR1 against over-voltage, R4 limiting the current through the diodes. Adjustment of overall preamplifier gain is effected by RV6 which controls the degree of feedback in the source of TR1.

The signal at the drain of TR1 is RC-coupled to the base of TR2, a grounded-emitter stage. The output at the collector is taken via C5 to the attenuator.

A stabilised supply at 13v for TR1 & 2 is provided by reference diode MR3 in association with C6 & R10.

The preamplifier is by-passed in the AC and DC positions of S1. The input signal is applied either via C1 or directly to the attenuator. S2 selects four frequency-compensated resistive dividers which are used singly or in tandem to give nine division ratios. The first section provides ratios of 1, 10 or 100:1 and the second section ratios of 1, 2 or 5:1. C10, 11, 14, 15, 18 & 19 serve to equalise time-constant for all ranges. C8 & 9 affect compensation only when a high-impedance probe is used.

The single-ended output from the attenuator is applied to the grid of V21 in the main amplifier.

Amplifier - Figure JD2

V21 & 22 form a cathode-coupled phase-splitting stage which provides a push-pull output at the anodes; adjustable shunt-peaking inductors L21 & 22 extend the frequency response of the stage. Gain control is provided by VARIABLE RV23. C32 compensates for variation of input capacitance of V21 with change of gain. SET GAIN RV24 and PRESET GAIN RV30 enable the amplifier gain in the x1 gain condition to be accurately set. VAR BAL RV26 is set for no trace shift on rotation of RV23. Shift voltage is applied to the grid of V22 from Y SHIFT RV34. In the x10 Y gain condition R33 is brought into circuit to restrict the voltage swing provided by RV34. DC BAL RV35 is adjusted for no trace shift on switching between x1 and x10 gain; the voltage across RV35 is clamped at about 1 volt by MR22 & 23.

The heaters of V21 & 22 are fed from a -12.6V line; after decoupling by R94 & C35 this supply is applied to the shift circuit and input and sync amplifier stages.

Zener diode MR21 enables amplifier gain to vary inversely with changes in CRT deflection sensitivity caused by small changes in supply voltage.

The output at the anodes of V21 & 22 is coupled via emitter-followers TR21 & 22 to the emitter-coupled pair TR25 & 26 which provides current drive for TR27 & 28. The gain of TR25 & 26 is increased ten times by increase in emitter coupling in the x10 gain condition; RV58 SET GAIN x10 enables this increase to be accurately set. RV57 & C24 provide high-frequency compensation.

The emitter-coupled pair TR27 & 28 provide a low-impedance drive for the delay-line. The series RC combinations between TR27 & 28 provide compensation at various time-constants to match the impedance of the delay line.

Part of the output of TR27 & 28 is fed via R66 & 76 to the bases of the push-pull sync amplifying stage TR23 & 24. With the trace centred, the d.c. level at the collectors is arranged to be at about 0V. RV50 enables the levels referred to chassis to be balanced. Sync signals are taken from the amplifier before the delay-line so that the sweep can begin before the arrival of the vertical signal on the CRT Y plates.

After a 200ns delay in DL21, the output of TR27 & 28 is applied to the emitters of the grounded-base amplifying stage TR29 & 30. This stage offers the correct forward termination to the delay-line.

The signal at the collectors of TR29 & 30 is applied via R84 & 83 to the bases of output emitter-followers TR31 & 32. The output at the emitters is coupled directly to the Y plates of the CRT via spring contacts on the left-hand side of the amplifier.

HT current for the shift circuit, input stages V21 & 22, TR21 & 22 and sync amplifier TR23 & 24 is provided mainly by the emitter currents of TR31 & 32 via R89 & 91. This arrangement has the advantage of reducing total current consumption. The remainder of the current required is obtained via R85 & 86.

RECALIBRATION

The following procedure should be adopted if a more thorough recalibration is required than the balance and gain checks outlined in the operation section.

NOTE Insulated tools should be used for all internal adjustments to avoid the risk of damage to semiconductors.

For steps 1 and 4, a d.c. voltmeter is required with an internal resistance of 20 kilohms/volt or better.

For steps 5 to 10 a squarewave amplitude calibrator is required with an output of about 1kHz, variable between 50mV and 100Vp-p.

In step 11 the fast-rise squarewave generator should have a risetime of 5ns or less and have an output of up to about 500mV at a frequency from 100kHz to 1MHz.

1 Remove both side covers of the oscilloscope and the top screening cover of the amplifier. Plug the amplifier into the lower compartment, switch on and leave for 20 minutes for temperature to become stable. Connect a voltmeter between the collector of TR2 and chassis and adjust RV80 for a reading of 5 to 8 volts.

2 d.c. balance

Set INPUT to DC, VOLTS/CM to 0.1, VARIABLE fully clockwise to CAL and Y GAIN at x1 (out). Centre trace with Y SHIFT. Switch Y GAIN to x10 and recentre trace with DC BAL. Repeat, adjusting Y SHIFT on x1 and DC BAL on x10, until there is no trace shift on switching between x1 and x10.

3 Variable balance

Set Y GAIN at x10 and VARIABLE fully anti-clockwise. Centre trace with RV26 VAR BAL. Turn VARIABLE fully clockwise and recentre trace with DC BAL. Repeat, adjusting RV26 with VARIABLE anti-clockwise and DC BAL with VARIABLE clockwise, until there is no trace shift on rotation of VARIABLE.

Check that there is no trace movement when operating Y GAIN button. If trace moves, repeat steps 2 and 3.

4 Sync output level

Centre trace accurately with Y SHIFT. Connect a d.c. voltmeter, 20 kilohms/volt or better, across the sync take-off contacts at the right-hand side of the amplifier and adjust RV50, at right towards rear, for zero volts.

5 Gain x1

With VOLTS/CM at 0.1, set VARIABLE fully clockwise, Y GAIN at x1 and SET GAIN slightly anti-clockwise of mid-range. Feed in a 500mVp-p 1kHz squarewave and adjust RV30 PRESET GAIN x1 for about 5cm deflection; RV30 is suspended between L21 & 22, adjacent to the two valves. Adjust SET GAIN for precisely 5cm deflection.

6 Gain x10

Reduce input to 50mVp-p and set Y GAIN at x10. Adjust RV58, at right towards rear, for 5cm deflection.

7 Gain ACx100

Reduce input to 5mVp-p, set Y GAIN at x1 and INPUT at ACx100. Adjust RV6, through the circular hole left-front, for 5cm deflection. Return INPUT to DC.

8 Amplifier input capacitance

With Y GAIN at x1, set VARIABLE fully anti-clockwise and VOLTS/CM at 0.2. Feed in about 1Vp-p at 1kHz from the calibrator and adjust C18 on attenuator for best squarewave. Turn VARIABLE fully clockwise and adjust C32, beside V21 & 22, for best corner with no overshoot. Repeat, adjusting C18 with VARIABLE anti-clockwise and C32 with VARIABLE clockwise, until there is no change at the corners of the squarewave with rotation of VARIABLE.

9 Attenuator compensation

With VARIABLE clockwise and Y GAIN at x1, set VOLTS/CM and 1kHz calibrator output as below. Adjust the appropriate trimmer for best squarewave with no undershoot or overshoot at the corners.

Volts/cm	Calibrator Vp-p	Adjust
0.2	1	C18
0.5	2.5	C19
1	5	C10
2	10	C14
5	25	C15
10	50	C11

10 Probe adjustment and attenuator compensation for probe

Remove squarewave input and connect probe between INPUT and calibrator. Set VOLTS/CM and 1kHz calibrator output as below and adjust appropriate trimmer for best squarewave. The calibrator output is stated for a x10 probe.

Volts/cm	Calibrator Vp-p	Adjust
0.1	5	Probe
1	50	C8
10	100	C9

11 High-frequency compensation

Remove probe and, with Y GAIN at x1 and VOLTS/CM at 0.1, connect the fast-rise squarewave generator via appropriate termination. Adjust output from 300 to 500mVp-p at about 100kHz. Unscrew cores of L21 & 22 until they are nearly out of formers and set RV57 & 71 to mid-range.

Adjust C29 for a flat top to the first part of the waveform. Increase squarewave frequency to about 1MHz and adjust C31 & RV71 for flat tops. Adjust RV57 & C24 for square corners. Repeat these adjustments for best transient response.

L21 & 22 should now be adjusted. Screw-in the core of either inductor to a position just before over-shoot begins to appear. Screw-in the core of the other inductor similarly. Adjust both cores in step for the fastest leading-edge and square corner.

The 3dB bandwidth should not be less than 25MHz on x1 gain, 10MHz on x10 gain and 3Hz to 100kHz on ACx100. Repeat step 11 if the required bandwidth has not been attained.

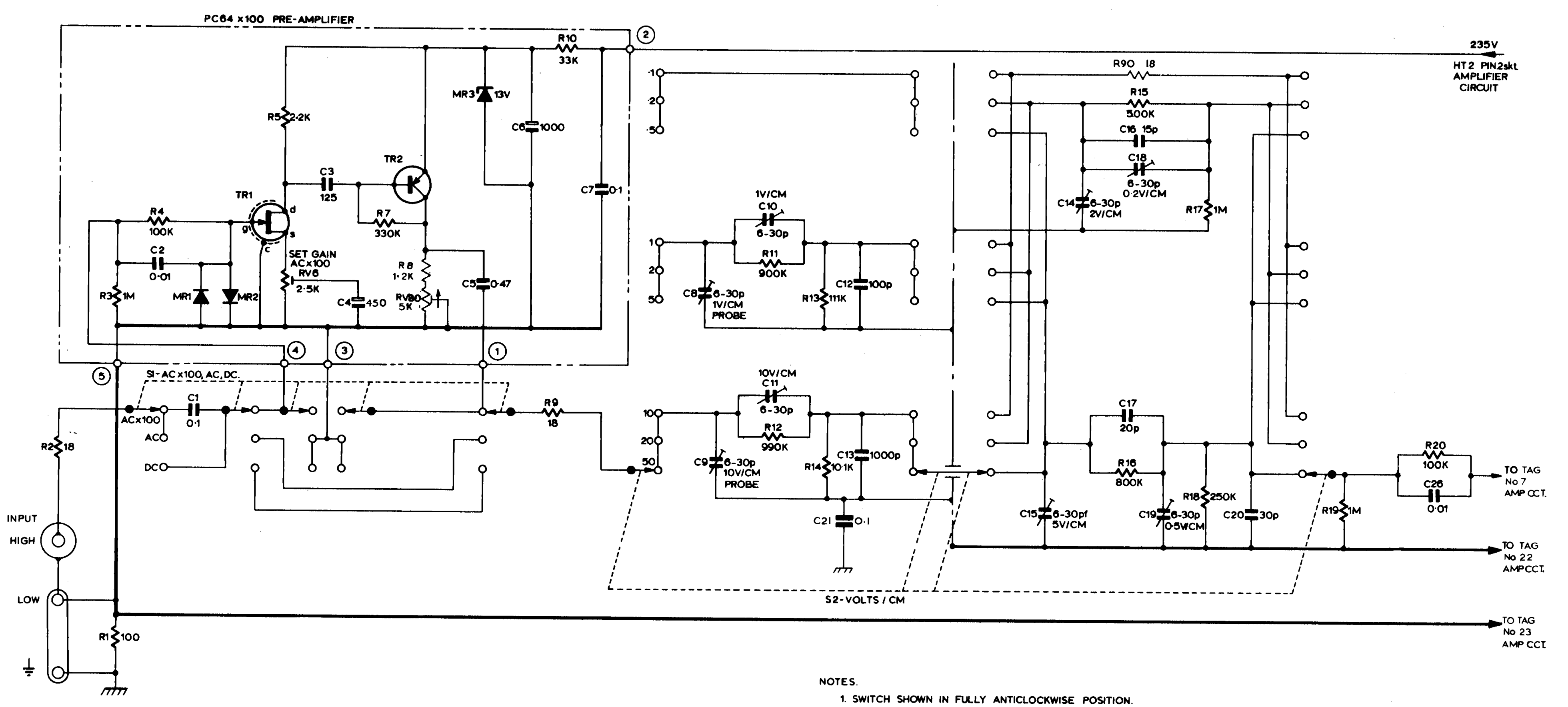
Cct. ref.	Part number	Value	Description	Tol. %	Rating
R1	316-0101-01	100	C		
R2	316-0180-01	18	C		
R3	319-0031-01	1M	HS	1	¼
R4	316-0104-01	100k	C		
R5	315-0222-01	2.2k	C	5	¼
RV6	311-0877-00	2.5k	CP	30	0.1
R7	319-0108-00	330k	HS	1	¼
R8	316-0122-01	1.2k	C		
R9	316-0180-01	18	C		
R10	307-0137-00	33k	MO	5	1½
R11	319-0005-01	900k	HS	1	¼
R12	319-0119-00	990k	HS	1	¼
R13	319-0096-00	111k	HS	1	¼
R14	319-0120-00	10.1k	HS	1	¼
R15	319-0112-00	500k	HS	1	¼
R16	319-0118-00	800k	HS	1	¼
R17	319-0031-01	1M	HS	1	¼
R18	319-0103-00	250k	HS	1	¼
R19	319-0031-01	1M	HS	1	¼
R20	316-0104-01	100k	C		
R21	316-0101-01	100	C		
R22	316-0561-01	560	C		
RV23	311-0726-00	500	CV	20	¼
RV24	311-0723-00	500	CP	20	¼
R25	316-0561-01	560	C		
RV26	311-0719-00	470	CP	20	¼
R27	316-0122-01	1.2k	C		
R28	316-0101-01	100	C		
R29	316-0684-01	680k	C		
RV30	311-0909-00	20k	CP	20	0.05
R31	316-0473-01	47k	C		
R32	316-0683-01	68k	C		
R33	316-0685-01	6.8M	C		
RV34	311-0778-00	100k	CV	20	¼
RV35	311-0783-00	100k	CP	20	¼
R36	316-0334-01	330k	C		
R37	316-0470-01	47	C		
R38	315-0561-01	560	C	5	¼
R39	316-0182-01	1.8k	C		
R40	315-0561-01	560	C	5	¼
R41	316-0561-01	560	C		
R42	316-0470-01	47	C		
R43	316-0561-01	560	C		
R44	307-0137-00	33k	MO	5	1½
R45	309-0042-01	68k	HS	1	½
R46	319-0117-00	8.2k	HS	1	¼

Carbon resistors are 10% ¼W unless otherwise shown

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R47	315-0222-01	2.2k	C	5	¼
R48	316-0101-01	100	C		
R49	316-0821-01	820	C		
RV50	311-0722-00	500	CP	30	0.1
R51	307-0137-00	33k	MO	5	1½
R52	315-0222-01	2.2k	C	5	¼
R53	316-0101-01	100	C		
R54	319-0117-00	8.2k	HS	1	¼
R55	309-0042-01	68k	HS	1	½
R56	316-0331-01	330	C		
RV57	311-0718-00	250	CP	30	0.1
RV58	311-0714-00	100	CP	30	0.1
R59	316-0331-01	330	C		
R60	315-0182-01	1.8k	C	5	¼
R61	315-0182-01	1.8k	C	5	¼
R62	307-0162-00	15k	MO	5	3¼
R63	307-0177-00	4.3k	MO	5	7
R64	315-0471-01	470	C	5	¼
R65	315-0471-01	470	C	5	¼
R66	316-0102-01	1k	C		
R67	319-0093-00	100	HS	1	¼
R68	319-0095-00	107	HS	1	¼
R69	316-0101-01	100	C		
R70	316-0102-01	1k	C		
RV71	311-0755-00	5k	CP	30	0.1
R72	315-0103-01	10k	C	5	¼
R73	315-0223-01	22k	C	5	¼
R74	315-0471-01	470	C	5	¼
R75	315-0471-01	470	C	5	¼
R76	316-0102-01	1k	C	10	¼
R77	319-0093-00	100	HS	1	¼
R78	319-0095-00	107	HS	1	¼
R79	315-0471-01	470	C	5	¼
RV80	311-0755-00	5k	CP	30	0.1
R81	307-0135-00	1k	MO	5	1½
R82	307-0135-00	1k	MO	5	1½
R83	316-0180-01	18	C		
R84	316-0180-01	18	C		
R85	307-0143-00	5.6k	MO	5	1½
R86	315-0272-01	2.7k	C	5	¼
R87	307-0165-00	2.2k	MO	5	3¼
R88	316-0473-01	47k	C		
R89	307-0145-00	6.8k	MO	5	1½
R90	316-0180-01	18	C		
R91	307-0145-00	6.8k	MO	5	1½
R92	307-0163-00	22k	MO	5	3¼
R93	307-0163-00	22k	MO	5	3¼
R94	316-0101-01	100	C		

Cct. ref.	Part number	Value	Description	Tol. %	Rating
C1	285-0772-00	0.1	PE	10	400
C2	285-0769-00	0.01	PE	20	400
C3	290-0406-00	125	E		4
C4	290-0341-00	450	E		3
C5	285-0779-00	0.47	PE	20	100
C6	290-0377-00	1,000	E		16
C7	285-0796-00	0.1	PE	20	250
C8	281-0137-00	6-30p	CT		350
C9	281-0137-00	6-30p	CT		350
C10	281-0137-00	6-30p	CT		350
C11	281-0137-00	6-30p	CT		350
C12	285-0854-00	100p	PS	2p	350
C13	285-0850-00	1,000p	PS	5	125
C14	281-0137-00	6-30p	CT		350
C15	281-0137-00	6-30p	CT		350
C16	285-0842-00	15p	PS	1p	350
C17	285-0867-00	20p	PS	1p	350
C18	281-0137-00	6-30p	CT		350
C19	281-0137-00	6-30p	CT		350
C20	285-0843-00	30p	PS	2p	350
C21	285-0788-00	0.1	PE	10	125
C22	281-0713-00	10p	CER	¼p	750
C23	281-0713-00	10p	CER	¼p	750
C24	281-0135-00	4-20p	CT		250
C25	285-0874-00	470p	PS	5	125
C26	285-0769-00	0.01	PE	20	400
C27	285-0842-00	15p	PS	1p	350
C28	281-0713-00	10p	CER	¼p	750
C29	281-0135-00	4-20p	CT		250
C30	285-0874-00	470p	PS	5	125
C31	281-0135-00	4-20p	CT		250
C32	281-0136-00	3-10p	CT		250
C33	285-0850-00	1,000p	PS	5	125
C34	285-0779-00	0.47	PE	20	100
C35	290-0407-00	640	E		16
C36	290-0378-00	8	E		275
C37	285-0800-00	0.01	PE	20	250
C38	285-0800-00	0.01	PE	20	250
C39	290-0350-00	40	E		100
C40	290-0378-00	8	E		275
DL21	119-0155-00	200ns	Delay line assembly		
L21	114-0265-00	0.91-2μH	Variable inductor		
L22	114-0265-00	0.91-2μH	Variable inductor		
MR1	152-0343-00		1N914T Si		
MR2	152-0343-00		1N914T Si		

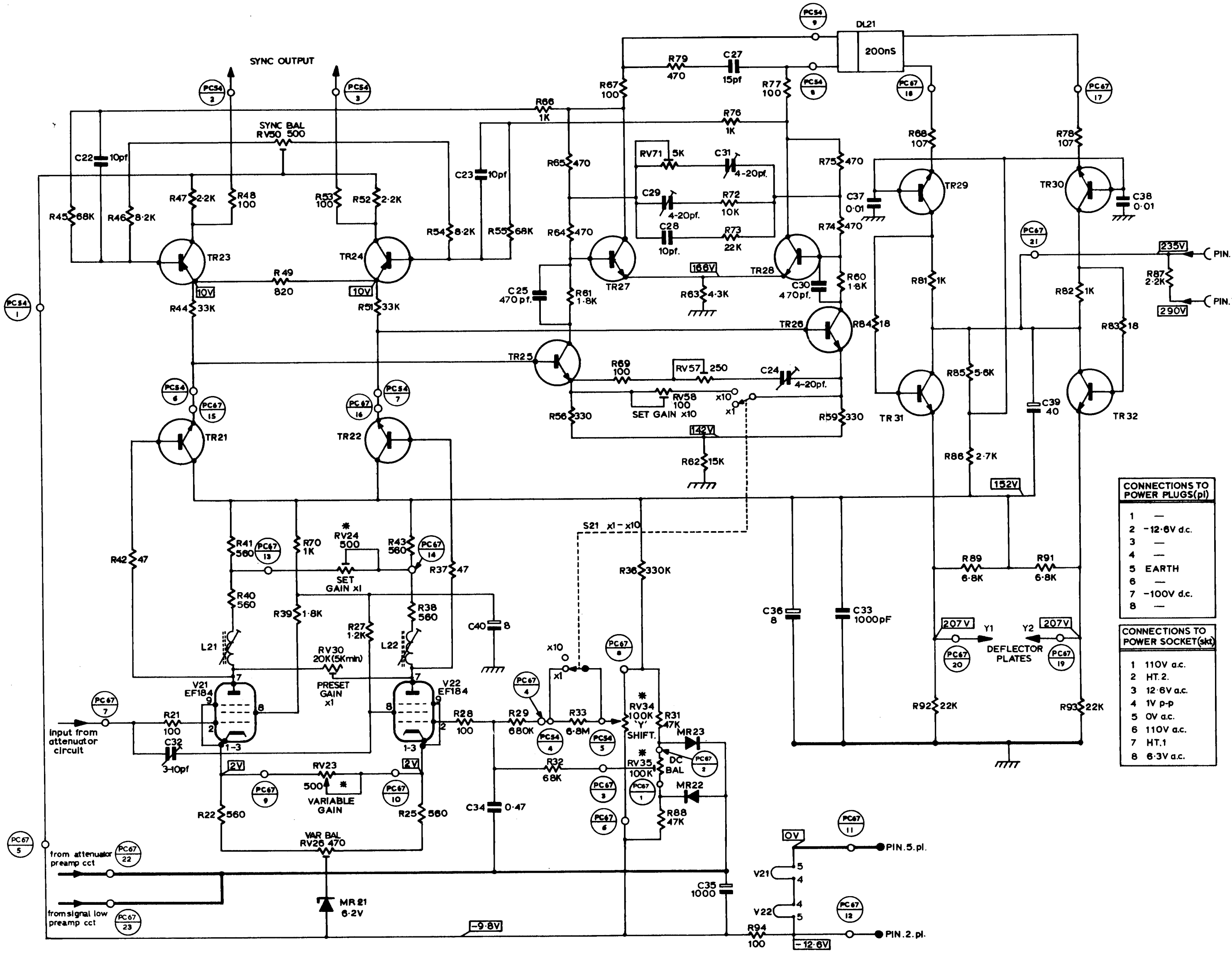
Cct. ref.	Part number	Value	Description		Tol. %	Rating
MR3	152-0372-00	13V	Si zener		5	0.33W
MR21	152-0348-00	6.2V	Si zener		5	0.33W
MR22	152-0062-01		1N914 Si			
MR23	152-0062-01		1N914 Si			
S1	260-1027-00		Rotary (3-position)			
S2	260-0953-00		Rotary (9-position)			
S21	260-1100-00		Push (1-button)			
TR1	151-0265-00		KEM103	Union Carbide	Si	
TR2	151-0244-00		U15712/2	Fairchild	Si	
TR21	151-0242-00		SPS2506	Motorola	Si	
TR22	151-0242-00		SPS2506	Motorola	Si	
TR23	151-0244-00		U15712/2	Fairchild	Si	
TR24	151-0244-00		U15712/2	Fairchild	Si	
TR25	151-0246-00		BSY95A	Fairchild	Si	
TR26	151-0246-00		BSY95A	Fairchild	Si	
TR27	151-0242-00		SPS2506	Motorola	Si	
TR28	151-0242-00		SPS2506	Motorola	Si	
TR29	151-0245-00		2N1564T	C.S.F.	Si	
TR30	151-0245-00		2N1564T	C.S.F.	Si	
TR31	151-0245-00		2N1564T	C.S.F.	Si	
TR32	151-0245-00		2N1564T	C.S.F.	Si	
V21	154-0535-00		EF184/6EJ7			
V22	154-0535-00		EF184/6EJ7			



NOTES.

1. SWITCH SHOWN IN FULLY ANTICLOCKWISE POSITION.
2. (Nº) DENOTES TAG NUMBERS ON PRINTED CIRCUIT BOARD PC64.

PRE-AMPLIFIER & ATTENUATOR TYPE JD FIG.JD·1

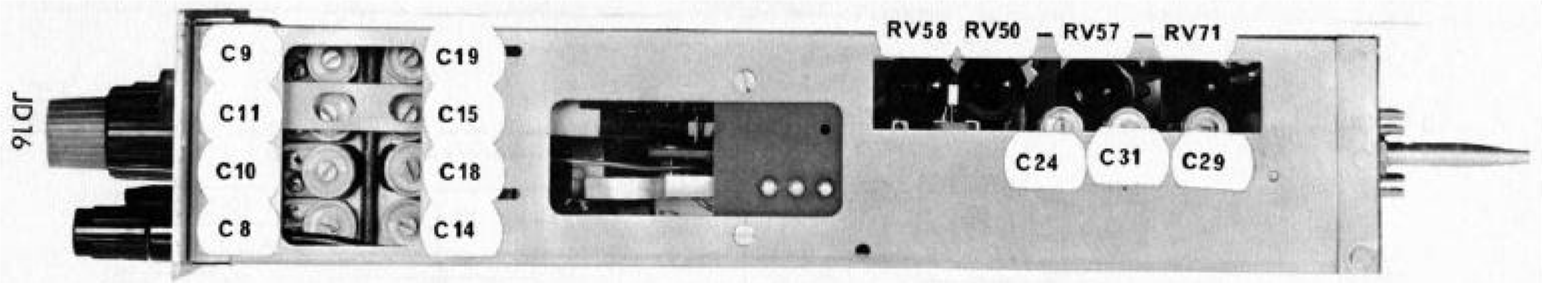


NOTES

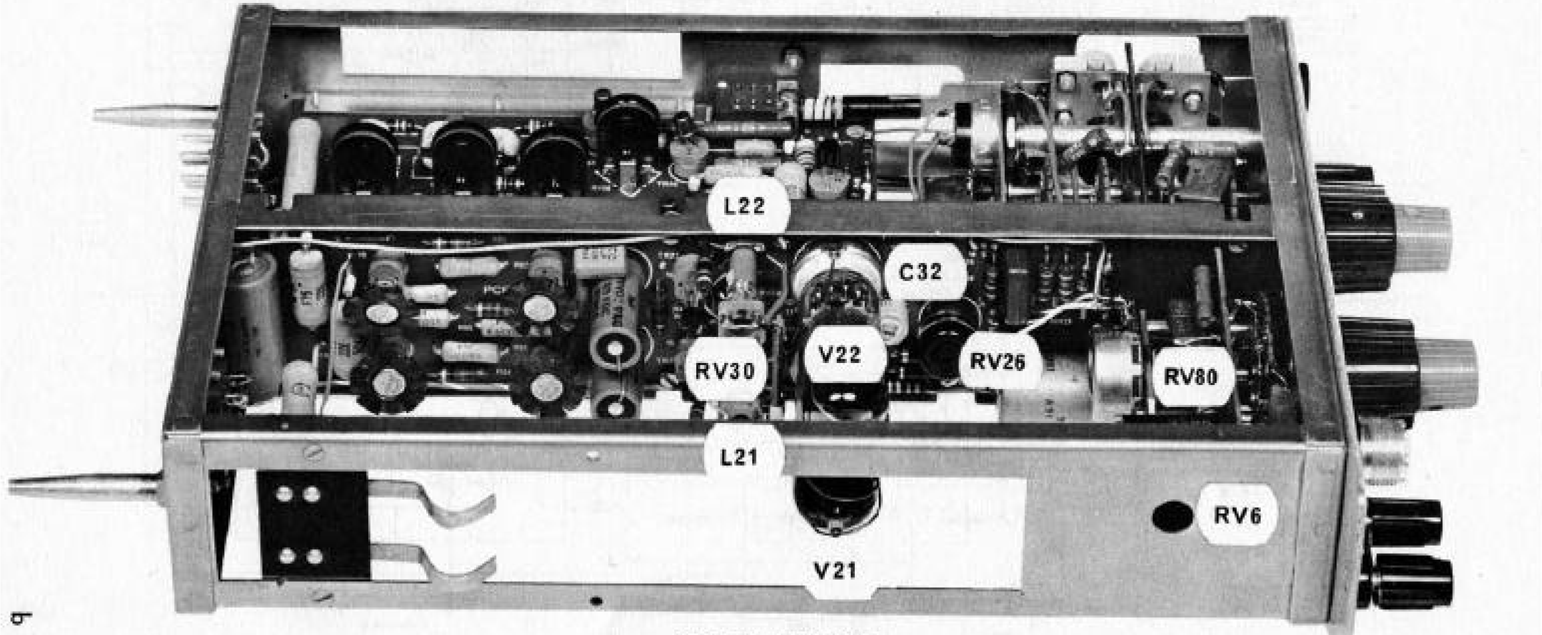
1. (PCN° / N°) DENOTES PRINTED CIRCUIT BOARD (UPPER) AND TERMINAL NUMBER (LOWER)
2. COMPONENTS MARKED THUS ✱ ARE NOT MOUNTED ON PRINTED CIRCUIT BOARDS

AMPLIFIER TYPE JD

FIG JD·2



RIGHT-HAND SIDE



LEFT-HAND SIDE

JD AMPLIFIER COMPONENT LOCATIONS