Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for adjustment or repair following failure of the instrument to pass any of the performance checks detailed in Chap. 4.

Before attempting any adjustment or repair, read the technical description given in Chap. 3.

CAUTION

This instrument uses semiconductor devices which, although having inherent long term reliability and mechanical ruggedness, are susceptible to damage through overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as reversed potentials, prolonged soldering, strong r.f. fields or other forms of radiation, use of insulation testers or accidentally applied short circuits. Even the leakage current from an unearthed soldering iron could cause trouble. Before shorting or breaking any circuit, refer to the circuit diagrams to establish the effect on bias arrangements of any associated transistors.

The performance limits quoted in this chapter are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the Data Summary section.

5.2 SCREW FASTENERS

Screw threads used on this equipment are of the following sizes: 8 BA, 6 BA, 4 BA and 2 BA.

Cruciform headed screws are of the Pozidriv type; to avoid damaging them a Pozidriv screwdriver should be used.

5.3 REMOVAL OF COVER

To remove the instrument from its case, undo the four 2 BA screws at the rear and slide the instrument forward. Alternatively, turn the instrument with its front panel resting on a soft surface and slide the case off.

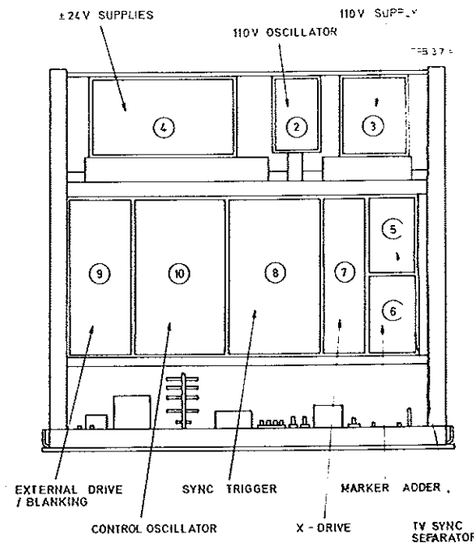

Fig. 5.1 Location of printed circuit boards, underside of chassis

5.4 ACCESS TO PRINTED CIRCUIT BOARDS

All components of the main unit are accessible from the underside of the chassis, except the power supply transformer and rectifier circuits which are accessible from the top, behind the plug-in unit. The eight printed circuit boards accessible from the underside are arranged as shown in Fig. 5.1; each board is mounted in an open tray, except the 110 V oscillator board which is fully enclosed with a clip-on cover. To remove this cover, lever it off by inserting the blade of a small screwdriver under the lip provided for this purpose.

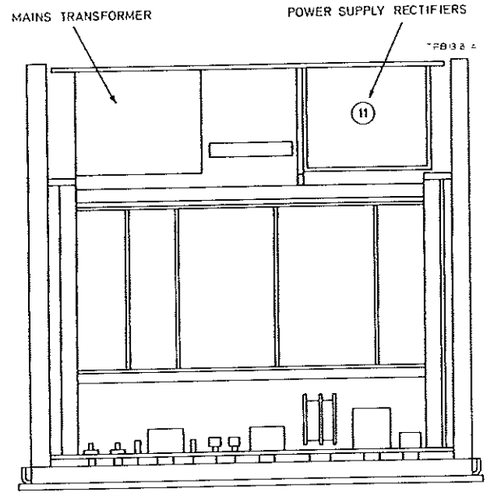

Fig. 5.2 Location of printed circuit boards, top of chassis

The boards on top of the chassis are shown in Fig. 5.2.

Each printed circuit board can be raised up out of its tray for inspection or repair by removing the four 6 BA screws holding it in position and if necessary it can then be completely removed by disconnecting the wired terminals which are pressed on to spigots on the board. It is possible to get a test probe on to these terminals without removing the wires, a short section of the spigot being left exposed between the board and the insulated sleeving round the terminal.

CAUTION

When removing, inserting or working on printed circuit boards, take care not to bend them or to damage the printed circuit tracks on the underside of the boards. Bending can cause hair-line breaks in a track, and such breaks are very difficult to locate.

If it is found necessary to remove a printed circuit board for return to the manufacturer, it should be removed complete with its tray. Each tray is held in position by four 4 BA screws, two on a flange at the front and two at the rear.

5.5 ACCESS TO PRESET CONTROLS

All preset controls are mounted on the printed circuit boards accessible from the underside of the chassis. For the location of these controls, refer to Fig. 5.3.

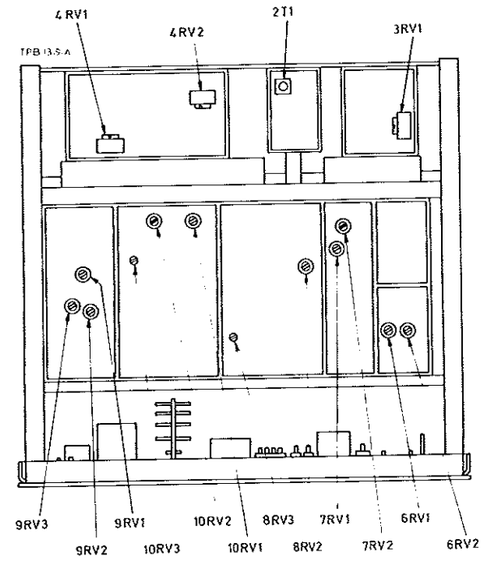

Fig. 5.3 Location of preset controls

5.6 COMPONENT LOCATION

Component location diagrams are shown in Figs. 5.4 to 5.13, and these diagrams also show the location of the board terminals. For front and rear panel components, refer to Figs. 2.2 and 2.3 respectively.

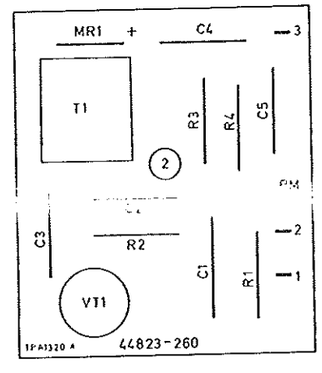

Fig. 5.4 Component location, Board 2, 110 V oscillator

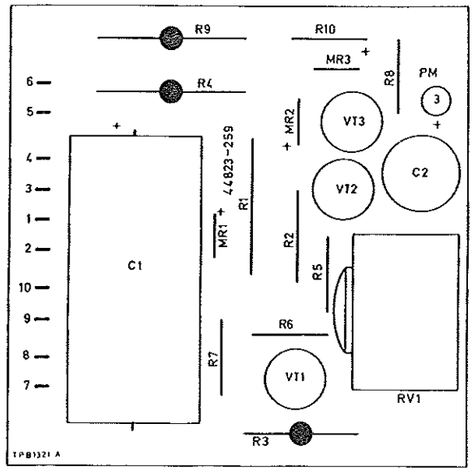

Fig. 5.5 Component location, Board 3, 110 V supply

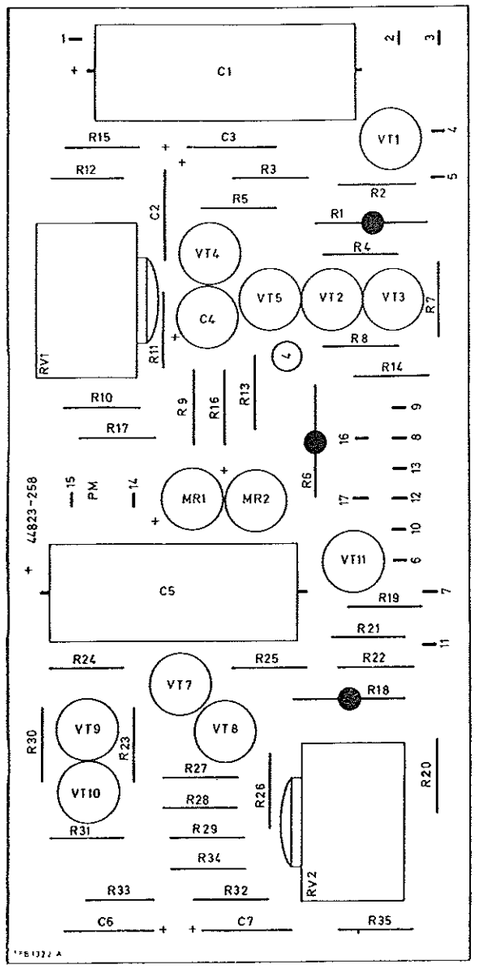

Fig. 5.6 Component location, Board 4, 24 V supply

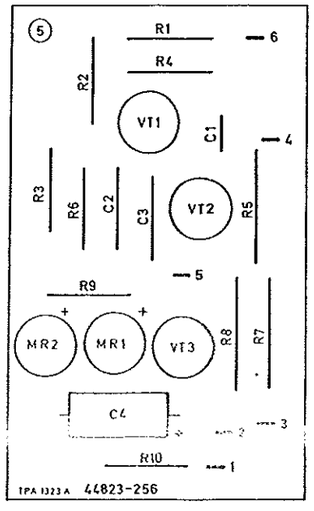

Fig. 5.7 Component location, Board 5, TV sync separator

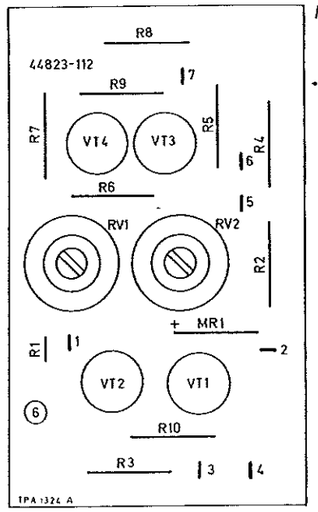

Fig. 5.8 Component location, Board 6, Marker adder

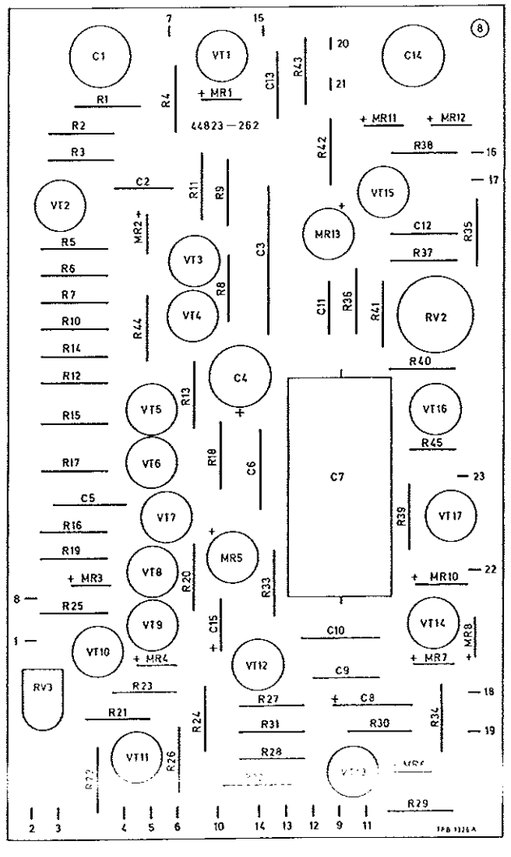

Fig. 5.10 Component location, Board 8, Sync trigger and binary

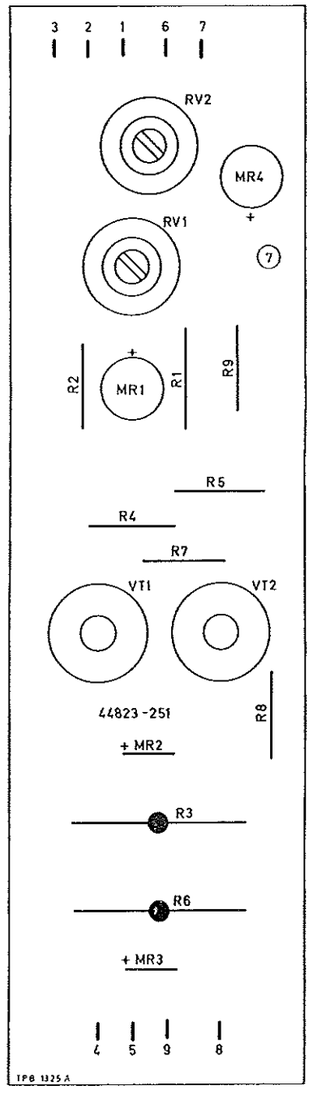

Fig. 5.9 Component location, Board 7, X-drive amplifier

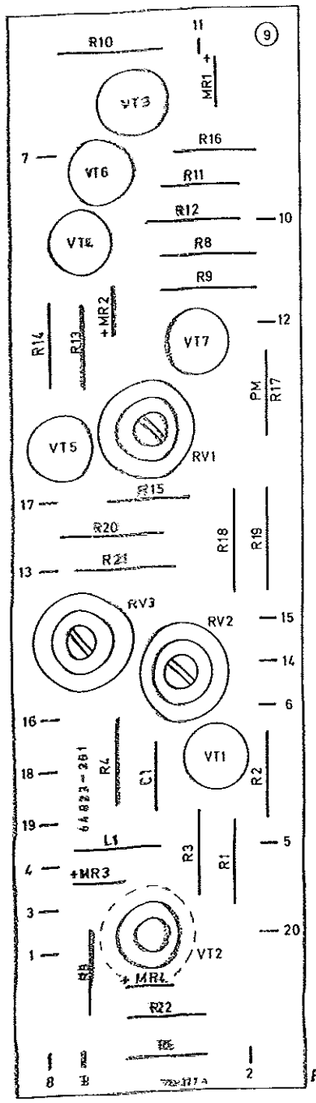

Fig. 5.11 Component location, Board 9, Blanking and ext. drive

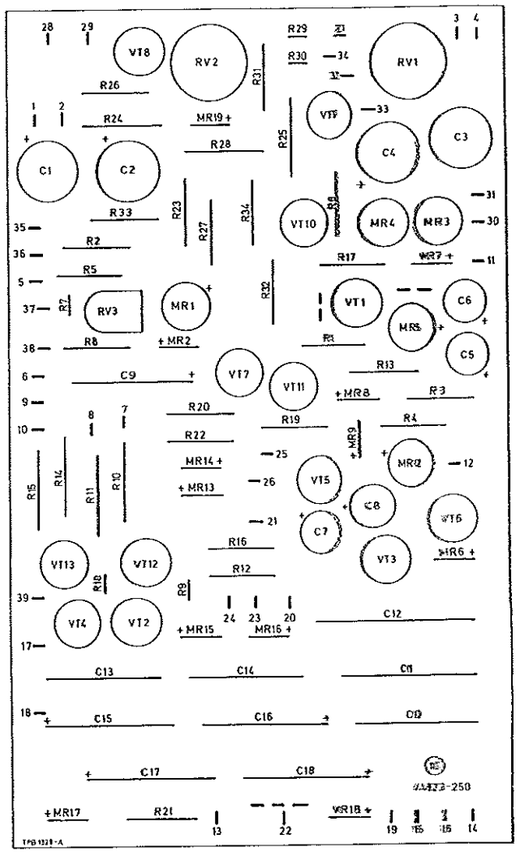

Fig. 5.12 Component location, Board 8, Control oscillator

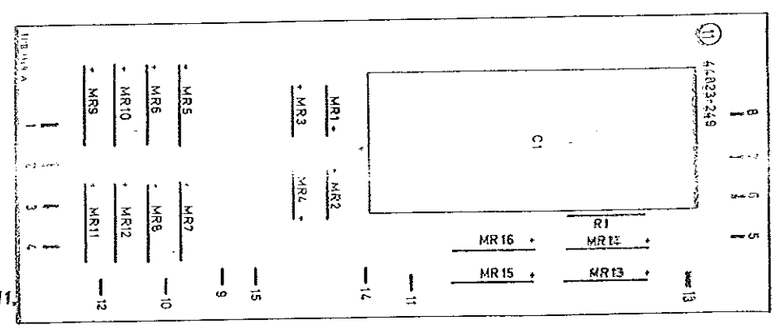

Fig. 5.13 Component location, Board 11, Power supply rectifiers

5.7 ADJUSTMENT AND CALIBRATION

This section provides a list of the test equipment that will be required to carry out the adjustment and calibration procedures detailed in this chapter. Do not attempt to calibrate the instrument using test equipment having an accuracy less than that of the items recommended. If repairs are necessary and adequate test equipment is not available, the instrument should be returned to the manufacturer, where a repair and calibration service is provided.

a) Dummy load, see Fig. 4.1

b) Oscilloscope, Tektronix type 547.

c) Oscilloscope plug-in, Tektronix type W.

d) Oscilloscope plug-in, Tektronix type 1A1.

e) Oscilloscope probe (two), Tektronix P 6023.

f) R C oscillator, M.I. type TF 1370A.

g) Digital voltmeter, Digital measurements type DM 2005.

h) Transformer, variable, Variac.

i) Multimeter, 20 000 Ω/V, such as Avometer, model 8.

j) Differential voltmeter, M.I. type TF 2606.

k) Counter frequency meter, such as M.I. TF 1417 series.

l) Blanking and sync mixer, M.I. type TF 2908.

m) V.L.F. oscillator, 0.01 to 10 kHz.

n) Sync pulse generator, BD 289.

p) Video sweep unit, M.I. type TM 9692.

q) Video detector (supplied with p), M.I. type TM 9560.

r) 1 kΩ pad, see Fig. 5.14.

s) 50 kΩ resistor, 1%, 3/4 W.

t) 1 kΩ resistor, 1%, 3/4 W.

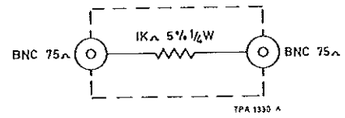

Fig. 5.14 1 kΩ pad

5.7.1 Initial conditions

For adjustment and calibration, the instrument should be removed from its case (see Sect. 5.3) and operated on its side so that the preset controls are accessible. Remove the plug-in unit and fit the dummy load (Fig. 4.1) to the 24-pin socket on the main unit. Do not operate the instrument with the cover removed from the 110 V oscillator board.

WARNING When the instrument is operated in this condition, dangerous voltages are accessible near the mains transformer. Take all necessary precautions to avoid contact with these voltages.

Set the front panel controls to the following positions:

SUPPLY switch OFF

MARKER switch OFF

A.L.C. switch INT

X-DRIVE switch FORWARD

X-DRIVE OUTPUT LEVEL fully clockwise

RATIO switch 1:1

BLANKING switch ON

SWEEP MODE switch NORMAL

PHASE SHIFT control fully counter-clockwise

SWEEP FUNCTION switch 10 - 100 Hz

VARIABLE RATE control fully clockwise

EXTERNAL DRIVE SET LEVEL control fully counter-clockwise

5.7.2 Power supply regulation

Test equipment: a, b, c, e, h, i and j

(1) Connect the Variac, set to 115 V or 230 V output according to the range in use, between the mains supply and the mains input socket, with the multimeter (250 V a.c. range) connected across

the Variac output. Connect the Y input of the oscilloscope to pin 1 on the dummy load. Connect the differential voltmeter TF 2606 to pin 1 on the dummy load (positive) and earth and set it to discriminate 100 mV at 24 V. Switch the supply on.

(2) Check that the voltmeter indicates +24 V ±50 mV; if necessary adjust RV1 on the 24 V supplies board (board 4).

(3) Apply a short circuit across the +24 V supply (dummy load pin 1 to earth) for 1 second, and check that the voltage recovers to within 5 mV of its original value when the short circuit is removed.

(4) Set up the differential voltmeter for a null balance, and use the Variac to change the mains supply voltage. Check that the +24 V supply does not vary by more than ±10 mV for a ±15% change in mains voltage.

(5) Display the +24 V supply on the oscilloscope, and check that the ripple does not exceed 1 mV p-p for a ±10% change in mains voltage. Reset the Variac to nominal mains voltage.

(6) Transfer the oscilloscope and differential voltmeter from pin 1 to pin 5 (negative) on the dummy load.

(7) Repeat (2) to (5) for the -24 V supply, adjusting RV2 on board 4 if necessary.

(8) Set the differential voltmeter to discriminate 100 mV at +110 V. Transfer the oscilloscope and differential voltmeter from pin 5 to pin 3 (positive) on the dummy load.

(9) Check that the voltmeter indicates +110 V ±100 mV; if necessary adjust RV1 on the 110 V supply board (board 3). If this voltage cannot be obtained, or can only be obtained with RV1 at the limit of its travel in one direction, check the output of the 110 V oscillator. To do this, remove the cover from the 110 V oscillator board (see Sect. 5.4) and connect the oscilloscope set to display a 7 MHz waveform to the connection between MR1 and T1. Then adjust the core of the oscillator transformer T1 for maximum output. Replace the cover on the board before resuming the tests.

(10) Apply a short circuit across the +110 V supply (dummy load pin 3 to earth) for 1 second, and check that the voltage recovers to within ±50 mV when the short circuit is removed.

(11) Set up the differential voltmeter for a null balance, and use the Variac to change the mains supply voltage. Check that the +110 V supply does not vary by more than ±20 mV for a ±15% change in mains voltage.

(12) Display the +110 V supply on the oscilloscope, and check that the ripple does not exceed 10 mV p-p for a ±10% change in mains voltage. Disconnect the Variac, multimeter, oscilloscope and differential voltmeter.

5.7.3 Internal sweep

Test equipment: a, b, c, g and k

(1) Connect the oscilloscope X input to the X-drive output socket, and the oscilloscope Y input to pin 21 on the control oscillator board (board 10).

(2) Check that the oscillator is operative on the four internal ranges of the sweep function switch (0.01 to 100 Hz), with the ratio switch set at 1:1 and 10:1.

(3) Set up the oscilloscope for differential operation, as follows: set the display to A-B; connect two probes to the two inputs and link the two earth leads but make no connection to earth; set the oscilloscope to AUTO, time base to 20 ms/cm and input sensitivity to 200 mV/cm.

(4) Set the SWEEP FUNCTION switch to 0.01 - 0.1 Hz and the RATIO switch to 10:1.

(5) Connect both the A and B probes to the junction of C17 and C18 on board 10, and adjust the trace to the top line of the graticule. Connect probe A to the other end of C17, switch the supply to the main unit off and discharge C17 and C18. Switch the supply to the main unit on and check that the first negative excursion of the trace does not exceed 1 V (5 cm). Repeat this test with probe A connected to the other end of C18, and repeat both tests for a ratio setting of 1:1.

(6) Repeat (5) with the sweep function switch set to 0.1 - 1 Hz, measuring across capacitors C13 and C14.

(7) Set the SWEEP FUNCTION switch to 10 - 100 Hz and the RATIO switch to 1:1. Reset the oscilloscope for normal use.

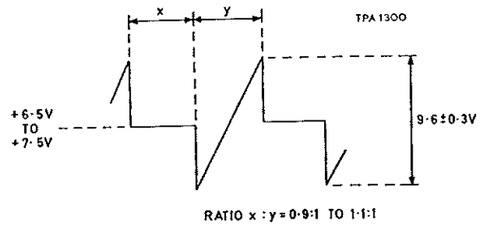

Fig. 5.15 Control oscillator waveform, 1:1 ratio

(8) Connect the oscilloscope to pin 21 on board 10 and check that the level and ratio of the waveform is as shown in Fig. 5.15.

(9) Set the RATIO switch to 10:1 and check that the level and ratio of the waveform is as shown in Fig. 5.16.

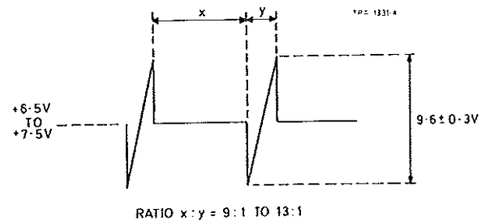

Fig. 5.16 Control oscillator waveform, 10:1 ratio

(10) Set the SWEEP FUNCTION switch to TV and check that the oscillator is inhibited, and that the d.c. level of the trace is between +6.5 V and +7.5 V. Repeat with the RATIO switch at 1:1.

(11) Set the SWEEP FUNCTION switch to EXTERNAL, CW and MANUAL in turn, adjusting the VARIABLE RATE control over its full range in each case. Check that the oscillator remains inactive during each test. Disconnect the oscilloscope.

(12) Connect the start B socket on the counter frequency meter to the BLANKING OUTPUT socket. Set the counter to period B and the first clockwise ms position. Set the VARIABLE RATE control fully counter-clockwise, and set the SWEEP FUNCTION to one of the internal sweep ranges.

(13) Allow at least three complete cycles of operation on any range before taking measurements. Note the values marked with an asterisk in the following table and, by switching to each range in turn, find the range which gives a rate on the counter nearest to one of these marked values. Then adjust RV3 on board 10 to give +10% on the value quoted. For example, if the 1 - 10 Hz range is nearest at 1.05 second, adjust RV3 so that the counter records 1.1 second.

Sweep function switch	*Variable rate control*	*Sweep time* *min.*	*max.*	*Frequency (Hz)*
10 - 100 Hz	FCW	7 ms	10 ms	100 min
	FCCW	100 ms *	130 ms	10 max
1 - 10 Hz	FCW	70 ms	100 ms	10 min
	FCCW	1 sec *	1.3 sec	1 max
0.1 - 1 Hz	FCW	0.7 sec	1.0 sec	1 min
	FCCW	10 sec *	13 sec	0.1 max
0.01 - 0.1 Hz	FCW	7 sec	10 sec	0.1 min
	FCCW	100 sec *	130 sec	0.01 max

FCW = fully clockwise

FCCW = fully counter-clockwise

(14) Check that the VARIABLE RATE control adjusts the sweep rate within the minimum and maximum limits quoted for each internal range, with the ratio switch set at 1:1 and 10:1. On the lowest range, the time at 100 seconds must not exceed 150 seconds. Disconnect the counter.

(15) Connect input A of the oscilloscope to pin 14 on the dummy load using a 1:1 probe, and set the oscilloscope for comparative voltage checking as follows: set the type W plug-in to A-Vc, input A to ground, input attenuator to 1, mV/cm to 10, Vc range to 1.1 and Vc digits to zero.

(16) Set the SWEEP FUNCTION switch to 10 - 100 Hz, RATIO switch to 1:1 and VARIABLE RATE control fully counter-clockwise.

(17) Adjust the oscilloscope to set the trace to the lowest line of the graticule, then switch input A to d.c.

(18) Set the digits on the oscilloscope plug-in for a Vc of 33.75 mV (i.e. 3 in the middle window and 37.5 on the inner scale). Adjust RV1 (level) and RV2 (amplitude) on board 10 progressively until the negative peak of the displayed waveform is on the lowest line of the graticule. Note that RV1 and RV2 interact.

(19) Set the digits for a Vc of 341.25 mV (i.e. 3 on outer knob, 4 in the middle window and 12.5 on the inner scale). Adjust RV1 and RV2 again until the positive peak of the displayed waveform is on the lowest line of the graticule.

(20) Repeat (18) and (19) until both conditions are satisfied. Disconnect the oscilloscope.

(21) Connect the input of the digital voltmeter to pin 14 on the dummy load, and set the digital voltmeter range to 0.7999, filter CR to 0, resolution to 1 and trip to counter-clockwise. Set the SWEEP FUNCTION switch to 0.01 - 0.1 Hz, RATIO switch to 1:1 and VARIABLE RATE control fully counter-clockwise.

(22) Set the digital voltmeter mode to 'min' and check that it indicates 33.75 mV ±1 mV. Set the mode to 'max' and check that it indicates 341.25 mV ±1 mV. Note that the readings are held until cancelled by the min - max switch.

(23) Set the RATIO switch to 10:1 and repeat (22), the limits for this test being ±2 mV. Disconnect the digital voltmeter.

5.7.4 X-drive, sweep linearity and one shot operation

Test equipment: a, b, c, s and t

(1) Connect the oscilloscope to the X-drive output socket via a T-junction adaptor, and connect the 50 kΩ resistor across the T-junction. Set the SWEEP FUNCTION switch to 10 - 100 Hz, RATIO switch to 10:1 and VARIABLE RATE control fully clockwise.

(2) Check that the amplitude of the displayed waveform is at least 30.5 V p-p, and adjust RV1 on the X-drive board (board 7) for equal positive and negative excursions on either side of earth, ±1 V.

(3) Set the X-DRIVE switch to REVERSE, and repeat (2), adjusting RV2 on board 7 for equal excursions about earth.

(4) Remove the 50 kΩ resistor and fit the 1 kΩ resistor in its place. Check that the amplitude of the displayed waveform is at least 2.1 V p-p, and repeat with the X-DRIVE switch in the FORWARD position. Set the X-DRIVE control fully counter-clockwise and check that the level is less than 0.1 V p-p.

(5) Remove the 1 kΩ resistor and fit the 50 kΩ resistor in its place. Set the X-DRIVE LEVEL control fully clockwise and the RATIO switch to 1:1. Check that the negative-going spike on the X-drive ramp is less than 1.5 V. Note the precise level for a subsequent check in 5.8.5 (12).

(6) Set the RATIO switch to 10:1 and display one cycle of the sweep over the full extent of the graticule. Check the linearity of the ramp over the centre 92%; it should be a straight line within 3% (0.01 - 0.1 Hz) or 2.5% (0.1 - 100 Hz). For accurate measurement of this linearity, a chart recorder should be connected to the X-DRIVE OUTPUT to give a tracing of the sweep waveform.

(7) Set the SWEEP MODE switch to ONE SHOT and operate the ONE SHOT switch. Check that when the switch is released a single sweep is generated. Repeat for the other three internal ranges on the SWEEP FUNCTION switch. On completion, set the SWEEP MODE switch back to NORMAL.

5.7.5 TV sync separator and sync trigger

Test equipment: a, b, d, f, l, n and r

(1) Feed blanking and sync pulses (625 line system) from the synchronizing pulse generator to the blanking and sync inputs of the blanking and sync mixer, also feed a 10 MHz sine wave (75 Ω source and 700 mV amplitude) from the attenuator output of the R C oscillator to the video input of the blanking and sync mixer. Set the blanking and sync mixer to give a 1 V composite signal output (600 mV video, 300 mV sync and 100 mV blanking) and connect this output to the EXTERNAL DRIVE INPUT socket on the sweep generator. Set the SWEEP FUNCTION switch to TV and the RATIO switch to 1:1.

(2) Connect the oscilloscope (fitted with the type 1A1 plug-in) to pin 7 on the sync trigger board (board 8) and check that the displayed waveform is a pulse of 50 Hz ±5 Hz frequency, width less than 150 µs, amplitude more than 20 V peak, and rise time less than 10 µs. Remove the inputs to the blanking and sync mixer.

(3) Feed negative field blanking pulses at 300 mV from the synchronizing pulse generator to the sync input of the blanking and sync mixer. Repeat (2). Disconnect the synchronizing pulse generator and the blanking and sync mixer.

(4) Connect the R C oscillator lower output socket to the external drive socket via the 1 kΩ pad, and set the oscillator output to 50 Hz sine wave. Connect the oscilloscope to the sweep generator side of the 1 kΩ pad and adjust the oscillator level to give 4.8 V p-p. Repeat para (2).

(5) Change the R C oscillator frequency to 400 Hz sine wave at the same level, and connect the oscilloscope time base and channel 1 input to pin 7 on board 8. Set the oscilloscope to chop, and connect channel 2 input to pin 12 on board 8. Check that the frequency displayed is 400 Hz ±20 Hz.

(6) Set the PHASE SHIFT control fully clockwise and adjust RV3 on board 8 so that the width of the pulse on channel 2 is 50 µs ±10 µs. Check that the negative-going edge of the pulse on channel 2 is at least 1 ms after the negative-going edge of the pulse on channel 1.

(7) Set the PHASE SHIFT control fully counter-clockwise and check that the negative-going edge of the channel 2 pulse moves to at least 0.9 ms before the negative-going edge of the channel 1 pulse. Check that the channel 2 pulse has an amplitude of at least 4 V peak.

(8) Reset the oscillator to 50 Hz sine wave and check with the oscilloscope that the sweep generator input is 50 Hz ±2 Hz, 4.8 V p-p.

(9) Set the PHASE SHIFT control fully clockwise and check that the negative-going edge of the channel 2 pulse is at least 5 ms after the negative-going edge of the channel 1 pulse.

(10) Set the PHASE SHIFT control fully counter-clockwise and check that the negative-going edge of the channel 2 pulse is at least 10 ms before the negative-going edge of the channel 1 pulse.

(11) Set the oscillator output to 40 Hz sine wave at the same level. Set the oscilloscope to channel 2 operation, internal positive trigger, and connect it to the X-DRIVE OUTPUT socket. Set the VARIABLE RATE control fully clockwise and check that the sweep time (sweep plus flyback) is less than 14.3 ms, on ratios of both 1:1 and 10:1.

(12) Set the oscilloscope time base to 2 ms/cm. Adjust RV2 on board 8 for the best compromise to give a clean waveform on both 1:1 and 10:1 ratios, especially for least rounding at the transition from sweep to flyback; also to give a d.c. level for the waiting time that is within ±1 V of the negative peak voltage noted in 5.8.4 (5).

(13) Adjust the VARIABLE RATE control for minimum stable waiting time, and check that this does not exceed 400 µs on either 1:1 or 10:1 ratio. Disconnect the R C oscillator.

(14) Set the SWEEP FUNCTION switch to MAINS LOCK and check that the X-DRIVE OUTPUT is at least 30.5 V p-p.

(15) Adjust the VARIABLE RATE control for minimum stable waiting time, and check that this does not exceed 400 µs on either 1:1 or 10:1 ratio. Display at least 3 cycles of the ramp output and check that each cycle is equal in time.

5.7.6 Blanking

Test equipment: a, b and c

(1) Set the SWEEP FUNCTION switch to 0.01 - 0.1 Hz, RATIO switch to 1:1 and VARIABLE RATE control fully clockwise. Connect the oscilloscope (fitted with the type W plug-in) to pin 9 on the

dummy load. Check that the waveform displayed is a square wave of at least +21 V amplitude. Repeat for the other three internal ranges of the SWEEP FUNCTION switch, also for the MAINS LOCK position. In each case set the BLANKING switch to OFF and check that the trace indicates a steady d.c. level of at least +21 V.

(2) Check the blanking output as detailed in Chap. 4, Sect. 4.4.6.

5.7.7 External drive and manual control

Test equipment: a, b, c, f, m and s

(1) Set the SWEEP FUNCTION switch to EXTERNAL and the EXTERNAL DRIVE SET LEVEL control fully clockwise. Connect the oscilloscope to pin 14 on the dummy load and set it up for comparative voltage checking as in 5.8.3 (15). Adjust the trace to the lowest line on the graticule and switch input A to d.c. Set the digits on the oscilloscope plug-in for a Vc of 18.5 mV (i.e. 1 on the outer knob, 8 in the middle window and 75 on the inner scale).

(2) Short circuit the external drive input socket and adjust RV3 on the external drive amplifier board (board 9) until the trace is on the lowest line of the graticule ±1 mV. Remove the short circuit.

(3) Set the SWEEP FUNCTION switch to MANUAL and the VARIABLE RATE control fully counter-clockwise. Set the digits on the oscilloscope to 38.75 and adjust RV1 and RV2 on board 9 progressively until this value is obtained within 1 mV (note that RV1 and R32 interact).

(4) Set the VARIABLE RATE control fully clockwise and set the digits on the oscilloscope to 361.25 mV. Adjust RV1 and RV2 progressively until this value is obtained within 1 mV.

(5) Repeat (3) and (4) until both conditions are satisfied.

(6) Reset the oscilloscope for normal operation and connect it to the X-DRIVE OUTPUT socket loaded with the 30 kΩ resistor. Set the SWEEP FUNCTION switch to EXTERNAL and connect the v.l.f. oscillator to the EXTERNAL DRIVE INPUT socket. Set the oscillator to 0.01 Hz, 4 V p-p symmetrical about earth.

(7) Check that the X-drive output is at least 30.5 V and repeat with the oscillator set to 0.1 Hz and 1 Hz.

(8) Disconnect the v.l.f. oscillator and connect the RC oscillator in its place. Set the oscillator to 10 Hz sine wave, 4 V p-p output, 75 Ω source.

(9) Check that the X-drive output is at least 30.5 V, and repeat with the oscillator set to 100 Hz, 200 Hz, 2 kHz, 10 kHz and 20 kHz.

5.7.8 Marker adder

Test equipment: b, c, p and q

(1) Turn the SUPPLY switch OFF, remove the dummy load and fit the video plug-in unit into the main unit. Turn the SUPPLY switch ON and connect the oscilloscope to the COMBINED OUTPUT socket.

(2) Adjust RV2 (coarse) and RV1 (fine) on the marker adder board (board 6) for zero d.c. output ±5 mV.

(3) Connect the input of the video detector to the VIDEO OUTPUT socket on the video sweep unit, and the output of the detector to the DETECTED INPUT socket. Put the MARKER switch ON, and check that markers are displayed with detected video on the oscilloscope. Switch the markers OFF and check that detected video only is displayed. Switch power supplies OFF and disconnect all test equipment.

5.8 FAULT FINDING

Fault finding techniques should follow standard electronic practice, and this section is confined to giving some guidance on possible causes of failure to meet specified performance, in tabular form related to the information given in Sect. 5.8. Voltages are quoted on the circuit diagrams in Chap. 7. In addition, the waveforms illustrated in Figs. 3.2 to 3.10 will be found useful as an aid to fault finding.

5.8.1 Performance failures

Failure to meet performance figures quoted in section	*Possible causes*
5.7.2 (3)	VT1 faulty; if VT1 is short circuited, suspect VT6 is damaged.
5.7.3 (5)	Faulty smoothing capacitors on rectifier board, also C1 or C5 on board 4.
5.7.2 (10)	VT1 faulty.
5.7.3 (5) & (6)	Protection diode across capacitor faulty.
5.7.3 (8)	MR3, MR12, MR7 or MR9 faulty.
5.7.3 (13)	Relevant timing capacitor(s) faulty.
5.7.3 (18)	VT9, MR19 or associated resistors faulty.
5.7.4 (2)	MR1, R1 or MR4 faulty (amplitude); VT1, VT2 or feedback resistors faulty (equality).
5.7.4 (5)	VT8 or VT10 in differential amplifier faulty.
5.7.4 (6)	Lack of linearity on any one sweep range indicates a faulty timing capacitor; on all ranges, general fault in control oscillator.
5.7.5 (2)	C3, R8 faulty (width); VT3 faulty (amplitude); VT3 faulty (rise time).
5.7.5 (6)	Mainly general, but suspect first R28, R29, C15, R21 & R22.
5.7.5 (12)	VT14, 15, 16 or 17 faulty; also suspect all diodes.
5.7.6 (1)	VT1 or VT2 faulty; if spikes are present, suspect MR3 or MR4 faulty.
5.7.6 (2)	Faulty reference supply from VT9 on control oscillator board.
5.7.8 (2)	Leakage fault on VT2, or faulty VT3.

5.8.2 Circuit voltages

The voltages given on the circuit diagrams were taken on a typical TF 2361 using an oscilloscope with a 10:1 probe, giving an input resistance of 10 MΩ. All measurements are with respect to earth.

Conditions: SWEEP FUNCTION switch at C.W., VARIABLE RATE control fully clockwise, PHASE SHIFT control fully counter clockwise, RATIO switch at 10:1.

Chapter 6

Replaceable parts

Introduction

This chapter lists replaceable parts in alphabetical order of their circuit references, and in the order of the sub-assembly and printed circuit board numbers, as follows :

1 : Main chassis and front panel
2 : 110 V oscillator board
3 : 110 V supply board
4 : ±24 V supplies board
5 : TV sync separator board
6 : Marker adder board
7 : X-drive amplifier board
8 : Sync trigger and binary board
9 : External drive and blanking board
10 : Control oscillator and differential amplifier board
11 : Rectifiers

When ordering parts or referring to them in correspondence, use the board number to prefix the circuit reference number, for example 7R1, 10MR16. The following abbreviations are used in the list of replaceable parts :

C : capacitor
C* : capacitor selected for low leakage current
Carb : carbon
Cer : ceramic
Elec : electrolytic
FS : fuse
L : inductor
Lin : linear
MR : semiconductor diode
Ox : oxide
PL : plug
PLP : pilot lamp
Plas : plastic
R : resistor
RV : variable resistor
S : switch
SKT : socket
T : transformer
TP : terminal
VT : transistor
VT* : transistor selected for high current gain
W : watts at 70 °C
W* : watts at 40 °C
WW : wirewound
ø : feed-through component

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

(1) Type * and serial number of instrument.
(2) Complete circuit reference.
(3) Description.
(4) MI code.

* as given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

If a part is not listed, state its function, location and description when ordering.

Circuit reference	Description	M.I. code
Unit (1) Front panel and chassis		
When ordering, prefix circuit reference with 1		
FS1	Glass cartridge 250mA (230V), time-lag	23411-055
	Glass cartridge 500mA (115V), time-lag	23411-056
FS2	Glass cartridge 250mA (230V), time-lag	23411-055
	Glass cartridge 250mA (115V), time-lag	23411-056
FS3	Glass cartridge 1A, time-lag	23411-058
FS4	Glass cartridge 1A, time-lag	23411-058
FS5	Glass cartridge 1A, time-lag	23411-054
L1	10μH 10%	23642-555
L2	10μH 10%	23642-555
L3	10μH 10%	23642-555
PL1	3-pin mains	23423-151
PLP1	100V neon indicator	23733-150
RV1	WW double gang 10kΩ/2kΩ 5% 1W lin.	25872-385
SA	Sweep function	44325-903
SB	ALC int/ext.	23462-252
SC	Marker on/off	23462-252
SD	Blanking on/off	23462-258
SE	Sweep mode normal - one shot	23462-266
SF	One shot (biased)	23462-253
SG	Supply on/off	44334-003
SH	Supply range 115V-230V	23467-155
SKT1	24-pin	23435-640
SKT2	BNC 50Ω coaxial	23443-443
SKT3	BNC 50Ω coaxial	23443-443
SKT4	BNC 50Ω coaxial	23443-443
SKT5	BNC 50Ω coaxial	23443-443
SKT6	BNC 50Ω coaxial	23443-443
SKT7	BNC 50Ω coaxial	23443-443
T1	Mains transformer	43467-702
TP1	Miniature red	23235-204
TP2	Miniature black	23235-205
TP3	Miniature red	23235-204
Unit (2) 110 V oscillator		
When ordering, prefix circuit reference with 2		
	Complete board	44823-259
C1	Paper 0.02μF 10% 200V	26174-151
C2	Cer 100pF 2% 750V	26324-897
C3	Paper 500pF 20% 600V	26174-122
C4	Paper 0.001μF 10% 500V	26174-125
C5	Paper 0.001μF 10% 500V	26174-125
C6	Paper 0.003μF 10% 350V	26174-133
C7	Cer ø 4700pF +80-20% 500V	26373-665
C8	Cer ø 4700pF +80-20% 500V	26373-665
C9	Cer ø 4700pF +80-20% 500V	26373-665
MR1	1N4148	28336-676
R1	Met film 470Ω 2% ¼W	24773-265
R2	Met film 39kΩ 2% ¼W	24773-311
R3	Met film 220Ω 2% ¼W	24773-257
R4	Met film 220Ω 2% ¼W	24773-257
R5	Carb 47Ω 5% ¼W	24312-837
T1	Transformer	43557-002
VT1	2N2907A	28435-863
VT2	2N4240	28458-657
Unit (3) 110 V supply		
When ordering, prefix circuit reference with 3		
	Complete board	44823-259
C1	Elec 100μF +50-20% 150V	26417-495
C2	Elec 4.7μF +50-20% 63V	26423-211
MR1	1S923	28356-018
MR2	1S923	28356-018
MR3	1N4148	28336-676
R1	Carb 18kΩ 1% ½W	24155-180
R2	Carb 4.7kΩ 1% ½W	24154-470
R3	WW 1kΩ 5% 1½W	25123-080
R4	WW 10kΩ 5% 3W	25125-110

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R5	Met film 2.2kΩ 2% ¼W	24773-281
R6	Met film 2.2kΩ 2% ¼W	24773-281
R7	Met film 15kΩ 2% ¼W	24773-301
R8	Met film 1.8kΩ 2% ¼W	24773-279
R9	WW 330Ω 5% 3W	25125-063
R10	Met film 1kΩ 2% ¼W	24773-273
RV1	WW 1kΩ 10% 1W lin.	25811-538
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3	BCY70	28434-857

Unit (4) 24 V supplies

When ordering, prefix circuit reference with 4

	Complete board	44823-258
C1	Elec 220μF +100-20% 40V	26415-819
C2	Elec 2μF +100-20% 25V	26414-109
C3	Elec 2μF +100-20% 25V	26414-109
C4	Elec 22μF +100-20% 40V	26423-222
C5	Elec 220μF +100-20% 35V	26415-819
C6	Elec 2μF +100-20% 25V	26414-109
C7	Elec 2μF +100-20% 25V	26414-109
MR1	Z5B6.2	28371-483
MR2	Z5B5.6	28371-434
R1	WW 2.2Ω 10% 1½W	25133-006
R2	Met film 470Ω 2% ¼W	24773-265
R3	Met film 8.2kΩ 2% ¼W	24773-295
R4	Met film 15kΩ 2% ¼W	24773-301
R5	Met film 470Ω 2% ¼W	24773-265
R6	WW 680Ω 5% 11½W	25123-075
R7	Met film 2.2kΩ 2% ¼W	24773-081
R8	Met film 470Ω 2% ¼W	24773-265
R9	Met film 2kΩ 2% ¼W	24773-280
R10	Met film 1.8kΩ 2% ¼W	24773-279
R11	Met film 100Ω 2% ¼W	24773-249
R12	Met film 4.7kΩ 2% ¼W	24773-289
R13	Met film 4.7kΩ 2% ¼W	24773-289
R14	Met film 4.7kΩ 2% ¼W	24773-289
R15	Met film 220kΩ 2% ¼W	24773-329
R16	Met film 470Ω 2% ¼W	24773-265
R17	Met film 1.2kΩ 2% ¼W	24773-275
R18	WW 2.2Ω 10% 1½W	25133-006
R19	Met film 470Ω 2% ¼W	24773-265
R20	Met film 12kΩ 2% ¼W	24773-299
R21	Met film 15kΩ 2% ¼W	24773-301
R22	Met film 1.2kΩ 2% ¼W	24773-075
R23	Met film 470Ω 2% ¼W	24773-265
R24	Met film 270Ω 2% ¼W	24773-059
R25	Met film 390Ω 2% ¼W	24773-063
R26	Met film 390Ω 2% ¼W	24773-063
R27	Met film 470Ω 2% ¼W	24773-265
R28	Met film 10kΩ 2% ¼W	24773-297
R29	Met film 10kΩ 2% ¼W	24773-297
R30	Met film 10kΩ 2% ¼W	24773-297
R31	Met film 220Ω 2% ¼W	24773-257
R32	Met film 47kΩ 2% ¼W	24773-313
R33	Met film 10kΩ 2% ¼W	24773-297
R34	Met film 4.7kΩ 2% ¼W	24773-289
R35	Met film 4.3kΩ 2% ¼W	24773-288
RV1	WW 500Ω 10% 1W lin.	25811-535
RV2	WW 1kΩ 10% 1W lin.	25811-538
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3	BCY70	28434-857
VT4	BCY70	28434-857

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
VT5	BCY70	28434-857
VT6	NKT403	28423-924
VT7	BCY70	28434-857
VT8	BCY70	28434-857
VT9	BCY70	28434-857
VT10	BCY70	28434-857
VT11	BCY70	28434-857
VT12	NKT403	28423-924

Unit (5) TV sync separator

When ordering, prefix circuit reference with 5

	Complete board	44823-256
C1	Cer 0.1μF +50-25% 30V	26383-031
C2	Paper 0.003μF 10% 350V	26174-133
C3	Plas 0.033μF 10% 250V	26582-205
C4	Elec 22μF +100-20% 25V	26415-805
C5	Cer ø 0.001μF +80-20% 500V	26373-714
MR1	Z5B5.6	28371-434
MR2	Z5B4.7	28371-373
R1	Met film 75Ω 2% ¼W	24773-246
R2	Met film 270kΩ 2% ¼W	24773-331
R3	Met film 47kΩ 2% ¼W	24773-313
R4	Met film 3.9kΩ 2% ¼W	24773-287
R5	Met film 12kΩ 2% ¼W	24773-299
R6	Met film 2.2kΩ 2% ¼W	24773-281
R7	Met film 20kΩ 2% ¼W	24773-304
R8	Met film 1.5kΩ 2% ¼W	24773-277
R9	Met film 4.7kΩ 2% ¼W	24773-289
R10	Met film 2.7kΩ 2% ¼W	24773-283
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3	BC107	28455-437

Unit (6) Marker adder

When ordering, prefix circuit reference with 6

	Complete board	44823-112
MR1	1N4148	28336-676
R1	Met ox 1MΩ 2% ½W	24573-145
R2	Met film 56kΩ 2% ¼W	24773-315
R3	Met film 6.8kΩ 2% ¼W	24773-293
R4	Met film 11kΩ 2% ¼W	24773-298
R5	Met film 12kΩ 2% ¼W	24773-299
R6	Met film 22kΩ 2% ¼W	24773-305
R7	Met film 9.1kΩ 2% ¼W	24773-296
R8	Met film 10kΩ 2% ¼W	24773-297
R9	Met film 18kΩ 2% ¼W	24773-303
R10	Met film 4.7kΩ 2% ¼W	24773-289
RV1	Carb 220Ω 20% ¼W lin.	25611-068
RV2	WW 3.3kΩ 10% 1W lin.	25811-022
VT1	BC107	28455-437
VT2	MPF104 (selected for V_{GS})	28459-009
VT3	BC109	28452-777
VT4	BCY70	28434-857

Unit (7) X-drive amplifier

When ordering, prefix circuit reference with 7

	Complete board	44823-251
MR1	Z5B16	28372-473
MR2	1N4148	28336-676
MR3	1N4148	28336-676
MR4	Z5B4.3	28371-313
R1	Carb 9kΩ 1% ¼W	24134-900
R2	Met ox 1.5kΩ 2% ¼W	24773-277

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R3	Carb 22kΩ 5% 2W*	24316-718
R4	Met ox 75Ω 2% ¼W	24773-246
R5	Met ox 47Ω 2% ¼W	24773-241
R6	Carb 22kΩ 5% 2W*	24316-718
R7	Met ox 33kΩ 2% ¼W	24773-309
R8	Met ox 33kΩ 2% ¼W	24773-309
R9	Met ox 4.3kΩ 2% ¼W	24773-288
RV1	WW 470Ω 10% 1W lin.	25811-017
RV2	WW 1kΩ 10% 1W lin.	25811-019
RV3	WW 25kΩ 10% 1W lin.	25815-376
SA	SPDT toggle	23462-252
VT1	BC107	28455-437
VT2	BC107	28455-437

Unit (8) Sync trigger and binary

When ordering, prefix circuit reference with 8

	Complete board	44823-262
C1	Elec 47μF +100-20% 25V	26423-231
C2	Plas 0.01μF 10% 630V	26555-463
C3	Plas 0.33μF 10% 250V	26512-256
C4	Elec 100μF +100-20% 25V	26423-243
C5	Paper 0.0055μF 2% 125V	26516-666
C6	Plas 0.047μF 5% 160V	26511-337
C7	Elec 1000μF +100-20% 25V	26415-826
C8	Elec 2μF +100-20% 25V	26414-109
C9	Paper 0.0055μF 2% 125V	26516-666
C10	Plas 0.033μF 10% 400V	26555-469
C11	Plas 470pF 2% 125V	26516-406
C12	Plas 470pF 2% 125V	26516-406
C13	Paper 0.001μF 10% 500V	26174-125
C14	Elec 100μF +100-20% 25V	26423-243
C15	Elec 6.8μF 20% 6V	26487-274
MR1	1N4148	28336-676
MR2	1N4148	28336-676
MR3	1N4148	28336-676
MR4	1N4148	28336-676
MR5	Z5B2	28372-143
MR6	1N4148	28336-676
MR7	1N4148	28336-676
MR8	1N4148	28336-676
MR9	Not used	
MR10	CG5H	28321-201
MR11	1N4148	28336-676
MR12	1N4148	28336-676
MR13	Z5B4.8	28371-203
R1	Met film 1kΩ 2% ¼W	24773-273
R2	Met film 12kΩ 2% ¼W	24773-299
R3	Met film 10kΩ 2% ¼W	24773-297
R4	Met film 10kΩ 2% ¼W	24773-297
R5	Met film 2.7kΩ 2% ¼W	24773-283
R6	Met film 4.7kΩ 2% ¼W	24773-289
R7	Met film 1.5kΩ 2% ¼W	24773-277
R8	Met film 22kΩ 2% ¼W	24773-305
R9	Met film 39kΩ 2% ¼W	24773-311
R10	Met film 2.2kΩ 2% ¼W	24773-281
R11	Met film 1kΩ 2% ¼W	24773-273
R12	Met film 10kΩ 2% ¼W	24773-297
R13	Met film 10kΩ 2% ¼W	24773-297
R14	Met film 270kΩ 2% ¼W	24773-331
R15	Met film 3.9kΩ 2% ¼W	24773-287
R16	Met film 33kΩ 2% ¼W	24773-309
R17	Met film 7.5kΩ 2% ¼W	24773-294
R18	Met film 10kΩ 2% ¼W	24773-297
R19	Met film 2kΩ 2% ¼W	24773-280
R20	Met film 6.8Ω 2% ¼W	24773-265
R21	Met film 15kΩ 2% ¼W	24773-301
R22	Met film 8.2kΩ 2% ¼W	24773-295

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R23	Met film 1kΩ 2% ¼W	24773-273
R24	Met film 5.6kΩ 2% ¼W	24773-291
R25	Met film 47kΩ 2% ¼W	24773-313
R26	Met film 15kΩ 2% ¼W	24773-301
R27	Met film 10kΩ 2% ¼W	24773-297
R28	Met film 36kΩ 2% ¼W	24773-310
R29	Met film 220Ω 2% ¼W	24773-257
R30	Met film 68kΩ 2% ¼W	24773-317
R31	Met film 22kΩ 2% ¼W	24773-305
R32	Met film 5.6kΩ 2% ¼W	24773-291
R33	Met film 68kΩ 2% ¼W	24773-317
R34	Met film 12kΩ 2% ¼W	24773-299
R35	Met film 24kΩ 2% ¼W	24773-306
R36	Met film 39kΩ 2% ¼W	24773-311
R37	Met film 39kΩ 2% ¼W	24773-311
R38	Met film 27kΩ 2% ¼W	24773-307
R39	Met film 100kΩ 2% ¼W	24773-321
R40	Met film 10kΩ 2% ¼W	24773-297
R41	Met film 100kΩ 2% ¼W	24773-321
R42	Met film 2kΩ 2% ¼W	24773-280
R43	Met film 12kΩ 2% ¼W	24773-299
R44	Met film 27Ω 2% ¼W	24773-235
R45	Met film 5.6kΩ 2% ¼W	24773-291
RV1	WW 10kΩ 5% 1W lin.	25815-051
RV2	WW 4.7kΩ 10% 1W lin.	25811-023
RV3	Carb 5kΩ 10% 0.21W lin.	25541-375
VT1	BC107	28455-437
VT2	BC107	28455-437
VT3	BC107	28455-437
VT4	BC107	28455-437
VT5	BCY70	28434-858
VT6	BCY70	28434-858
VT7	BC107	28455-437
VT8	BCY70	28434-858
VT9	BC107	28455-437
VT10	BC107	28455-437
VT11	BC107	28455-437
VT12	BC107	28455-437
VT13	BC107	28455-437
VT14	BC107	28455-437
VT15	BC107	28455-437
VT16*	TCH98	28434-813
VT17	BC107	28455-437

Unit (9) External drive and blanking

When ordering, prefix circuit reference with 9

	Complete board	44823-261
C1	Plas 0.0022μF 2% 125V	26516-564
L1	100μH 10%	23642-561
MR1	1S923	28356-018
MR2	1S923	28356-018
MR3	1N4148	28336-676
MR4	1N4148	28336-676
R1	Met film 270kΩ 2% ¼W	24773-331
R2	Met film 12kΩ 2% ¼W	24773-299
R3	Met film 10kΩ 2% ¼W	24773-297
R4	Met film 10kΩ 2% ¼W	24773-297
R5	Met film 1.3kΩ 2% ½W	24773-076
R6	Met film 56Ω 2% ¼W	24773-243
R7	Met ox 1kΩ 2% ½W	24573-073
R8	Carb 3.9kΩ 1% ¼W	24134-390
R9	Carb 5.6kΩ 1% ¼W	24134-396
R10	Carb 6.8kΩ 1% ¼W	24134-680
R11	Met film 430Ω 2% ¼W	24773-264

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R12	Carb 2.2kΩ 1% ¼W	24134-220
R13	Met film 430Ω 2% ¼W	24773-264
R14	Met film 6.8kΩ 2% ¼W	24773-293
R15	Met film 200Ω 2% ¼W	24773-256
R16	Met film 6.8kΩ 2% ¼W	24773-317
R17	Met film 33kΩ 2% ¼W	24773-309
R18	Carb 11kΩ 1% ¼W	24135-110
R19	Carb 2kΩ 1% ¼W	24134-200
R20	Carb 22kΩ 1% ¼W	24135-220
R21	Carb 9kΩ 1% ¼W	24134-900
R22	Met ox 2kΩ 5% ½W	24573-080
RV1	WW 3.3kΩ 10% 1W lin.	25811-022
RV2	WW 4.7kΩ 10% 1W lin.	25811-023
RV3	WW 3.3kΩ 10% 1W lin.	25811-022
RV4	WW 500Ω 10% 1W lin.	25815-106
VT1	BC107	28455-437
VT2	BSX36	28434-867
VT3	BC107	28455-437
VT4	BC107	28455-437
VT5	BC107	28455-437
VT6	BC107	28455-437
VT7	BCY70	28434-857

Unit (10) Control oscillator and differential amplifier

When ordering, prefix circuit reference with 10

	Complete board	44823-250
C1	Elec 47μF +100-20% 63V	26423-233
C2	Elec 47μF +100-20% 63V	26423-233
C3	Elec 47μF +100-20% 63V	26423-233
C4	Elec 47μF +100-20% 63V	26423-233
C5	Elec 4.7μF +50-20% 63V	26423-211
C6	Elec 4.7μF +50-20% 63V	26423-211
C7	Elec 4.7μF +50-20% 63V	26423-211
C8	Elec 4.7μF +50-20% 63V	26423-211
C9	Elec 2μF +50-20% 150V	26417-107
C10	Plas 0.33μF 5% 60V	26551-221
C11	Plas 0.68μF 5% 60V	26551-229
C12	Plas 3.3μF 5% 60V	26551-242
C13*	Elec 68μF 10% 15V	44435-024
C14*	Elec 68μF 10% 15V	44435-024
C15*	Elec 330μF 10% 6V	44435-023
C16*	Elec 330μF 10% 6V	44435-023
C17*	Elec 330μF 10% 6V	44435-023
C18*	Elec 330μF 10% 6V	44435-023
MR1	Z5H5.1	28371-404
MR2	1S923	28356-018
MR3	Z1B6.8	28371-547
MR4	Z5B8.2	28371-673
MR5	Z5B10	28371-843
MR6	1N4148	28336-676
MR7	1N4148	28336-676
MR8	1N4148	28336-676
MR9	1N4148	28336-676
MR10	Not used	
MR11	Not used	
MR12	Z5B10	28371-843
MR13	1N4148	28336-676
MR14	1N4004	28357-028
MR15	1S923	28356-018
MR16	1S923	28356-018
MR17	1S923	28356-018
MR18	1S923	28356-018
MR19	1S923	28356-018
R1	Met film 24kΩ 2% ¼W	24773-306
R2	Met film 2.7kΩ 2% ¼W	24773-283

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R3	Met film 4.3kΩ 2% ¼W	24773-288
R4	Met film 3.3kΩ 2% ¼W	24773-285
R5	Met film 22kΩ 2% ¼W	24773-305
R6	Met film 1.5kΩ 2% ¼W	24773-277
R7	Met film 10Ω 2% ¼W	24773-225
R8	Met film 1.5kΩ 2% ¼W	24773-277
R9	Met film 47kΩ 2% ¼W	24773-313
R10	Carb 5.6kΩ 1% ¼W	24134-560
R11	Carb 10kΩ 1% ¼W	24135-100
R12	Met film 560Ω 2% ¼W	24773-267
R13	Met film 270kΩ 2% ¼W	24773-331
R14	Carb 5.6kΩ 1% ¼W	24134-560
R15	Carb 1kΩ 1% ¼W	24134-100
R16	Met film 560Ω 2% ¼W	24773-267
R17	Met film 270kΩ 2% ¼W	24773-331
R18	Met film 47kΩ 2% ¼W	24773-313
R19	Met film 24kΩ 2% ¼W	24773-306
R20	Met film 4.7kΩ 2% ¼W	24773-289
R21	Met film 680Ω 2% ¼W	24773-269
R22	Met film 1MΩ 2% ¼W	24773-145
R23	Met film 1.5kΩ 2% ¼W	24773-277
R24	Carb 1.8kΩ 1% ¼W	24134-180
R25	Carb 6.2kΩ 1% ¼W	24134-620
R26	Met film 33kΩ 2% ¼W	24773-309
R27	Met film 56kΩ 2% ¼W	24773-315
R28	Carb 1kΩ 1% ¼W	24134-100
R29	Met film 1kΩ 2% ¼W	24773-273
R30	Met film 1kΩ 2% ¼W	24773-273
R31	Met film 5.1kΩ 2% ¼W	24773-290
R32	Met film 1.5kΩ 2% ¼W	24773-277
R33	Met film 43kΩ 2% ¼W	24773-312
R34	Met film 56kΩ 2% ¼W	24773-315
RV1	WW 3.3kΩ 10% 1W lin.	25811-022
RV2	WW 4.7kΩ 10% 1W lin.	25811-023
RV3	Carb 100Ω 10% 0.4W lin.	25541-366
SA	Ratio 1:1 - 10:1	23462-258
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3*	TCH98	28434-813
VT4	BCY70	28434-857
VT5*	TCH98	28434-813
VT6	BCY70	28434-857
VT7	BC107	28455-437
VT8	BCY70	28434-857
VT9	BCY70	28434-857
VT10	BCY70	28434-857
VT11	BC107	28455-437
VT12	BC107	28455-437
VT13	BC107	28455-437

Unit (11) Rectifiers

When ordering, prefix circuit reference with 11

	Complete board	44823-249
C1	Elec 1000μF +100-20% 25V	26415-826
C2	Elec 2500μF +50-20% 50V	26427-134
C3	Elec 2500μF +50-20% 50V	26427-134
C4	Elec 500μF +50-20% 250V	26427-110
MR1 to MR4	1S923	28356-018
MR5 to MR16	1N4004	28357-028
R1	Met film 100kΩ 2% ¼W	24773-321

For symbols and abbreviations see introduction to this chapter

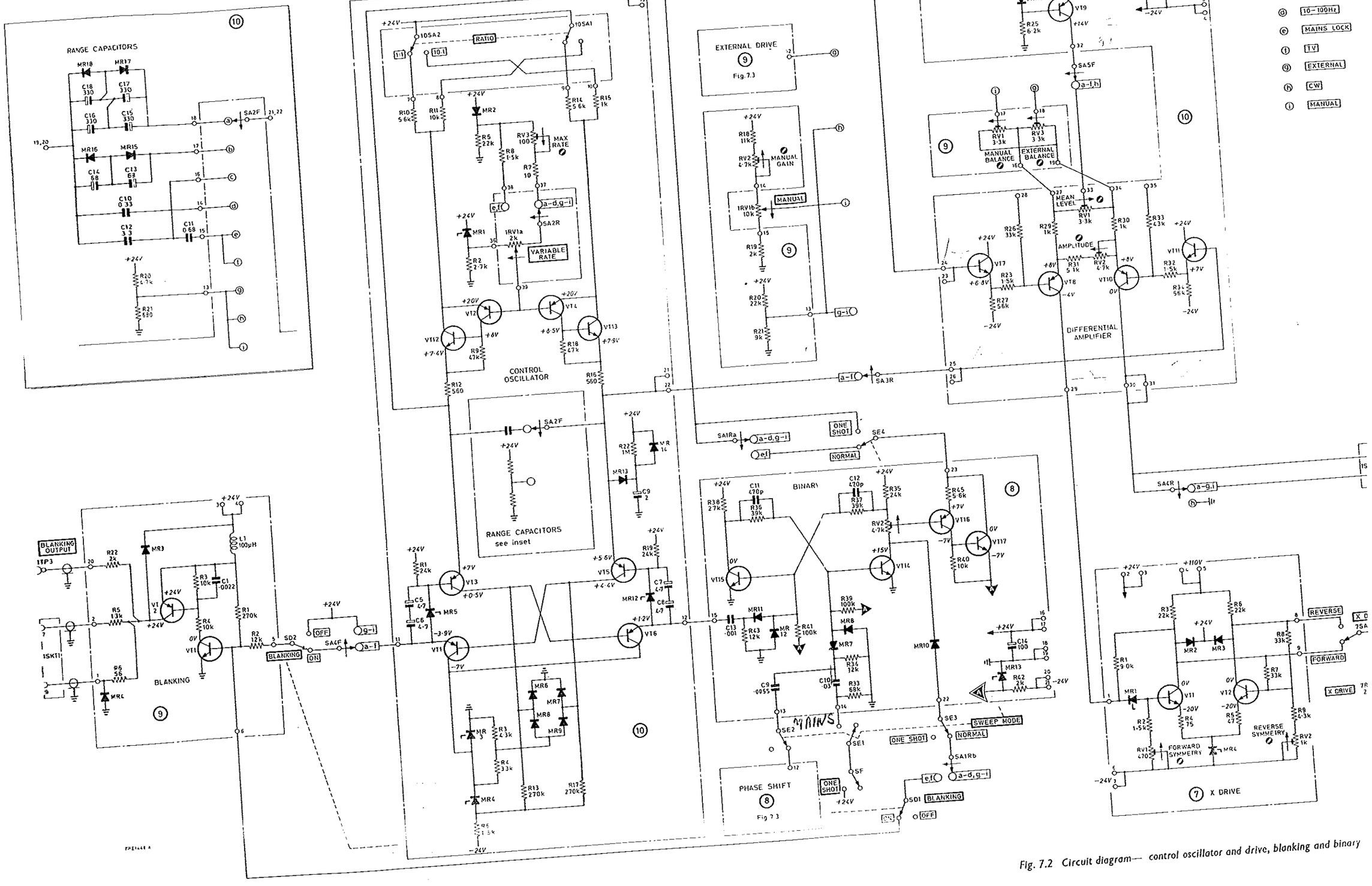

Fig. 7.2 Circuit diagram— control oscillator and drive, blanking and binary

is viewed from knob end with switch in fully position

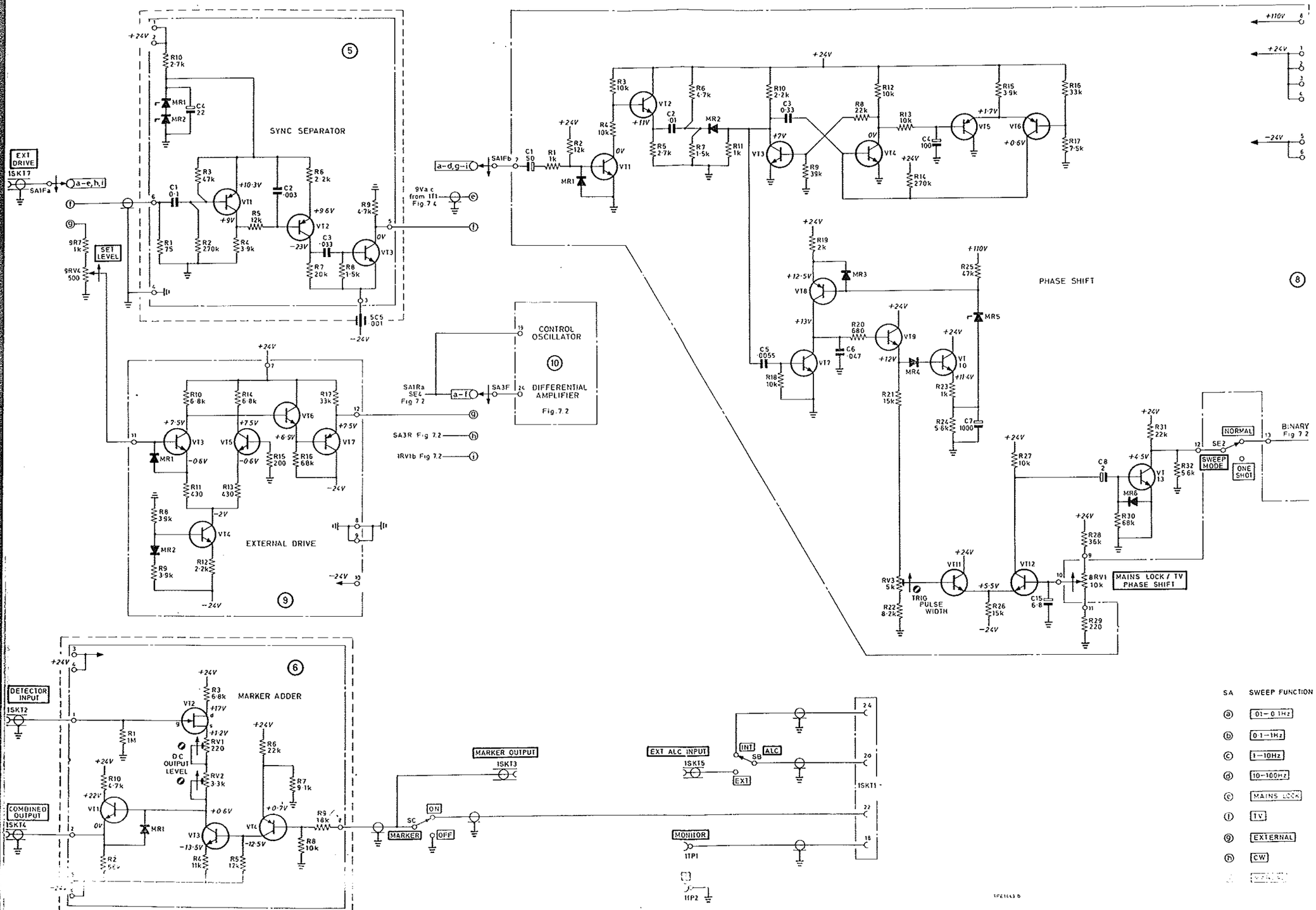

Fig. 7.3 Circuit diagram— sync separator and phase shift, external drive and marker adder

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors: No suffix = microfarads, p = picofarads.
* value selected during test, nominal value shown.

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers. See section 5.8.2 for conditions.

3. SYMBOLS

+► arrow indicates clockwise rotation of knob.

RANGE etc., external front or rear panel marking.

preset control.

(26) unit identification number.

a-d letters associated with switch contacts refer to the switch key sketch and indicate the knob settings at which the connection is made.

point marked with this symbol is connected to and receives power from point marked with this symbol

These symbols are used to identify branches of the power supply circuitry but have no particular physical reality on the printed boards.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form.
See also introduction to chapter 6.

5. SWITCHES

Rotary switches are drawn schematically.
Letters indicate control knob settings.
1F = 1st section (front panel), front
1B = 1st section, back
2F = 2nd section, front
etc.

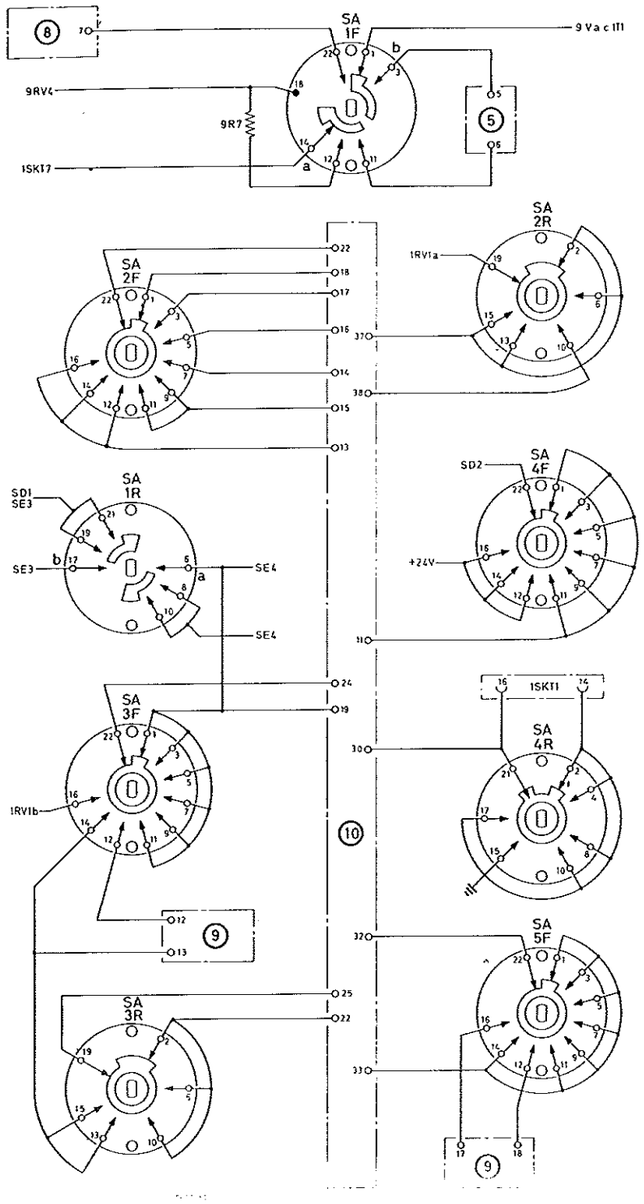

Fig. 7.1 SA plan of sections viewed from knob end with switch in fully counter-clockwise position