TELEQUIPMENT

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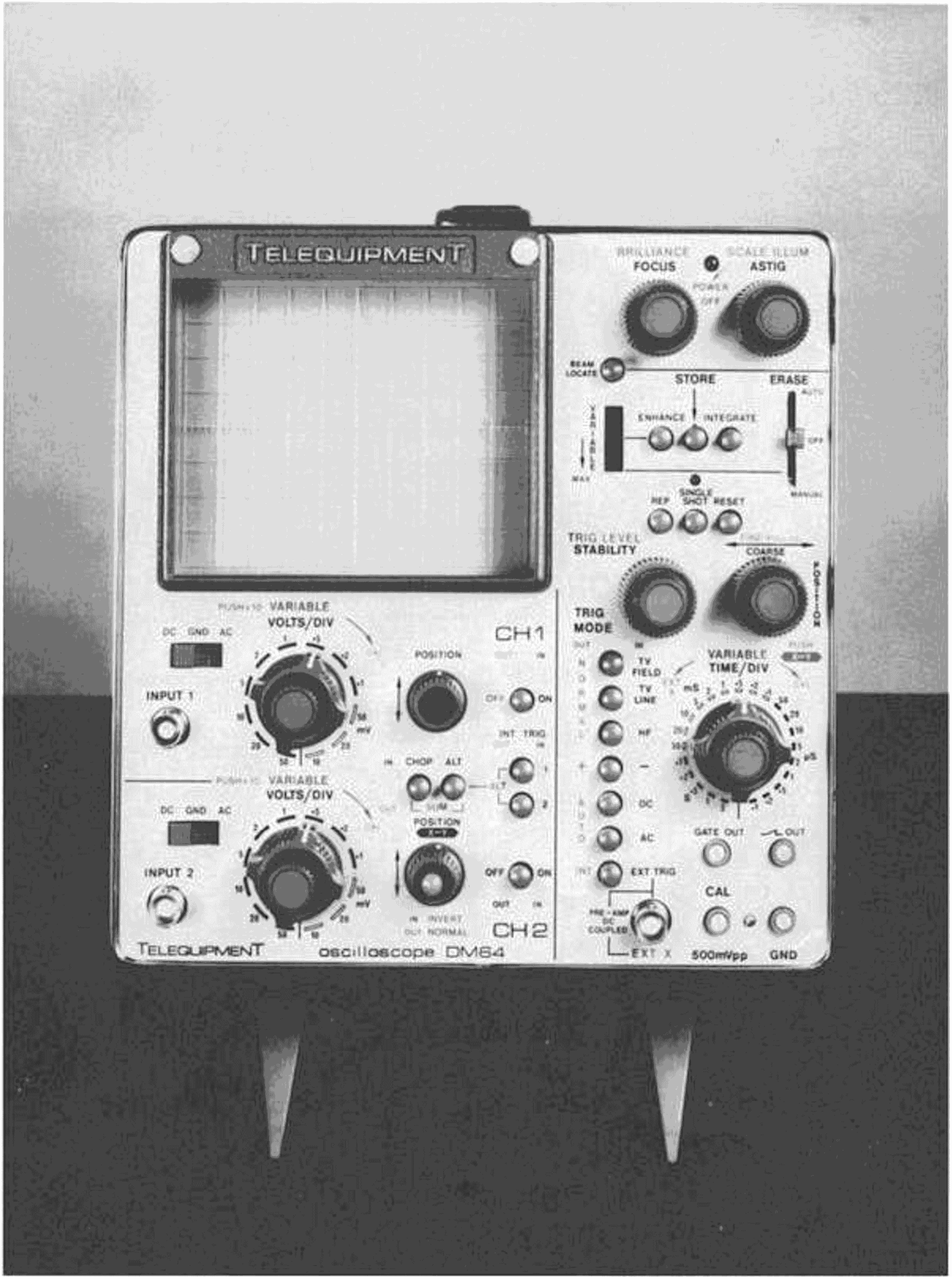

TELEQUIPMENT
BRILLIANCE
FOCUS
SCALE ILLUM
ASTIG
POWER
OFF
BEAM LOCATE
STORE
ERASE
ENHANCE
INTEGRATE
AUTO
OFF
MANUAL
VARIABLE
MAX
REP
SINGLE SHOT
RESET
TRIG LEVEL
STABILITY
COARSE
TRIG MODE
VARIABLE
TIME/DIV
TV FIELD
TV LINE
HF
DC
AC
EXT TRIG
GATE OUT
OUT
CAL
500mVpp
GND
EXT X
VARIABLE
VOLTS/DIV
DC GND AC
INPUT 1
POSITION
CH1
OFF ON
INT TRIG
CHOP ALT
VARIABLE
VOLTS/DIV
DC GND AC
INPUT 2
POSITION
OFF ON
IN INVERT
OUT NORMAL
CH2
TELEQUIPMENT
oscilloscope DM64

CHAPTER I
SPECIFICATION

1.1 VERTICAL SYSTEM

Operating modes	Channel 1 Channel 2 (normal or inverted) Channels 1 & 2 Alternate Chopped (at 150 kHz approx.) Summed X – Y

3 dB bandwidth	x1	x10
D.C. Coupled	D.C. – 10 MHz	D.C. – 8 MHz
A.C. Coupled	2 Hz – 10 MHz	2 Hz – 8 MHz
Risetime	35 ns nominal	44 ns nominal

X – Y	CH1 is vertical input, CH2 selected via timebase switch as horizontal input
Bandwidth (– 3 dB)	D.C. – 1 MHz
Phase error	Less than 1^{o} at 10 kHz
Deflection factors	
Calibrated (12 ranges 1-2-5 sequence)	10 mV – 50 V/div ± 5%
Gain X10	1 mV/div – 5 V/div
Uncalibrated – with variable	Complete cover between sequence and to 125 V/div
Input impedance	1 MΩ and 47 pF approx.
Maximum input – D.C., peak A.C. or sum of	400 V
Maximum H.F. deflection at 10 MHz	4 div

1.2 HORIZONTAL SYSTEM

Sweep generator	
Sweep rates	
Calibrated (23 ranges 1-2-5 sequences)	2 s – 100 ns/div ± 5% (without expansion) 400 ms – 100ns/div ± 8% (with X5 expansion)
Uncalibrated (with variable)	Complete cover between sequence and to 5 s/div
Repetitive Single Shot	Selected by switch
External horizontal amplifier	
3 dB bandwidth	D.C. – 1 MHz
Risetime	350 ns
Deflection factors	200 mV/div or 1 V/div approx.
Input impedance	100 kΩ and 30 pF approx.
Maximum input – D.C., peak A.C. or sum of	400 V

1.3 TRIGGER

Coupling	A.C. or D.C.
Source	CH1, CH2, alternate or external
Internal	
Amplitude – Automatic	0.25 div 40Hz to 1 MHz } Alternate
Trigger level	0.25 div D.C. to 1 MHz } 1.0 div
	rising to 0.5 div at 5 MHz
HF	1 div from 1 MHz to > 10 MHz
External	
Amplitude	250 mV peak to peak
Impedance	100 kΩ parallel with 30 pF

1.4 CATHODE RAY TUBE (CRT)

Display area	8 x 10 cm
Phosphor Standard	P31
Overall accelerating potential	3.5 kV approx.
External intensity modulation	
Coupling	A.C. to Cathode
Amplitude, peak	50 V maximum
	20 V for perceptible modulation at average brilliance
Time constant	10 nF and 10 kΩ
Store Mode	1 hour
Erasure	Manual or automatic at end of sweep
Erase time	0.25 s. approx.
Writing rate	
Enhance off	25 div/ms
on	250 div/ms
Variable enhancement	25 – 250 div/ms

1.5 FRONT PANEL OUTPUTS

Calibrator, peak to peak	500 mV square wave at supply frequency
Accuracy	2%
Sweep sawtooth	
Coupling	D.C.
Amplitude peak to peak	10 V approx.
Minimum load	47 kΩ
Gate out	
Coupling	D.C.
Amplitude, peak to peak	500 mV approx.

1.6 POWER REQUIREMENTS

Voltage	100 – 125 V in 5 V steps 200 – 250 V in 10 V steps
Frequency	48 – 400 Hz
Consumption	100 VA approx.

1.7 SIZE

Height	24 cm
Width	21 cm
Depth	37 cm

1.8 WEIGHT

12.97 kg

1.9 COOLING

Convection

1.10 TEMPERATURE LIMITS, ambient

Operating	– 5 to +40°C approx.
Non-operating	–25 to +70°C approx.

CHAPTER 3
CIRCUIT DESCRIPTIONS

3.1 BLOCK DIAGRAM

3.1.1 This chapter will assist the reader to comprehend the circuitry of the DM64. By referring to the Block Diagram reference Figure 1 the reader will see the interfaces of the various circuits and signal paths, which will be dealt with in detail later.

3.1.2 The signal is fed via the Attenuator to the Vertical Amplifier. Its description covers the function of the 'Y' input pre-amplifiers and Output amplifier, Channel switching multivibrator and trigger pre-amplifier. The output is fed to the 'Y' plates of the CRT with a portion of it being fed to the trigger network.

3.1.3 The Trigger circuit provides pulses of suitable amplitude and polarity to trigger the timebase from internally or externally derived waveforms.

3.1.4 The Timebase description deals with the ALT pulse and Sweep generators, Gating and Hold-off bistables. This stage determines the start and finish of each sweep and generates a sawtooth waveform for the horizontal amplifier.

3.1.5 The Horizontal amplifier description covers the 'X' output, which amplifies the sawtooth waveform or an external 'X' signal and applies it in push-pull to the 'X' plates of the CRT.

3.1.6 The Unblanking amplifier description covers the Chop and Sweep retrace blanking amplifiers. The output being fed to the CRT g_2 electrode.

3.1.7 The Calibrator and E.H.T. are included with the description on the Power supplies, the function of the former is to provide a calibrated peak to peak squarewave at power-line frequency for the purpose of checking the vertical amplifier and timebase calibration.

3.1.8 The CRT description covers the store and non store switching, manual and auto erase generators, enhance generator and collimation correction for the storage section of the CRT Also included is a brief description of the manner in which the CRT actually stores information.

3.2 ATTENUATORS

The signals to be observed are connected to the instrument via BNC sockets and switch S901, reference Figure 2. Two identical attenuators each comprising four frequency-compensated resistive dividers with ratios of 100:1, 10:1, 5:1 and 2:1. These are switched singly or in tandem; C902, C905, C908 and C912 serve to standardize the input time constants; C904, C907, C911 and C914 compensate the respective dividers.

3.3 VERTICAL AMPLIFIER ('Y'-AMPLIFIER)

The circuits of channel 1 (CH1) and channel 2 (CH2) are identical with zener diodes D604, D611 providing stabilized positive and negative voltages and diodes D607, D608 the shift voltages CH1 is described below reference Figure 3. Where references are made to CH2, CH2 will be quoted.

3.3.1 The output from the attenuator is fed to the gate of TR601 via a protection circuit C601, C602, R601, R602a, R602b, and R603 which prevents excessive voltage damaging the input FET.

3.3.2 TR601 and TR602 form a paraphase amplifier with their sources long-tailed through TR628. R624 provides variable gain control. Compensation is provided by R625 for trace movement caused by varying R624. R622 compensates for supply voltage variation in conjunction with R626, R630, R632 and D604. Neutralization is effected by C604.

3.3.3 The output from the FET input stage is taken via emitter followers TR603 and TR604 to a gain stage TR605 and TR606. In the emitter circuit R617 sets the X1 channel gain and R618 the X10. The collector outputs are connected to the switching stage, TR609 and TR611, via emitter followers, TR607 and TR608, which provide in push-pull the channel trigger signal. The Miller capacities of the above gain stage are neutralized by C603 and C609.
In CH2 the emitter followers TR624 and TR625 provide the horizontal signal in the X-Y mode.

3.3.4 TR609 and TR611 form a long-tailed pair with C606 and R614 providing H.F. compensation. Their output feeds a shunt feedback amplifier TR612 and TR613. The feedback resistors are split into pairs, R644, R650 and R658 R661; with H.F. compensation being provided by C621, R656, C619, R655, connected between the junctions of the above pairs of resistors.

3.3.5 The output from TR612, TR613 is fed to the emitter input of the output stage, TR752 and TR753, which drives the 'Y' plates of the CRT Fig.8.
A portion of the output is taken via a balanced divider, R771, R773 and R772, R774 to switch, S751, which switches either the above portion of the signal or the channel signal from the emitter followers, TR607 and TR608, to a long-tailed pair TR755, TR757, which drive the Trigger circuit.

3.3.6 The CH2 output from TR624, TR625 also drives a separate long-tailed pair, TR754, TR756 which acts as a horizontal pre-amplifier in the X-Y mode. The X-Y gains are equalized with R787. The outputs from TR754, TR756 collectors drive the diode switching matrix in the horizontal output amplifier.

3.3.7 Channel switching is carried out by TR614 and TR615, which act as a bistable in the ALT mode and a free-running multivibrator in the CHOP mode the current being provided via a long-tail TR616.

3.3.8 In the ALT mode a negative-going pulse coinciding with the start of the sweep flyback is fed, via D606 or D609, to the above bistable causing it to switch. When TR614 is conducting, it passes current from the switching stage, TR609 and TR611, allowing the CH1 signal to pass to the shunt feedback amplifier, TR612 and TR613. At the same time TR615 is off, its collector rises to 16 V approximately taking the emitters of CH2 switching stage, TR626 and TR627 with it and so cutting off the current. Diodes D610 and D612 prevent the base-emitter junctions from breaking down in the reverse condition.

3.3.9 In the CHOP mode, R664 and R648 are returned to H.T. via R639 and R649, forming an astable multivibrator. The frequency is mainly determined by R664, R648, C613, C622, R647, R663, R639 and R649.

3.3.10 In the SUM mode, the current supplied via TR616 is switched off, so both TR614 and TR615 are non-conducting. Both switching stages, TR609, TR611 and TR626, TR627 are required to be on, so extra current is bled from the 115 V line via R637 and R638. Current flows through the switching stages, via R646 and R662 through R673 to earth. Hence these signals are added at the bases of TR612 and TR613. CH2 signal can be inverted by switch, S604, to provide addition or subtraction of the two signals. Also in the SUM mode, CH1 POSITION becomes a coarse shift control, CH2 POSITION being the very fine shift control.

3.3.11 The table below shows the state of the switched components for all switch combinations; followed by a resume on the part of circuit activated.

Condition A denotes R637, R638 connected to + 110 V.
Condition B denotes TR616 conducting.
Condition C denotes R673 connected to junction R646/R662.

		ALTernate			CHOP			SUM			X–Y		
CH1	CH2	A	B	C	A	B	C	A	B	C	A	B	C
ON	OFF	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO
OFF	ON	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO
ON	ON	NO	YES	NO	NO	YES	NO	YES	NO	YES	NO	NO	NO
OFF	OFF	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO

1. CH1 On, CH2 Off.

TR614, TR609 and TR611 are conducting, this feeds the output of TR609 and TR611 to the bases of TR612 and TR613; TR626 and TR627 being reversed biased by the potential at TR615 collector.

2. CH1 Off, CH2 On.

TR615, TR626 and TR627 are conducting, so only the output of TR626 and TR627 may pass to the bases of TR612 and TR613; TR609 and TR611 being reversed biased by the potential at TR614 collector.

3. CH1 On, CH2 On. ALTERNATE.

TR614 and TR615 are connected to form a bistable circuit. At the end of each sweep, a negative-going pulse appears at the junction D606/D609 which reverses the state of the bistable. Hence TR614 and TR615 conduct alternately and allow the outputs of CH1 and CH2 alternately to reach the bases of TR612 and TR613.

4. CH1, CH2 CHOPPED

R648 and R664 are returned to H.T. via R639 and R649 to form an astable multivibrator, which free runs at 150 kHz approx. Thus the outputs of CH1 and CH2 are successively switched into TR612 and TR613 at 150 kHz. At each transition a pulse is fed from the emitters of TR614 and TR615 via C642 to the unblanking amplifier Fig.6, which blanks the CRT beam and thus provides automatic transient blanking in the chopped mode.

5. CH1, CH2 SUM.

The tail of the multivibrator and R633 are disconnected; TR614 and TR615 are non-conducting; R673 is connected to ground providing a current path for both channels simultaneously; TR609, TR611, TR626 and TR627 are conducting; extra current being fed to their collectors, via R637 and R638 from the + 110 V line, to maintain correct conditions. CH1 and CH2 may be used as a summing or differential (with INVERT pressed) amplifier. In this mode, the CH1 POSITION control provides a coarse shift, and CH2 POSITION control provides a very fine shift control (reference 3.3.10).

6. CH1 Off, CH2 Off.

TR614 and TR615 are non conducting, preventing outputs from either CH1 or CH2 from reaching TR612 and TR613.

7. X-Y

When the X-Y switch is selected, the circuit is connected for X-Y operation as follows, regardless of any vertical amplifier mode switching. R641 is returned to ground, ensuring CH1 signal is connected to TR612 and TR613; TR626 and TR627 are biased off, TR616 is non-conducting and the junction R646/R662 is returned to H.T.

3.4 SWEEP TRIGGER

The bases of trigger input amplifiers TR2 and TR3, reference Figure 5, are fed with internal or external trigger signals via switch, S4, which selects the source from either the collectors of TR753 and TR754 in the vertical amplifier or TR1 the external trigger amplifier. S2 selects the polarity of the signal on which the triggering occurs.

3.4.1 When switched in by S3a or S3b, R15, the LEVEL control varies the base potentials of TR2 and TR3 in antiphase. This alters the quiescent voltage on the base of TR4 and D.C. level of signal required to trip TR4 and TR5.

3.4.2 When S3a and S3b are open in the AUTO position, feedback is applied from TR4 collector via R27 and R9 to TR2 base and from TR5 collector via R26 and R23 to TR3 base. This feedback causes TR2, TR3, TR4 and TR5 to oscillate, in the absence of a trigger input, at a low frequency primarily determined by C11, R26 and R27. Input signals are A.C. coupled only and override the above oscillation, causing the circuit to lock to the input frequency. The trigger sensitivity is set by R34, this adjusts the hysteresis of TR4 and TR5. R17 is set to provide symmetrical operation of TR2 and TR3.

3.4.3 When S1a and b are in the NORMAL position, TR4 and TR5 form a Schmitt trigger. The constant amplitude rectangular-wave output at the collector of TR5 is

differentiated by C15 and R38. The resulting bidirectional pulses are applied to the series clipper D1, which provides the collector of TR68 in the sweep circuit with negative-going trigger pulses.
In the TV positions of S1a and b, R25 is disconnected from the emitter of TR4; TR4 converts into a sync separator with C12 being switched across R31. TR5 changes into an inverter with decoupling capacitor C16 being switched across the emitter resistors R36, R25 and R34. In the TV F position of S1a, the differentiating time-constant of C15 and R38 is increased by the addition of R39.

3.4.4 With S1c set to HF, R32 is added in series with R34 across C14; this converts TR4 and TR5 into a free-running oscillator whose frequency is adjusted, by R15 the LEVEL control, to synchronise with the H.F. trigger input.

3.5 SWEEP GENERATOR (TIMEBASE)

The sweep generator, reference Figure 6, consists of a Miller integrator TR71 and emitter follower TR72; and also bistables, a gating bistable TR66, TR68 and hold-off bistable TR73, TR74, connected between the Miller output and input.

3.5.1 Initially, for an incoming trigger pulse to fire the sweep the following conditions apply:—

Diodes D67, D68 and TR69 are conducting and clamp the drain of TR71 at + 2.5 V approx. The hold-off bistable is held with TR73 off, TR74 on and the gating bistable with TR66 on, TR68 off.

3.5.2 A negative-going trigger pulse causes TR66 to switch off, TR68 on, and D66 to conduct. Hence current flowing through R84 diverts from D67, D68 to D66. This open circuits D67, D68 and releases the gate of TR71. TR71 drain starts to rise, due to Miller action, taking TR72 base and emitter with it and cutting off TR69. This rising sawtooth voltage passes through D71 until eventually TR73 base becomes sufficiently positive to switch the bistable over. Hence TR74 switches off, TR73 on and the negative voltage step at TR73 collector causes TR68 to switch off and TR66 on. TR68 collector goes positive, switching D66 off, D67 and D68 on; starting the flyback.

3.5.3 Current flows through R84, D67 and D68 into the timing capacitor C_t to commence flyback. When TR72 emitter has fallen sufficiently taking TR69 emitter with it then TR69 conducts and clamps C_t at the initial start potential. This potential is determined by the resistor ratios R85, R86, R94 and R95.

3.5.4 During the flyback period, D71 is off due to the charge on the hold off capacitor C_h. This charge leaks away through R104, R105, R106, R107 and R112 until eventually TR73 switches off, TR74 on; the initial conditions (3.5.1 above) are restored.

3.5.5 When the sweep is switched to single-shot mode, TR73 base is prevented from switching at the end of the flyback and clamped by diode D72. The bistable is switched over by pressing RESET, this applies a negative-going pulse to TR73 base and causes the collector current to switch off and TR74 to conduct. The circuit is then ready for the next incoming trigger pulse to fire the sweep.

3.6 HORIZONTAL AMPLIFIER (X-AMPLIFIER)

The horizontal amplifier reference Figure 6, consists of a pre-amplifier TR76, followed by a cascode connected long-tailed pair output stage, TR77, TR78, TR79 and TR81.

3.6.1 The pre-amplifier TR76 is a shunt feedback stage in which the sweep and shift voltages are mixed via R103, R121 on its base. In the EXT X position; TR1 is connected in place of a sweep signal, which converts the high impedance external input into a low impedance suitable for mixing with the shift voltage at TR76 base. The TR76 collector output is fed to the base of TR78 via D76. TR78 and TR79 form the bottom half of a cascode amplifier, their collectors driving the emitters of TR77 and TR81; tail current being supplied via TR82.

3.6.2 Gain control is provided in the X1 condition by R132, in the X5 position by R131. The output from TR77 and TR81 collectors driving the CRT "X" plates.

3.6.3 In the sweep and EXT X positions D76 and D81 are conducting; D77 and D82 are not conducting, the signal being fed to the base of TR78 with D75 and D79 not conducting. D74 and D78 are conducting shorting the collectors of the X-Y pre-amplifier TR751 and TR752.

3.6.4 In the X-Y mode D74 and D78 are not conducting, D75 and D79 are conducting allowing the push pull output from CH2 to be fed to the bases of TR78 and TR79. Also D76 and D81 are not conducting; D77 and D82 are conducting shorting out the signal on TR76 collector.

3.7 UNBLANKING AMPLIFIER

The amplifiers for unblanking comprise TR65, TR67 and for chopped blanking TR62 and TR64, reference Figure 6.

3.7.1 In the absence of a sweep TR66 conducts, causing current to flow through TR65 making the TR65 collector, the TR67 emitter and the CRT Mod Plate electrode negative with respect to the CRT A_1 electrode so blanking the trace.

3.7.2 When the sweep starts TR66 switches off; TR65 current ceases; hence its collector goes to h.t. causing TR67 emitter and CRT Mod Plate to follow. The potentials of A_1 and Mod Plate electrodes are equalized so unblanking the trace.

3.7.3 Chopped blanking pulses are fed from the vertical amplifier via C642 to the cascode circuit TR62 and TR64, which amplifies the pulse. The collector of TR64 falls; allowing D64 to conduct and pass blanking pulses, via TR67 to the CRT Mod Plate electrode to blank the trace.

3.8 CRT CIRCUIT

The CRT is of the direct viewing bistable storage type and contains special storage electrodes additional to a conventional CRT. To make the circuitry comprehensible two figures are included in this manual. Figure 8 shows the conventional mode circuit. Figure 9 the storage.

3.8.1 The storage circuit provides the voltage levels necessary to operate the flood guns, collimation electrodes, target backplate, and erase generators. Additional circuitry includes the enhance generator, which permits faster single sweeps to be stored and the integrate switch which permits a stored image of a number of repetitive sweeps, each of which are too fast to store alone as a single sweep.
Fig. 1 a block diagram includes the storage circuit.

3.8.2 Storage Basic Operating Principles

The storage target backplate (STB) collects the secondary electrons emitted by the insulator surface, when the insulator is bombarded with high energy electrons from the writing gun. This stored positive charge on the insulator is then used to control the flow of flood gun electrons to a phosphor screen, in order to produce a visual image.

3.8.3 The flood guns provide low energy electrons directed in a large cone towards the screen, the collimation electrodes shape the electron beam to provide uniform coverage of the STB.

3.8.4 The operating level of the tube, that is the storage or non-storage mode, is determined by the potential difference between the STB and the flood gun cathodes.

3.8.5 In the storage mode, the following states are required to exist in sequence.

1. Ready to write. The insulator surface of the STB tends to discharge down towards the flood gun cathodes, such that the flood gun landing energy is not sufficient to illuminate the phosphor in the target.

   The target is now ready to write.

2. Writing. The storage target is scanned by high energy electrons from the writing cathode. These electrons cause secondary emission to occur over the scanned area and the bombarded surface charges sufficiently positive to switch over to a higher voltage stable state and remains in this state after the writing gun excitation is removed.

3. Viewing. In this written state, the potential difference between the flood gun cathodes and the STB has increased due to the positive charge on the insulator. The flood gun electrons now penetrate the written area and illuminate the phosphor. This visual display will persist as long as the flood beam is allowed to continue to land on the insulator surface.

   At high sweep rates, the writing beam energy is not sufficient to cause the insulator to switch to the upper voltage stable state, so when flood gun electrons land on the target they discharge the insulator down to the flood gun cathode potential.
   Hence, storage is a function of writing speed.

4. Erasure. When the stored display is no longer required, a positive pulse is applied to raise the whole STB voltage above the writing threshold, so that the whole area is written with flood gun electrons. The pulse then goes negative and as the voltage gradually returns towards zero, the target is charged towards the ready to write threshold and the whole procedure can be repeated.

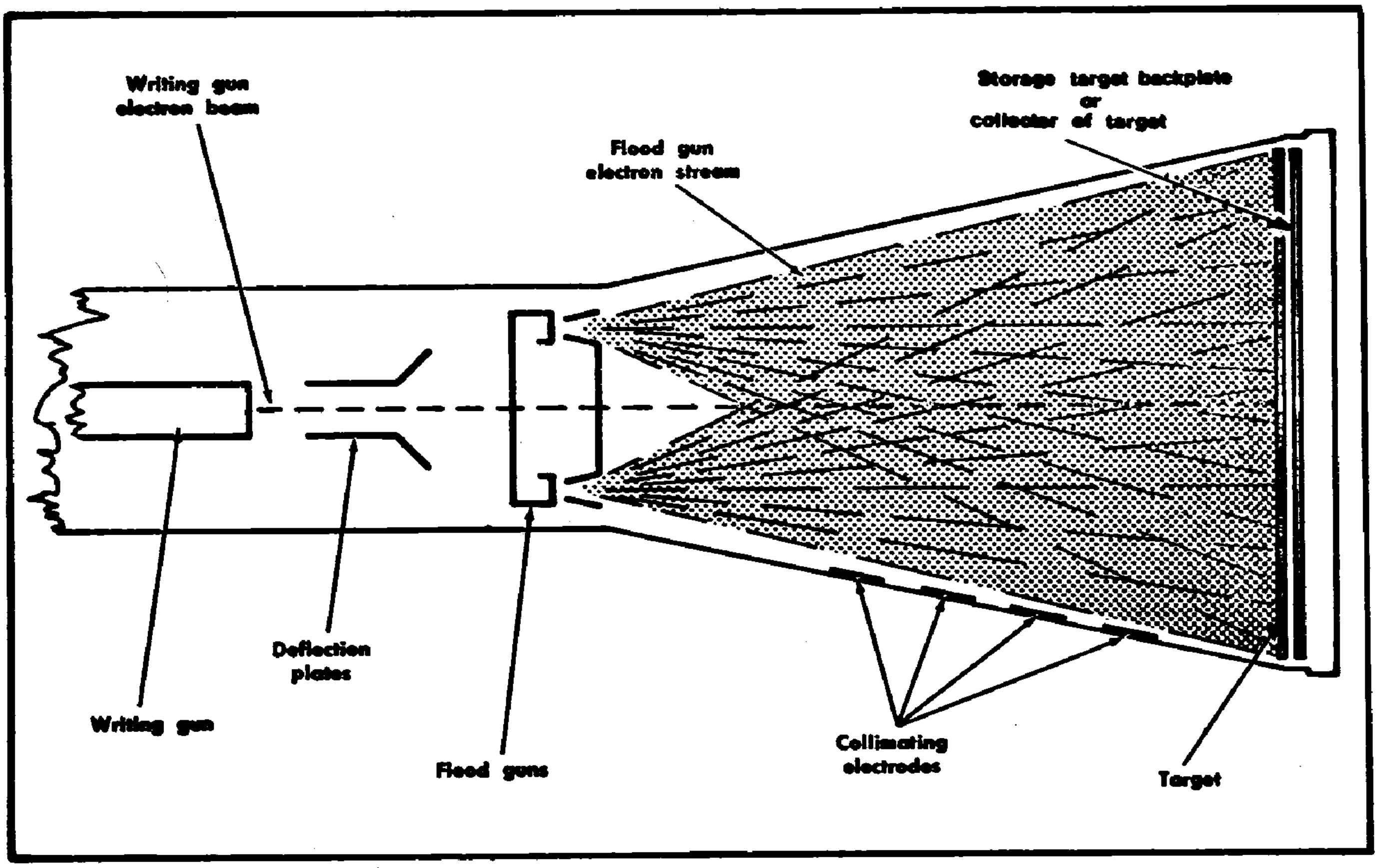


PLATE.1. Storage Tube.

3.8.6 Circuit Description:

The circuit, reference Figure 9, comprises three triggered monostable pulse generators; enhance TR1001, TR1002, manual erase TR1003, TR1004 and auto erase TR1007, TR1009. The outputs from these circuits are connected, via the erase amplifier TR1005, TR1006, to the CRT STB electrode. Additionally D.C. supplies are provided for the collimation electrodes CE1 to CE5.

3.8.7 In the NORMAL (non-store) condition of the CRT, the base of TR1005 is connected to a fixed potential. TR1005, TR1006 are connected as a single stage shunt feedback amplifier; the D.C. output level sets the STB potential at approximately 75 V.

3.8.8 When switched to STORE mode, the base of TR1005 is connected to a resistive mixing circuit comprising, the D.C. level adjustment R1026, via R1028, the erase generator output from TR1004 via R1029 and the enhance generator output from TR1002 via R1031. The STB electrode resides at a potential of approximately 150 V.

Note: These potentials will vary from instrument to instrument.

3.8.9 The ENHANCE and AUTO ERASE monostables are triggered by a pulse from the sweep generator that occurs at the start of the flyback period. This pulse is shaped by TR1000 and applied via C1001 and C1014, to the respective monostables.

The MANUAL ERASE is applied via S1004a. A negative pulse is applied to the base of TR1003 causing it to switch off, TR1004 to switch on and bottom. The circuit will switch back after a period determined approximately by C1007 and R1017; the collector of TR1004 will then rise until it is clamped by D1007. When TR1004 switches on, it also discharges C1008. Hence at the end of the pulse period C1008 will charge towards −100 V line until clamped by D1008 at −14 V.

3.8.10 The waveform at TR1005 base is the sum of the D.C. level, a negative-going rectangular pulse of approximately 14 V amplitude from the TR1004 collector followed by an exponential decay back to −14 V approximately from the negative side of C1008.

3.8.11 This signal is inverted and amplified by the shunt feedback stage TR1005, TR1006 and applied to the STB electrode of the CRT. At the same time, the emitter of TR1006 drives the bootstrap emitter follower TR1008 via the zener diode D1014. The signal voltage passes through C1013 cutting off D1009 so disconnecting the +300 V line. The collector of TR1006 rises due to bootstrap action taking the collimation electrodes CE4, CE5 positive. This is done to maintain correct collimation of the flood beam during the erase period.

3.8.12 The AUTO ERASE generator is triggered by a negative pulse occurring at the start of the sweep flyback. The sequence of events for auto-erasure is to first put the timebase into the single sweep mode. This is done automatically when switching to auto-erase, then the sweep flyback switches the auto-erase generator to produce a negative-going rectangular pulse. The leading edge of the pulse fires the erase generator to erase the display and at the end of the pulse period, when erasure is complete the back edge of the pulse resets the sweep; ready for the next input signal to trigger it.

The negative pulse from C1014 switches TR1007 off, TR1009 on; the circuit recovery rate being determined approximately by C1015, R1045. The output from the TR1009 collector is differentiated and the positive edge removed by D1024. The negative edge from D1024 is then used to fire the erase generator TR1003, TR1004. The positive output from TR1009 collector is used to reset the sweep so that it fires on the next input signal.

3.8.13 The ENHANCE generator is also fired by a pulse occurring at the start of the flyback; a variable width rectangular pulse is produced which is fed to the base of TR1005, so raising the potential of the STB. This increases the writing speed of the CRT and also the background level, so reducing the contrast of the stored image. If the Manual or Auto Erase generators are also operating, then the enhance pulse sits on top of the erase pulse amplitude and assists in clearing the stored information.

3.8.14 To increase the writing speed still further with a recurrent waveform, the flood gun cathode can be open circuited by the INTEGRATE switch S1003. This switches off the collimated flood beam and allows successive sweeps to build up the stored charge on the insulator until the insulator is able to switch to its higher voltage stable condition. Then if the INTEGRATE switch is released; the flood beam switches on, permitting the stored image to be viewed.

3.9 EHT SUPPLIES

3.9.1 The negative supply voltage, reference Figure 8, for the CRT cathode is supplied by a class 'C' oscillator circuit consisting of TR302, transformer T301 and a current sensing amplifier TR301 and TR303. The oscillator runs at approximately 40 kHz with the secondary of the transformer being rectified by D302 and C303 serving as a reservoir capacitor. This produces a voltage of −3.2 kV relative to chassis.

3.9.2 The potential divider chain between the −3.2 kV and the + 110 V lines provides the necessary voltages for the CRT writing gun electrodes and senses the output of the regulator circuit. Any change in the regulator output induces a current change in the potential divider chain. This current change is amplified by the current amplifiers TR301 and TR303 to control the automatic self bias for the class 'C' amplifier TR302. This is developed across C301 to vary the conduction angle of the class 'C' amplifier and maintain a constant voltage output.

3.9.3 The zener diodes D306 and D304 maintain constant voltages across the Focus circuit, so as to make the current in the potential divider chain independent of the Focus control, which is achieved by controlling the photo-energy incident on the photo-transistor PTR304 from the light source LP 301.

3.9.4 TR307, R315 and R319 form a clipper circuit which clips the negative-going portion of the E.H.T. oscillator at the collector of TR307. This clipped signal is then peak to peak rectified by D306 & D308 and superimposed onto the 3.2 kV line to control the bias on the grid of the CRT. R319 varies the clipping level and hence alters the brightness of the trace.

3.10 POWER SUPPLIES

3.10.1 The power supply circuit is shown in Fig. 10. All the rectifiers used are silicon semiconductors thus ensuring a minimum of delay for the rectified voltages to obtain their maximum value. A power transformer T401 provides all the required voltages from its secondaries. The primary may be adjusted, by a means of a link input voltage selector panel, for operation on alternating voltages from 100–125 V and 190–240 V at 50–60 Hz.

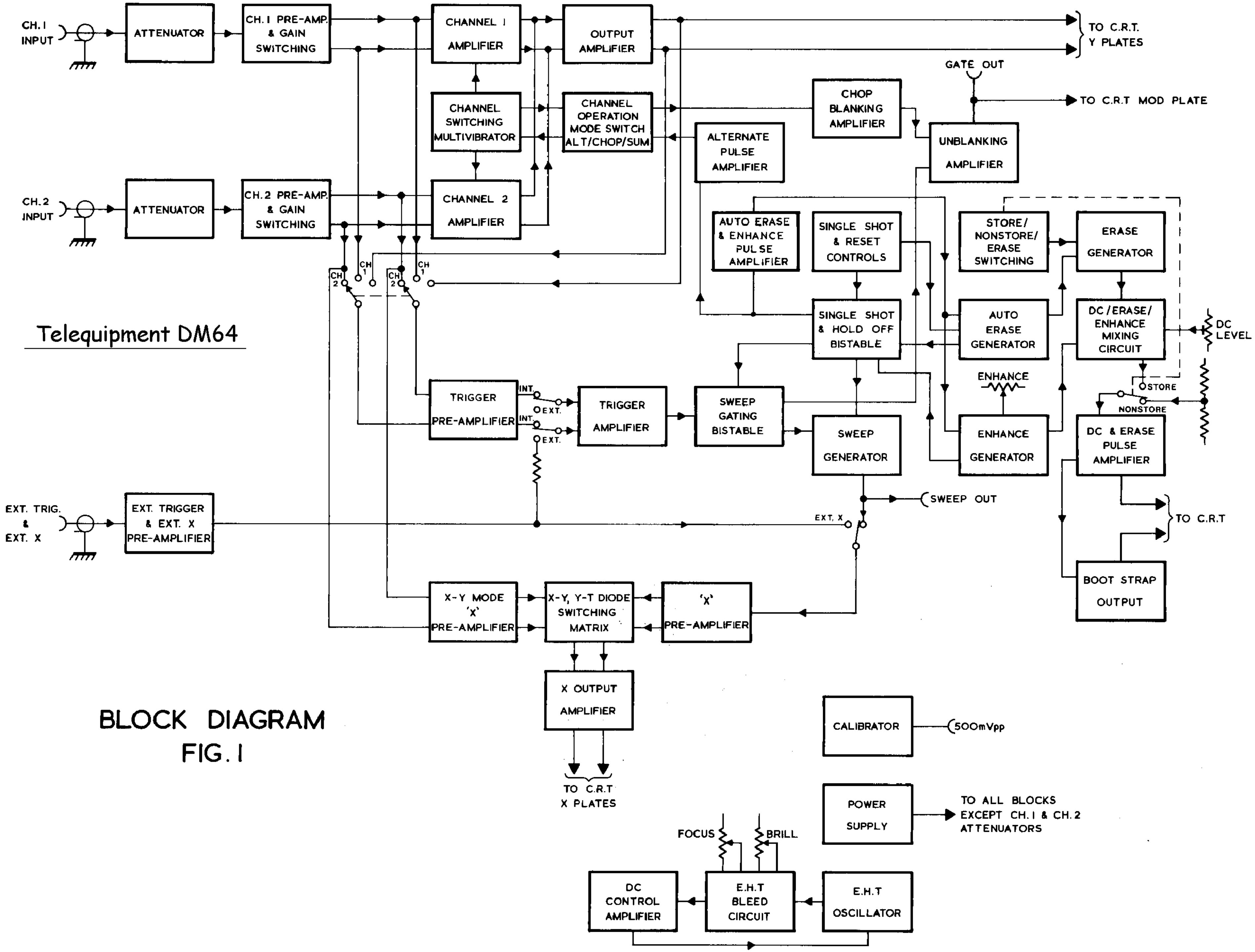
3.10.2 One secondary winding, 14-0-14 V, is full wave rectified twice and supplies ± 12.5 V and ± 14 V. Another full wave rectifier provides D.C. for the CRT flood gun heater. One half of the winding provides power for the graticule illumination bulbs.

3.10.3 A second winding, 100-0-100 V, also with two full wave rectifiers supply ± 100 V.

3.10.4 Two additional floating windings drive bridge rectifiers to supply the + 180 V and + 300 V lines

3.10.5 All lines are R-C smoothed, to provide low ripple supply voltages for the relevant circuit boards

3.10.6 The 500 mV peak to peak square wave calibrator output is developed across R407 by using the 14 V A.C. output from the transformer to switch D416 alternately on and off. D416 is in series with R408 and R411 to a 6.2 V zener diode. R411 sets the current through the chain and consequently the voltage developed across R407.



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BLOCK DIAGRAM
FIG. 1

MISC	S901	S902	S902	S902
C	901 902 903 904	905 906 907	908 909 911	912 913 914
R	901 909 902	903 904	905A 905B	905C 905D

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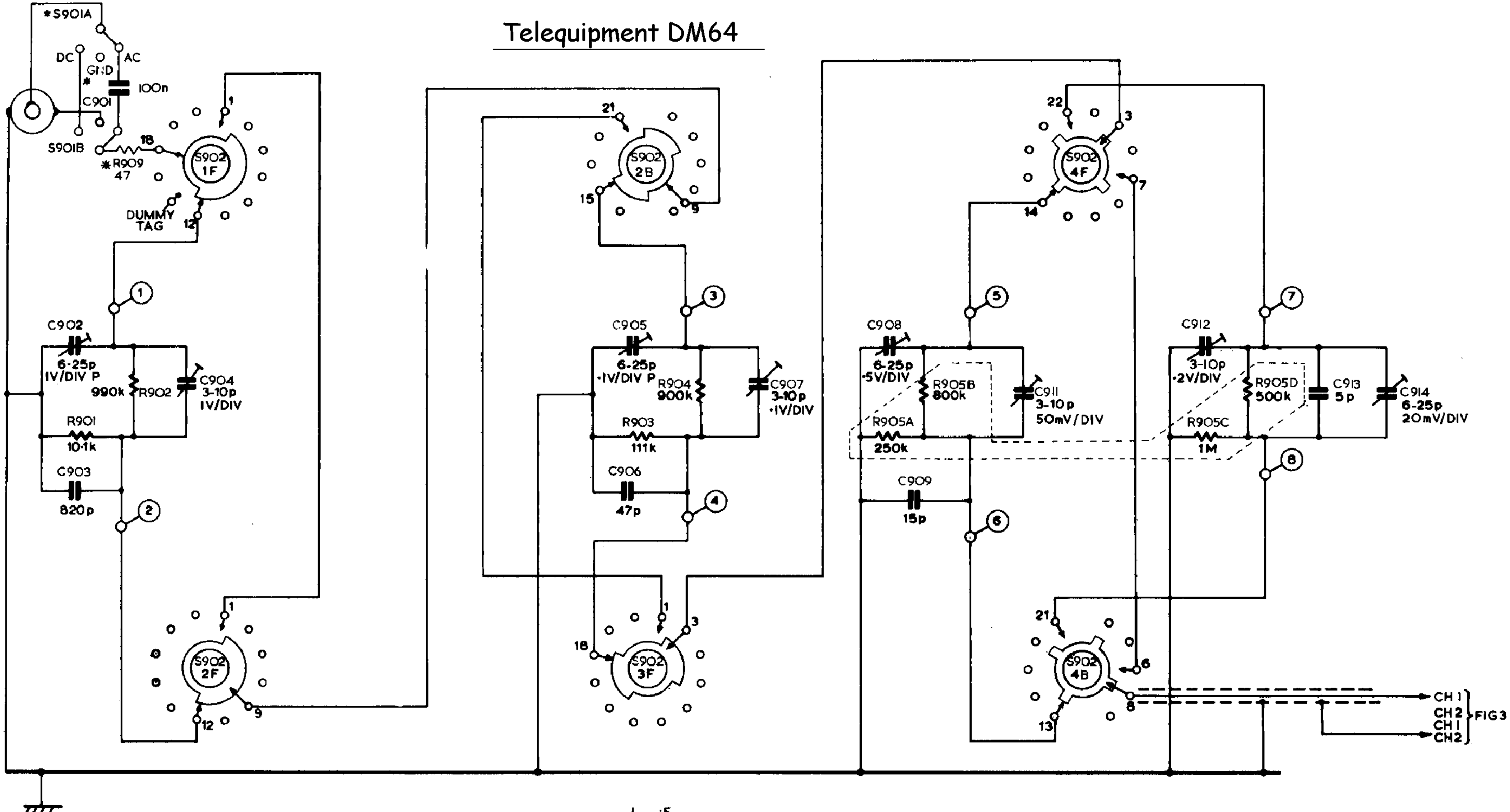
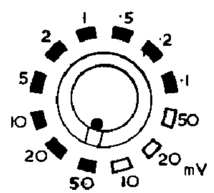


NOTES:-
1. (N) DENOTES TAG NOS. ON P.C.73
2. SWITCHES SHOWN IN FULLY ANTI-CLOCKWISE POSITION
3. * DENOTES COMPONENTS NOT MOUNTED ON P.C. 73
4. 76/1 DENOTES PC76/EYELET No1.



S902 (VOLTS/DIV) SWITCH POSITIONS

ATTENUATOR CIRCUIT FIG. 2

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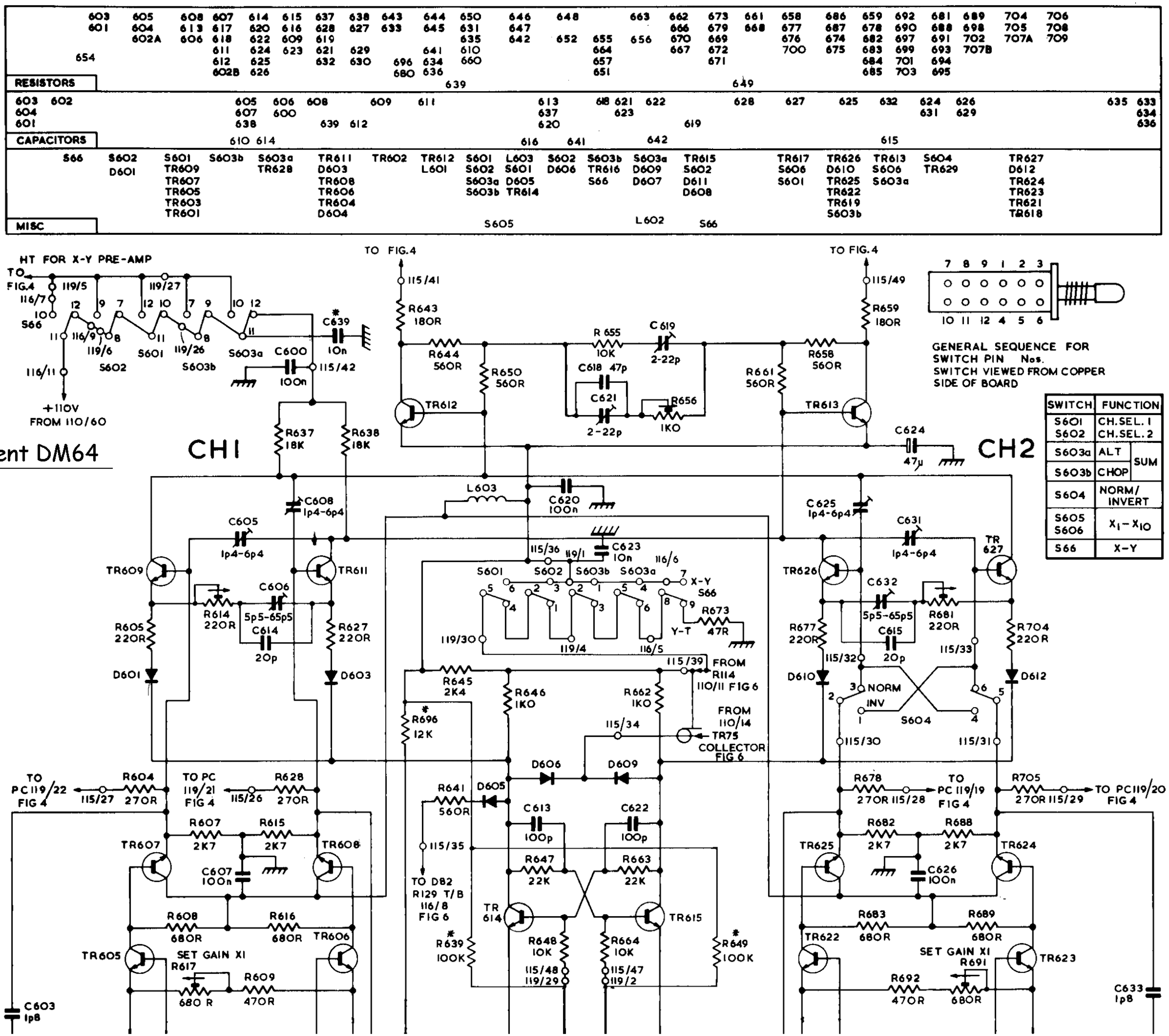
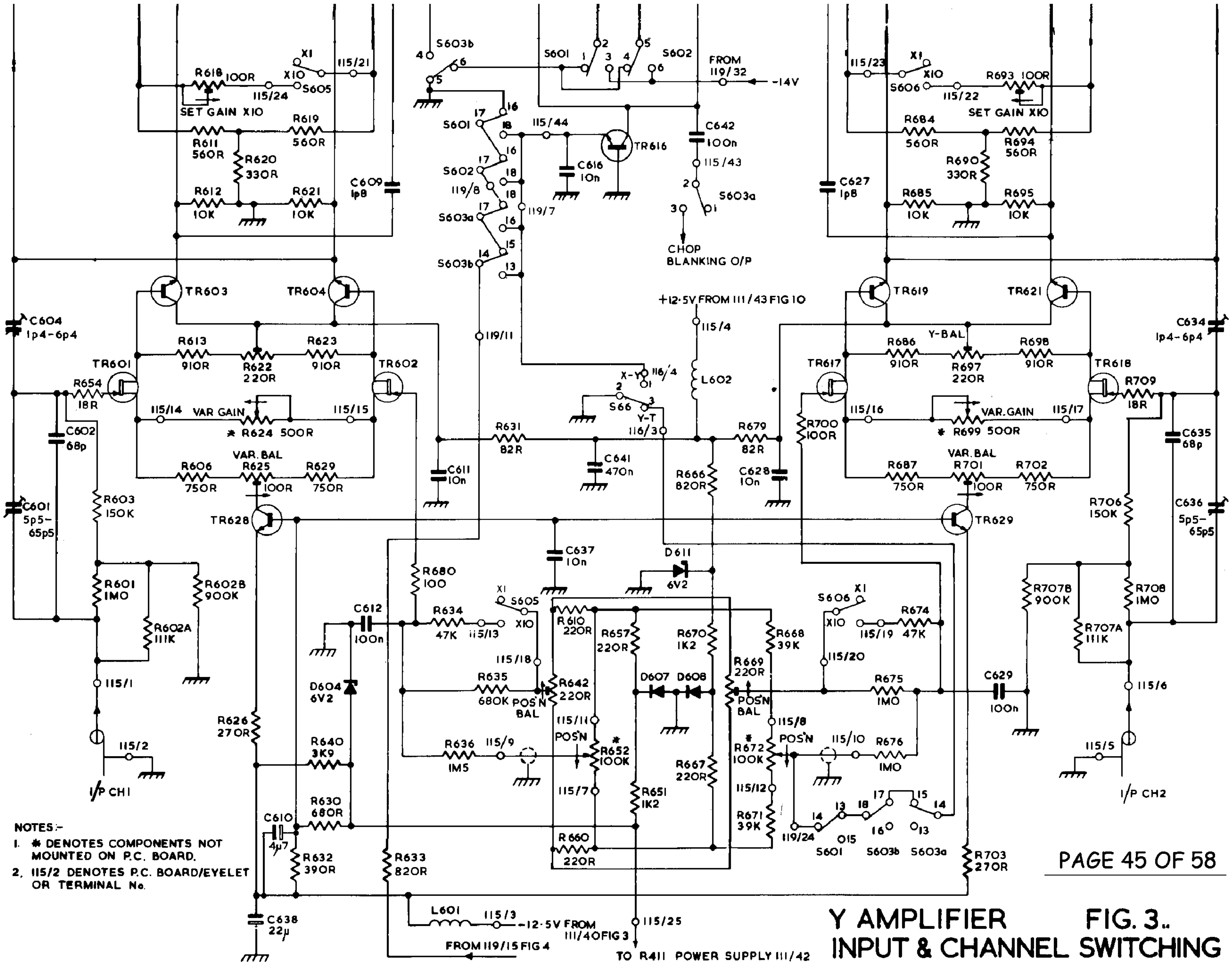


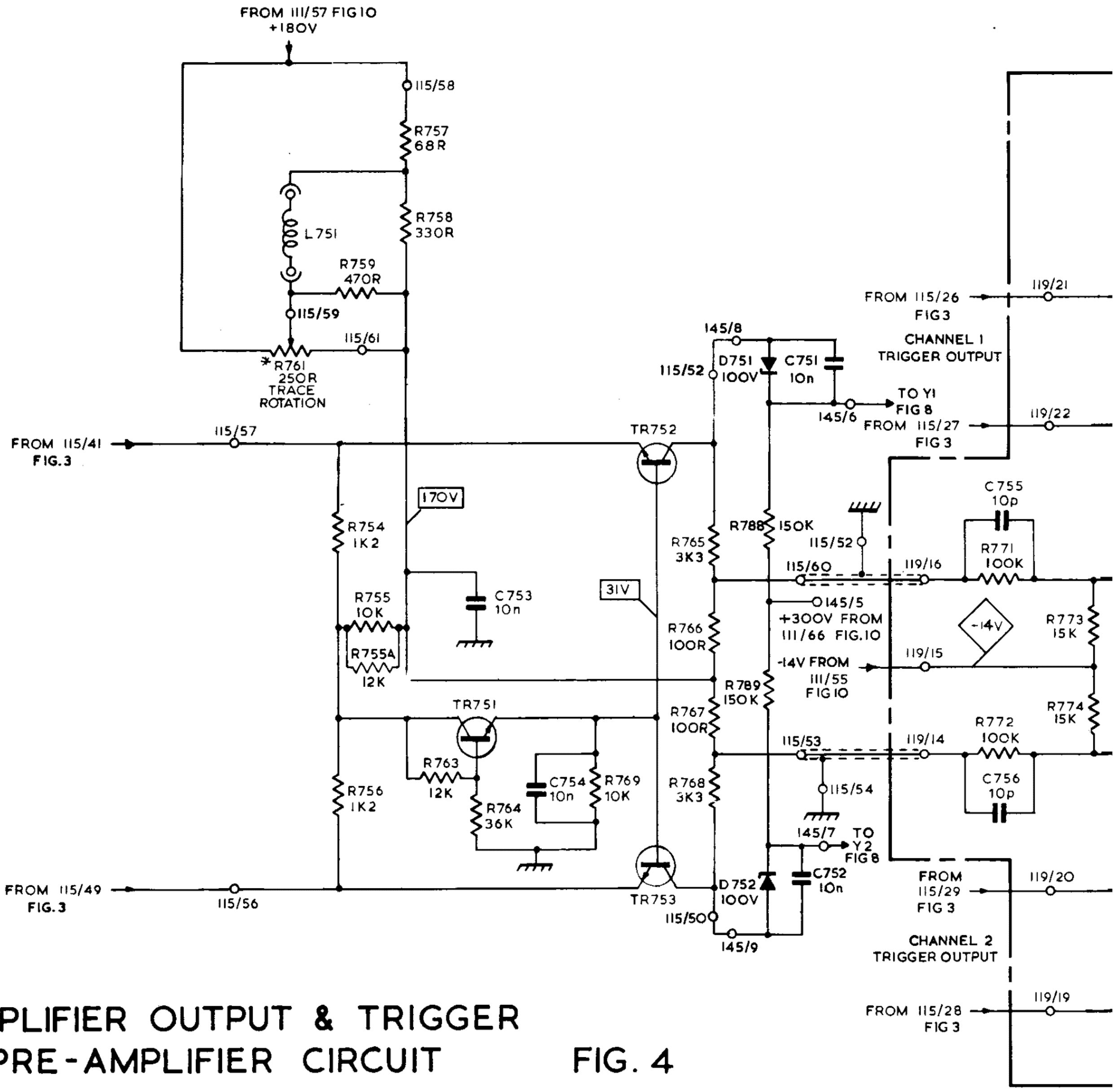


NOTES:-
1. ✱ DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 115/2 DENOTES P.C. BOARD/EYELET OR TERMINAL No.

Y AMPLIFIER FIG. 3.
INPUT & CHANNEL SWITCHING

RESISTORS	761	759 754 755 &A 756	757 758	763 764		769	751	765 766 767 768	752 788 789	771 772	773 774
CAPACITORS				753	754				751 752	755 756	
MISCELLANEOUS	L751			TR751		TR752 TR753		D751 D752			

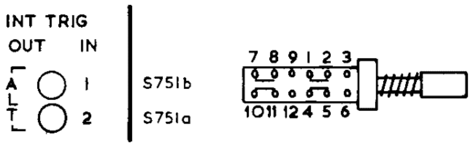
Telequipment DM64

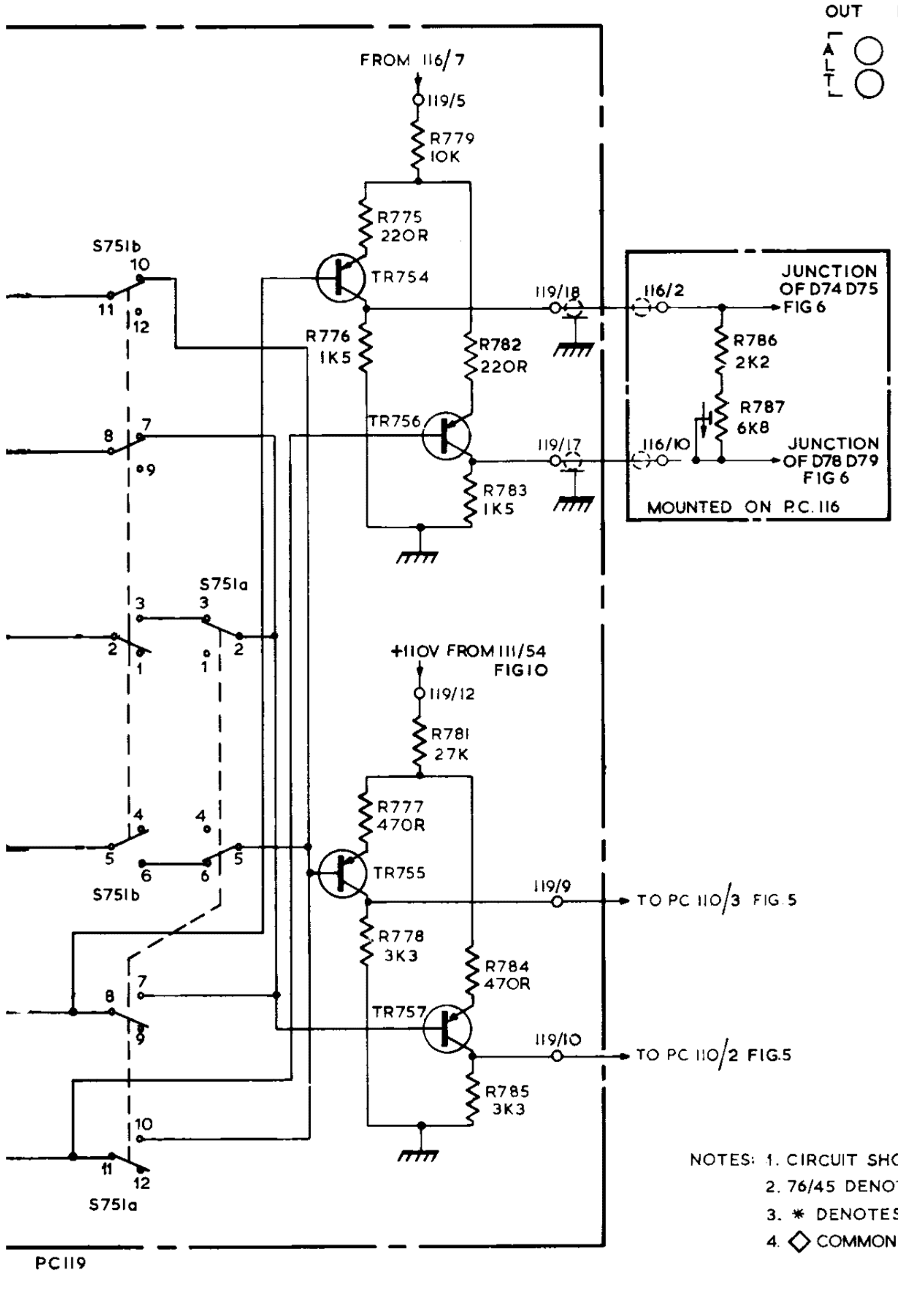


Y-AMPLIFIER OUTPUT & TRIGGER
PRE-AMPLIFIER CIRCUIT FIG. 4

		775	779	782	786
		776	781	783	787
		777		784	
		778		785	
S751b	S751a	TR754		TR756	
		TR755		TR757	

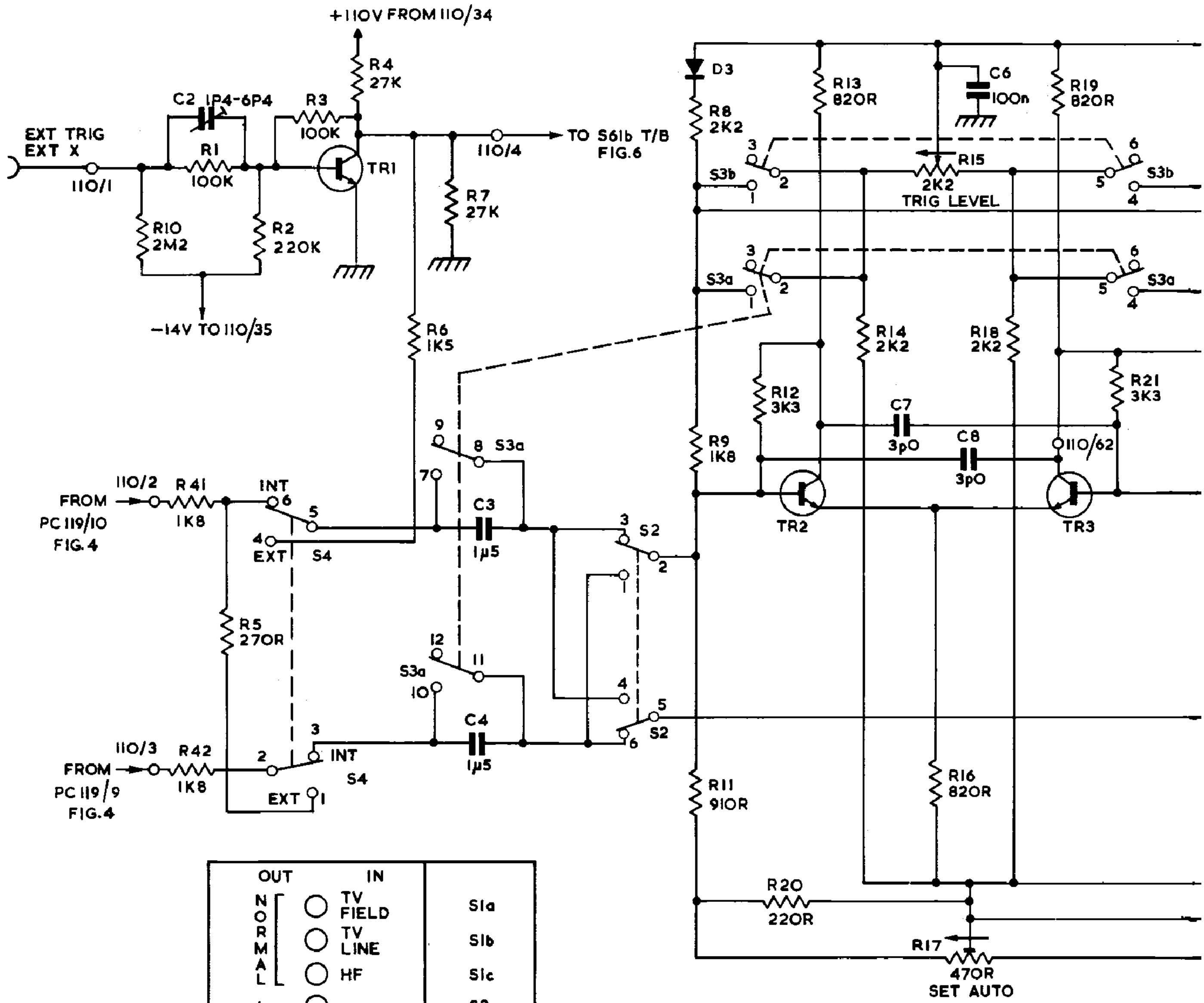
Telequipment DM64





NOTES: 1. CIRCUIT SHOWN WITH CHANNEL 1 TRIG SELECTED.
2. 76/45 DENOTES PC BOARD No/EYELET OR TERMINAL No.
3. * DENOTES COMPONENTS NOT MOUNTED ON PC BOARD.
4. ◇ COMMON -12V.

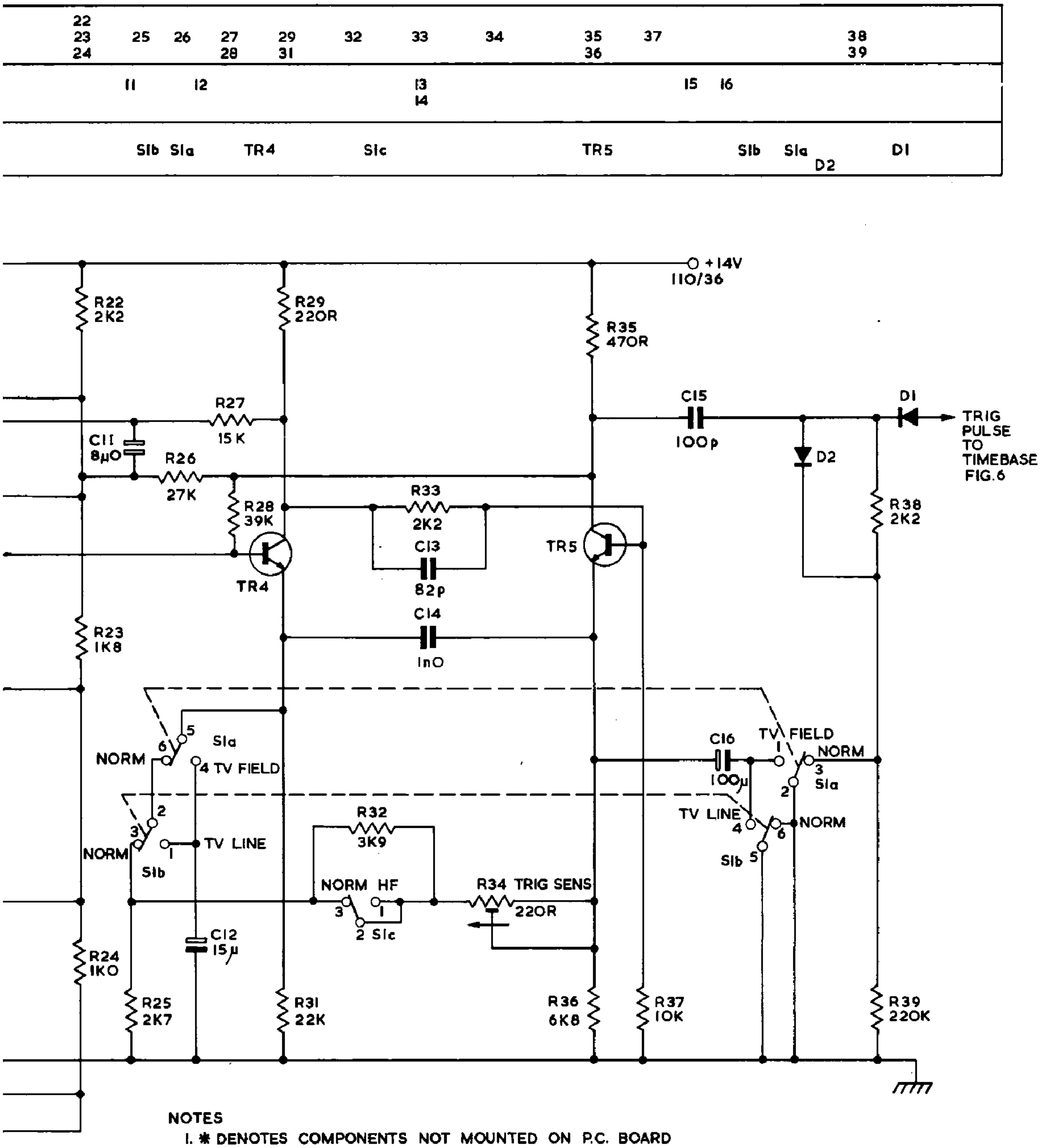
RESISTORS	10 41 42 1 5 2 3 4 6 7 8 9 11 12 20 13 14 15 16 17 18 19 21
CAPACITORS	2 3 4 7 8 6
MISC	S4 TR1 S3a S3b S3a D3 TR2 TR3 S3b S3a



OUT	IN	
NORMAL	TV FIELD	S1a
NORMAL	TV LINE	S1b
NORMAL	HF	S1c
+	−	S2
AUTO	DC	S3a
AUTO	AC	S3b
INT	EXT	S4
FRONT PANEL MARKING		SWITCH REF

Telequipment DM64

TRIGGER



NOTES
1. ✱ DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD
2. 110/4 DENOTES P.C. BOARD / EYELET OR TERMINAL N°

CIRCUIT FIG. 5

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RESISTORS	62 60, 65, 66, 67 68, 69 70, 71 71A 72, 80 75 74, 73 77, 82, 78, 83 148, 79 84 76, 85 86, 145 64, 61 87 RT Rs, 81, 89 91, 63, 92 93 88, 94 95, 96 97, 98 99 101, 102
CAPACITORS	60, 76, 61, 90 62, 82, 73, 77, 70 CT, 63, 64, CH
MISC.	TR64 TR62, D64, TR65 TR66, S65a, TR67, TR68, D66, TR69, D67, D68, D69, TR71, TR72, D71, S61b S62b S1004d, D65, D72

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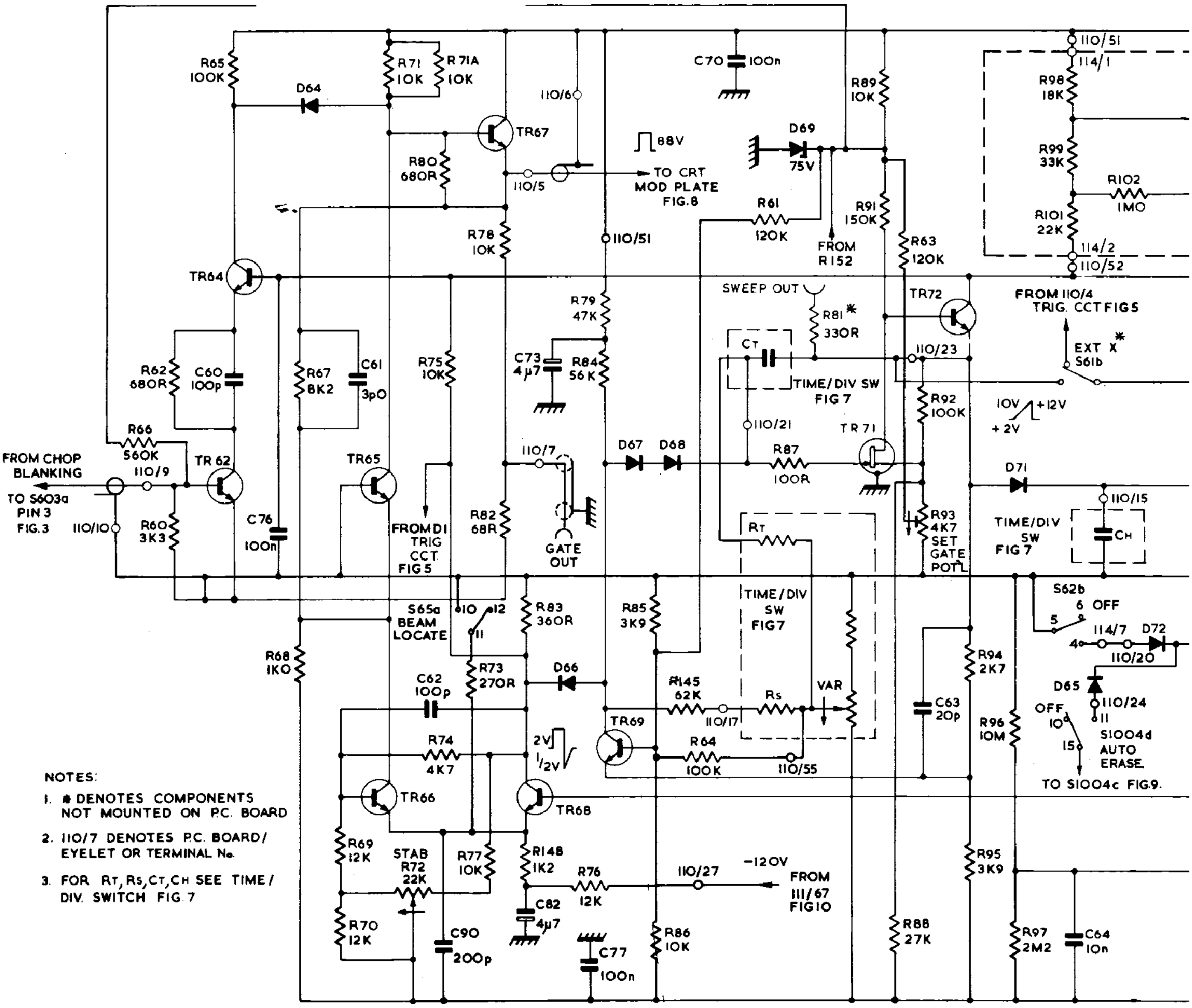
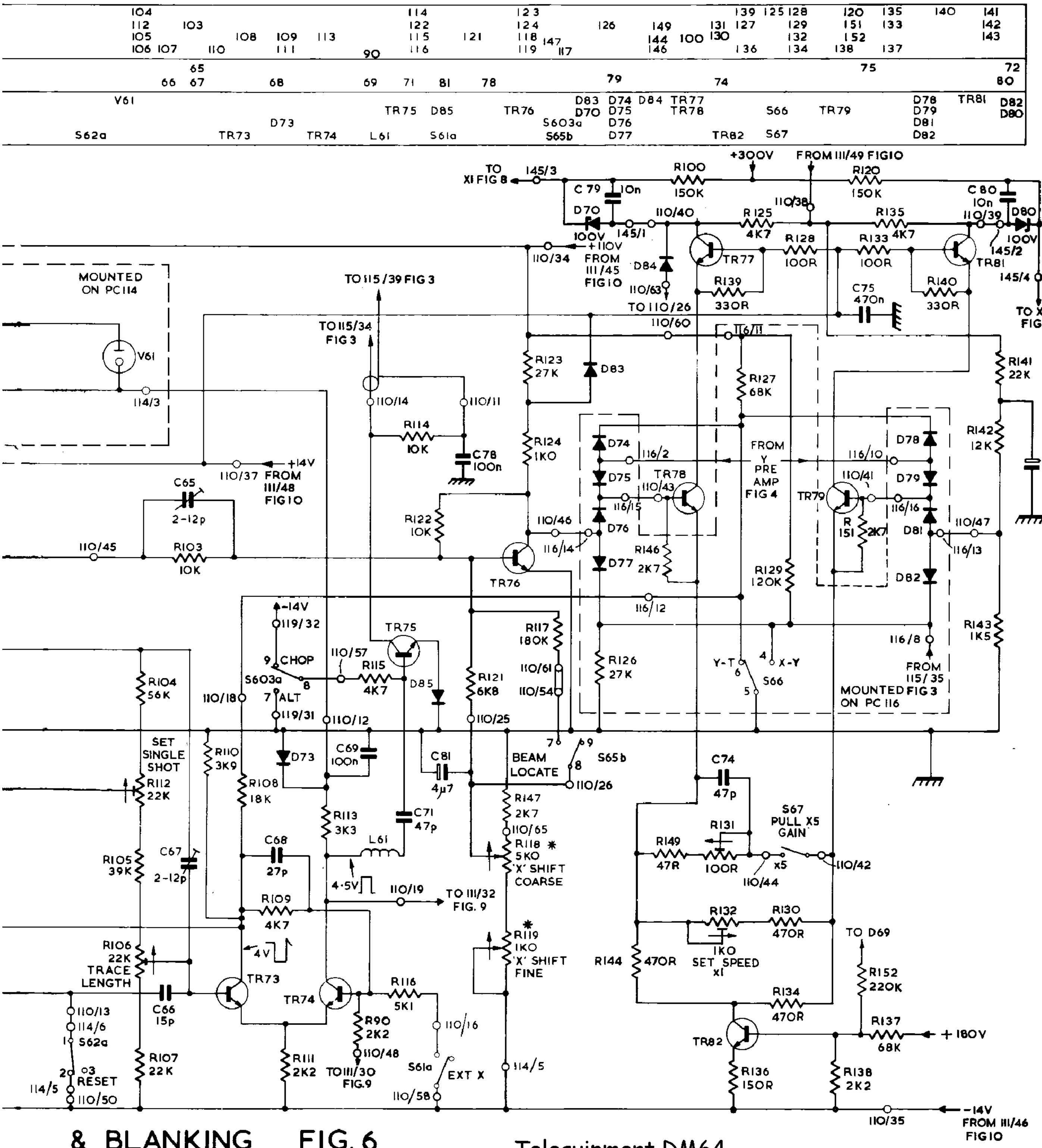


NOTES:

1. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD
2. 110/7 DENOTES P.C. BOARD/ EYELET OR TERMINAL No.
3. FOR RT, Rs, CT, CH SEE TIME/ DIV. SWITCH FIG. 7

TIMEBASE X-AMP



& BLANKING FIG. 6

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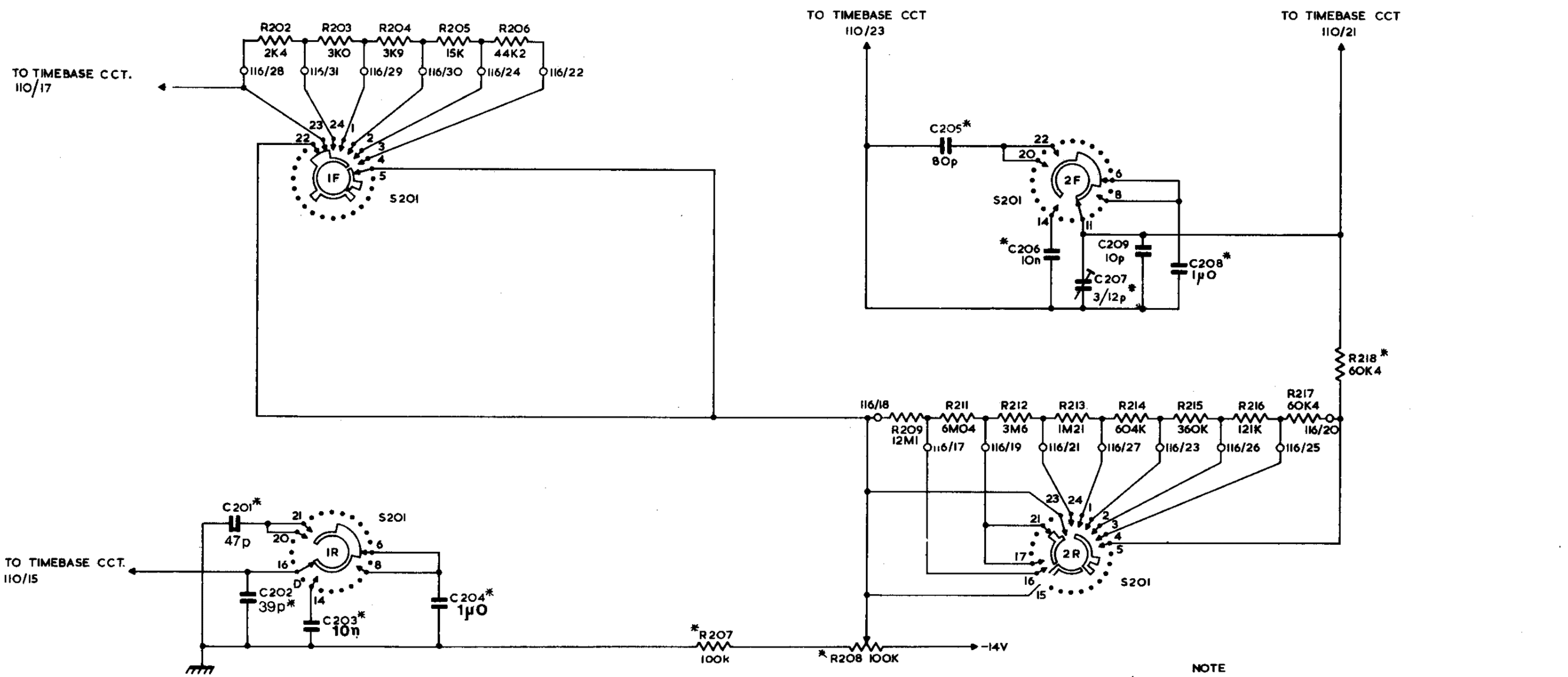
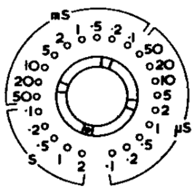
RESISTORS		202	203	204	205	206	207	208 209	211	212	213	214	215	216	217 218
CAPACITORS	201 202		203		204				205		206 207	209	208		

Telequipment DM64



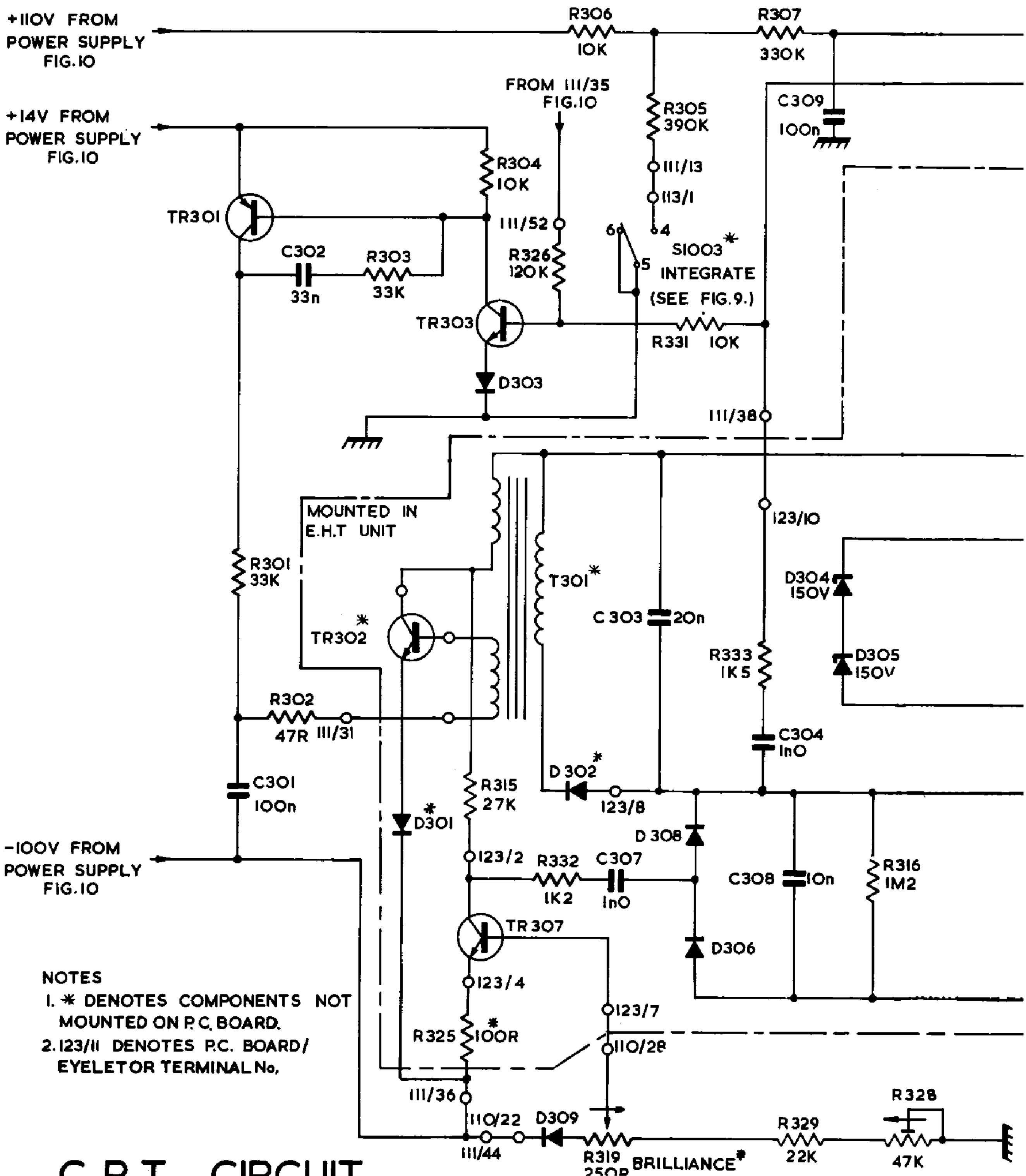
NOTE
1. * DENOTES COMPONENTS NOT MOUNTED ON P.C.116
2. 110/15 DENOTES PC BOARD/ EYELET OR TERMINAL No

TIME / DIV. SWITCH
FIG. 7
64



TIME/DIV SWITCH POSITIONS.
SWITCH SHOWN IN FULLY ANTI-CLOCKWISE POSITION.

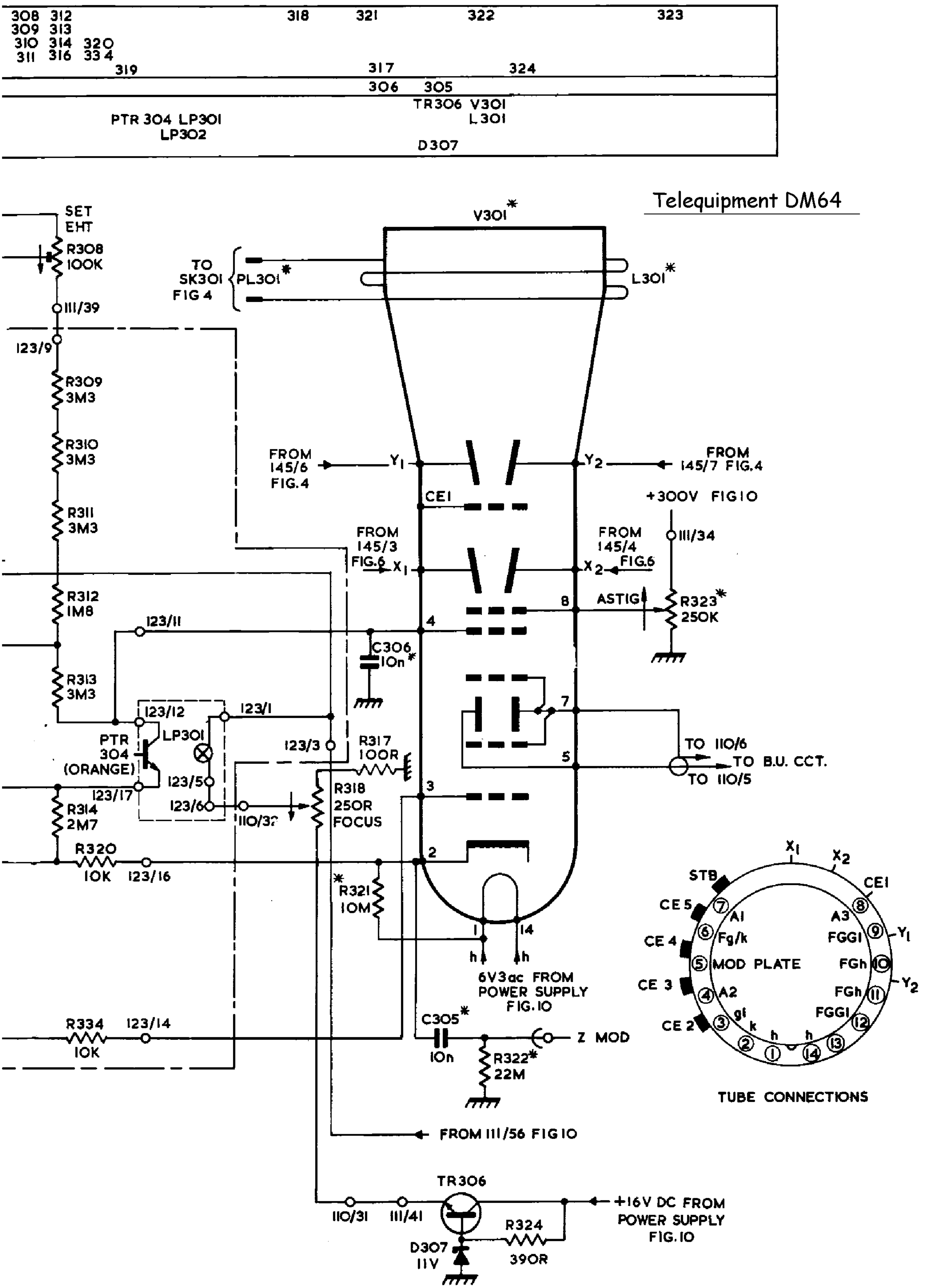
RESISTORS	301 302 303 315 325 304 326 332 306 319 305 333 331 329 307 328
CAPACITORS	301 302 307 303 304 308 309
MISC.	TR301 D301 TR302 TR307 D303 TR303 T301 D302 D309 S1003 D308 D306 D304 D305



C.R.T. CIRCUIT
FIG. 8

Telequipment DM64

Telequipment DM64



RESISTORS	1000 1002 1004 1005 1006 1003 1007 1008 1001 1009 1013 1014 1011 1012 1015 1016 1017 1018 1019 1021 1020 1022 1023 1024 1025 1030 1026 1027 1028 1068 1029 1031 1043 1032 1033 1034 1035 1036
CAPACITORS	1000 1002 1003 1001 1004 1005 1006 1007 1008 1009
MISC.	S1001 D1001 D1002 D1003 D1004 TR1000 TR1001 S1002 TR1000 S1004a TR1002 S1002 D1005 D1006 TR1003 TR1004 D1007 D1008 S1001 TR1005

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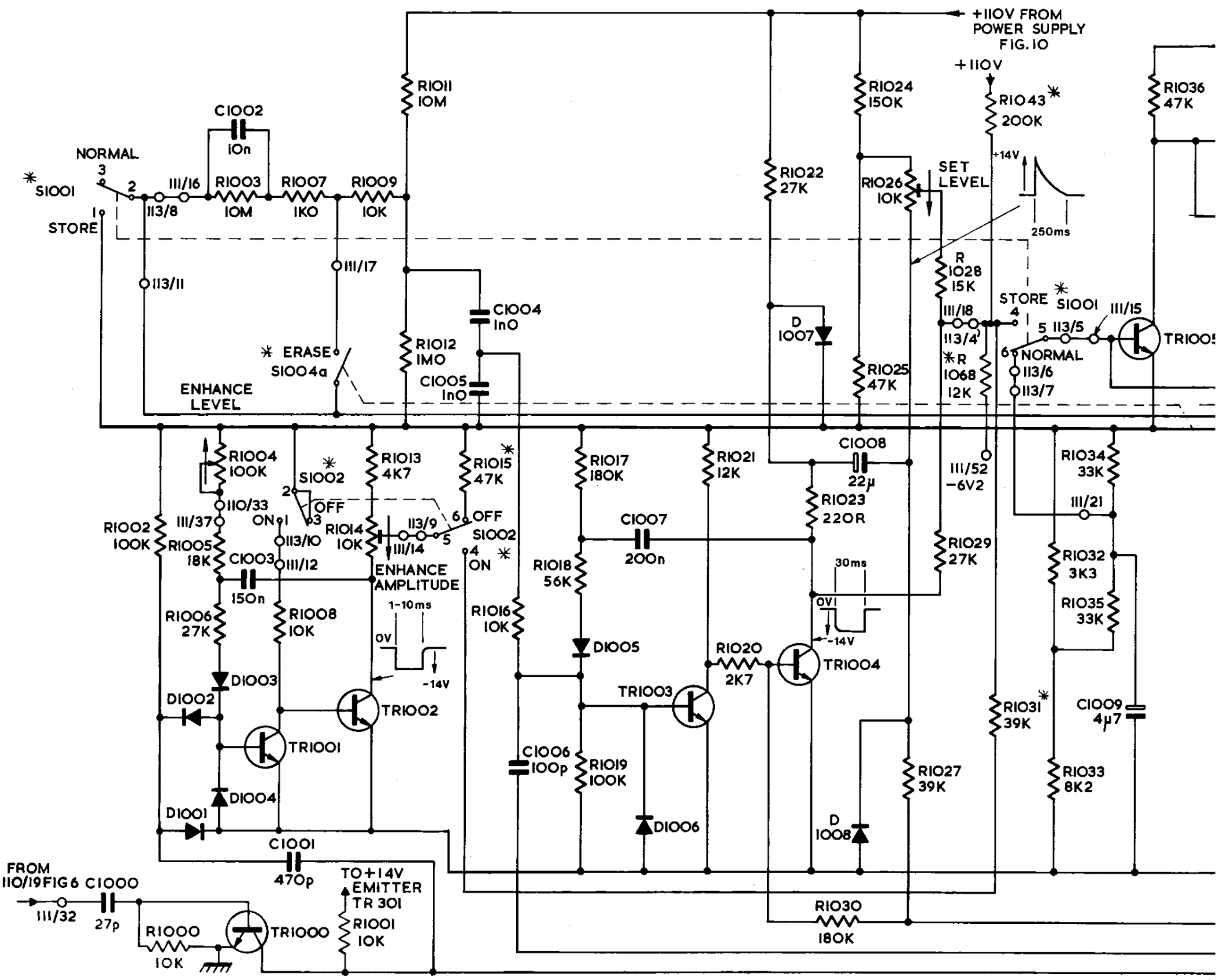
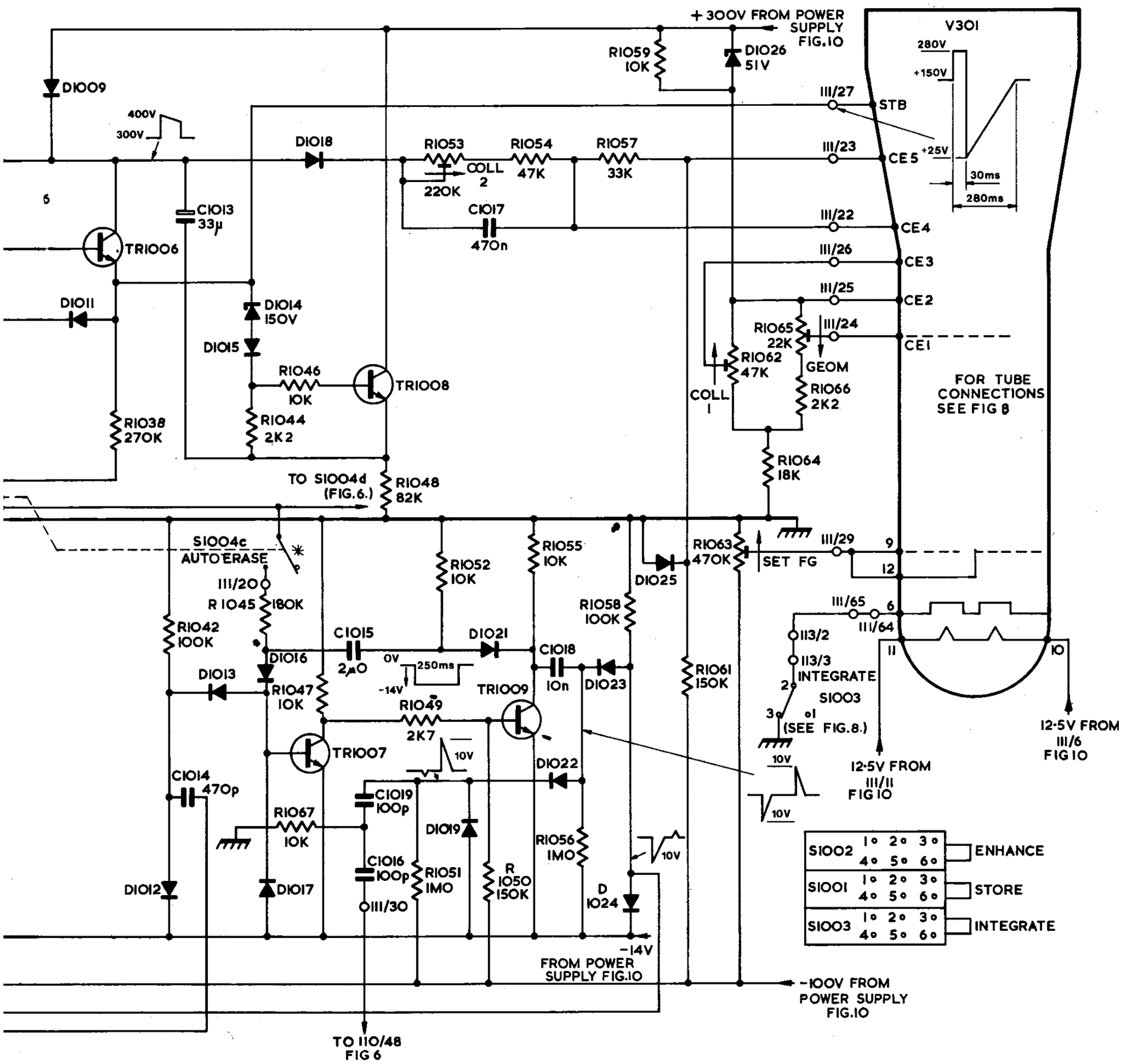


NOTES 1. ✱ DENOTES COMPONENTS NOT MOUNTED ON P.C.111 BOARD.
2. 111/17 DENOTES P.C. BOARD/EYELET OR TERMINAL No.
3. ALL MEASUREMENTS ARE APPROXIMATE.

STORAGE CIRCUIT
FIG. 9

1038 1044 1045 1048 1049 1051 1050 1054 1055 1059 1061 1064 1065 1066
1042 1046 1047 1067 1052 1053 1056 1057 1058 1062 1063
1013 1014 1019 1016 1015 1017 1018
TR1006 D1009 D1011 D1012 D1013 D1014 D1015 D1016 D1017 TR1007 D1018 S1004c TR1008 D1019 D1021 TR1009 D1022 D1023 D1024 D1025 D1026 S1003
V301



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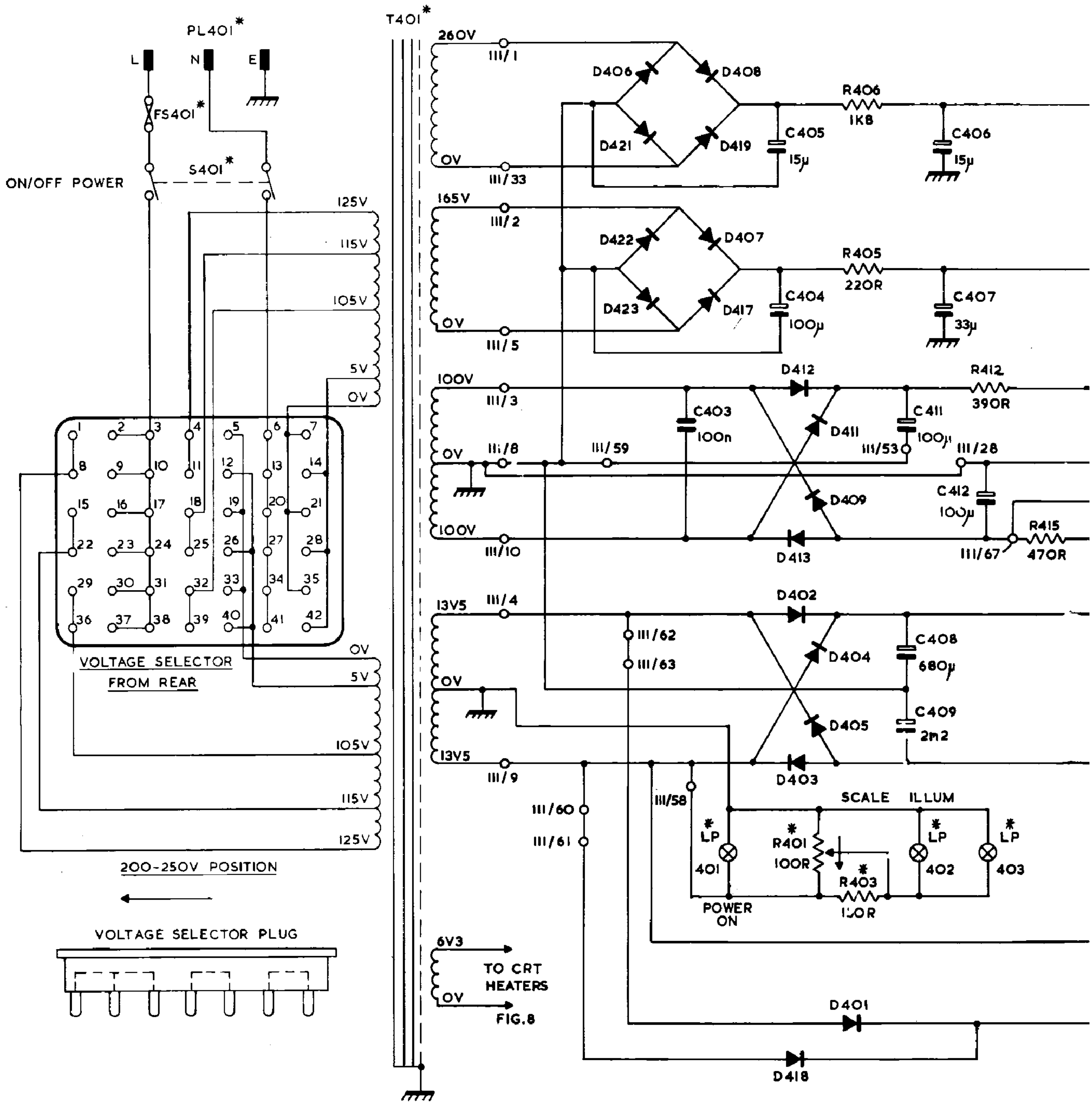
RESISTORS						401	406 405 403		412
CAPACITORS				403		405 404		411 406 408 407 409	412
MISC.	PL401 FS401 S401	T401	D406 D421 D422 D423	LP401	D408 D419 D407 D417	D412 D413 D402 D403	D411 D409 D404 D405	D401 D418 LP402	LP403



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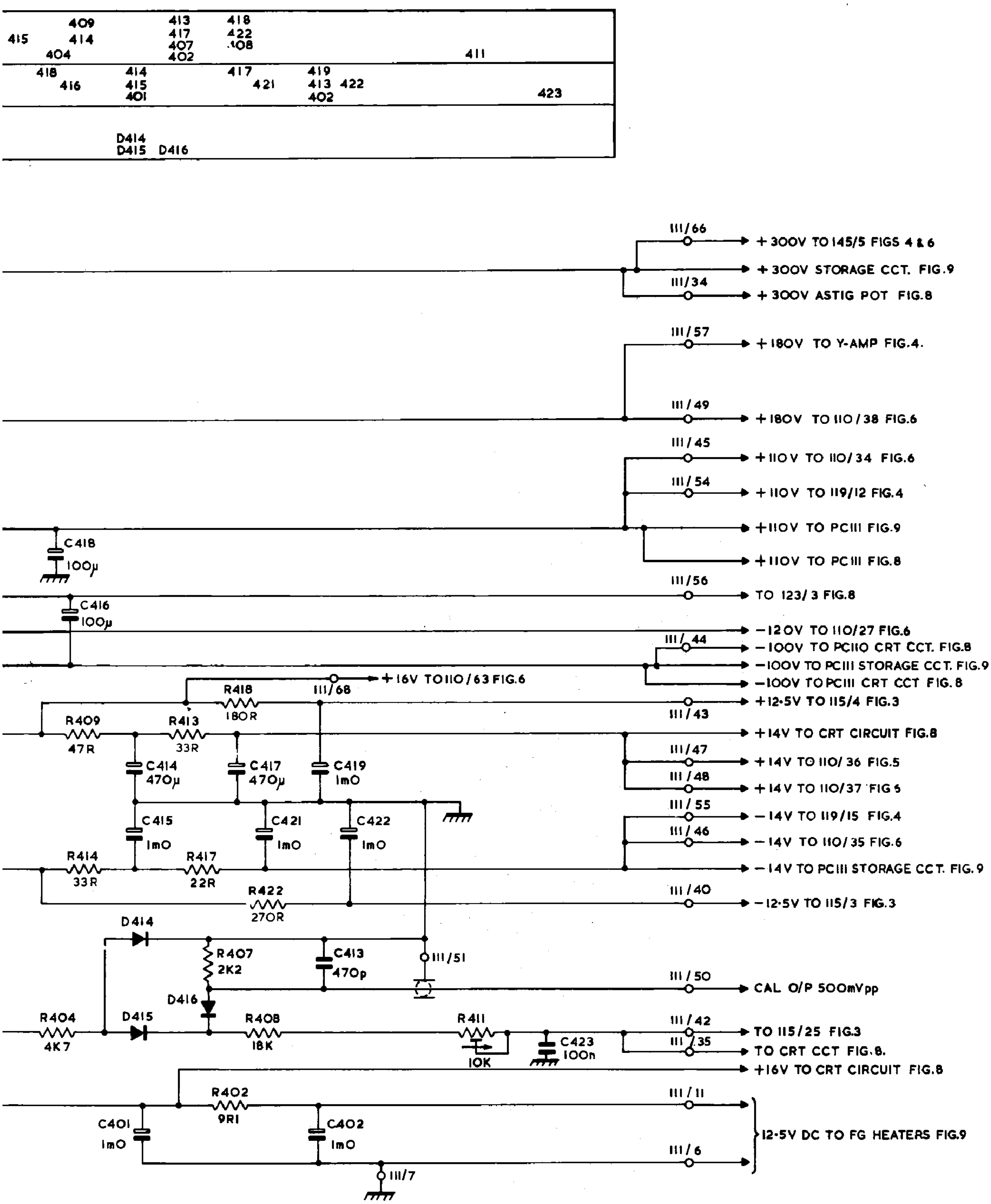
NOTES:

1. ✱ DENOTES COMPONENTS NOT MOUNTED ON PC BOARD
2. 111/9 DENOTES PC BOARD / EYELET OR TERMINAL No.



POWER SUPPLY FIG. 10

Telequipment DM64