TYPE C-2 VERTICAL AMPLIFIER - HIGH-GAIN

GENERAL

The Type C-2 plug-in is a four-range amplifier offering sensitivities from 100μV to 50V/cm on a.c. and 10mV to 50V/cm on d.c. at bandwidths up to 15MHz.

The amplifier may be used in either the 43 or 53 series of oscilloscope.

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.-15MHz	23ns
	x10	10mV-5V	d.c.-800kHz	440ns
AC	x1	100mV-50V	3Hz-15MHz	23ns
	x10	10mV-5V	3Hz-800kHz	440ns
ACx100	x1	1mV-500mV	3Hz-100kHz	3.5μs
	x10	100μV-50mV	3Hz-100kHz	3.5μs

Maximum input (via 400V capacitor a.c. coupled)		
DC & AC		400Vp
ACx100		100mVp-p before limiting
Hum and noise		
Short-circuited input		20μVp-p or better
Open-circuited but shielded input		100μVp-p or better
Calibrator output		1Vp-p ± 2%
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.	1.4 kg	3 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 part of the 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 100mVp-p, it is recommended that, for signals in excess of 60mVp-p, the AC or DC input switch settings should be used. A 6cm display is obtainable from a 60mV signal on AC or DC with VOLTS/CM at 0.1 and Y GAIN at x10.

AC Except for inputs below 60mVp-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 - coarse & fine

These controls position the display in the vertical axis of the CRT.

Volts/cm

A setting should be chosen to produce a convenient amplitude of display. The calibrations, which relate to the x1 Y gain setting on AC or DC, are accurate to within ± 5%.

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 x1 and x10 gain may be readily checked as follows:

Check x1 gain: Select x1 gain, DC input and 0.2V/cm. Link CAL 1Vp-p and INPUT and adjust SET GAIN x1 for a 5cm display.

Check x10 gain: Switch to 2V/cm and select x10 gain. Adjust SET GAIN x10 for a 5cm display.

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 C1

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 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 attenuator output is applied to the grid of V21 in the main amplifier.

Amplifier - Figure C2

The single-sided output from the attenuator is applied to the grid of V21. V22 grid is returned to input low. V21 & 22 form a cathode-coupled paraphase amplifier, providing a push-pull output at the anodes. Shunt-peaking inductors L21 & 22 are adjusted for optimum pulse response. To provide constant-current operation and stability of gain, the cathodes are long-tailed to a negative bias source obtained by rectification of the 12.6V heater supply. RV40 determines the gain of the stage by variation of cathode coupling.

In the x10 position of S21, the anode loads of V21 & 22 are increased in value thus increasing gain by a factor of 10. RV41 enables this increase to be accurately set. Astigmatism correction preset RV50, introduced in the anode

supply in the x10 position, enables the overall d.c. level of the amplifier and hence Y plate potential to be maintained constant in both settings of the Y gain switch.

The signal at the anodes of V21 & 22 is mixed with the d.c. shift potential provided by RV29 & 34 and fed to the grids of cathode-followers V23a & b.

The output at the cathodes of V23 is applied directly to the grids of the second amplifying stage V24a & 25a. Shunt-peaking is provided by L23 & 24.

From the anodes of V24a & 25a the signal passes to the grids of output cathode-followers V24b & 25b. Neons N21 & 22 protect V24b & 25b against excessive grid to cathode potentials, by striking and conducting after switching on, until cathode bias voltage is developed by the valves conducting.

The CRT Y plates are driven from the cathodes of V24b & 25b via damped series-peaking inductors L25 & 26, these consist of 16 turns of wire around 4.7kilohm resistors.

The output at the cathode of V24b is taken via R56 & C27 to a spring contact at the right-hand side to provide internal triggering of the timebase.

RECALIBRATION

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

A squarewave amplitude calibrator is required with an output in the region of 1kHz, variable between 5mV and 100Vp-p. For step 8 a squarewave generator of 5ns or better risetime is necessary with a termination to match its impedance. The generator should have an output of up to approximately 500mV at a frequency from 100kHz to 1MHz.

1 Preliminary

Plug the amplifier into an oscilloscope, switch on and leave for at least 15 minutes to enable temperature to become stable.

2 Gain x1

Select DC, 0.1V/cm, x1 gain and apply a 500mVp-p 1kHz squarewave. Adjust SET GAIN x1 for 5cm deflection.

3 Astigmatism balance

With SET GAIN x10 fully anti-clockwise, remove signal, short input to chassis, switch off timebase, centralise spot and adjust oscilloscope FOCUS and ASTIG controls for minimum spot size. Switch to x10 gain and recentre spot. Adjust RV50, located towards rear on right-hand side of amplifier, for minimum spot size.

4 Gain x10

With x10 gain still selected, remove short from INPUT, apply 50mVp-p 1kHz squarewave and switch-on timebase. Adjust SET GAIN x10 for 5cm deflection.

5 Gain ACx100

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

6 Attenuator compensation

Check gain is at x1 and INPUT at DC. Set VOLTS/CM and 1kHz calibrator output as below. Adjust appropriate trimmer for best squarewave with no under or over-shoot 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

7 Probe adjustment and attenuator compensation for probe

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

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

8 High-frequency compensation

Remove probe and connect the fast-rise squarewave generator via appropriate termination. With x1 gain and VOLTS/CM at 0.1, feed in between 300 & 500mV at a frequency from 100kHz to 1MHz. Adjust cores of L21, 22, 23 & 24, with a low-capacitance trimming tool, for best transient response, square corners and flat tops. L21 & 22 mainly affect the corners, while L23 & 24 have more influence on the d.c. level immediately following the corners.

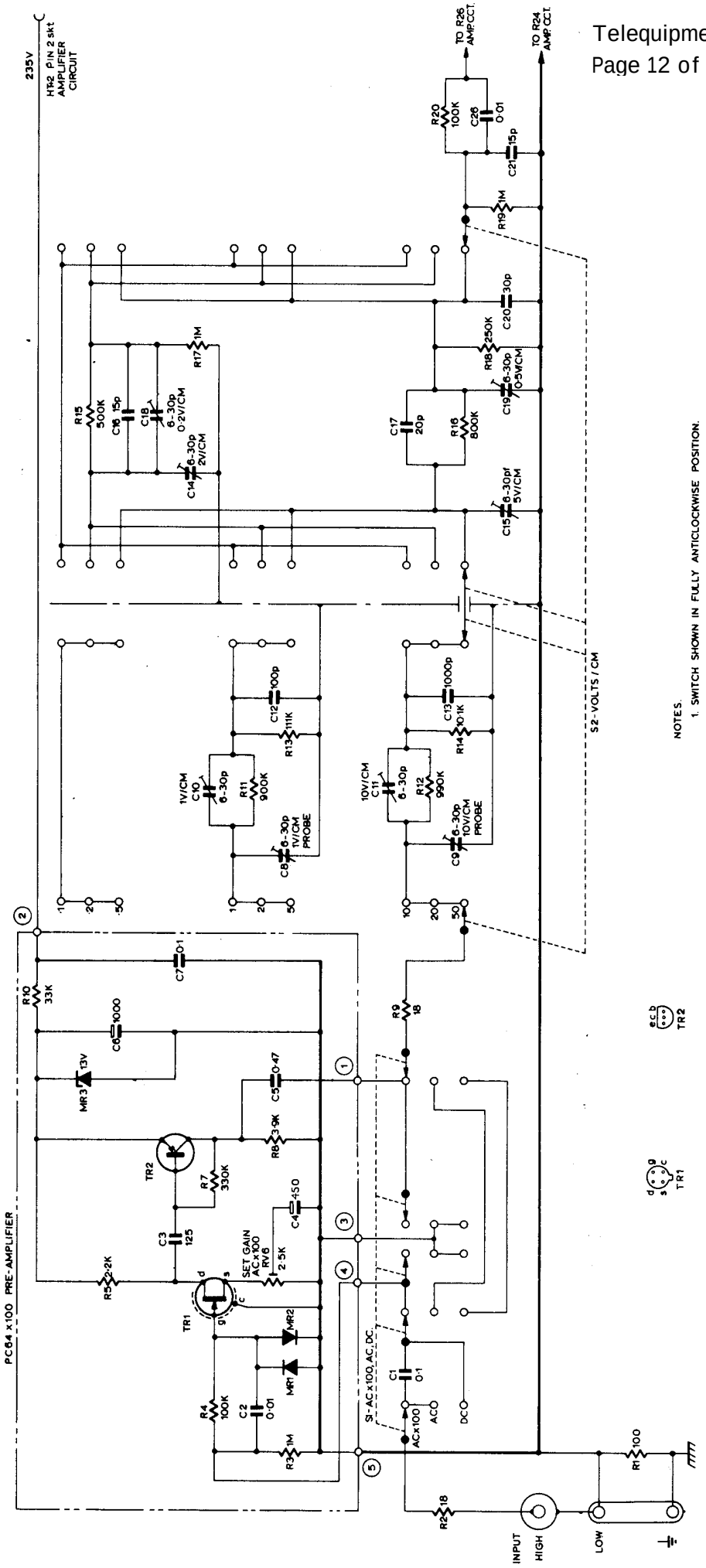
Cct. ref.	Part number	Value	Description	Tol. %	Rating
R1	316-0101-01	100	C		
R2	316-0180-01	18	C		
R3	319-0031-01	1M	HS	1	$\frac{1}{4}$
R4	316-0104-01	100k	C		
R5	315-0222-01	2.2k	C	5	$\frac{1}{4}$
RV6	311-0877-00	2.5k	CP	30	0.1
R7	319-0108-00	330k	HS	1	$\frac{1}{4}$
R8	316-0392-01	3.9k	C		
R9	316-0180-01	18	C		
R10	307-0137-00	33k	MO	5	$1\frac{1}{2}$
R11	319-0005-01	900k	HS	1	$\frac{1}{4}$
R12	319-0119-00	990k	HS	1	$\frac{1}{4}$
R13	319-0096-00	111k	HS	1	$\frac{1}{4}$
R14	319-0120-00	10.1k	HS	1	$\frac{1}{4}$
R15	319-0112-00	500k	HS	1	$\frac{1}{4}$
R16	319-0118-00	800k	HS	1	$\frac{1}{4}$
R17	319-0031-01	1M	HS	1	$\frac{1}{4}$
R18	319-0103-00	250k	HS	1	$\frac{1}{4}$
R19	319-0031-01	1M	HS	1	$\frac{1}{4}$
R20	316-0104-01	100k	C		
R21	316-0223-01	22k	C		
R22	316-0102-01	1k	C		
R23	316-0152-01	1.5k	C		
R24	316-0101-01	100	C		
R25	316-0102-01	1k	C		
R26	316-0101-01	100	C		
R27	316-0101-01	100	C		
R28	307-0184-00	15k	MO	5	$1\frac{1}{2}$
RV29	311-0751-00	25k	CP	20	2
R30	307-0184-00	15k	MO	5	$1\frac{1}{2}$
R31	316-0101-01	100	C		
R32	308-0485-00	7.5k	WW	5	2
R33	316-0563-01	56k	C		
RV34	311-0778-00	100k	CV	20	$\frac{1}{4}$
R35	316-0563-01	56k	C		

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

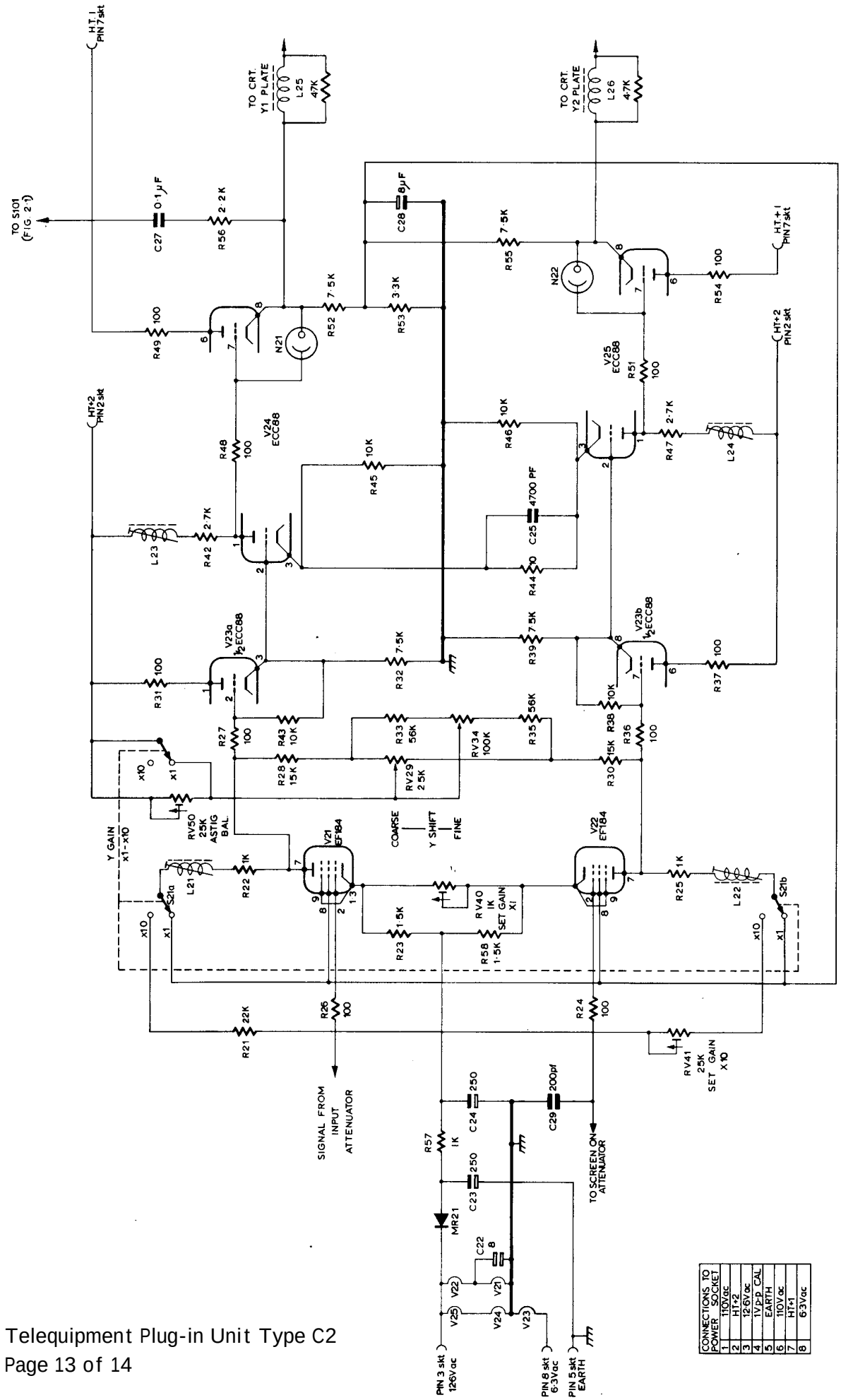
Cct. ref.	Part number	Value	Description	Tol. %	Rating
R36	316-0101-01	100	C		
R37	316-0101-01	100	C		
R38	316-0103-01	10k	C		
R39	308-0485-00	7.5k	WW	5	2
RV40	311-0746-00	1k	CP	20	$\frac{1}{4}$
RV41	311-0776-00	25k	CP	20	$\frac{1}{4}$
R42	307-0141-00	2.7k	MO	5	$1\frac{1}{2}$
R43	316-0103-01	10k	C		
R44	316-0100-01	10	C		
R45	308-0476-00	10k	WW	5	$3\frac{1}{2}$
R46	308-0476-00	10k	WW	5	$3\frac{1}{2}$
R47	307-0141-00	2.7k	MO	5	$1\frac{1}{2}$
R48	316-0101-01	100	C		
R49	316-0101-01	100	C		
RV50	311-0751-00	25k	CP	20	2
R51	316-0101-01	100	C		
R52	308-0485-00	7.5k	WW	5	2
R53	308-0489-00	3.3k	WW	5	$3\frac{1}{2}$
R54	316-0101-01	100	C		
R55	308-0485-00	7.5k	WW	5	2
R56	316-0222-01	2.2k	C		
R57	316-0102-01	1k	C		
R58	316-0152-01	1.5k	C		
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

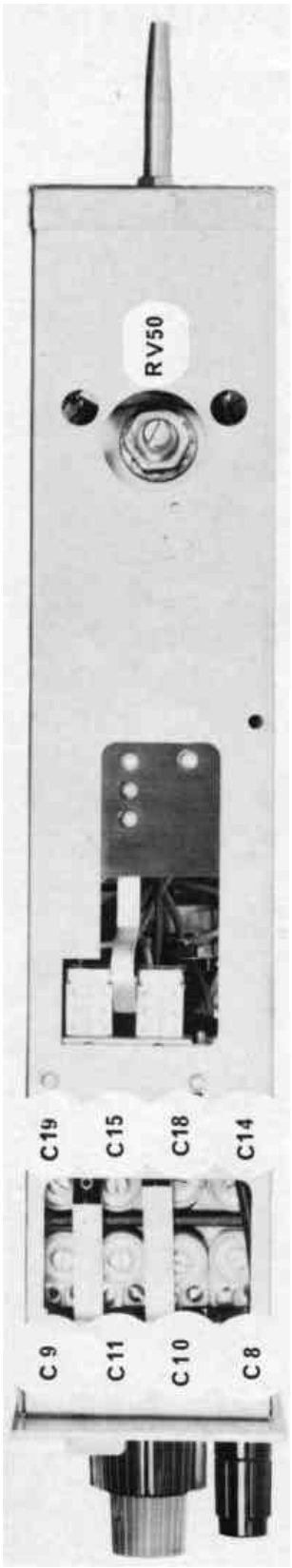
Cct. ref.	Part number	Value	Description	Tol. %	Rating
C14	281-0137-00	6-30p	CT		350
C15	281-0137-00	6-30p	CT		350
C16	285-0842-00	15p	PS	1p	500
C17	285-0867-00	20p	PS	1p	500
C18	281-0137-00	6-30p	CT		350
C19	281-0137-00	6-30p	CT		350
C20	285-0843-00	30p	PS	2p	500
C21	285-0842-00	15p	PS	1p	500
C22	290-0399-00	8	RE		25
C23	290-0386-00	250	E		18
C24	290-0386-00	250	E		18
C25	285-0792-00	4,700p	PE	20	400
C26	285-0769-00	0.01	PE	20	400
C27	285-0772-00	0.1	PE	10	400
C28	290-0113-01	8	E		150
C29	285-0873-00	200p	PS	5	350
L21	114-0251-00	3.9-7.5μH	Variable inductor		
L22	114-0251-00	3.9-7.5μH	" "		
L23	114-0252-00	9.1-20μH	" "		
L24	114-0252-00	9.1-20μH	" "		
L25	108-0484-00	1.15μH	Inductor (on 4.7k resistor)		
L26	108-0484-00	1.15μH	" " " "		
MR1	152-0062-01		1N914 Si		
MR2	152-0062-01		1N914 Si		
MR3	152-0372-00	13V	Si zener	5	0.33W
MR21	152-0339-00	50V	Si rectifier		0.5A
N21	150-0069-00	60V	Neon 3L		
N22	150-0069-00	60V	Neon 3L		
S1	260-1027-00		Rotary (3-position)		
S2	260-0953-00		Rotary (9-position)		
S21	260-0997-00		Push (2-button)		

Cct. ref.	Part number	Description
TR1	151-0265-00	KEM103 Union Carbide Si
TR2	151-0244-00	U15712/2 Fairchild Si
V21	154-0535-00	EF184/6EJ7
V22	154-0535-00	EF184/6EJ7
V23	154-0187-01	ECC88/6DJ8
V24	154-0187-01	ECC88/6DJ8
V25	154-0187-01	ECC88/6DJ8

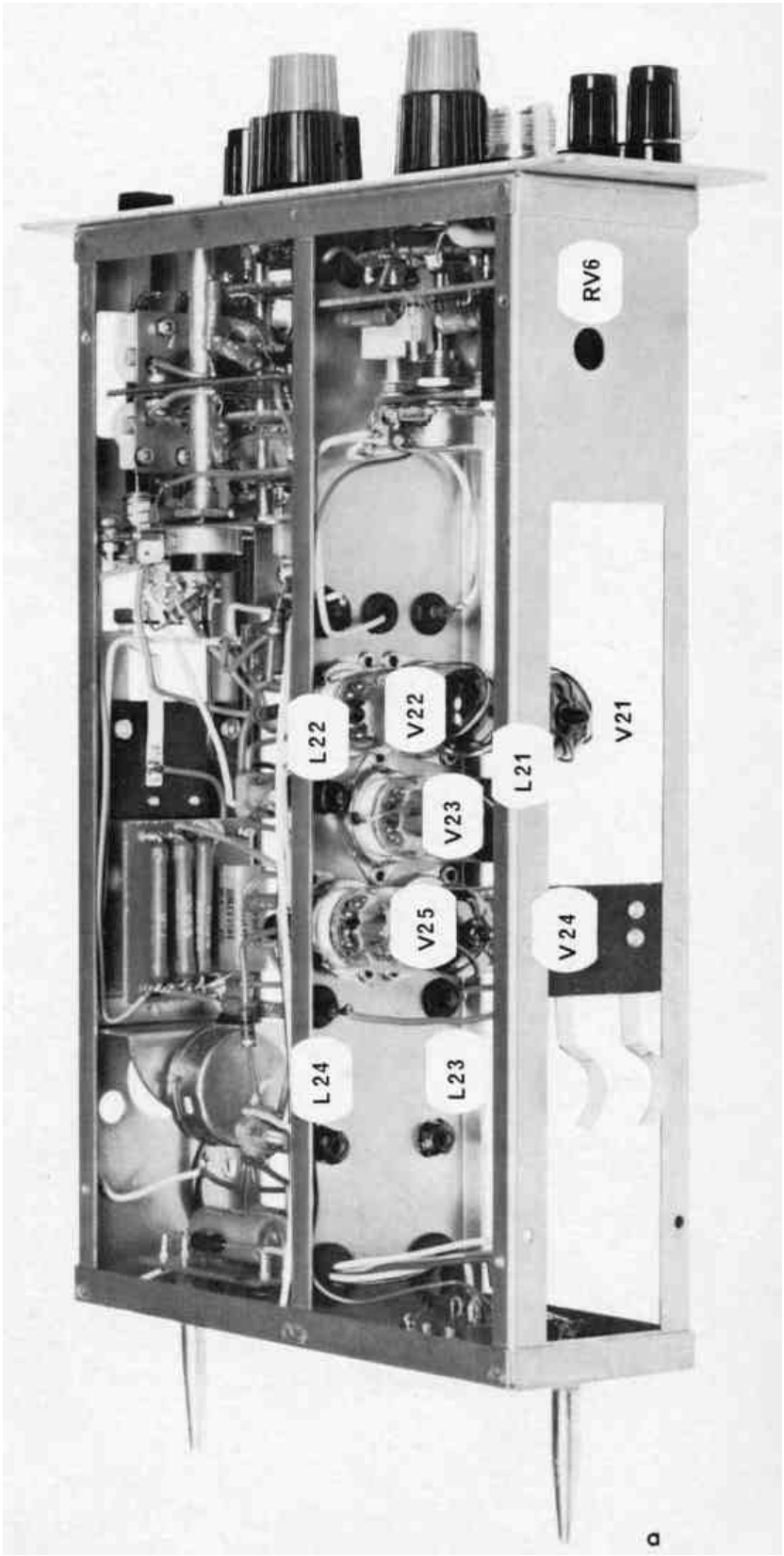


PRE-AMPLIFIER & ATTENUATOR TYPE C-2 FIG. C-1


VERTICAL AMPLIFIER TYPE C-2
FIG C·2
CONNECTIONS TO POWER SOCKET
1 110Vac
2 HT+2
3 12·6Vac
4 1Vp-p CAL
5 EARTH
6 110Vac
7 HT+1
8 6·3Vac
SIGNAL FROM INPUT ATTENUATOR
TO SCREEN ON ATTENUATOR
TO S101 (FIG. 2·1)
TO CRT Y1 PLATE
TO CRT Y2 PLATE
Y GAIN x1-x10
COARSE
Y SHIFT
FINE
RV50 25K ASTIG BAL
RV40 1K SET GAIN X1
RV41 25K SET GAIN X10
V21 EF184
V22 EF184
V23a ½ECC88
V23b ½ECC88
V24 ECC88
V25 ECC88
MR21
N21
N22
PIN 3 skt 12·6V ac
PIN 8 skt 6·3Vac
PIN 5 skt EARTH



RIGHT-HAND SIDE



LEFT-HAND SIDE

C-2 AMPLIFIER COMPONENT LOCATIONS