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SINGLE TRACE AMPLIFIER UNIT TYPE V5

INSTRUCTION MANUAL

Issue 2
October 1978
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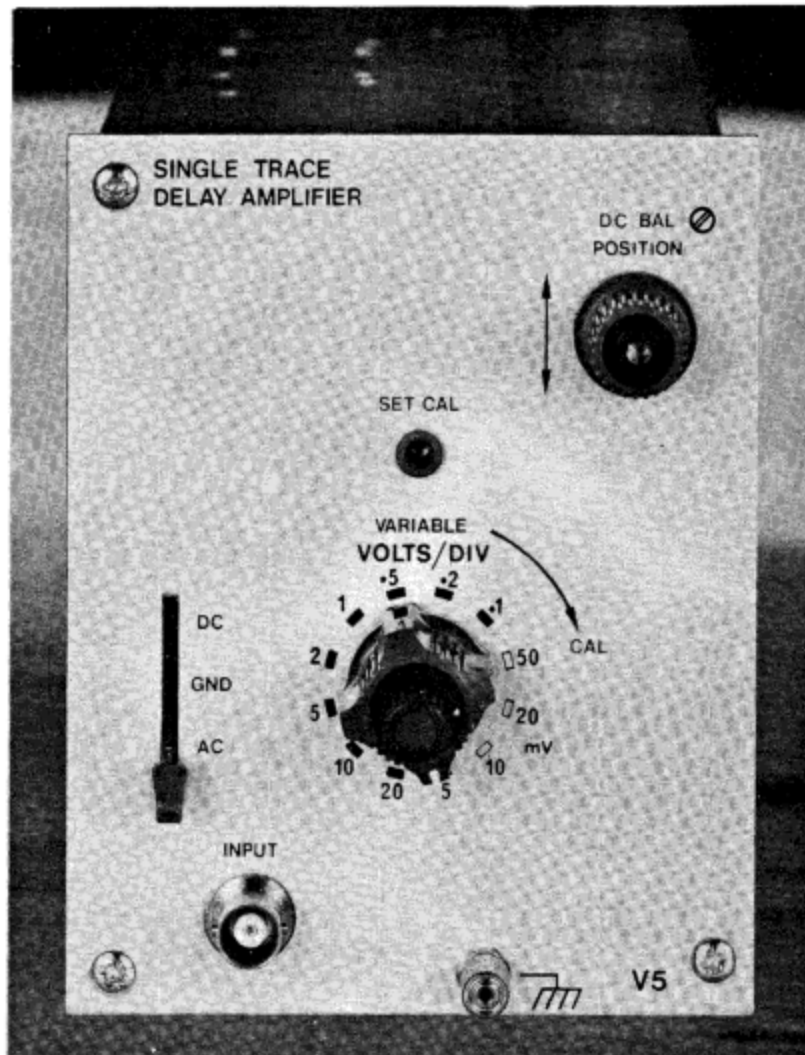
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Printed in England by D & H NEWMAN LTD, 29 Harcourt Street, London W.1.

INTRODUCTION

The V5 is a 15 MHz single trace, plug-in vertical amplifier with a built-in signal delay of about 200 ns.

The design of this instrument is subject to continuous development and improvement, consequently this instrument may incorporate minor changes in detail from the information contained herein. This would, in the main, affect the Components List and Circuit Diagrams.



NOTICE TO OWNER

To obviate the risk of damage during transit and facilitate packaging, the owner is requested NOT to send the following items unless they are suspect, should this instrument be returned to TELEQUIPMENT for servicing:—

Manual
Probes
Plug Assemblies

CONTENTS

CHAPTER 1	SPECIFICATIONS
CHAPTER 2	OPERATING INSTRUCTIONS
CHAPTER 3	CIRCUIT DESCRIPTION
CHAPTER 4	MAINTENANCE AND CALIBRATION
CHAPTER 5	COMPONENTS LIST
CHAPTER 6	CIRCUIT DIAGRAMS AND PC BOARDS

CHAPTER 1

SPECIFICATIONS

IN D63 or DM63 MAIN FRAME

OPERATING MODE	Single channel with delay
Sensitivity	5 mV to 20 V/DIV
Risetime	23 ns
3 dB bandwidth	
5 mV – 20 V/DIV	15 MHz
Deflection factors	
Calibrated (12 ranges, 1-2-5 sequence)	5 mV – 20 V/DIV \pm 3%
Delay	200 ns approx.
Variable range	> 2.5 : 1
Position range	> \pm 8 divisions
Input impedance	1 M Ω , 29 pF in parallel
Max. input voltage (DC, AC, or Sum of)	400 V
Power consumption	1.85 VA
Weight	1.0 kg (2.2 lbs)

CHAPTER 2

OPERATING INSTRUCTIONS

2.1 FUNCTION OF CONTROLS AND CONNECTORS

2.1.1 CRT

2.1.2 SWEEP

2.1.3 TRIGGER

2.1.4 VERTICAL

DC-GND-AC

selects the input signal coupling.

In the DC position the signal, from the INPUT connector is coupled directly to the attenuator. In the AC position a capacitor is inserted in series.

In the GND position the input to the attenuator is grounded and the input signal is open-circuited; this position enables the 0 V DC level of a trace to be ascertained.

VOLTS/DIV

provides twelve steps of attenuation of input signal. Calibrated sensitivities are only valid when VARIABLE is fully clockwise.

SET CAL

preset; adjusted to correct accuracy of the VOLTS/DIV.

NOTE: VARIABLE should be fully clockwise.

VARIABLE

enables all deflection sensitivities between that selected by the VOLTS/DIV switch and the next below to be covered. The control must be fully clockwise for a calibrated display.

Refer to D63 or DM63 MF Manual.

POSITION

moves the trace in the vertical axis.

DC BAL

preset, adjusted to eliminate trace movement when the VARIABLE VOLTS/DIV control is turned through its range.

2.1.5 CONNECTORS

INPUT

BNC socket connects the signal to be viewed to vertical amplifier.



terminal connected to the chassis of the instrument.

INTERFACE

edge connector situated at the rear; connects with mother-board in the main frame.

2.2 PRE-OPERATIONAL CHECKS

2.2.1 SUPPLY

Refer to D63 or DM63 MF Manual.

2.2.2 CONTROL SETTING

1. CRT

2. SWEEP

Refer to D63 or DM63 MF Manual.

3. Set controls as follows:

POSITION	Central
VOLTS/DIV	5 mV
VARIABLE	fully clockwise
DC-GND-AC	GND

CHAPTER 3

CIRCUIT DESCRIPTION

3.1 VERTICAL AMPLIFIER

The V5 plug-in is a single amplifier, which feeds the main amplifier in the main frame.

3.1.1 The input attenuator, reference Figure 1, is simply capacity compensated L type sections which are switched singly or in cascade to obtain the correct attenuation. The sections on the two rear wafers of the attenuator are the $\div 1$, $\div 2$ and $\div 4$; on the front two wafers are the $\div 10$, $\div 100$ and $\div 1000$. The input impedance of the attenuator is maintained at $1\text{ M}\Omega$ and 29 pF on all positions.

The DC-GND-AC switch selects either a through connection on DC, a capacitor coupled connection via a $0.1\text{ }\mu\text{F}$ 400 V capacitor on AC, or a GND connection with the signal path input open-circuited and the amplifier input grounded.

3.1.2 TR601 and TR602 are FETS used as source followers. The gate of TR601 is protected from excessive positive excursions by the D601 and D602. A DC BALANCE, applied to the gate of TR602, is adjusted to eliminate trace movement due to variations of VARIABLE setting. The output from TR601 and TR602 drives the phase splitter stage TR603 and TR604. The emitters of this stage contain the SET CAL potentiometer R614, which adjusts the accuracy of the VOLTS/DIV calibration. The output, from TR603 and TR604, drives a shunt feedback amplifier, TR605 and TR606 which has a very low input resistance. This input resistance in series with, $91\text{ }\Omega$, R621 and R622, is approximately $100\text{ }\Omega$ per side. When the VARIABLE

is at maximum resistance the attenuation of the signal is small, at minimum, however the resistance is approximately $32\text{ }\Omega$. The attenuation of the signal is now 3 i.e. $100\text{ }\Omega - 32\text{ }\Omega$ and covers the gaps in the 1-2-5 sequence in the attenuators. The shift signal inserted at the bases of TR605 and TR606, after the VARIABLE control, ensures that the same amount of shift is obtained regardless of VARIABLE setting.

3.1.3 Delay line DL601 has an iterative impedance of $100\text{ }\Omega$, however, the output impedance of the shunt feedback amplifier is approximately $25\text{ }\Omega$, therefore R641 and R642 are used to match the amplifier into the Delay line. The termination of the delay line is matched by R645 and R646, each $102\text{ }\Omega$. This resistance shunted by the input resistance of the following stage, adjusts the matching resistance to approximately $100\text{ }\Omega$. The feedback resistors of the shunt feedback amplifier R632, R626, R633, R628 are split and connected between them is a network made up of three time constants. This network compensates for the roll off caused by the delay line. The adjustment of C607 and C608 enables a flat response to be achieved. TR607 and TR608 are also driven by the shunt feedback amplifier, the output from TR608 collector is used to provide a pre-delay trigger signal thus enabling the timebase to be triggered before the delayed signal reaches the CRT 'Y' plates. The output of the delay line drives TR609 and TR611 the final stage amplifier. The emitters of this stage contain the POSITION BAL potentiometer, R653, which is adjusted to obtain equal excursions of the trace with the normal POSITION control. Between the emitters of TR609 and TR611 is C613 which is adjusted to provide H.F. peaking and the collectors are terminated at the connector to provide interfacing with display unit.

CHAPTER 4

MAINTENANCE AND CALIBRATION

4.1 GENERAL

4.1.1 The detailed calibration procedures enable the vertical plug-in V5 to be fully calibrated, assuming that the main frame has been calibrated and meets the specification as laid down in its manual.

4.2 MECHANICAL

4.2.1 ACCESS TO INTERIOR

Depress the plug-in retaining clip on the front of the main frame and withdraw the plug-in. Remove the side cover. The pre-amplifier preset controls are mounted on PC board PC166. The attenuator presets are on PC board PC137.

4.3 CALIBRATION

4.3.1 For calibration, the following tools and test equipment are required.

- Low-capacitance trimming tool (for preset controls).
- Small screwdriver (for preset potentiometers).
- Fixture Extender Rigid (067-0689-00).
- Squarewave Generator providing outputs of 5 mV to 50 V at 1 kHz accuracy $\pm 1\%$.
- Squarewave Generator providing 1 MHz risetime < 3 ns.
- Constant Amplitude Sinewave Generator providing 50 kHz to 30 MHz for measuring bandwidth.
- Input Normalizer (067-0539-02); alternative: LC Meter and x10 Probe.

4.3.2 CALIBRATION PROCEDURE

The plug in requiring calibration should always be installed in the left-hand channel of the main frame — this allows access to the internal preset controls.

- 1.0 **Check DC BAL.**
 - 1.1 Set DC-GND-AC to GND.
 - 1.2 Turn VARIABLE fully clockwise.
 - 1.3 Switch VOLTS/DIV to 5 mV.
 - 1.4 Set trace to graticule centre line using POSITION.
 - 1.5 Turn VARIABLE fully anticlockwise.
 - 1.6 Note direction and position of trace.
 - 1.7 Turn VARIABLE fully clockwise.
 - 1.8 Adjust DC BAL until trace is in same position as noted in 1.6.
 - 1.9 Repeat Ops. 1.4 through 1.8 until there is no trace movement with variable gain.
- 2.0 **Check VARIABLE range.**
 - 2.1 Set TIME/DIV to 1 ms.
 - 2.2 Connect 25 mV 1 kHz squarewave to INPUT.
 - 2.3 Set DC-GND-AC to DC.
 - 2.4 Set amplitude to 5 divs. using SET CAL.
 - 2.5 Rotate VARIABLE fully anticlockwise.
 - 2.6 Check amplitude < 2 divs.
 - 2.7 Turn VARIABLE fully clockwise.
- 3.0 **Set position balance (R653).**
 - 3.1 Set DC-GND-AC to AC.
 - 3.2 Connect 50 mV 1 kHz squarewave to INPUT.
 - 3.3 Adjust R653 such that at extreme anticlockwise and clockwise ends of the POSITION control, the amount of trace movement is similar.
 - 3.4 Turn VARIABLE anticlockwise to give 8 divisions of deflection.
 - 3.5 Check that at the extreme ends of POSITION, the top and bottom of the signal clear the centre line of graticule.

4.3.3 VERTICAL RESPONSE

Note: Remove V5 plug-in and re-connect it to MF using fixture extender 067-0689-00 thus allowing access to the attenuator presets.

- 1.0 **Check attenuation.**
 - 1.1 Connect 50 mV 1 kHz squarewave via * input normalizer (29 pF) to INPUT.
 - 1.2 Set DC-GND-AC to DC.
 - 1.3 Set VARIABLE to CAL.
 - 1.4 Set VOLTS/DIV as in Col. 1.
 - 1.5 Set squarewave generator as in Col. 2.
 - 1.6 Check 5 div trace for over or undershoot.

COL 1 VOLTS/DIV 5 mV	COL 2 1 kHz squarewave 50 mV	COL 3 Adjust C916 PC137
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Remove input normalizer

10 mV	50 mV	C917 PC137
20 mV	100 mV	C918 PC137
50 mV	250 mV	C907 PC137
0.1 V	500 mV	C915 PC137
0.2 V	1 V	C914 PC137
0.5 V	2.5 V	C906 PC137
5 V	25 V	C905 PC137

Fit input normalizer

50 mV	500 mV	C904 PC137
0.5 V	5 V	C903 PC137
5 V	50 V	C902 PC137

*If input normalizer is not available, follow the alternative procedure given below.

For 5 mV/DIV setting:
Check the input capacity using LC meter; adjust C916 to obtain 29 pF.
Display 250 mV 1 kHz squarewave via x10 probe and adjust probe trimmer for square corners.

For 50 mV, 0.5 V and 5 V/DIV settings:
Using compensated probe, display 5 divisions of 1 kHz squarewave.
Adjust C904, C903 and C902 on 50 mV, 0.5 V and 5 V settings respectively for over or undershoot.

Note: Remove fixture extender 067-0689-00 and install the plug-in in the MF.

- 2.0 **Check vertical pulse response.**
 - 2.1 Connect 20 mV 1 MHz < 3 ns risetime squarewave to INPUT.
 - 2.2 Set VOLTS/DIV to 5 mV.
 - 2.3 Set TIME/DIV to 0.2 μ s.
 - 2.4 Check pulse aberration is $< 2\%$.
 - 2.5 Adjust C608 PC166 for optimum response.
 - 2.6 Adjust C607 PC166 for optimum response.
 - 2.7 Adjust C613 PC166 for optimum response.
 - 2.8 Repeat Ops. 2.5 to 2.7 for overall optimum response.
- 3.0 **Check bandwidth in D63 or DM63 MF.**
 - 3.1 Connect 50 kHz sinewave to INPUT.
 - 3.2 Adjust signal generator to give 6 div trace.
 - 3.3 Set TIME/DIV to 1 ms.
 - 3.4 Switch signal generator to 15 MHz.
 - 3.5 Check amplitude > 4.2 divisions.

CHAPTER 5

COMPONENTS LIST

Values of resistors are stated in ohms or multiples of ohms; ratings at 70°C are in watts or sub-multiples of watts. Values of capacitors are stated in sub-multiples of farads; ratings at 70°C are in volts or kilovolts.

Whenever possible, exact replacements for components should be used, although locally available alternative may be satisfactory for standard components.

Any order for replacement parts should include:

1. Instrument type
2. Instrument serial number
3. Component circuit reference
4. Component part number
5. Component value

ABBREVIATIONS

BM	Button mica	CMP	Cermet preset	PS	Polystyrene
C	Carbon	E	Electrolytic	Se	Selenium
CP	Carbon preset	Ge	Germanium	Si	Silicon
CV	Carbon variable	MF	Metal film	SM	Silver mica
CER	Ceramic	MO	Metal oxide	WW	Wire-wound
CT	Ceramic trimmer	PE	Polyester	WWP	Wire-wound preset
CM	Cermet thick film	PP	Polypropylene	WWW	Wire-wound variable

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All requests for repairs or replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service.

CIR REF	PART NUMBER	VALUE F	DESCRIPTION			Eff. Ser.No.
			TYPE	TOL %	RATING Volts	
C601	285-0915-00	100 n	PE	20	100	
C602	281-0710-00	10 n	CER		250	
C603	281-0710-00	10 n	CER		250	
C604	285-1014-00	1 μ	PE	20	63	
C605	281-0710-00	10 n	CER		250	
C606	281-0710-00	10 n	CER		250	
C607	281-0156-00	1.4-6.4 p	PP		500	
C608	281-0154-00	2-12 p	PP		500	
C609	285-0867-00	20 p	PS	1 p	350	
C611	281-0710-00	10 n	CER		250	
C612	281-0710-00	10 n	CER		250	
C613	281-0155-00	2-22 p	PP		500	
C614	281-0710-00	10 n	CER		250	
C615	281-0710-00	10 n	CER		250	
C616	285-1014-00	1 μ	PE	20	63	
C901	285-0772-00	100 n	PE	10	400	
C902	281-0155-00	2-22 p	PP		500	

CIR REF	PART NUMBER	VALUE F	DESCRIPTION			Eff. Ser.No.
			TYPE	TOL %	RATING Volts	
C903	281-0155-00	2-22 p	PP		500	
C904	281-0155-00	2-22 p	PP		500	
C905	281-0156-00	1.4-6.4 p	PP		500	
C906	281-0156-00	1.4-6.4 p	PP		500	
C907	281-0154-00	2-12 p	PP		500	
C908	285-0872-00	180 p	PS	2	350	
C909	283-0607-00	2 n	BM	10	500	
C911	283-0719-00	470 p	BM	10	500	
C912	285-0844-00	39 p	PS	2 p	350	
C913	285-0869-00	47 p	PS	2 p	350	
C914	281-0154-00	2-12 p	PP		500	
C915	281-0154-00	2-12 p	PP		500	
C916	281-0156-00	1.4-6.4 p	PP		500	
C917	281-0155-00	2-22 p	PP		500	
C918	281-0154-00	2-12 p	PP		500	
C919	283-0662-00	7.5 p	SM	0.5 p	350	
C921	285-1017-00	10 n	PE	20	500	

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
D601	152-0565-00		EXP5072	Si			
D602	152-0543-00	5.1 V	Zener	Si	5	330 mW	
D603	152-0354-00	12 V	Zener	Si	5	330 mW	
DL601	636-0006-00	200 ns	Delay Line				
L601	108-0754-00	0.25 μH	Inductor Fixed				

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION			Eff. Ser.No.
			TYPE	TOL %	RATING W	
R601	311-1352-00	47 k	CV	20	250 m	
R602	317-0224-01	220 k	C	5	125 m	
R603	317-0102-01	1 k	C	5	125 m	
R604	317-0101-01	100	C	5	125 m	
R605	317-0103-01	10 k	C	5	125 m	
R606	317-0101-01	100	C	5	125 m	
R607	315-0123-02	12 k	C	5	250 m	
R608	315-0123-02	12 k	C	5	250 m	
R609	317-0101-01	100	C	5	125 m	
R611	317-0101-01	100	C	5	125 m	
R612	317-0391-01	390	C	5	125 m	
R613	317-0560-01	56	C	5	125 m	
R614	311-1350-00	100	CV	20	250 m	
R615	317-0391-01	390	C	5	125 m	
R616	315-0472-02	4.7 k	C	5	250 m	
R617	315-0472-02	4.7 k	C	5	250 m	
R618	317-0101-01	100	C	5	125 m	
R619	311-1351-00	2.2 k	CV	20	250 m	
R621	317-0910-01	91	C	5	125 m	
R622	317-0910-01	91	C	5	125 m	
R623	317-0432-01	4.3 k	C	5	125 m	
R624	311-1352-00	1.5 k	CV	20	250 m	
R625	317-0432-01	4.3 k	C	5	125 m	
R626	317-0471-01	470	C	5	125 m	
R627	317-0471-01	470	C	5	125 m	
R628	317-0471-01	470	C	5	125 m	
R629	317-0392-01	3.9 k	C	5	125 m	

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION			Eff. Ser.No.
			TYPE	TOL %	RATING W	
R631	317-0103-01	10 k	C	5	125 m	
R632	317-0471-01	470	C	5	125 m	
R633	317-0471-01	470	C	5	125 m	
R634	317-0560-01	56	C	5	125 m	
R635	317-0560-01	56	C	5	125 m	
R636	317-0511-01	510	C	5	125 m	
R637	317-0182-01	1.8 k	C	5	125 m	
R638	317-0182-01	1.8 k	C	5	125 m	
R639	317-0301-01	300	C	5	125 m	602016
R641	317-0750-01	75	C	5	125 m	
R642	317-0750-01	75	C	5	125 m	
R643	317-0392-01	3.9 k	C	5	125 m	
R644	317-0392-01	3.9 k	C	5	125 m	
R645	321-0098-48	102	MF	1	125 m	
R646	321-0098-48	102	MF	1	125 m	
R647	317-0101-01	100	C	5	125 m	
R648	315-0432-02	4.3 k	C	5	250 m	
R649	317-0221-01	220	C	5	125 m	
R651	315-0432-02	4.3 k	C	5	250 m	
R652	317-0101-01	100	C	5	125 m	
R653	311-0798-00	2.2 k	CP	20	250 m	
R654	317-0100-00	10	C	5	125 m	

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION			Eff. Ser.No.
			TYPE	TOL %	RATING W	
R901	317-0100-01	10	C	5	125 m	
R902	321-0481-42	1 M	MF	0.5	125 m	
R903	325-0124-00	990 k	MF	0.5	125 m	
R904	325-0125-00	900 k	MF	0.5	125 m	
R905	317-0470-01	47	C	5	125 m	
R906	317-0101-01	100	C	5	125 m	
R907	317-0331-01	330	C	5	125 m	
R908	317-0100-01	10	C	5	125 m	
R909	321-0193-42	1 k	MF	0.5	125 m	
R911	321-1289-42	10.1 k	MF	0.5	125 m	
R912	321-1389-42	111 k	MF	0.5	125 m	
R913	317-0470-01	47	C	5	125 m	
R914	321-0970-42	500 k	MF	0.5	125 m	
R915	325-0126-00	750 k	MF	0.5	125 m	
R916	317-0470-01	47	C	5	125 m	
R917	321-0481-42	1 M	MF	0.5	125 m	
R918	316-0224-01	220 k	C	10	250 m	
R919	321-0481-48	1 M	MF	1	125 m	
R921	321-0628-42	333 k	MF	0.5	125 m	

CIR REF	PART NUMBER	DESCRIPTION	TYPE	Eff. Ser.No.
S901	260-1412-00	Slide DC-GND-AC		
S902	260-1409-00	Rot. 12 Pos. VOLTS/DIV		
SK901	131-0650-01	Input		
TR601	151-1069-00	FET WD212	Si	N-channel
TR602		matched pair		
TR603	151-0127-02	BSX20	Si	NPN
TR604	151-0127-02	BSX20	Si	NPN
TR605	151-0127-03	BSX20 Mullard	Si	NPN
TR606	151-0127-03	BSX20 Mullard	Si	NPN
TR607	151-0320-01	MPS6518	Si	PNP
TR608	151-0320-01	MPS6518	Si	PNP
TR609	151-0127-02	BSX20	Si	NPN
TR611	151-0127-02	BSX20	Si	NPN

ASSEMBLIES

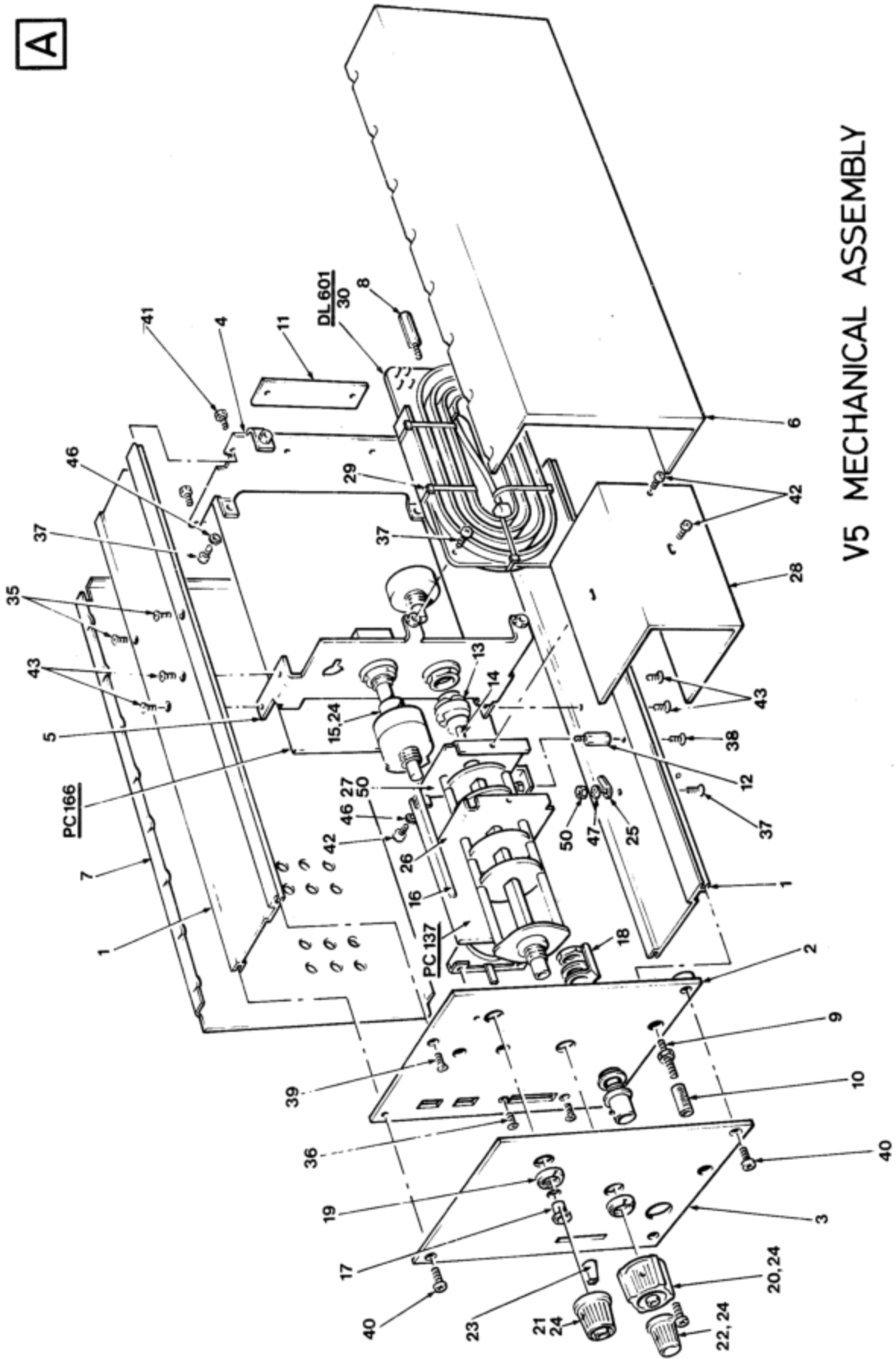
ASSEMBLY	PART NUMBER	INCLUDES CIRCUIT REFERENCES
Attenuator	011-0114-00	C901, C913, C921, PC137, R901, R905 to R907, R913 to R919, R921, S902
PC137	670-2191-00	C902 to C909, C911, C912, C914 to C919, R902 to R904, R908, R909, R911, R912
PC166	670-3042-00	C601 to C609, C611 to C616, D601 to D603, R602 to R609, R611 to R613, R615 to R618, R621 to R623, R625 to R629, R631 to R639, R641 to R649, R651, R652, R654, TR601 to TR609, TR611

MECHANICAL ASSEMBLY

(Item numbers refer to the view)

ITEM	DESCRIPTION	PART No.	STARTING SER. No.
1	Bar	381-0346-02	
2	Panel sub-front	386-2696-00	
3	Panel front	333-1787-01	
4	Bracket rear	407-1079-00	
5	Bracket pcb	407-1378-00	
6	Shield side	337-1661-01	
7	Shield side	337-1908-01	
8	Stop	105-0347-00	
9	Post terminal	129-0374-00	
10	Nut terminal	220-0647-00	
11	Plate name	334-1933-02	
12	Spacer	361-0576-00	
13	Coupling $\frac{1}{4}$ " - $\frac{1}{8}$ " flexible	376-0126-00	
14	Rod extension	384-1142-01	
15	Coupling $\frac{1}{4}$ " - $\frac{1}{8}$ "	376-0137-01	
16	Rod extension	384-1142-02	
17	Panel bush	358-0460-00	
18	Solder tag 3/8" i/d	210-0275-00	
19	Nut chrome	220-0527-00	
20	Knob assembly	366-1387-00	
21	Knob assembly	366-1254-00	
22	Knob assembly	366-1266-01	
23	Knob lever	366-0215-02	
24	Screw skt hd cup point M3 x 3	213-0248-00	
25	Solder tag 6BA	210-0297-00	
26	Screen attenuator	337-1658-00	
27	Bracket	407-1083-01	
28	Cover	200-1373-00	
29	Cleat	343-0198-00	
30	Delay line assembly	636-0006-00	
35	Screw 8BA c'sk hd x $\frac{1}{4}$ "	213-0454-00	
36	Screw 6BA c'sk hd x $\frac{3}{16}$ "	213-0467-00	
37	Screw 6BA pan hd x $\frac{1}{4}$ "	213-0393-00	
38	Screw 6BA c'sk hd x $\frac{1}{4}$ "	213-0391-00	
39	Screw 4BA c'sk hd x $\frac{1}{4}$ "	213-0570-01	
40	Screw 4BA inst hd x $\frac{1}{4}$ " chrome	213-0572-00	
41	Screw 4BA hex hd x $\frac{1}{4}$ " slot	213-0470-00	
42	Screw s/t No. 2 pan hd x $\frac{3}{16}$ "	213-0351-00	
43	Screw s/t No. 4 c'sk hd x $\frac{3}{16}$ "	213-0362-00	
46	Washer 6BA crinkle	210-1208-00	
47	Washer 6BA shakeproof	210-1210-00	
50	Nut 6BA full	220-0716-00	

A



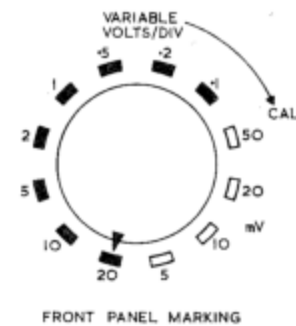
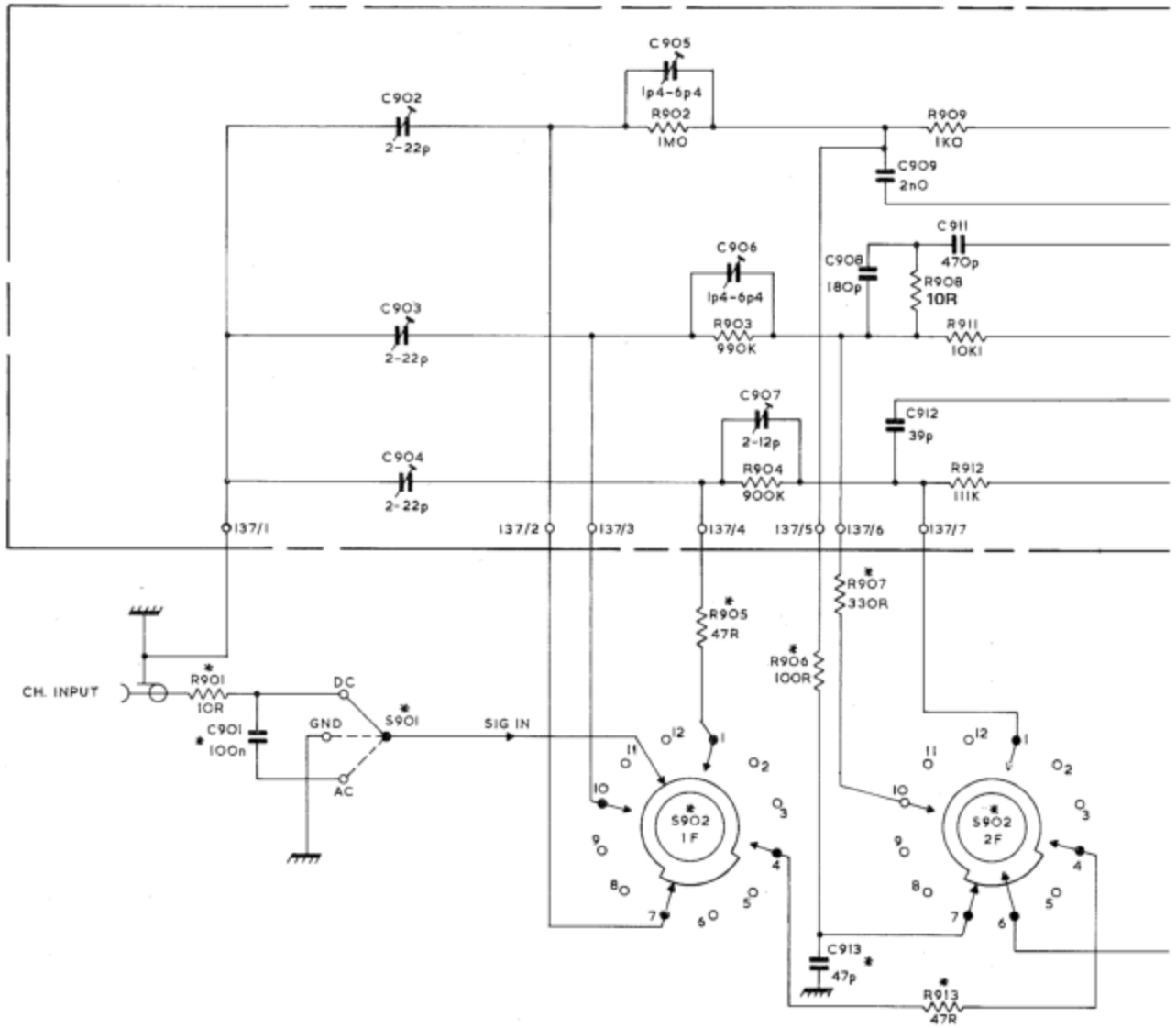
V5 MECHANICAL ASSEMBLY

CHAPTER 6

CIRCUIT DIAGRAMS AND PC BOARDS

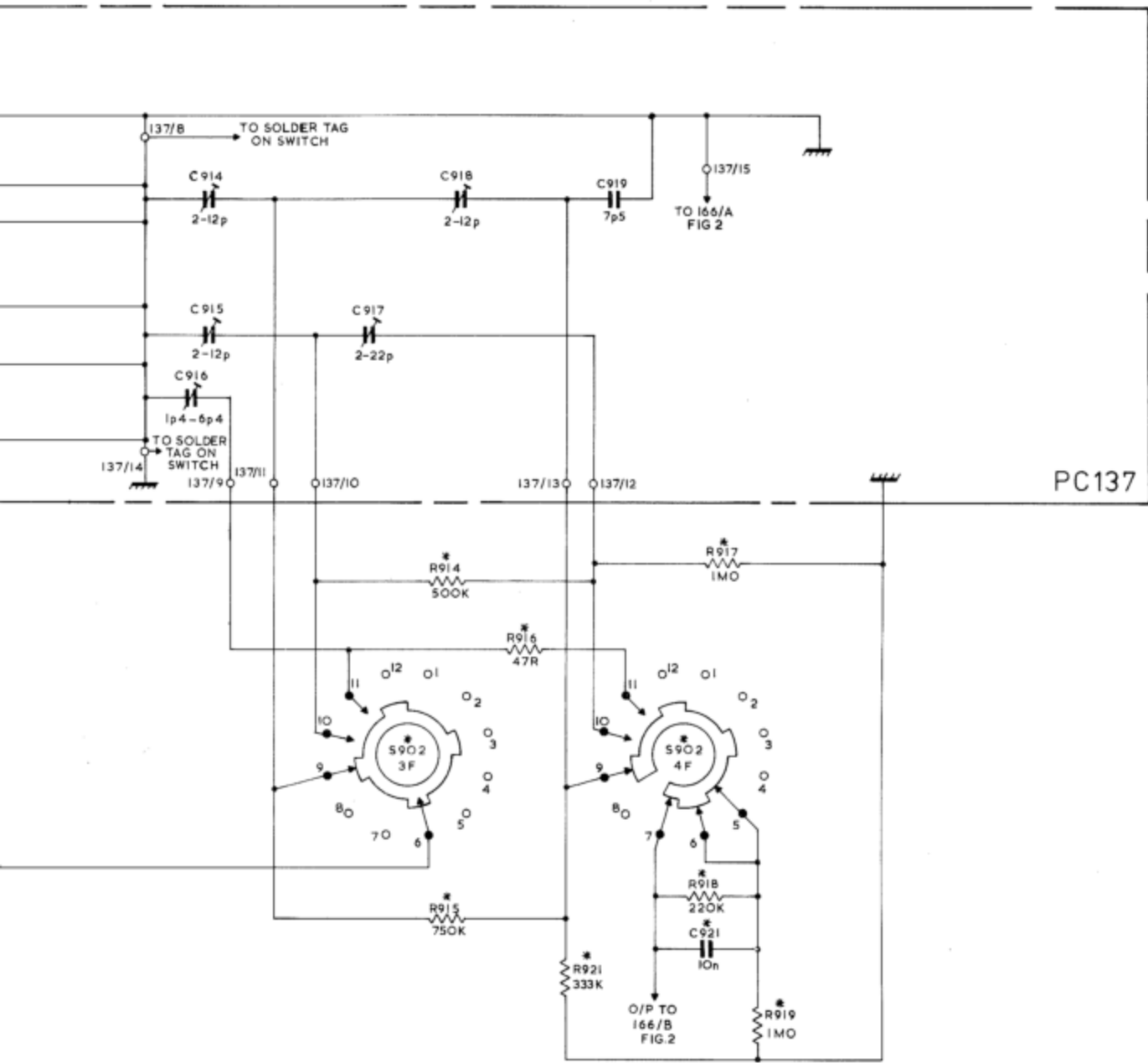
To minimize the risk of misinterpretation of component values on circuit diagrams, the decimal point has been replaced by the multiplier or sub-multiplier of the basic unit. For instance, 2.2 megohms is shown as 2M2 and 1.8 picofarads is shown as 1p8.

RESISTORS	901	902	903	904	905	906	907	908	909
		903						911	
		904						912	
CAPACITORS	901	902	903	904	905	906	907	908	909
								912	911
							913	912	
MISC.		S901			S902				



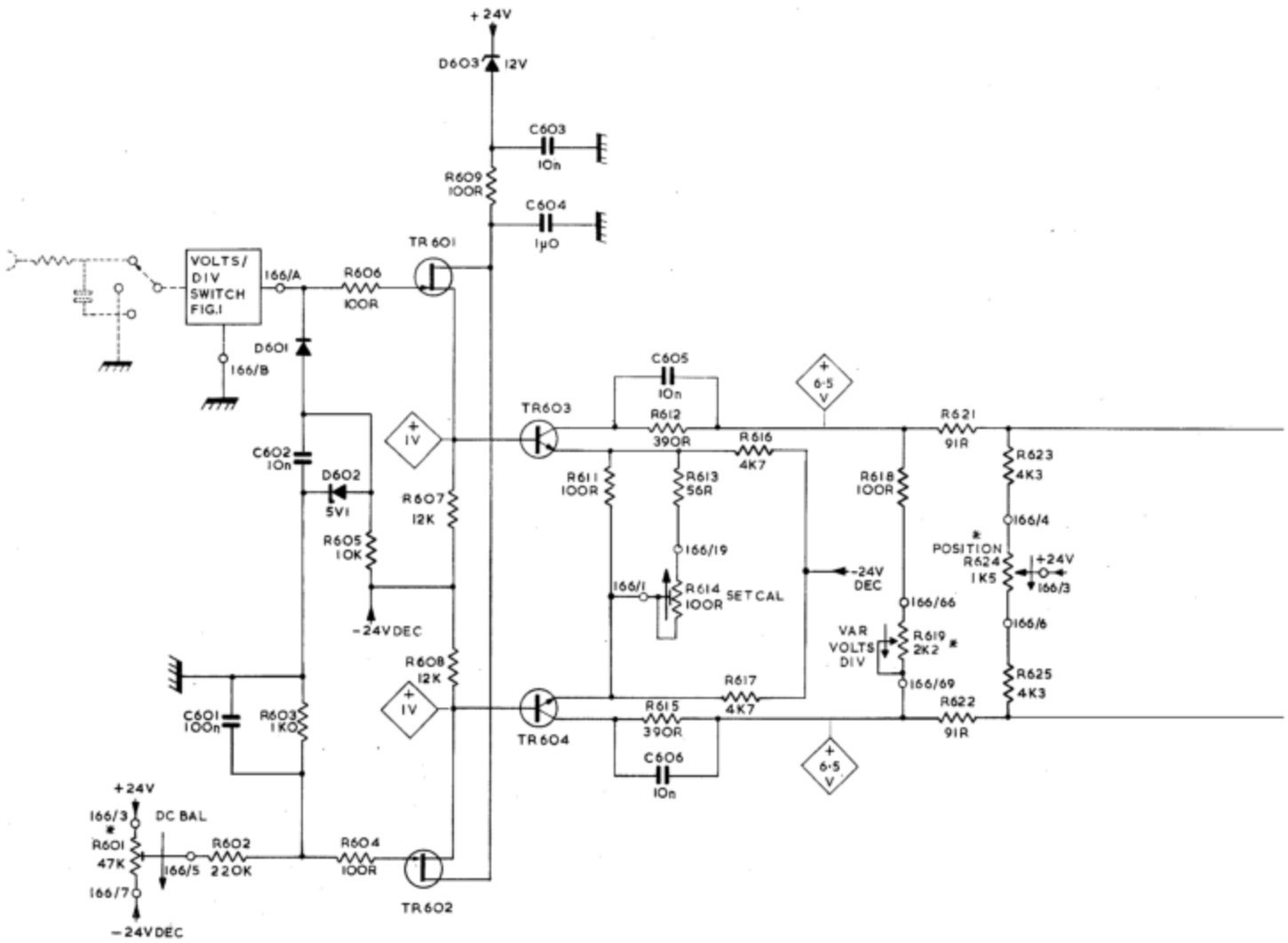
- NOTES.
1. 137/10 DENOTES PC BOARD/EYELET OR TERMINAL No.
 2. * DENOTES COMPONENTS NOT MOUNTED ON PC BOARD
 3. SWITCH IS SHOWN IN FULLY ANTICLOCKWISE POSITION

		914		917		918		919	
		915		916		917		918	
914	917	918		919	921				
915									
916									



SINGLE TRACE AMPLIFIER TYPE V5
 VOLTS / DIV SWITCH
 FIG.1

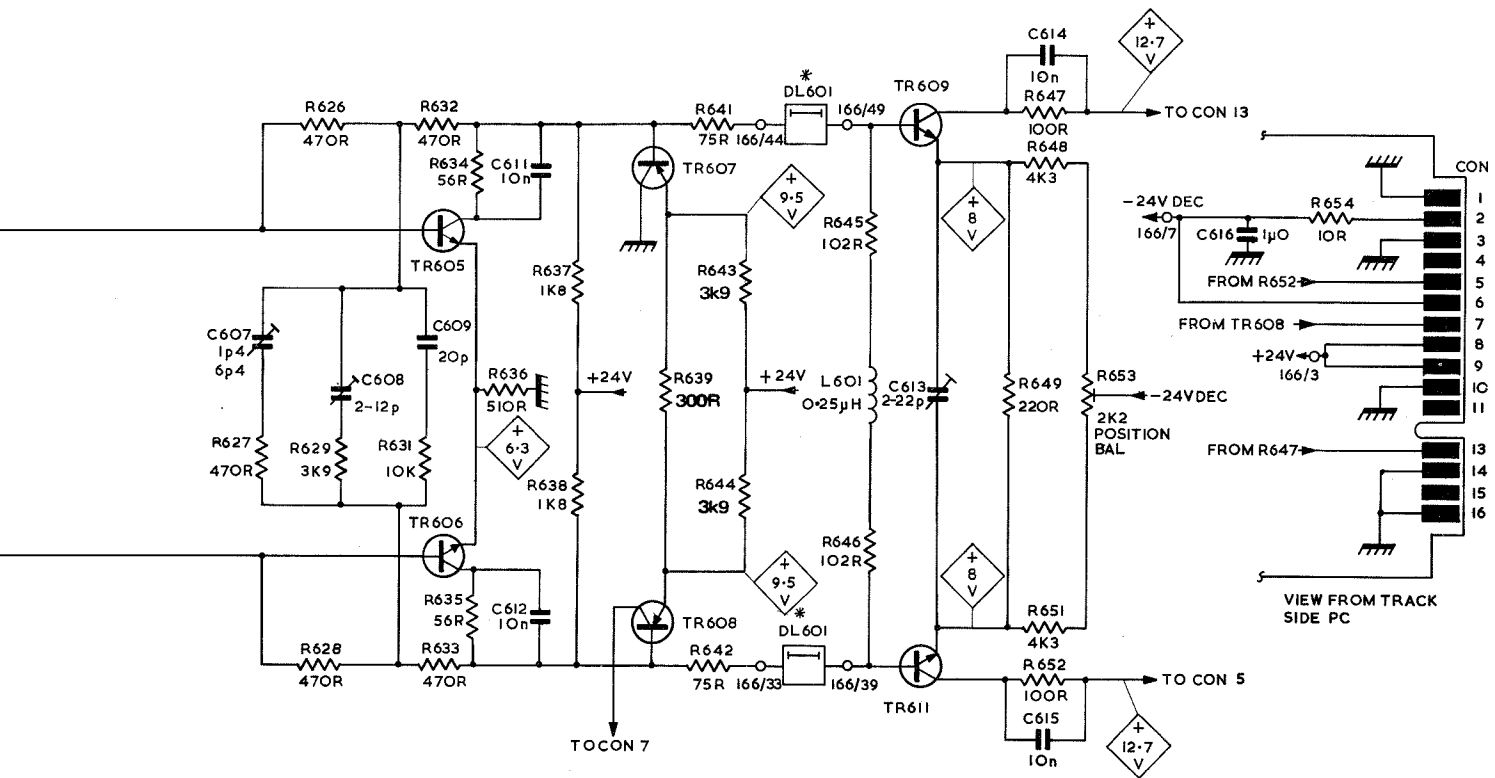
RESISTORS	601	602	603	604 605 606	607 608	609	611	612 613 614 615	616 617	618 619	621 622	623 624 625
CAPACITORS	601	602				603 604		605 606				
MISC			D601 D602		TR601 TR602	D603		TR603 TR604				



NOTES

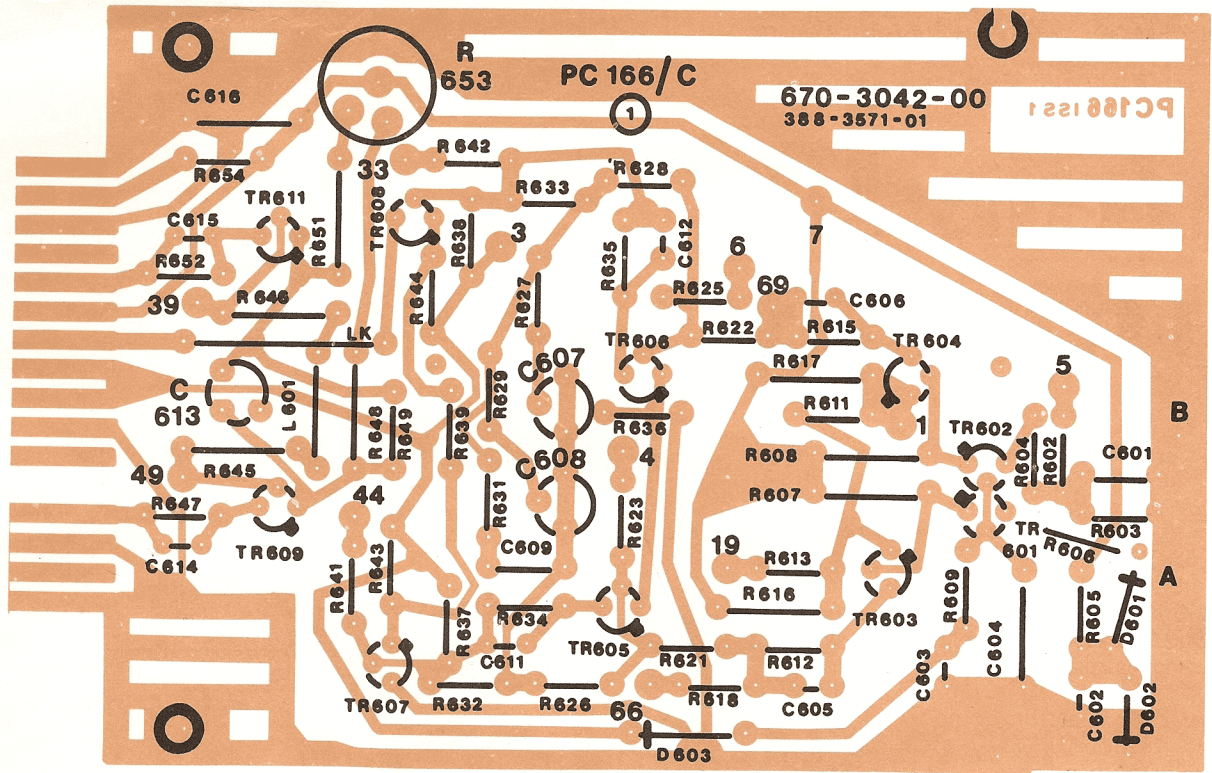
1. * DENOTES COMPONENTS NOT MOUNTED ON PC BOARD
2. 166/5 DENOTES PC BOARD/EYELET OR TERMINAL No CONNECTION

627	626 628 629	632 631 633	634 635 636	637 638	639	643 641 642 644	645 646	639 647 648 651 652	653	654
607	608	609	611 612				613	614 615		616
		TR605 TR606			TR607 TR608	DL601		TR609 TR611		

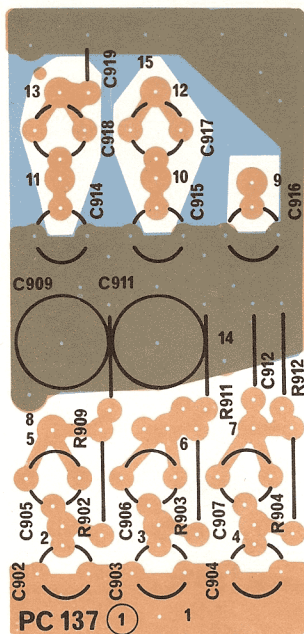


DELAY AMP V5 PC 166

FIG.2



P.C.166



P.C. 137

PRINTED CIRCUIT BOARDS

FIG. 3.