

SINCLAIR RESEARCH LTD

MAINTENANCE MANUAL FOR FLAT SCREEN POCKET TV

VERSION 1 AUGUST, 1986

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CHAPTER 1

OUTLINE TECHNICAL SPECIFICATION

1.1 The Microvision Flat-Screen Pocket TV (FTV) is a portable Monochrome Television receiver displaying a 50mm (2") diagonal picture size, operating in the UHF waveband (and in the VHF/UHF band on Models 2A USA and EURO versions).

The receiver incorporates a simple telescopic aerial and automatically selects response to 625 or 525 line UHF transmission standards on Issue 10 and 12 (and VHF/UHF on Issue 2A). Controls are provided for Volume/On-off and continuous tuning, and Band switching is provided on Issue 2A.

Sound output is through an internal loudspeaker or alternatively by personal earphone with automatic loudspeaker cut-out.

Power is supplied from a flat 6V battery giving approximately 15 hours normal life; 240v, 220v and 120v Mains power supply units are also available.

Dimensions:	140mm z 88mm x 32mm with aerial folded (5.5" x 3.5" x 1.25")
Weight:	280g (10oz.) excluding battery
Power supply:	4.7V to 6.5V DC
Receiving frequencies:	UHF 470MHz to 855MHz VHF 55MHz to 103MHz, and VHF 138MHz to 247MHz (2A Models)
Receiving standards:	525 and 625 lines (All Models) 6.0MHz sound (Issue 12), System 1 4.5MHz sound (Issue 2A) USA, System M 5.5MHz sound (Issue 2A) EURO, System B, G and H
Operating temperature range:	0 to 40 degrees C (32 to 104 degrees F)
Storage temperature range:	-20 to 40 degrees C

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CHAPTER 2

DESCRIPTION

2.1 A simplified block diagram of the receiver is given in Figure 1. Four main elements are shown, namely the flat electrostatic tube, vari-cap tuner, custom LSI circuit and power converter, also three discrete amplifiers: one each for the video, frame and sound waveforms. The circuit is completed by the line integrators and a number of preset potentiometers used for setting up circuit parameters during manufacture and after repair. There are five potentiometers for adjusting the picture size, position and height, and two others for optimizing the performance of the sound and line phase locked loops implemented within the IC.

2.2 Tube Design

2.2.1 The Microvision flat screen tube is comparable with a CRO tube, employing electrostatic beam deflection techniques rather than magnetic beam deflection found in conventional television tubes. The other, and perhaps most significant difference between flat and conventional tube design, is the need to 'bend' the electron beam to produce a linear picture viewed from the gun side of the phosphor (not through it) on a screen in a plane parallel with that of the gun (rather than normal to it). This 'bending' is achieved by shaping the scanning waveforms to counter the non-linear tube geometry and by generating a voltage gradient between the viewing screen and a repeller coating on the front glass, which encourages the electrons to strike the phosphor almost vertically. Without the repeller the electrons would strike the screen at an oblique angle making focusing extremely difficult.

2.2.2 EHT voltages for the tube, ranging from 460V to 2300V d.c., are generated by the power converter. The electron beam is sourced by a directly-heated cathode. The heater supply is from an isolated a.c. winding in the power converter and rides on top of the line-blanking waveform. The beam is modulated by video injected into the grid and accelerated by three anodes A1 to A3. A2 is a focusing anode fed from the frame supply via potentiometer RV6.

2.2.3 From A3 the beam passes between line and frame deflection plates, each pair fed with complementary drive waveforms which cause the beam to be deflected up and down, left and right across the screen. The beam finally strikes the phosphor screen deflected downwards by the repeller field.

2.2.4 Picture position is controlled by introducing d.c. offset voltages on the line and frame plates fed from the repeller supply via two potentiometers RV3 (horizontal) and RV4 (vertical). Picture height and width are functions of the frame amplifier and line integrator set by RV5 and RV7 respectively; contrast and brilliance are both fixed.

2.2.5 Two further electrodes affecting picture quality are the interplate shield (pin 8) and the guard band (pin 14). These control the astigmatism of the picture (not adjustable) and prevent edge effects around the screen caused by charging up of the glass.

2.3 Tuner

2.3.1 The UHF tuner may be regarded as a black box for repair purposes. It operates on the 'vari-cap' principle, receiving a variable voltage from the TUNE potentiometer RV1. The tuning voltage is a proportion of a 28V regulated supply derived within the power converter, and is relative to the +3V tuner supply from the IC. The IF signal is centred at 230MHz (280MHz on 2A) and is routed to an untuned IF amplifier incorporated within the IC.

2.4 Video, Syn and Sound Separation

2.4.1 The video, sync and sound separation circuits are incorporated in the IC. There are minimal external components, those illustrated being concerned mainly with the line phase locked loop and the sound. These include two potentiometers which adjust the free running frequency of the two VCOs, and a low pass RC filter network in the feedback circuit.

2.4.2 The receiver automatically adjusts the line and sound local oscillator frequencies to cater for 625 and 525 line transmission standards. The number of lines in a frame are counted and, having determined the standard, the corresponding frequencies are selected. In this application, the sound IF chosen is 250kHz. On the UK 625 standard, sound is received from the video detector 6MHz above the picture carrier. This is then mixed with the local oscillator operating at 5.75MHz to obtain the IF sound frequency. European 625 line sound is at 5.5MHz, also producing 250kHz sound IF. In the 525 line system, the sound carrier is at 4.5MHz and so the local oscillator must operate at 4.75MHz.

2.4.3 Sound. After detection the audio is applied to an external preamplifier and then returned to the IC power stage. Audio finally outputs to the internal loudspeaker or via the socket to the external earphone. The maximum power output is 140mW into 32 ohms nominal, the volume being controlled at the preamplifier stage using RV2.

2.4.4 Video. The picture video is detected within the IC and delivered to the tube grid after external amplification. A filtered version of the signal is also returned to the SYNC SEP input (pin 20) biased from the 31V tuning supply by R49. The separator derives line and frame sync for the line phase locked loop and the field counter referred to earlier.

2.4.5 Line Scan. The line scan waveforms delivered to the tube are derived by a pair of line integrators external to the IC. The integrators are in turn driven by complementary line drive outputs from the power converter and the line correction output from the IC. The former are derived from the converter drive waveform at IC pin 6 and charge the integrators during the line flyback time. The integrator discharge time is a function of the line correction waveform and RV7. White RV7 controls the overall discharge rate (i.e. the picture width) the correction waveform increases the discharge rate as the line progresses, thus compensating for the non-linear tube characteristics.

2.4.6 Frame Blanking. Frame blanking is a function of the line integrators. The integrators are charged in the normal way but are prevented from discharging until frame flyback is completed. In this way the line scan is kept at the left side of the tube, just outside the picture area.

2.4.7 Frame Scan. Complementary frame scan waveforms are derived entirely within the IC and are applied to the tube after external amplification. Because the frame sensitivity of the tube is non-linear (i.e. greater at the beginning of the line and less at the end) the application of linear frame scan waveforms would result in a trapezoidal picture narrowing at the gun end. To correct this irregularity the IC multiplies the line scan waveform into the frame scan in such a way that the frame scan is decreased at the start of a line and increased towards the end. Picture height is controlled independently using RV5.

2.5 Power Converter

2.5.1 The power converter derives the heater, line blanking and EHT supplies for the tube and delivers 18V and 31V supplies to the video amplifier and the tuning potentiometer RV1 respectively.

2.5.2 The primary power source is a slide-in 6V lithium battery or the output of the main adaptor at 5.9V. It is applied to the primaries of two variably coupled transformers and switched on and off by the converter drive waveform from IC pin 6. Energy is stored during line time and released during flyback. The secondary outputs are as follows:

- (a) 0.84V r.m.s. isolated heater supply;
- (b) line blanking pulse (a replica of the converter drive waveform);
- (c) 22V, rectified and applied to the video amplifier;
- (d) 128V, rectified and delivered to a 28V stabiliser supplying the tuning potentiometer RV1;
- (e) 182V (two windings) supplying the line integrators;
- (f) 268V, rectified and applied to the frame amplifiers and tube pin 5 (A2) via the focus potentiometer RV6;

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(g) 493V for the Cockcroft Ladder delivering the following EHT tube supplies either directly or via potential dividers:

- (i) 960V to A1 and A3;
- (ii) 960V to frame plates (+/- 40V variation on one plate using VERTICAL SHIFT potentiometer RV4);
- (iii) 1186V to line plate (1), 1060V to line plate (2) with a +/- 50V variation using HORIZONTAL SHIFT potentiometer RV3 (asymmetry in the line plate voltages takes into account a natural shift in the tube);
- (iv) 2400V to the screen;
- (v) 1920V to the guard band;
- (vi) 1440V to the repeller.

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CIRCUIT OPERATION

3.1 Documentation

3.1.1 Two models of FTV1 have been sold in UK and Europe – FTV1B incorporating Issue 10 printed circuit board and the later model FTV1C using Issue 12 board. These appear identical from the outer case but the model identification code (B or C) is included in the serial number, located underneath the hinged stand on the back of the case.

3.1.2 The European model FTV2 is a version optimised to receive VHF/UHF in most European countries (except France) and is recognisable by a 3 position slide switch on front of case.

3.1.3 The build standard of a unit is traced via the serial number. Appropriate circuit diagrams, component layout diagrams, test point diagrams and parts lists for FTV1B and FTV1C (Issue 10 and 12 p.c.b.) are included as annexes to this manual. Further copies are available from Timex Corporation, Harrison Road, Dundee.

3.2 Line Integrators

3.2.1 Both models of the receiver employ identical line integrators TR5 through TR9. The integrator has complementary stages which derive the familiar saw tooth scanning waveforms for the line plates. Considering one half only, integrator TR9/C5 is charged during the line flyback by the positive pulse from L2 via D7. Over the same period TR7 holds off TR9, maintaining the charge on C5. At the end of flyback, the integrator discharges via TR6 at a rate determined by the picture width potentiometer and the stair-step line correction waveform applied to TR6 base. The correction waveform compensates for non-linearity in the tube's line scan characteristic, causing the integrator discharge rate to increase as the line progresses. The resultant output at TR9 is a.c. coupled to the line plate via C7.

3.2.2 The process is mirrored by the negative integrator TR8/C4 which charges from negative flyback pulse via D6. However, since TR8 tends to possess a larger inherent capacitance, the value of C4 is lower than its counterpart C5, thus ensuring a symmetrical scan.

3.3 Frame Amplifiers

3.3.1 The frame amplifier is a simple co-linear amplifier TR10, TR11 fed with complementary frame drive waveforms from the IC. The waveforms are 50Hz ramps with a small proportion of the 15kHz line scan waveform added to compensate for the non-linear frame scan characteristics of the tube.

3.3.2 Capacitor C21 improves the frequency response of the amplifiers compensating for the cumulative effects of capacitive loading. Since the 15kHz correction waveform is most adversely affected by the gain characteristics, the value of C21A (select-on-test) in parallel with C21 must be carefully selected to obtain a linear scan. Too little capacitance causes the picture to taper left to right; too much causes a 'fishtail' effect (slewrate limiting).

3.3.3 The general gain characteristic of the amplifier is controlled by RV5 allowing the picture height to be adjusted.

Note that this also alters the time constant of C21/21A and hence the compensating effect.

3.4 IC and Supporting Circuits

3.4.1 Pin-out details of the IC and operation of the supporting circuits are summarised in the following paragraphs. In general wave shapes are shown on the circuit diagrams and in the oscillograms reproduced in Section 4.

3.4.2 Pin 1 (VCO Decouple). C32 decouples the control voltage to the sound local VCO. RV9 supplies a d.c. offset allowing the oscillator to be fine tuned for optimum sound quality.

3.4.3 Pin 2(VCO Control). This is similar to pin 1 but affects the line hold VCO. RV8 allows the line hold to be adjusted.

3.4.4 Pin 3(In-Lock Detector). R31/C34 are bias components for the in-lock detector.

3.4.5 Pin 4 (Line Correction). This feeds the line integrators with a stair-step waveform which compensates the line scan for non-linearity in the tube.

3.4.6 Pins 5, 10 (ground), and 12 (VCC). These carry the 6V battery/adaptor supply via ON/OFF switch S1. A battery voltage sensor automatically adjusts the line and frame scans as the battery level drops.

3.4.7 Pin 6 (Converter Drive). This feeds a pulse waveform to the power converter switching transistor TR4. The resultant output pulls current through the primaries of L1/L2 generating the unregulated d.c. power rails and the line blanking waveform for the tube.

3.4.8 Pins 7 and 8 (Frame Drives). These feed complementary frame scan waveforms to the frame amplifier TR10/TR11. The scans are compensated by the addition of a 15kHz line scan component which results in a 'bow tie' waveform seen in the oscillogram at the beginning and the end of the 50Hz ramp.

3.4.9 Pin 9 (3.2V). This feeds a temperature compensated, drift free d.c. supply to the line hold and sound offset potentiometers.

3.4.10 Pin 11 (Loudspeaker). This is the output from the audio power amplifier, and is fed to the internal loudspeaker via a coupling capacitor C42 and the earphone socket. The latter has a 47 ohm resistor R37 connected to ground, providing the amplifier with short-circuit protection.

3.4.11 Pins 13 and 15 (Audio Amplifier). An external virtual earth amplifier is connected between the sound discriminator (Pin 15) and audio power amplifier input (Pin 13). The amplifier has a maximum gain of 10 adjusted by the VOLUME potentiometer RV2. C39 at Pin 15 provides de-emphasis, R35 provides supply noise cancellation.

3.4.12 Pin 14. This is the 3V d.c. varicap tuner supply.

3.4.13 Pin 16 (Video). This is the output from the video detector and is fed to an external common emitter amplifier stage TR2. The mean amplitude of the video applied to the tube grid, and therefore the contrast, is fixed by the IC.

3.4.14 Pin 17 (AGC Capacitor). This pin carries the AGC decoupling capacitor C28 for the IF amplifier.

3.4.15 Pins 18 and 19 (IF Ground and IF). These pins carry the 230MHz IF signal from the tuner.

3.4.16 Pin 20 (Sync Separator). This carries the video signal from Pin 16 to the sync separation circuits in the IC via a filter R32, C38. The circuit is biased from the tuning supply via R41.

3.4.17 Pins 21 and 22 (Phase Filter). These pins connect a low pass filter (C29–C31 and R28) in the line hold phase locked loop. Shorting out the pins allows the oscillator to run at the natural frequency, adjusted using the line and hold potentiometer RV8.

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CHAPTER 4

DISASSEMBLY AND ASSEMBLY

4.1 Final Assembly Components

4.1.1 The flat screen TV comprises the following sub-assemblies:

- (a) front case moulding fitted with picture height correction lens (Fresnel) and fascia panel;
- (b) rear case moulding fitted with battery housing, battery terminals and leads, viewing stand, telescopic aerial and aerial lead;
- (c) printed circuit board (Issue 10 or 12) fitted with all circuit components including tube.

4.1.2 Electrical connections between the board and rear case are via three flexible leads, two for battery power (red +ve, black -ve) and one for the aerial input (white).

4.2 Disassembly

WARNING

The FTV generates EHT supplies in excess of 2400V; observe normal precautions and avoid contact.

ELECTROSTATIC SENSITIVITY

FTV chassis incorporate electrostatic sensitive devices (ESDs). Special ESD handling methods must be used (e.g. BS 5783).

NOTE

The front fascia is very susceptible to damage (scratches, scuffs). If it is intended to refit the existing fascia after servicing, first clean the fascia and cover with protection tape.

4.2.1 The board is accessed by separating the front and rear case parts. Disconnect the mains adapter and slide out the battery. Remove four cross-head self-tapping screws visible through recesses in the rear cover, and a fifth identical screw accessible after removing the CAUTION label fixed to the viewing stand and piercing the warranty seal underneath the stand. Turn the receiver screen side uppermost and after freeing the control knobs projecting through the front, lift the moulding clear.

4.2.2 Before touching the board, ground the EHT from TP8. The board is removed from the rear case simply by lifting it off the five mounting pillars observing the precautions in 5.1. The battery and aerial leads need not be disconnected for servicing, but excess strain must be avoided. Also avoid rocking the tube and keep the rubber sealing gasket in place to prevent scratching the tube face if the board is placed upside down on a work bench.

4.2.3 Note that later models of Issue 12 and Issue 2A have push-in tubes fitted. This is a modification intended to facilitate assembly and repair, and comprises a 20 position single in-line socket soldered into the PCB. Into this is pushed the CRT which then 'floats' and takes up its own position at assembly of case.

4.3 Assembly

4.3.1 Check the solder side of the p.c.b. for dry joints and shorts, particularly on any rework.

4.3.2 Before replacing the board on the rear case mounting pillars, ensure that the battery and aerial leads are making good connections and that the mounting holes are not obscured by components. Check that no swarf has been attracted into the loudspeaker.

4.3.3 After locating the board on the mounting pillars, ensure that the battery and aerial leads are not trapped, that they are neatly stowed beneath the board, and that they FOLLOW THE CORRECT ROUTE (this is extremely important, particularly for the aerial wire – see relevant drawing). Check for swarf and solder-splash shorts on the component side of the p.c.b. Gently ease off any radial components which are in danger of shorting.

4.3.4 Carefully remove the rubber tube gasket, clean the viewing area (only) of the tube with isopropyl alcohol and refit the gasket. Remove dust from the inside face of the Fresnel lens mounted in the front case, using a brush or airline if available.

4.3.5 Fit the front case by easing the control knobs through the apertures (if knobs are not aligned with apertures then the use of a scalpel or craft knife is recommended, but care must be taken to ensure the knobs and apertures are not damaged).

4.3.6 Check that the front and rear case parts fit together well with no obstructions and complete the assembly by securing the five fixing screws, taking care not to apply too much torque (this will strip the threads) but ensuring that the screws are fully home.

4.3.7 Carry out Functional and Soak tests. When these are completed satisfactorily, refit labels to units.

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5.1 Precautions

WARNING

EHT voltage up to 2.4kV are present in the FTV. Exercise extreme care when working on the exposed power-up p.c.b.

ELECTROSTATIC SENSITIVITY

FTV chassis incorporate electrostatic sensitive devices (ESDs). Special ESD handling methods must be used (e.g. BS 5783).

IMPORTANT NOTE

Setting up must never be carried out on returned FTVs without first checking for obscure faults which could have caused change of set up. See Table 4.

5.2 Setting-up involves checking the current consumption and various power supply voltages, selection of C21A, and alignment of the potentiometers. To carry out these procedures it is necessary to de-case the FTV (see 4.2).

5.3 For repair purposes, the complete setting-up procedure may not be necessary, depending on the nature of the fault. However, if any picture alignment potentiometer adjustments are necessary, then the complete picture alignment procedure must be followed as they interact to some extent (see Table 1). If a potentiometer is replaced it is important to set it initially to the mid position.

5.4 Current and Voltage Checks

5.4.1 When measuring the current consumption and voltages, the FTV must be locked onto a test signal with the volume (sound) control on minimum. The FTV will not lock or is slow and difficult to lock, check that RV8 (line hold adjuster) is set correctly. Short circuit I.C. pins 21 and 22 and adjust for near stationery picture.

5.4.2 Using the specified supply voltage (5.9V +/- 0.05V d.c., calibrated daily) check that the overall current consumption is within the specified limit. (95mA.max. for Issue 10 and 12; and 105mA.max. for Issue 2A, at minimum volume).

5.4.3 Check the following internally generated voltages are in accordance with those values as listed below:

(a) EHT (TP8), using 1000 megohm probe;	2400 +/- 50v.
(b) Frame (TP9), using 1000 megohm probe;	268 +/- 9v.
(c) Tuning Supply (TP7) w.r.t. 3V rail;	27.5 +/- 2v.
(d) Video Supply (TP6);	22.0 +/- 1.5v.
(e) Reference 3v Supply;	3.0 +/- 150millivolts
(f) Heater Supply (True R.M.S.);	0.84 +/- 50millivolts

In general, if these voltages are correct then the corresponding dependent voltages will be correct.

5.4.4 If the EHT is not correct, readjust by means of L1 and L2 and repeat current and voltage measurements. However, incorrect EHT is usually an indication of a fault and readjustment will probably obscure rather than eliminate the cause. L1 and L2 interact greatly and must be tuned by approximately the same amount (same height of slug) to set the EHT. It is important to increase the EHT slowly and carefully because if it is allowed to go too high, various components (notably D6) will fail.

5.5. Adjustment

5.5.1 The adjustment procedure requires that the FTV is locked onto the crosshatch pattern generated by a Phillips No. 5519 (or equivalent) Pattern Generator.

An oscilloscope is also required to monitor IC pin 15 (TP15) with suitable sound carrier to set RV9.

5.5.2 Loosely couple RF Test signal to Aerial on Microvision and when setting the geometry, it is important that the FTV is not affected by any spurious magnetic fields, e.g. adjacent steel benches, pillars, girders, etc.

5.5.3 Table 1 sets out the order in which setting up should be done and explains how to adjust each potentiometer and select the S.O.T. capacitor C21A.

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CHAPTER 6

FAULT DIAGNOSIS AND REPAIR

6.1 This chapter is a guide to the fault diagnosis and repair of the FTV1 and FTV2A. Knowledge of electronic theory and experience of servicing and fault finding are assumed. The following major equipment items are the minimum required:

- (a) Phillips Pattern Generator 5519 (or equivalent);
- (b) 4.7 to 6.5V variable power supply with 150mA current limit;
- (c) oscilloscope with rise time of $< 1\mu\text{s}$;
- (d) oscilloscope probe $\times 10$ (10 megohm);
- (e) general purpose multimeter;
- (f) high voltage multimeter probe with impedance minimum 1000 megohms total, capable of measuring 3kV;
- (g) Normal Anti-static protection is recommended for handling Microvisions;
- (h) earthed soldering iron;
- (i) true R.M.S. meter (to check heater voltage).

6.2 As a matter of course, the unit should be visually inspected for obvious damage, prior to powering up. DO NOT APPLY POWER if the CRT is broken.

6.3 Note that care should be taken if there is a necessity to repair broken tracks, particularly in High Voltage areas where such repairs are not recommended.

6.4 Before a suspect unit is powered up, an initial check should be made between each power rail and OV to isolate any short circuits, as shown in Table 2.

6.5 Power up the unit with 5.9V supply, current limited to 150mA, and carry out the voltage checks set out in Table 3.

6.6 Typical Waveforms

6.6.1 Examples of typical waveforms are given in Figures S1 to S20. It has been found that the best method of checking waveforms and response levels is to compare with the same point on a known good unit. Alternatively, the use of signal tracing equipment should identify a fault.

6.6.2 The waveforms shown were measured on a tuned unit locked to a pattern. The oscilloscope used for the measurements was equipped with a 10 megohm $\times 10$ probe. The reference on the figures (e.g. S1) refer to oscilloscope measuring points.

6.7 Fault Finding Guide

6.7.1 Table 1 is a fault diagnosis chart providing guidance to possible courses of action to follow when faults are identified. The order of symptoms is random and the list is as exhaustive as possible at the time of writing.

TABLE 1 – AID TO FAULT DIAGNOSIS

CONDITION	LIKELY CAUSE	RECOMMENDED ACTION
Insufficient width including white line at side of picture	TR5 to TR9, C5, D6/7, Tube IC1	Check suspect comps, coils, links, C6/7. R5/29 and PCB contamination monitor S7, 13, 15 with scope.
Insufficient height including corners folded over	TR10, 11, Tube, IC1, D8	Check suspect comps., R23/24 for correct value, check frames supply and links. Monitor S3, 4, 5, 6.
No picture (sound OK)	Tube, IC1, TR2	Visually check heater's AC on TP4-5. Check convertor S10
No sound (picture OK)	Speaker, TR1, C41/42	Check connections, and earphone sound.
No ear. sound (speaker OK)	SK2, R37	Check for faulty socket.
Insensitivity to signals	IC1, Tuner	Check tracks tuner to IC1. Check aerial and wire routing along ledge of case.
No picture or sound	Volume On/Off switch	Check switch, SK1 and battery. If convertor is heard whistling check as for no picture/sound.
Picture broken up, jagged jumpy	Tube	Use insulated screw driver and tap tube contacts gently for intermittance; Check short R3/R5.
No picture shift adjustment	RV3/4 Tube	Check suspect comps. including R8, 9, 10, 11, 16.
Cannot focus	RV6, Tube	Check RV6, R14, 15, CRT pin 5(A2).
Trapezoidal picture	C21, 21a, EHT (D8-17) Frame cct.	Check C21, 21a, EHT, contamination on PCB causing tracking.
Fishtail picture	C21, 21a	Check R20, 21, 23, 24, reduce C21a
Dim picture	EHT (D8-17), CRT, R1	Check EHT, R1 value. If focus also then change CRT.
Picture bright and washed out	C1, R1, CRT	Check leakage/short on C1 and value of R1.
Streaky picture	C1, CRT	Check o/c on C1.
Poor sound	Speaker, IC1, RV9	Check speaker cone for swarf or inversion, check RV9 setting.
Sound on vision	C47, IC1, RV9	Check RV9 setting. O/c C57, IC1 in socket firmly.
Shading (corners dark)	CRT and EHT	Don't confuse with foldover. Check using RV3.
Horizontal bright line on screen	IC1, D8	Check for scan at IC pins 7-8.

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Cont'd.

CONDITION	LIKELY CAUSE	RECOMMENDED ACTION
Picture large and distorted	EHT, D9-17, C8-16, CRT	Check PCB contamination, also on EHT stack.
Vertical line or short line scan	D6, 7, C6, 7	PCB contamination under C6, 7. Check and renew as necessary.
TV cuts out after prolonged use.	IC1	Renew
TV drifts off tune	C26	Check contamination under C26

It should be noted that the above fault finding table applies to Issue 12 version. For other versions the appropriate component numbers should be substituted.

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CHAPTER 7

REPAIR

7.1 Removal of components must be carried out using established desoldering and heatsinking techniques to avoid damage to adjacent components or to the p.c.b. The following points should also be noted.

(a) When changing the IC, static sensitive handling precautions must be used, also it is essential to avoid undue stress on the fragile tube connections. Most of the units have sockets fitted for the IC; a small screwdriver is recommended for removing the IC, prising it up from the end away from the tuner. Avoid contaminating the IC pins by finger contact. When replacing the IC in a socket, take care to locate all the legs into the socket pins.

(b) When changing any component it is essential that the FTV be disconnected from the power supply; switching the FTV off gives no protection in the case of a short in the on/off switch.

(c) Take **VERY GREAT CARE** when handling the CRT before and after installation. The pins are **VERY FRAGILE** particularly at the connections to the CRT tracks. Later versions of Issue 12 p.c.b. (FTV1C) are fitted with sockets for the CRT; replacement CRTs for this version must have the legs cropped to a length of 12 to 12½mm measured from the top surface of CRT.

To **REMOVE** the CRT from socket, push gently from underside through the PCB aperture, ensuring the CRT is kept parallel to PCB thereby avoiding stress on the joints between the legs and the glass.

To **REPLACE** the CRT locate a cropped CRT in position and gently press with both thumbs in the pin area until resistance is felt. The CRT will then 'float' and take up its own position when the case parts are assembled.

(d) The flaps on the underside of the tuner must not be disturbed, since this changes the tuner response. The components underneath the tuner, particularly the disc capacitors, should be examined to ensure they do not foul the flaps when a new tuner is fitted.

(e) Diodes D8 to D17 are particularly prone to heat damage. They should be preformed and soldered carefully, with the component body at least 2mm above the p.c.b. surface.

7.2 Workmanship Standards

7.2.1 All aspects of the work undertaken to carry out FTV servicing must be performed to standards and under conditions adequate to achieve the objectives, in particular the following:

(a) Clean, dry and well-organised conditions for repair work and storage.

(b) Appropriately experienced and trained operators.

(c) Adequate instruction documentation available for all operators.

(d) Good soldering practices, using appropriate temperature-controlled soldering and desoldering equipment.

(e) Static sensitive handling facilities for the IC.

(f) FTV parts to be clearly labelled and kept separate from parts for other work.

(g) Full records and reporting in accordance with specific instructions.

7.3 Parts Lists and Specifications

7.3.1 It is essential to adhere to the Parts Lists and Specifications provided.

Documentation is intended to be self-explanatory, but if there are any doubts or queries, they **MUST** be directed to the appropriate personnel.

7.3.2 It is the responsibility of the servicing agent to ensure that only the correct components are used. This responsibility includes adequate verification of components on receipt, irrespective of the source.

7.3.3 All serviced FTVs which have been decased must conform to Bill of Materials and incorporate the correct components as defined by the relevant Parts List.

7.3.4 Serviced FTVs must also comply with the requirements of being functional in all respects. Cosmetic defects are allowed provided the FTV is returned to the original individual owner and provided the cosmetic defects have no effect on its function.

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CHAPTER 8

DIFFERENCES FTV12A AND FTV2A

8.1 The VHF/UHF version (Issue 2A), is basically the same circuitry as the Issue 12A with some differences in the P.C.B. layout and components.

The component differences can be identified from the Parts List which is Issue 12A orientated, and for further information the differences are as detailed below.

8.1.1 The P.C.B. legend on Issue 12a boards is in White Ink, and on Issue 2A boards it is in Yellow Ink.

8.1.2 The Tuner is more complex on Issue 2A and has a 3 position slide switch to cover both VHF/UHF bands (2-VHF, and 1-UHF), and the Tuner is optimized for either U.S.A. or Europe. (Identified)

8.1.3 Under the Tuner is a SAW filter. Like the Tuner it is also optimized for U.S.A. or Europe, although at a later date it is envisaged that a common SAW will be developed in order to cover both types.

8.1.4 The IC is unique depending on type of TV set, and is identified by either a Yellow or Blue dot as follows:

Yellow Dot – U.S.A. or Europe or U.K.

Blue Dot – Europe or U.K. only

No Marking – U.K. only

8.1.5 On all Issue 2A there is a tuned capacitor fitted between the end of the aerial wire and the P.C.B. connection. The purpose of this is to filter out strong FM signals which can interfere with reception, especially in large cities.

8.1.6. On all FTV2A there are three components attached to the IC, C55-390pf. disc capacitor fitted to pins 5 and 6; C54-100nf axial capacitor fitted to pins 14 and 18; and C53-100pf. axial capacitor fitted to pins 18 and 20.

8.1.7. Underneath the P.C.B. there are two additional capacitors, C26-22 to 47nf (existing C26 position on board no used), and C52-390pf axial capacitor.

TABLE 2 – PICTURE SET UP PROCEDURE

NOTE: Picture may shift slightly depending on Microvision orientation relative to the Earth's magnetic field, therefore to obtain consistency, Microvision should be set up then orientated to ensure magnetic effect on picture shift is minimal.

COMP.	FUNCTION	ADJUSTMENT
RV8	Line Hold	Short TP1/TP2 to achieve min. motion of image, then remove short.
RV3	Horizontal Shift	Adjust for horizontal centering of circle.
RV4	Vertical Shift	Adjust for vertical centering of circle.
RV5	Height	Adjust for optimum picture height.
RV7	Width	Adjust for optimum picture height.
C21a	Horizontal Taper	Select C21a to adjust line taper to within spec. limits. Reset RV5 if necessary.
RV6	Focus	Adjust for best compromise between focus in centre and lower corner furthest from gun, with emphasis on centre focus. Reset RV3, 5, 5, 7 if necessary.
RV2	Volume	Check on/off function and range of control.
RV9	Sound Offset	Adjust as follows: Use spec. signal with sound carrier alternating between 6.0 and 5.532125 MHz and monitor IC pin 15(TP15) with oscilloscope. Set RV9 for 1.1v pk-pk signal, the 6MHz portion of signal should be the lower.
RV1	Tuning	Check for travel over full range receiving channels 21 and 69.

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TABLE 3 – INITIAL SHORT CIRCUIT TESTS WITHOUT POWER

Check continuity between test points and –ve battery terminal.

CIRCUIT UNDER TEST	TEST POINT
Heater supply	TP 4
Frame Supply	TP 9
EHT Supply	TP 8
+3v Supply	TP 14
Tuner Supply	TP 7
Video Supply	TP 6
Battery Supply	Battery +ve.

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MICROVISION PARTS LIST

PCB ASSEMBLY

RESISTORS – UNLESS OTHERWISE STATED ALL RESISTORS ARE 0.25W, +/- 5%. METAL GLAZE TYPE MUST BE FITTED WHERE INDICATED (MG). VALUES WITH 10% TOLERANCE ARE INDICATED '*'. *

LOC'N	12A	TOL.	OTHER ISSUES	
			10	2A EURO
R1	6M8 HORIZ	*	=	=
R2	100R VERT		100R HORIZ	=
R3	100K HORIZ		=	100K VERT
R4	N/U		27K HORIZ	N/U
R5	100K HORIZ		100K VERT	100K VERT
R8	47M VERT (MG)	*	=	=
R9	47M VERT (MG)	*	=	=
R10	27M VERT (MG)	*	=	=
R11	10M VERT	*	=	=
R12	33M HORIZ	*	33M VERT	=
R13	15M VERT	*	=	=
R14	100M HORIZ (MG)	*	=	=
R15	12M VERT	*	12M HORIZ	=
R16	100M VERT (MG)	*	=	=
R17	100M VERT (MG)	*	=	=
R20	2M2 HORIZ		2M2 VERT	2M2 HORIZ
R21	2M2 HORIZ		2M2 VERT	2M2 HORIZ
R23	30K VERT		27K VERT	30K VERT
R24	30K VERT		27K VERT	30K VERT
R25	1K5 VERT		=	=
R26	1M2 HORIZ		=	820K HORIZ
R27	100K VERT		=	1M VERT
R28	2K7 VERT		=	=
R29	2K2 HORIZ		2K2 VERT	2K2 VERT
R31	270K VERT		=	=
R32	1K VERT		=	=
R33	2K7 VERT		=	=
R34	1K VERT		=	=
R35	10K VERT		=	=
R36	2K2 VERT		=	=
R37	47R VERT		=	=
R41A	N/U		33M HORIZ @	N/U
R42	10K HORIZ		=	=
R43	2K7 HORIZ		=	=
R44	560R HORIZ		560R VERT	560R HORIZ
R46	820K VERT		=	470K VERT
R47	100K HORIZ		100K VERT	100K HORIZ
R48	22M HORIZ		N/U	22M HORIZ
R49	1K HORIZ	*	1K HORIZ \$	1K HORIZ
R50	N/U		N/U	220R HORIZ

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NOTE: @ – R41A FITTED FROM SPEAKER END OF R41 TO MIDDLE LEAD OF RV1 – LEAD MUST BE SLEEVED.

\$ – 1K MINIATURE BODY FITTED IN SERIES WITH D1.

DIODES	12A	TOL.	10	2A EURO
D1	ZPD27/28 HORIZ	+/- 5% TOL.	= S	=
D3	1N4148 HORIZ		1N4148 VERT	1N4148 HORIZ
D4	BAV21 HORIZ		BAV21 VERT	BAV21 HORIZ
D5	-- " --		-- " --	-- " --
D6	-- " --		-- " --	D6 MOD. *
D7	-- " --		-- " --	D7 MOD. *
D8	1N4937 VERT		=	=
D9	-- " --		=	=
D10	-- " --		=	=
D11	-- " --		=	=
D12	-- " --		=	=
D13	-- " --		=	=
D14	-- " --		=	=
D15	-- " --		=	=
D16	-- " --		=	=
D17	-- " --		=	=

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NOTE: D8-17 REQUIRE ADDITIONAL SPEC. ON REVERSE CAPACITANCE AT 100V TO BE <3PF. TRR TO BE <250NS.
S MOD. IN CONJUNCTION WITH R49. * IN SERIES WITH 3K3 RES.

DISC CAPACITORS

		TOL.		
C1	47NF 50V	+80/- 20%	=	=
C2	2P2 500V	+/- 0.5PF	=	=
C3	-- " --	=	=	=
C4	4P7 500V	+/- 0.25PF	=	=
C5	5P6 500V	=	=	=
C6	2N2 1500V	+80/-20%	=	=
C7	-- " --	=	=	=
C8	2N2 750V	=	=	=
C9	-- " --	=	=	=
C10	-- " --	=	=	=
C11	-- " --	=	=	=
C12	-- " --	=	=	=
C13	-- " --	=	=	=
C14	-- " --	=	=	=
C15	-- " --	=	=	=
C16	-- " --	=	=	=
C18	2N2 1500V	=	=	=
C19	-- " --	=	=	=
C21	1N5	+/-10%	=	=
C21A	100PF-1NF S.O.T.	(SEE END NOTES)	=	=
C22	4N7 350V	+80/--20%	=	=
C23	-- " --	=	=	=
C24	390PF 10V	+80/- 20%	=	N/U
C25	-- " --	=	=	390PF 10V HOR
C26	47NF 50V	=	=	SEE NOTES
C27	390PF 10V	=	=	=
C30	47NF 50V	=	=	=
C31	-- " --	=	=	=
C33	100PF 10V	=	=	=
C34	N/U	=	=	100NF 25V
C37	100NF 10V	=	=	100NF 25V
C38	270PF 10V	=	=	=
C39	47NF 50V	=	=	=
C43	47NF 50V	+80/--20%	=	=

DISC CAPACITORS (Cont'd.)

	12A		10	2A EURO
C49	N/U	N/U	N/U	4P7 10V
C50	N/U	=	N/U	4P7 10V
C51	N/U	=	N/U	100NF HORIZ
C52	N/U	=	N/U	SEE NOTES
C53	N/U	=	N/U	-- " --
C54	N/U	=	N/U	-- " --
C55	N/U	=	N/U	-- " --

NOTE: ALL VERTICALLY MOUNTED – EXCEPT C26 AND C37 ALTERNATIVE. SEVERAL CAPACITORS REQUIRE ADDITIONAL SPEC. REQUIREMENTS.

C26 PIN 8 TO PIN 10 TUNER 22/47NF HORIZ. (MOD. SOLDER SIDE)
 C52 PIN 10 TUNER TO GRD. 390PF HORIZ (MOD.)
 C53 PIN 18 / PIN 20 I.C.1 100PF HORIZ "
 C54 PIN 14 / PIN 18 I.C.1 100NF HORIZ "
 C55 PIN 5 / PIN 6 I.C.1 390PF RAD. "

ELECTROLYTIC CAPACITORS -- ALL VERTICALLY MOUNTED

C28	4U7 6.3V	+80/- 20%	=	=
C29	10UF 6.3V	=	=	=
C32	-- " --	=	=	=
C34	0.1UF 6.3V	=	=	=
C35	10UF 25V	=	=	=
C40	.22UF 6.3V	=	=	=
C41	1UF 6.3V	=	=	=
C42	10UF 25V	=	=	=
C44	10UF 6.3V	=	=	=
C46	10UF 25V	=	=	=
C47	470UF 6.3V	=	=	=

TRANSISTORS – ALL VERTICALLY MOUNTED
 WHERE CHOICE OF TYPES IS GIVEN, THE EQUIVALENTS MAY NOT HAVE THE SAME POLARITY.

TR1	BCP 184P/BC239/549B	=	=
TR2	BF 199/MPSH 10	=	=
TR4	ZTX655/FST289	=	=
TR5	BC213P/BC308B/558B	=	=
TR6	BCP184P/BC239/549B	=	=
TR7	-- " --	=	=
TR8	BF493/MPSA92/FST340	=	=
TR9	BF393	=	=
TR10	-- " --	=	=
TR11	-- " --	=	=

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VARIABLE RESISTORS - ALL VERTICALLY MOUNTED

12A			10	2A EURO
RV1	1M 20 TURN	20% *	=	=
RV2/S1	10K LOG/SW	20%	=	=
RV3	10M PRESET	30%	=	=
RV4	12M PRESET	25%	=	=
RV5	100K PRESET	20%	=	=
RV6	10M PRESET	30%	=	=
RV7	100K PRESET	20%	47K PRESET	100K PRESET
RV8	47K PRESET	20%	=	=
RV9	47K PRESET	20%	22K PRESET	47K PRESET

NOTE: * IF RV1 IS LINEAR TYPE, R53 IS REQUIRED.

OTHER COMPONENTS

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I.C.1	ZN401E-2	=	EURO TYPE
I.C. SOCKET	22 PIN	=	N/U
V1 CRT	=	=	=
TUNER BOX	=	=	EURO TYPE
LS1 SPEAKER	32 OHM	=	=
L1	CANS A1399 YUT	=	=
L2	CZNS 5044 FOT	=	=
L3	N/U	N/U	A210SNS-896FRH
SAW FILTER	N/U	N/U	EURO TYPE
SK1 PWR. SKT.	HEC 0737 (SPEC. PIN LGTH.)	=	=
SK2 EAR SKT.	HSJ 0836 (SPEC. PIN LGTH.)	=	=
STRIP-2WAY	=	=	=
STRIP-7WAY	=	=	=
TUNED CAP	N/U	=	BACK OF BOARD*

NOTE: *- TUNED CAP. SUB-ASSY. - 47PF + 4 TURNS 38 SWG WIRE (SLEEVED), FIT BETWEEN AERIAL WIRE AND TUNER PIN 5.

D6 DIODE MOD. 3K3 RES. + BAV21 (CATHODE TOWARDS)
D7 DIODE MOD. 3K3 RES. + BAV21 (CATHODE AWAY)

100PF	.....	20%
220PF	.....	10%
270PF	.....	5%
390PF	.....	5%
470PF	.....	5%
560PF	.....	5%
680PF	.....	2.5%
820PF	.....	2%
1NF	.....	2%

NON UNDERGLAZE VERSIONS

THE FOLLOWING CHANGES ALLOW TUBES WITH HIGH LEAKAGE CURRENT TO BE USED. THIS TYPE OF TUBE CAN BE IDENTIFIED BY THE LACK OF UNDERGLAZING ON THE TUBE BASE UNDER THE GUN ASSEMBLY. (ON A TUBE WITH UNDERGLAZE THIS AREA LOOKS GREY).

NON UNDERGLAZE UNITS CAN ALSO BE IDENTIFIED BY A BLUE PRINTED SERIAL NUMBER LABEL ON THE CASE.

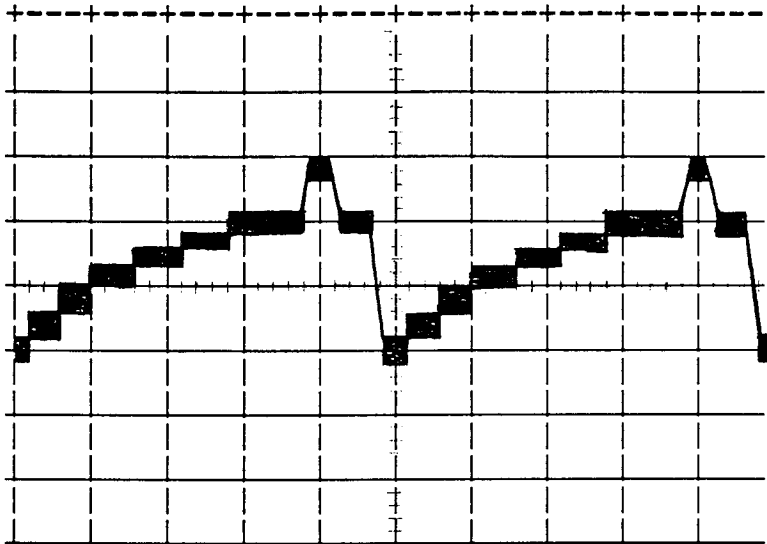
CHANGES:

C18 .. DELETE	2N2	REPLACE WITH	56NF M.L.C.
R17 .. DELETE	100M	REPLACE WITH	10M METAL GLAZE
R10 .. DELETE	27M	REPLACE WITH	12M METAL GLAZE
R11 .. DELETE	10M	REPLACE WITH	2M2 C.F.
R12 .. DELETE	33M	REPLACE WITH	22M METAL GLAZE
R13 .. DELETE	15M	REPLACE WITH	10M C.F.

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HALF GREY SCALE.

OSCILLOSCOPE SET TO:-



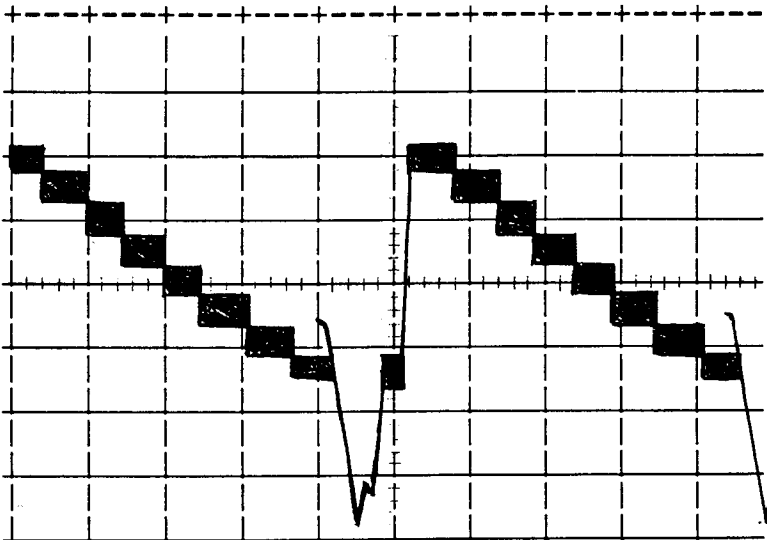
HORIZONTAL. VERTICAL.

10 μ S. 200MV.

S 1.

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OSCILLOSCOPE SET TO:-



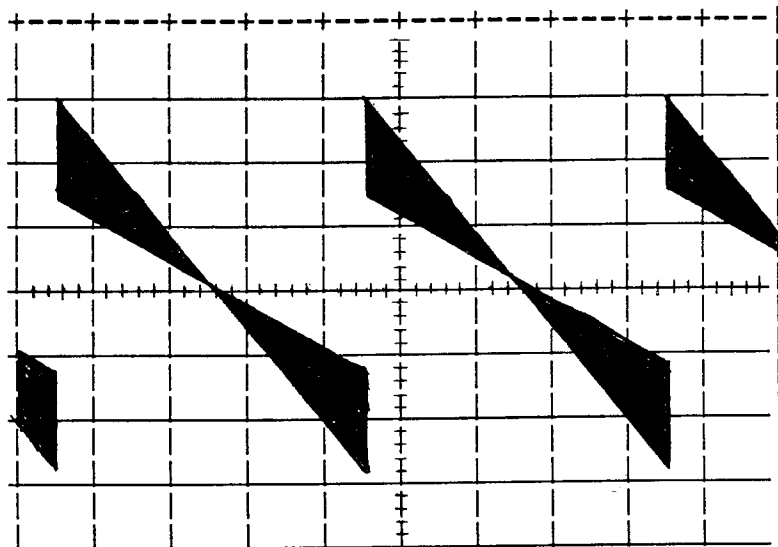
HORIZONTAL. VERTICAL.

10 μ S. 2V.

S 2.

HALF GREY SCALE.

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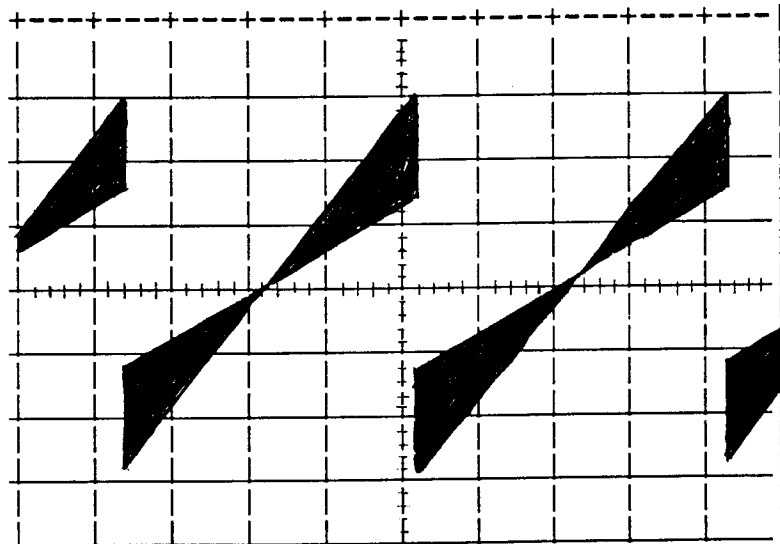


HORIZONTAL. VERTICAL.

5MS. 200MV.

S 3,6.

OSCILLOSCOPE SET TO:-



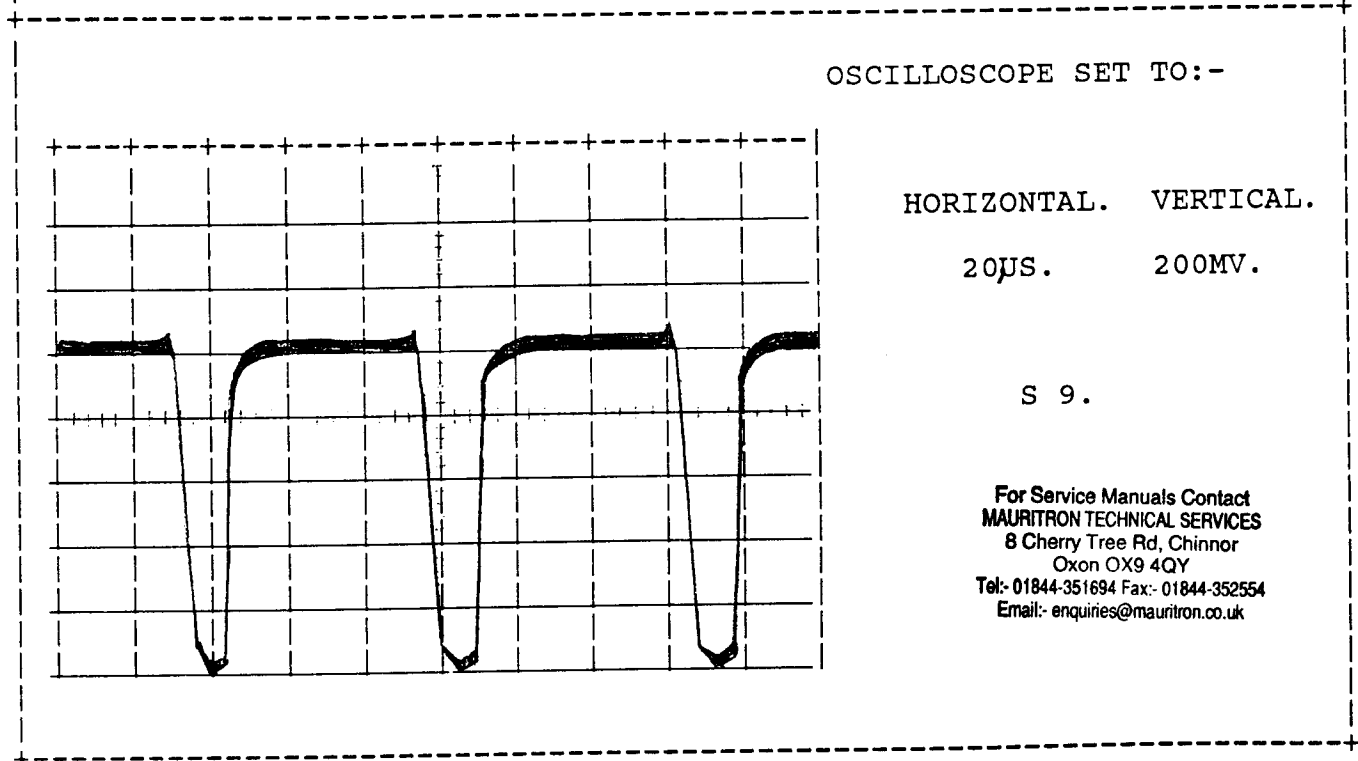
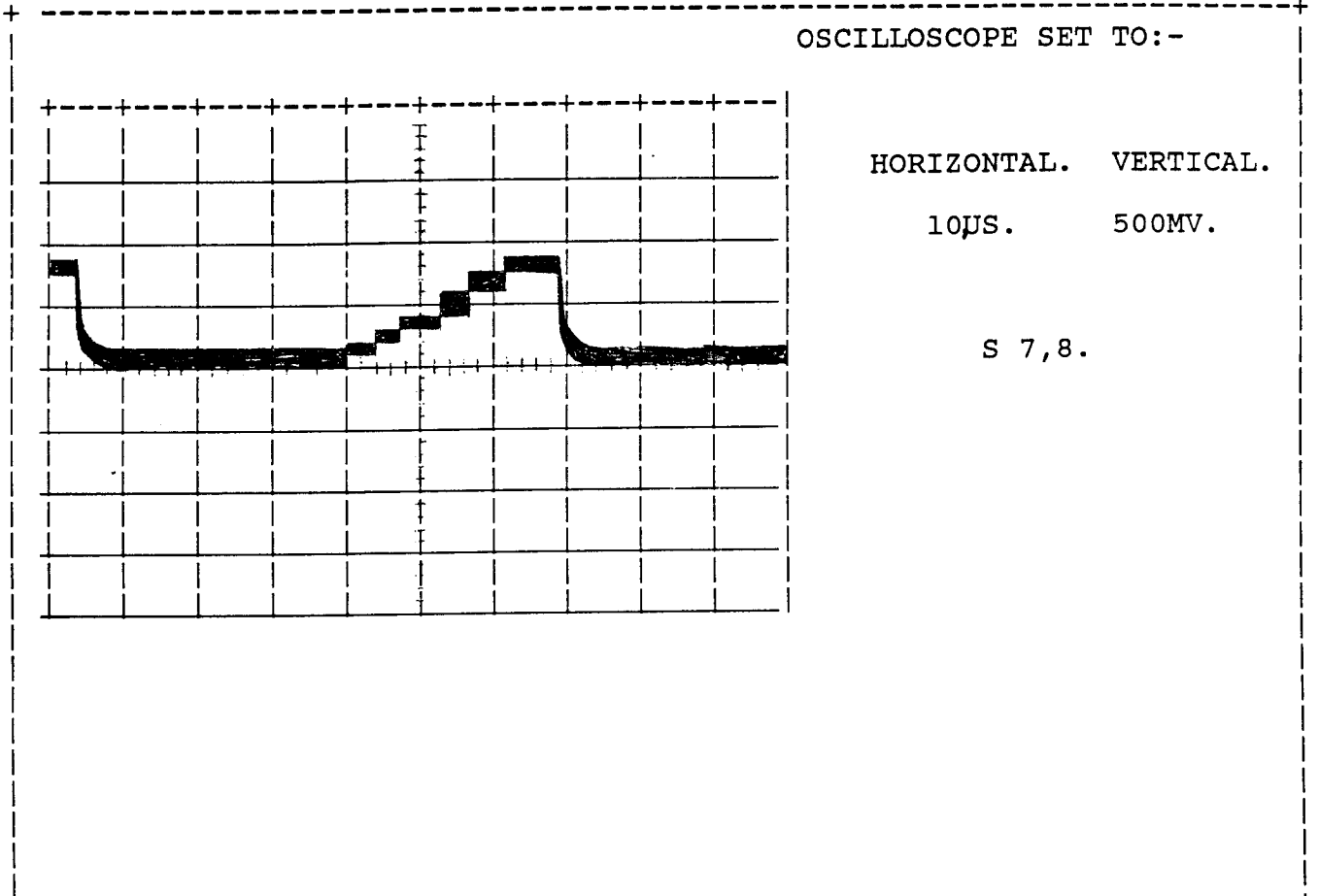
HORIZONTAL. VERTICAL.

5MS. 200MV.

S 4,5.

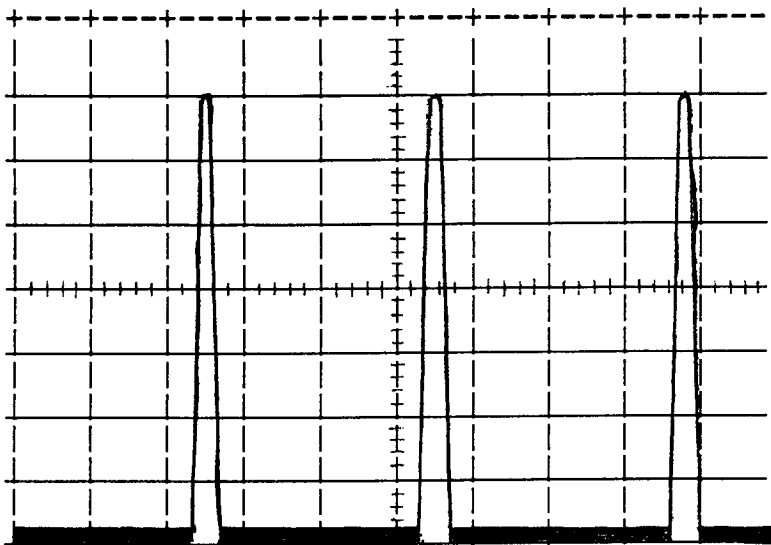
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HALF GREY SCALE.



HALF GREY SCALE.

OSCILLOSCOPE SET TO:-



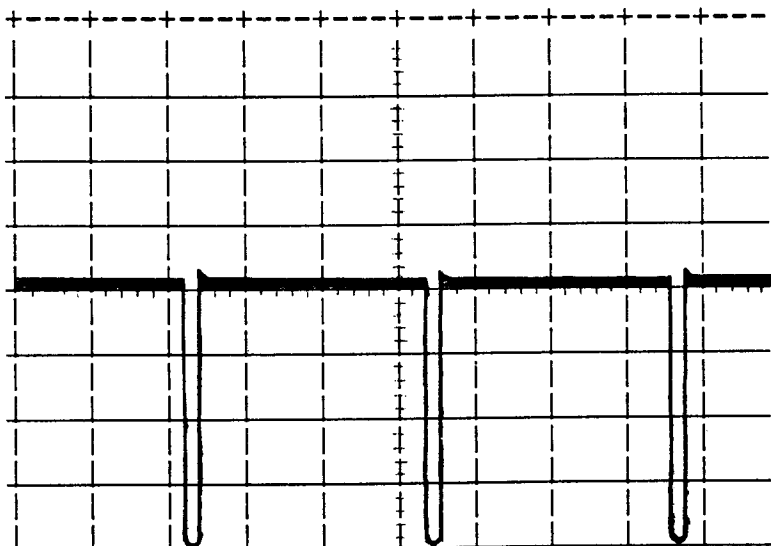
HORIZONTAL. VERTICAL.

20 μ S.

20V.

S 10.

OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

20 μ S.

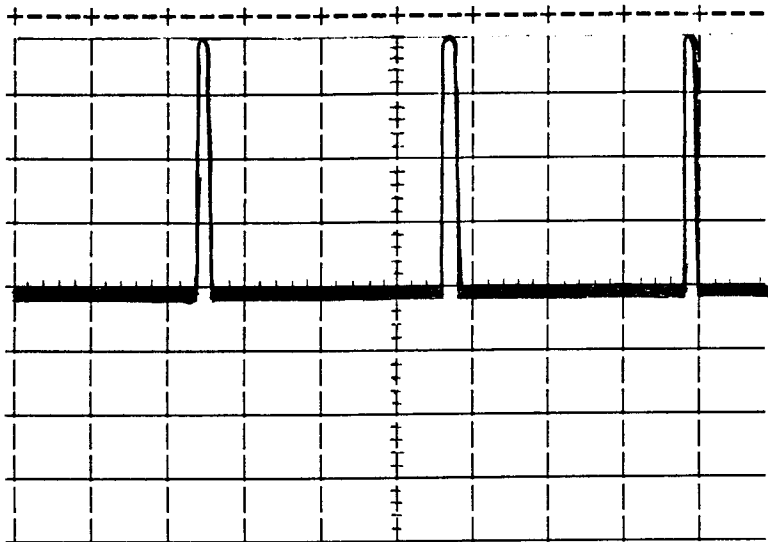
50V.

S 11.

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HALF GREY SCALE.

OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

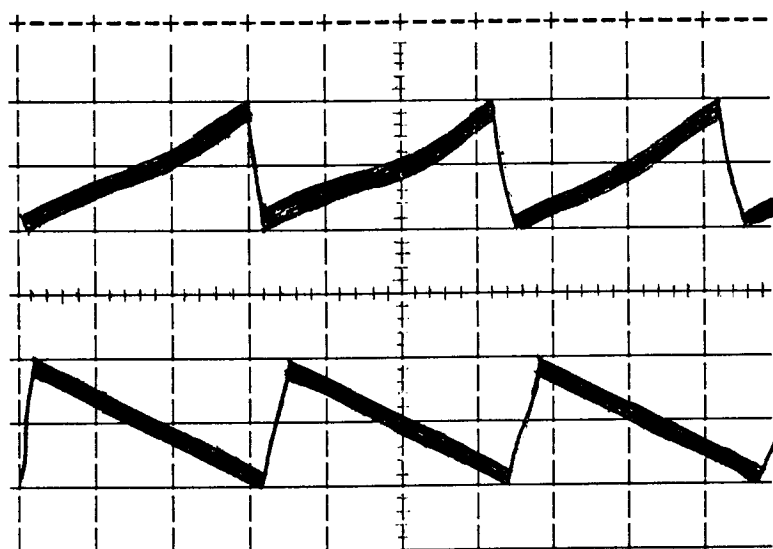
20µS.

50V.

S 12.

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OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

20µS.

100V.

S 13,14.

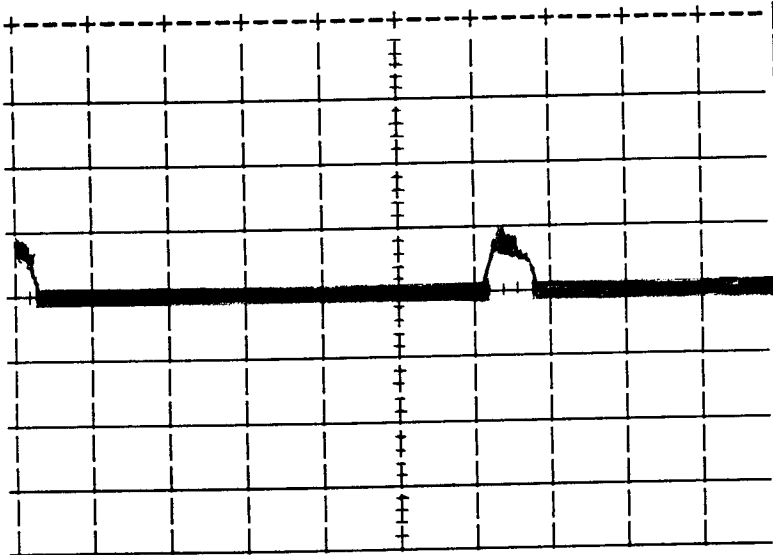
20µS

100V

S 15,16.

HALF GREY SCALE.

OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

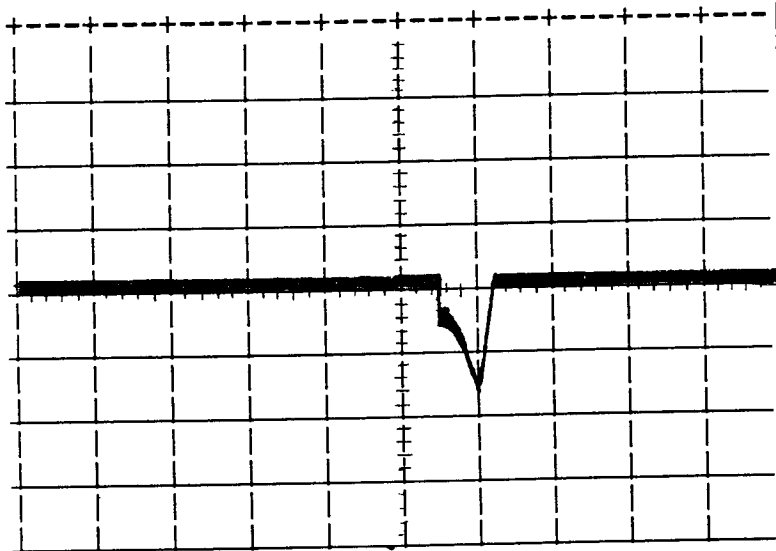
10 μ S.

1V.

S 17.

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OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

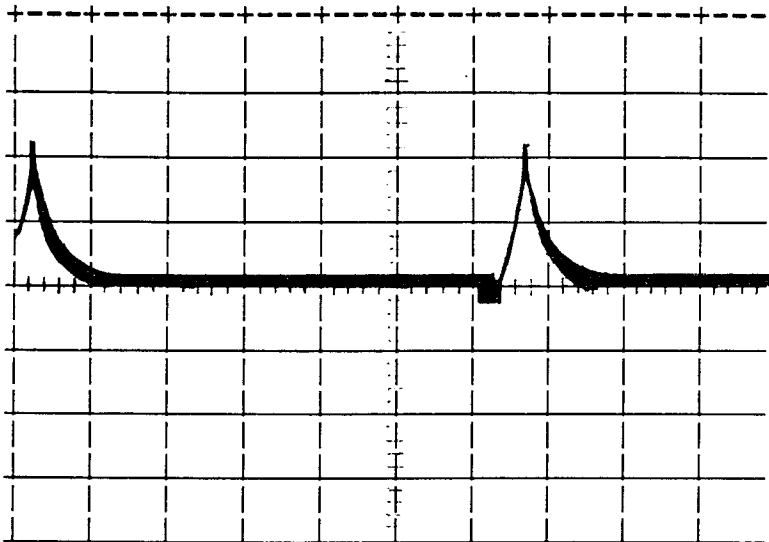
10 μ S.

1V.

S 18.

HALF GREY SCALE.

OSCILLOSCOPE SET TO:-



HORIZONTAL. VERTICAL.

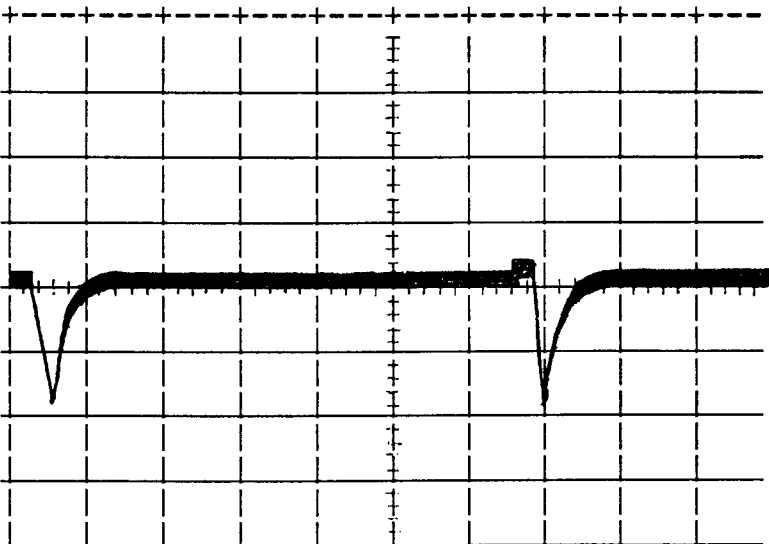
10µs.

1V.

S 19.

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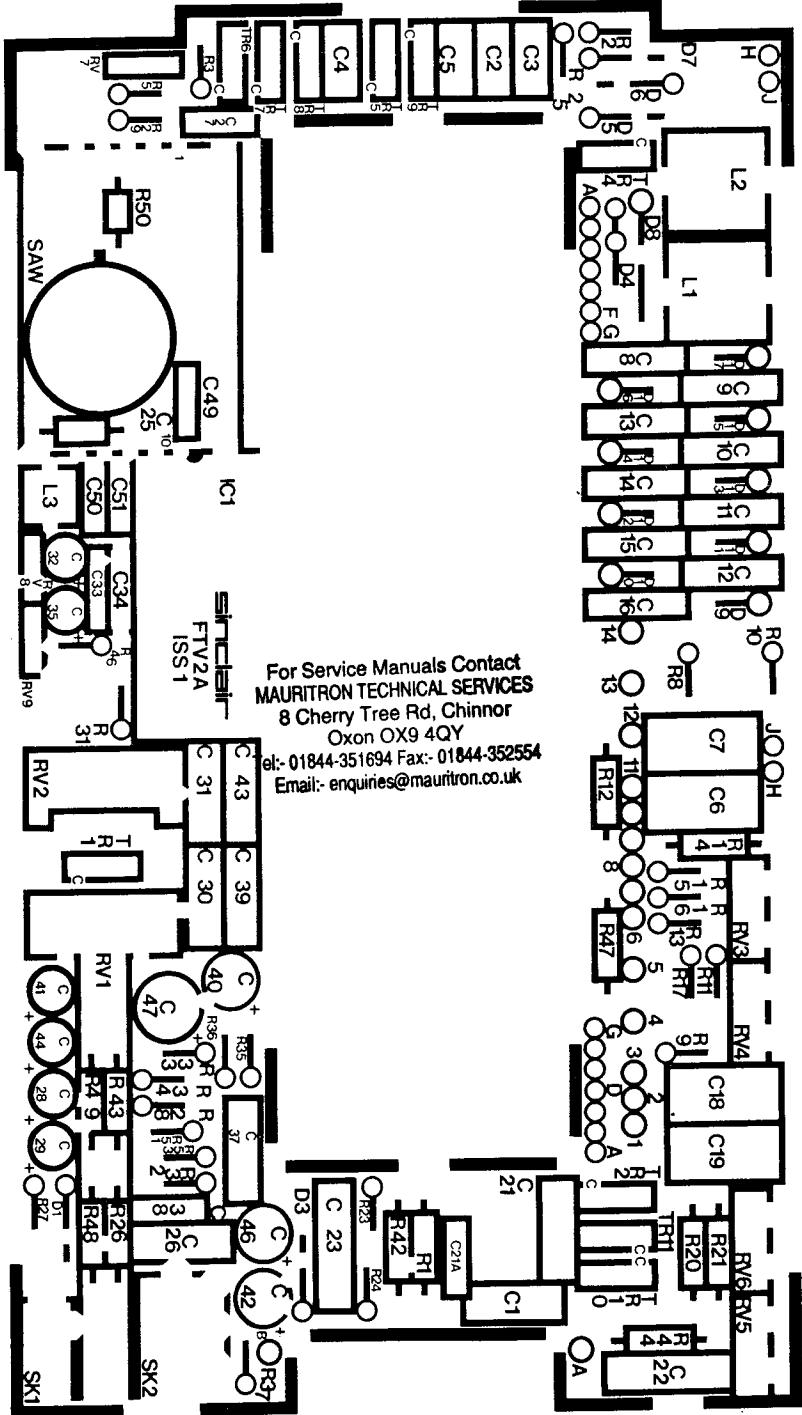


HORIZONTAL. VERTICAL.

10µs.

5V.

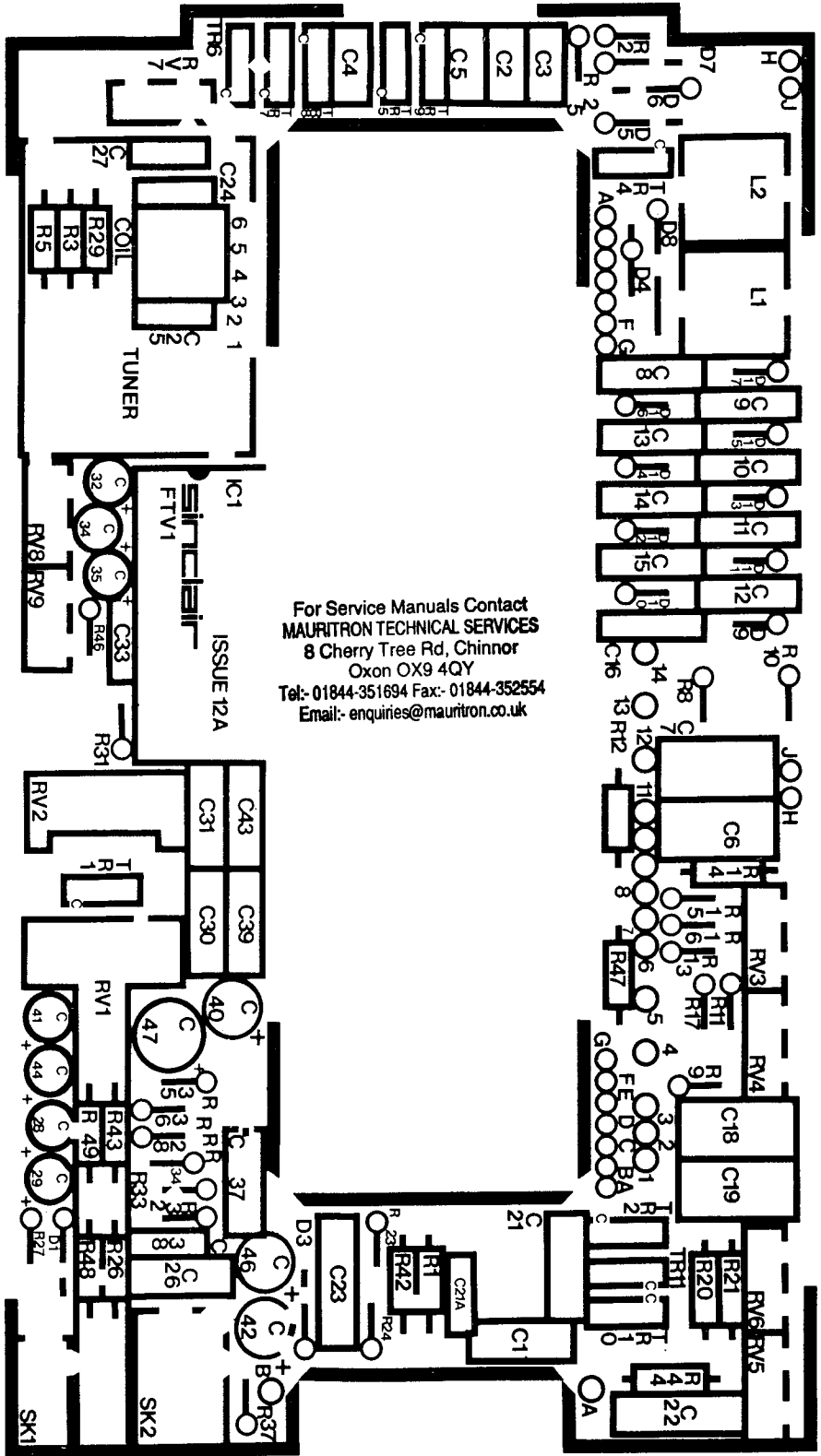
S 20.



For Service Manuals Contact
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 8 Cherry Tree Rd, Chinnor
 Oxon OX9 4QY
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 Email:- enquiries@mauritron.co.uk

7.000"

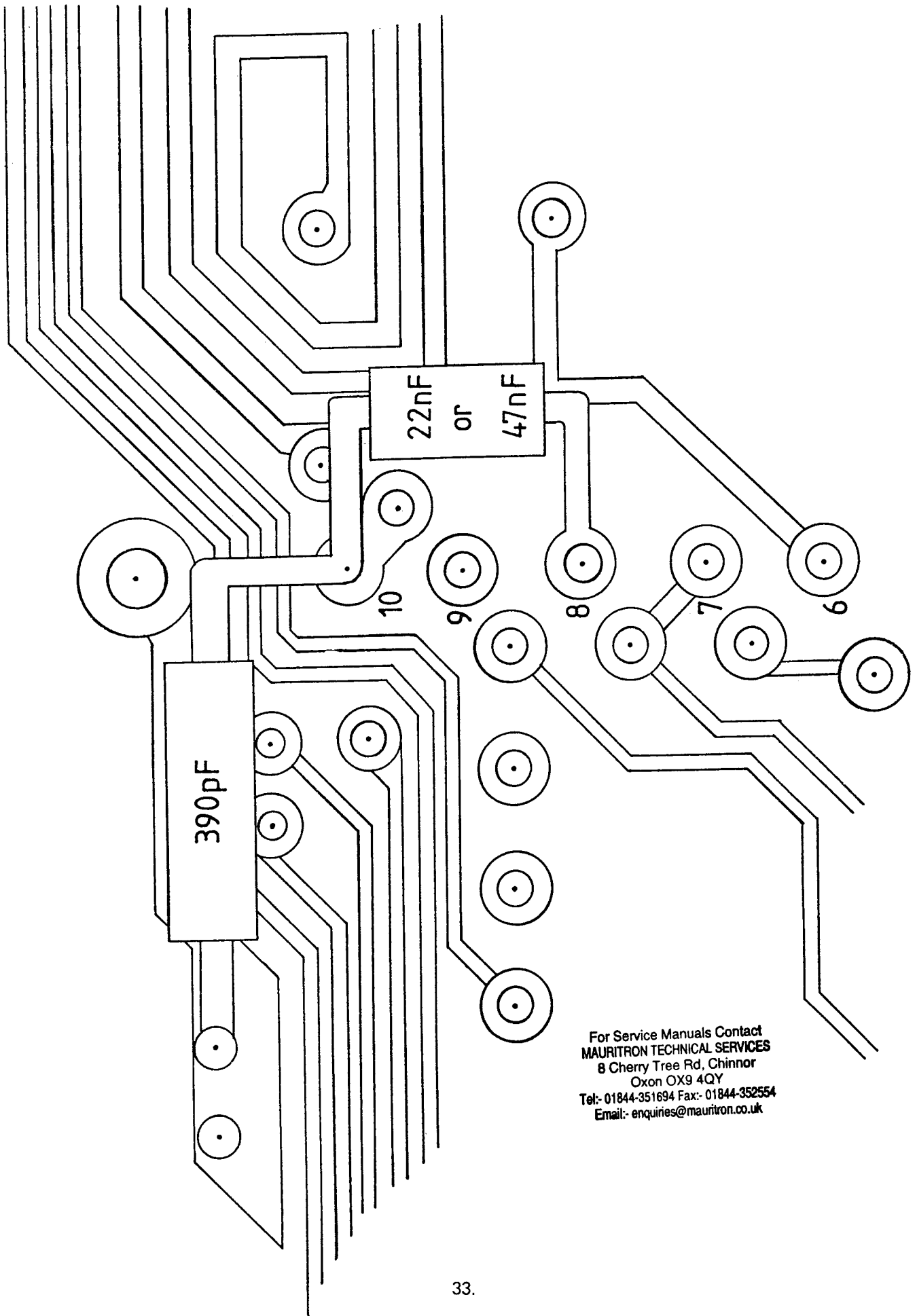
BALRAY	PHOTO-TOOLS LTD SELKIRK
PHOTO-TOOL MASTER LEGEND	
JOB NO	15341582
DATE	27/05/85



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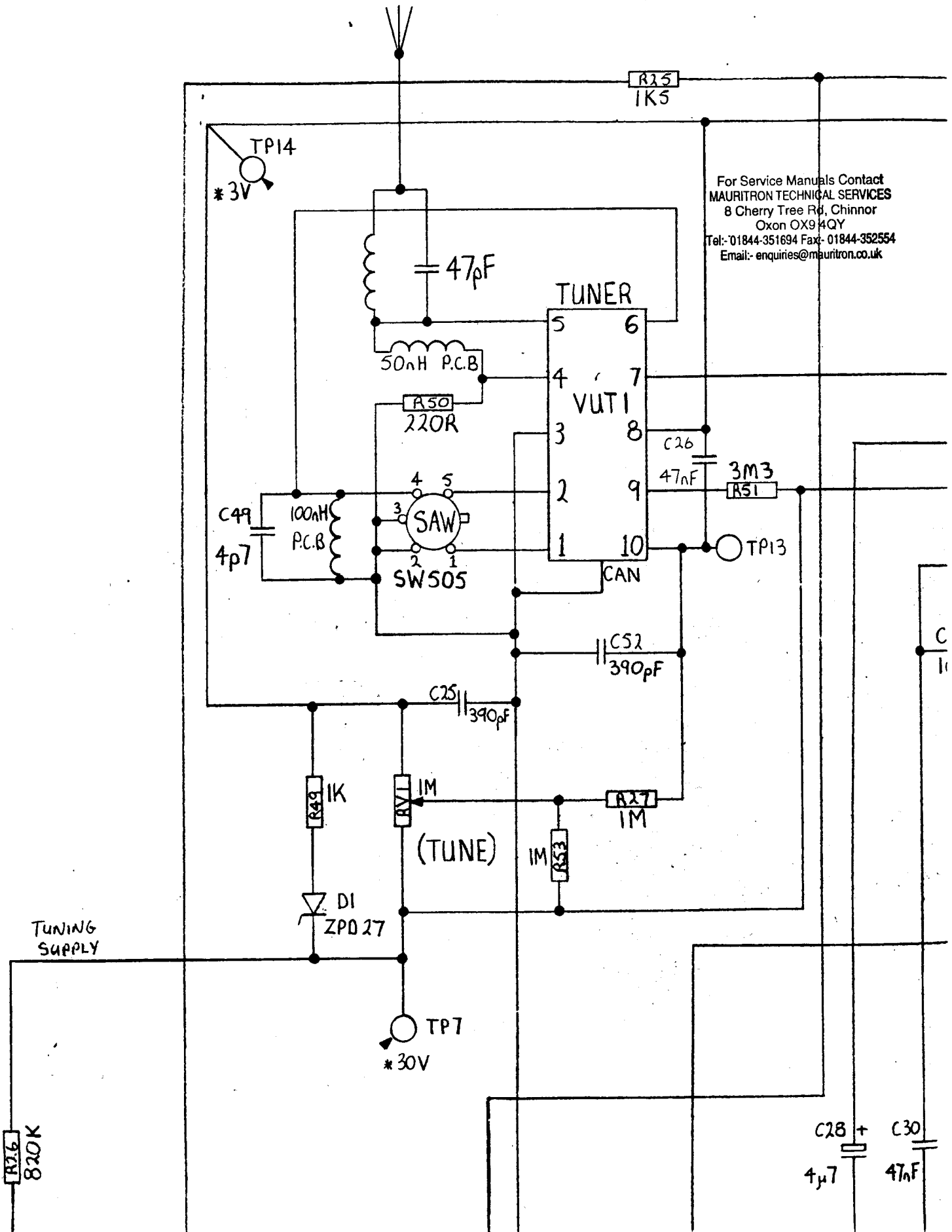
6.000"

BALRAY PHOTO-TOOLS LTD SELKIRK	
PHOTO-TOOL MASTER LEGEND	
JOB No	127713331362147615171535
DATE	1/84/84 17/84 17/84 17/85 2/85



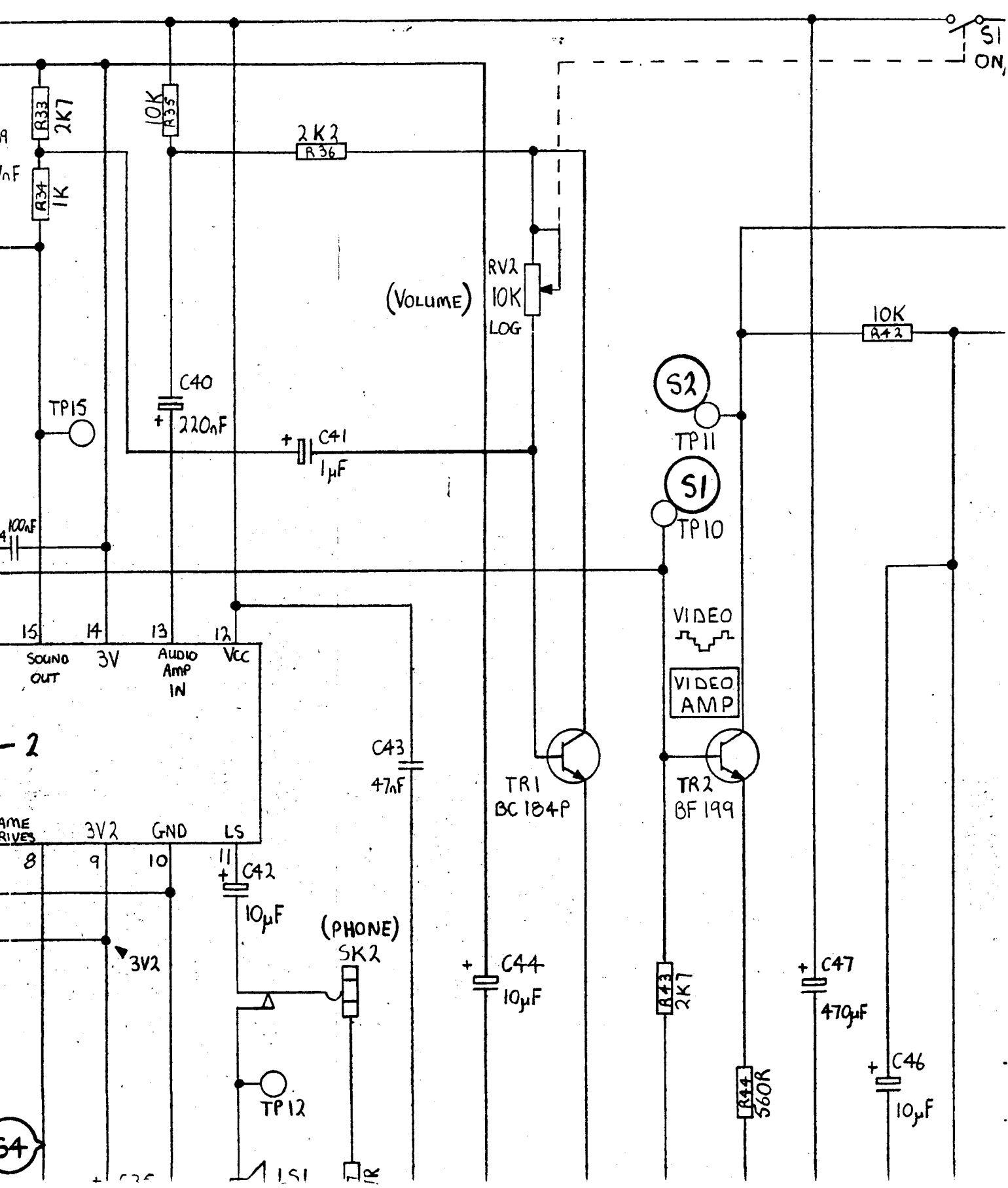
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R	26	1	2	49	RVI 3	50	53 5	54,55,27,25 RV7	51	-		
C	23		1	49		2	25	3, 52	26	4 5	28	30
MISC.	D3			D4, D8, TR4, D1, D5				TUNER	TR5 TR6 TR7	D6 D7		TR8 TR9

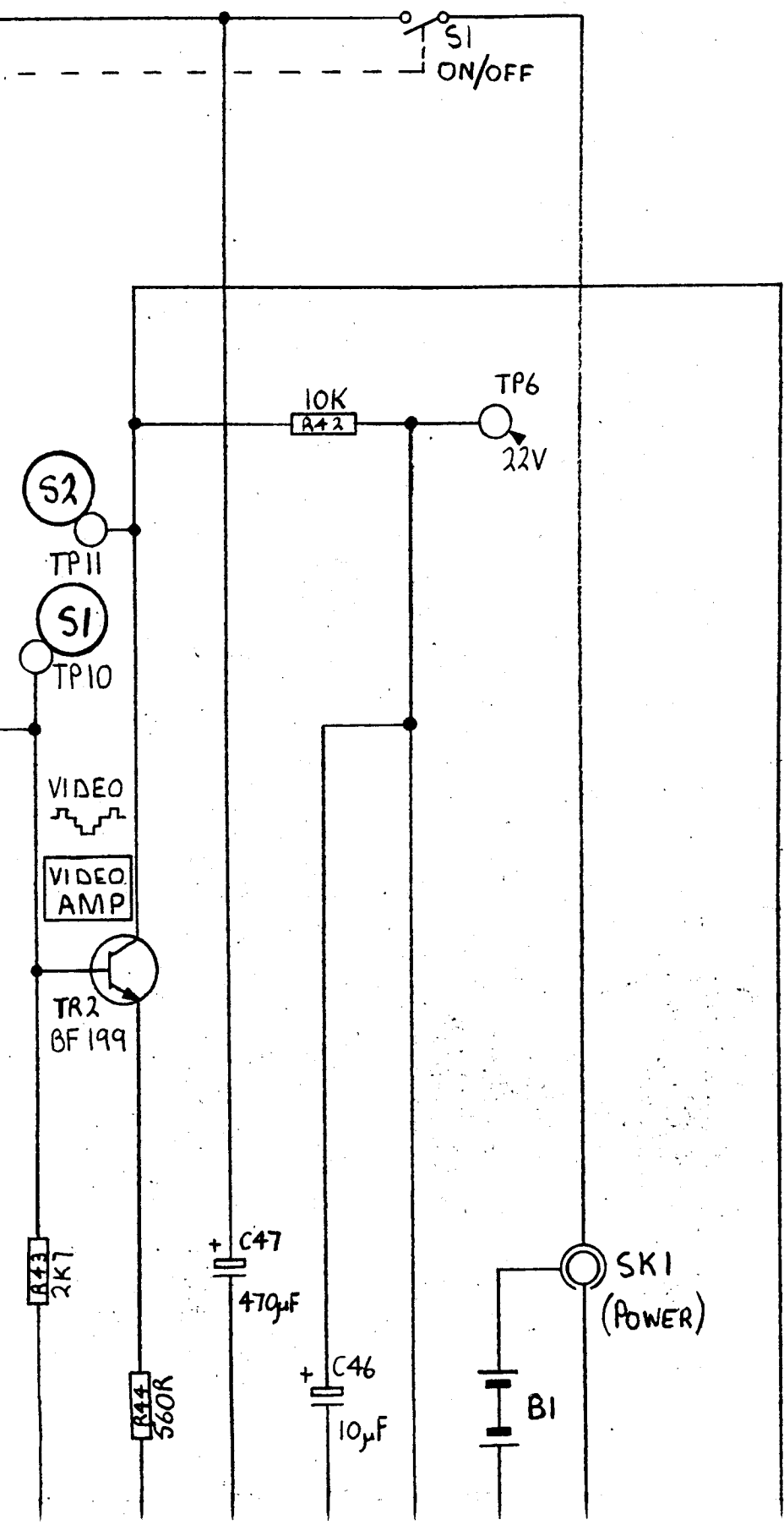


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33 34	35 RV3	RV4 16	17,36,37	9 11 13	47	RV2	43, RV6, 44	20 23	42 RV5	21 24
54	35	40	42	41	43	44,18	19	47	46 ^{21a} 21	
	LS1		SK2			TR1		TR2	TR11	TR11



43, RV6, 44	20 23	42 RV5	21 24
	47	46 ^{21a} 21	22
TR2	TR11	TR10, B1, SK1	



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R

C

C.R.T

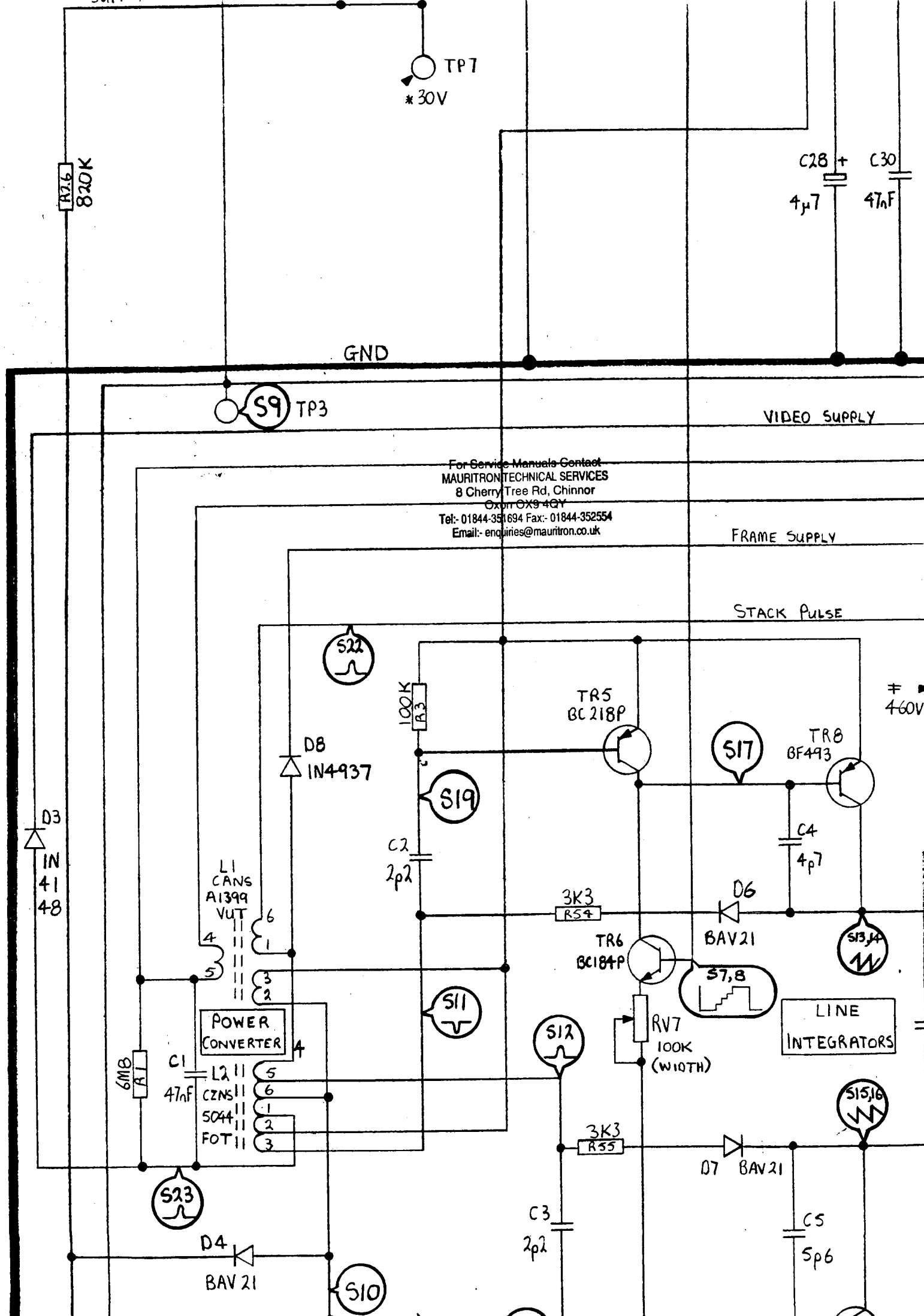
MISC

ISSUE No.	COMMENT	DATE

NOTES

► VOLTAGES MEASURED AT 5.9 SUPPLY
PROPORTIONAL TO BATTERY EXCEPT
THOSE MARKED *
MEASURED WITH 10M Ω PROBE EXCEPT
THOSE MARKED \neq (1000M Ω).

Ⓢ SCOPE WAVEFORM.



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VIDEO SUPPLY

FRAME SUPPLY

STACK PULSE

LINE INTEGRATORS

± 460V

R76
820K

TP7
*30V

C28 + C30
4µ7 47nF

GND

S9 TP3

D3
IN 41 48

LI CANS
A1399
VUT

POWER CONVERTER

1 2 3 4 5 6

1 2 3

6M8 R1
47nF C1

S23

D4
BAV 21

S22

D8
IN4937

100K R3

C2
2p2

S19

TR5
BC 218P

S17

TR8
BF493

C4
4p7

3K3
R54

TR6
BC184P

S18

RV7
100K (WIDTH)

S13,14

S12

3K3
R55

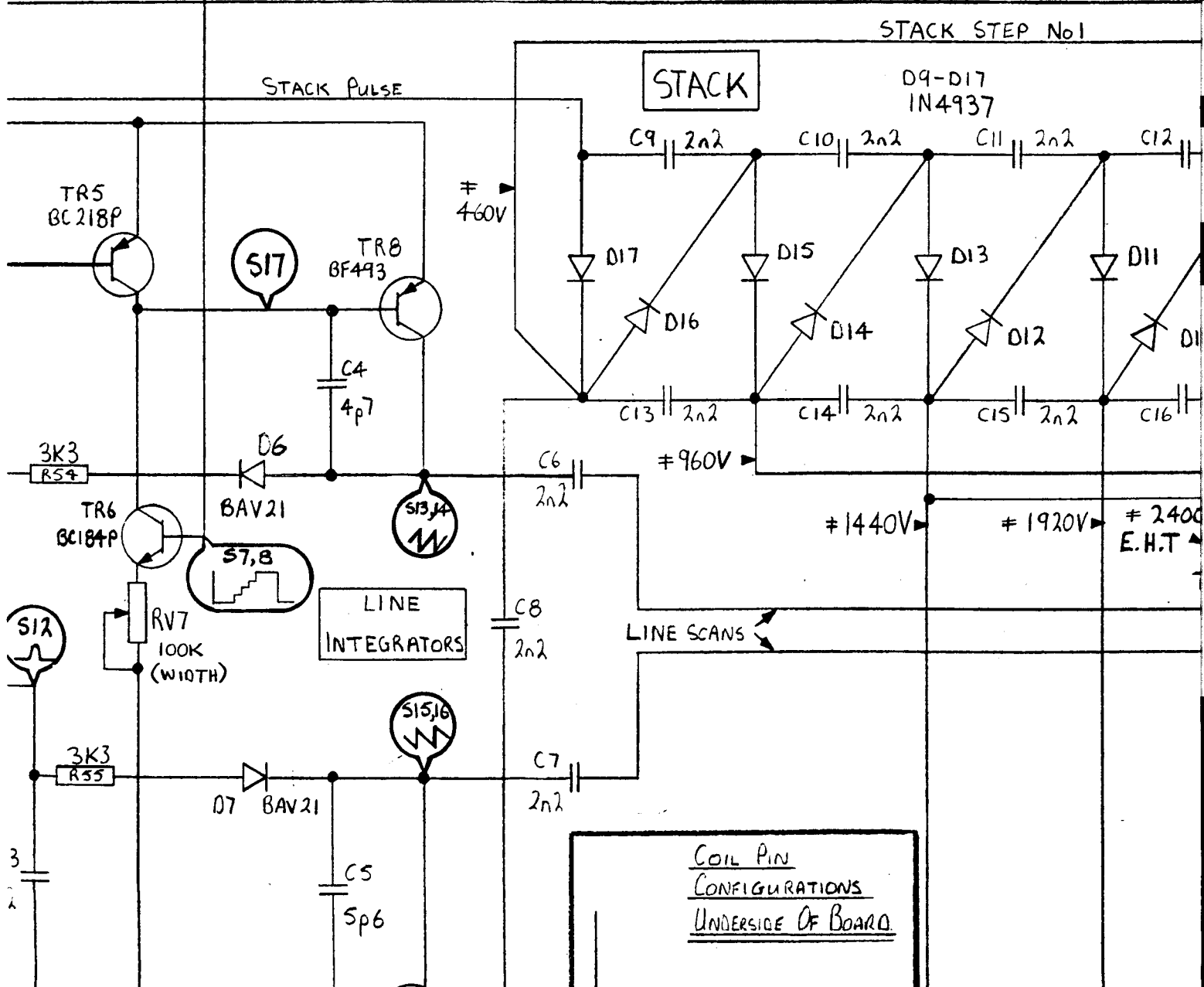
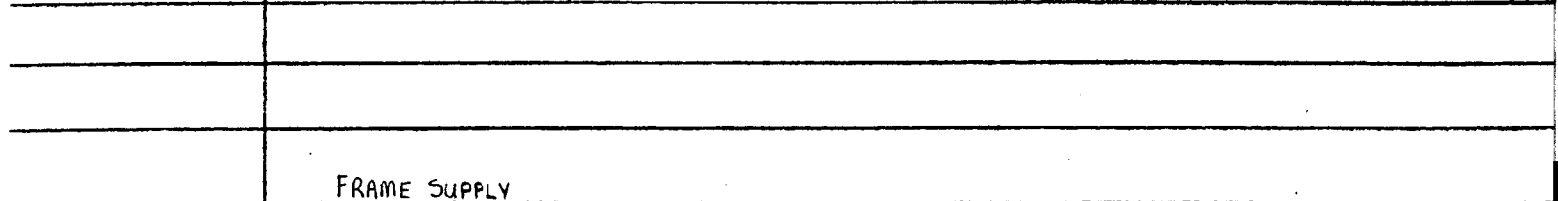
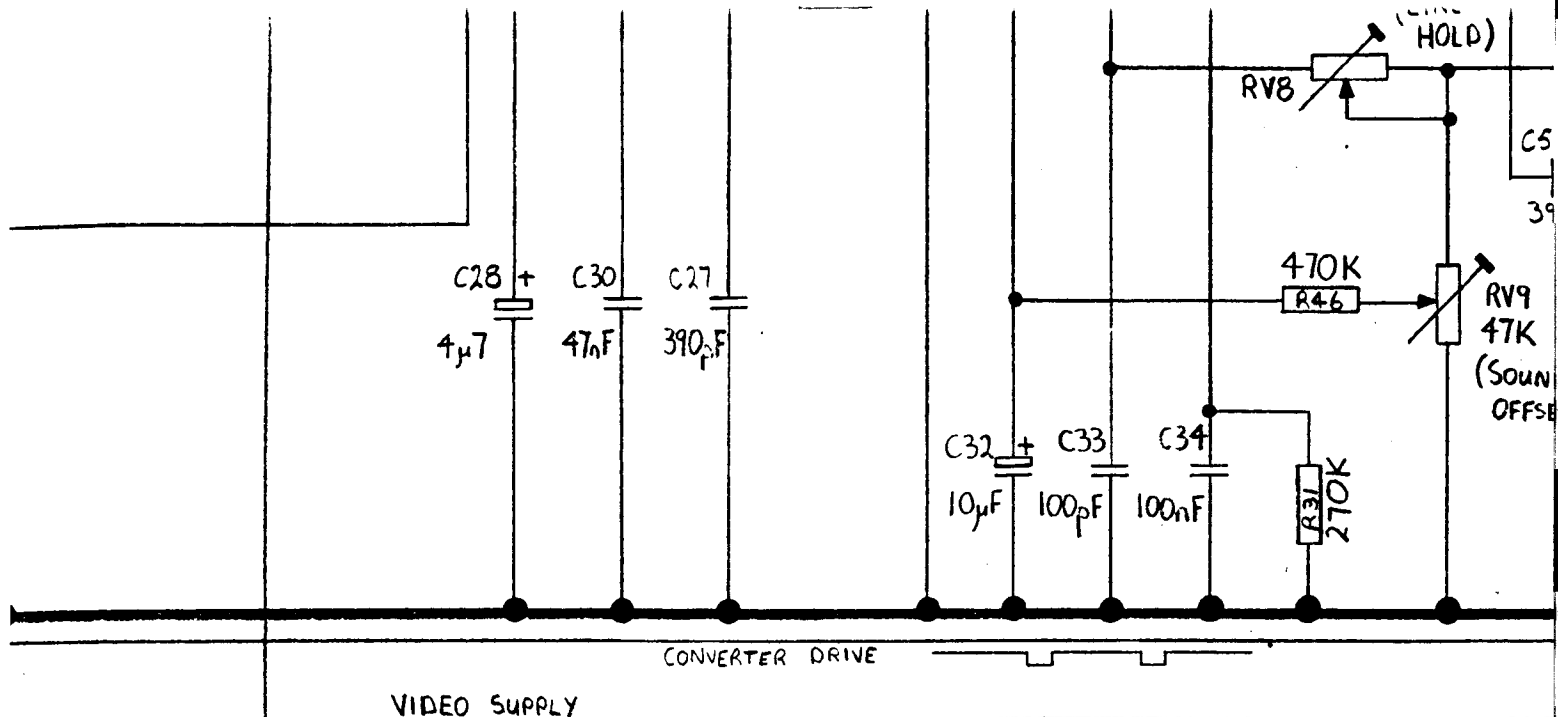
D7
BAV 21

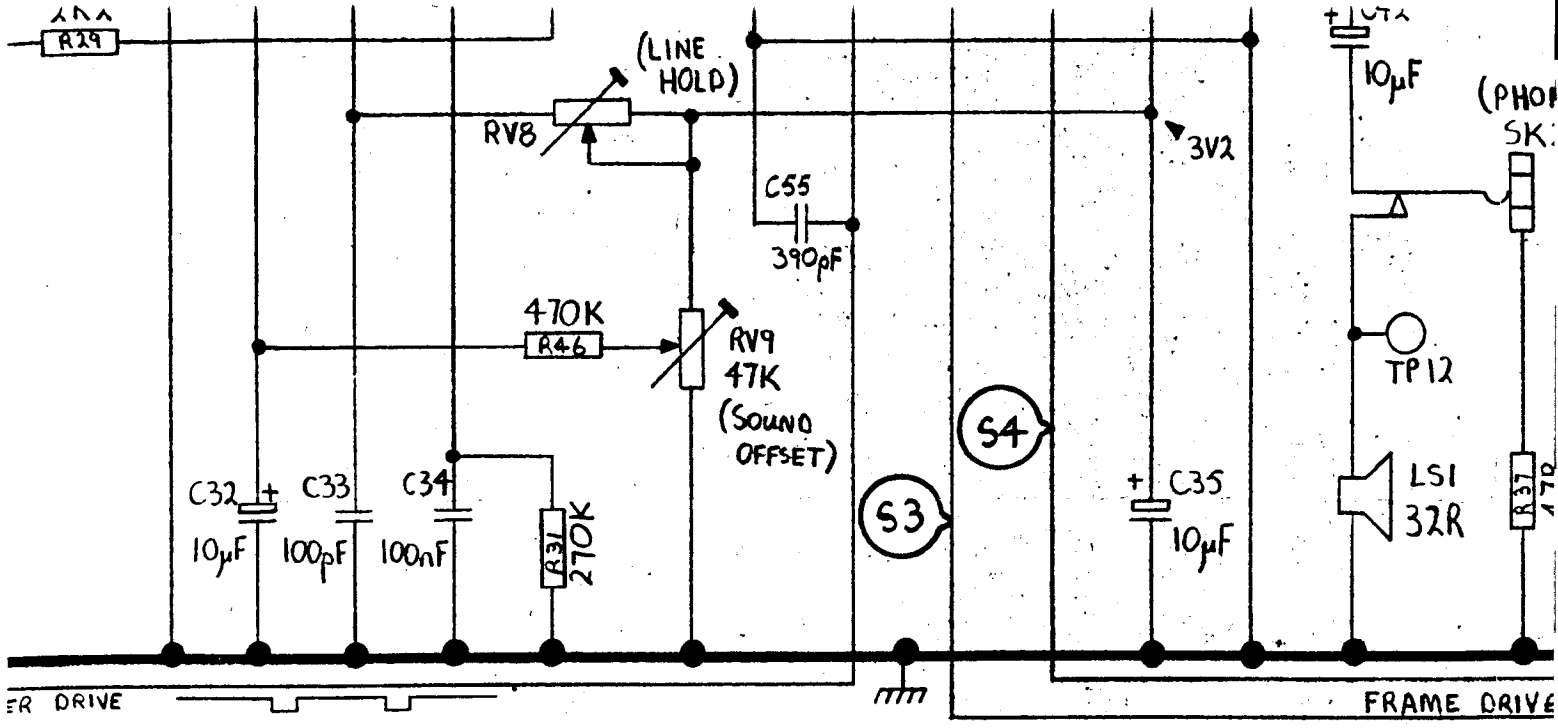
S15,16

C3
2p2

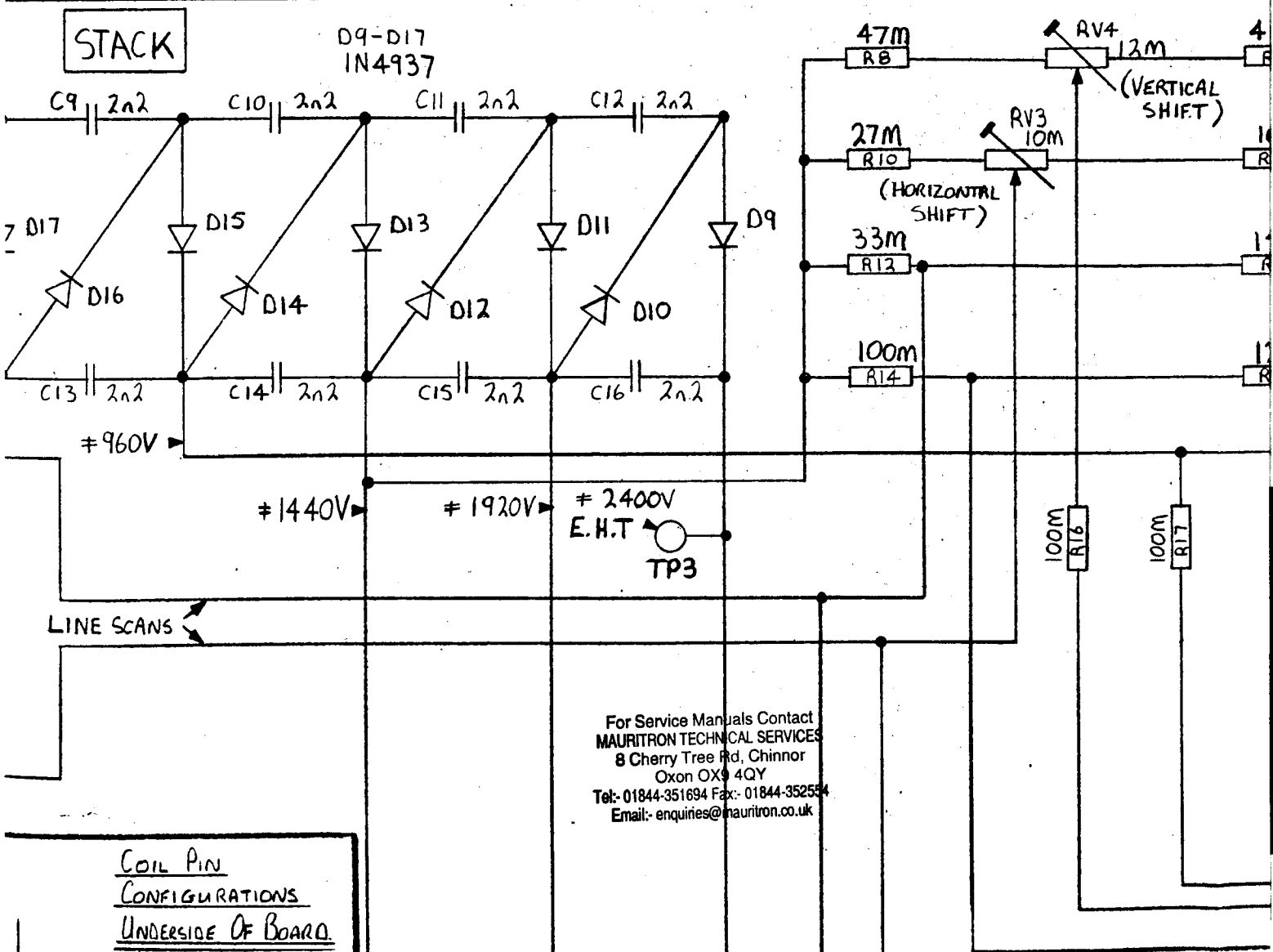
C5
5p6

S10



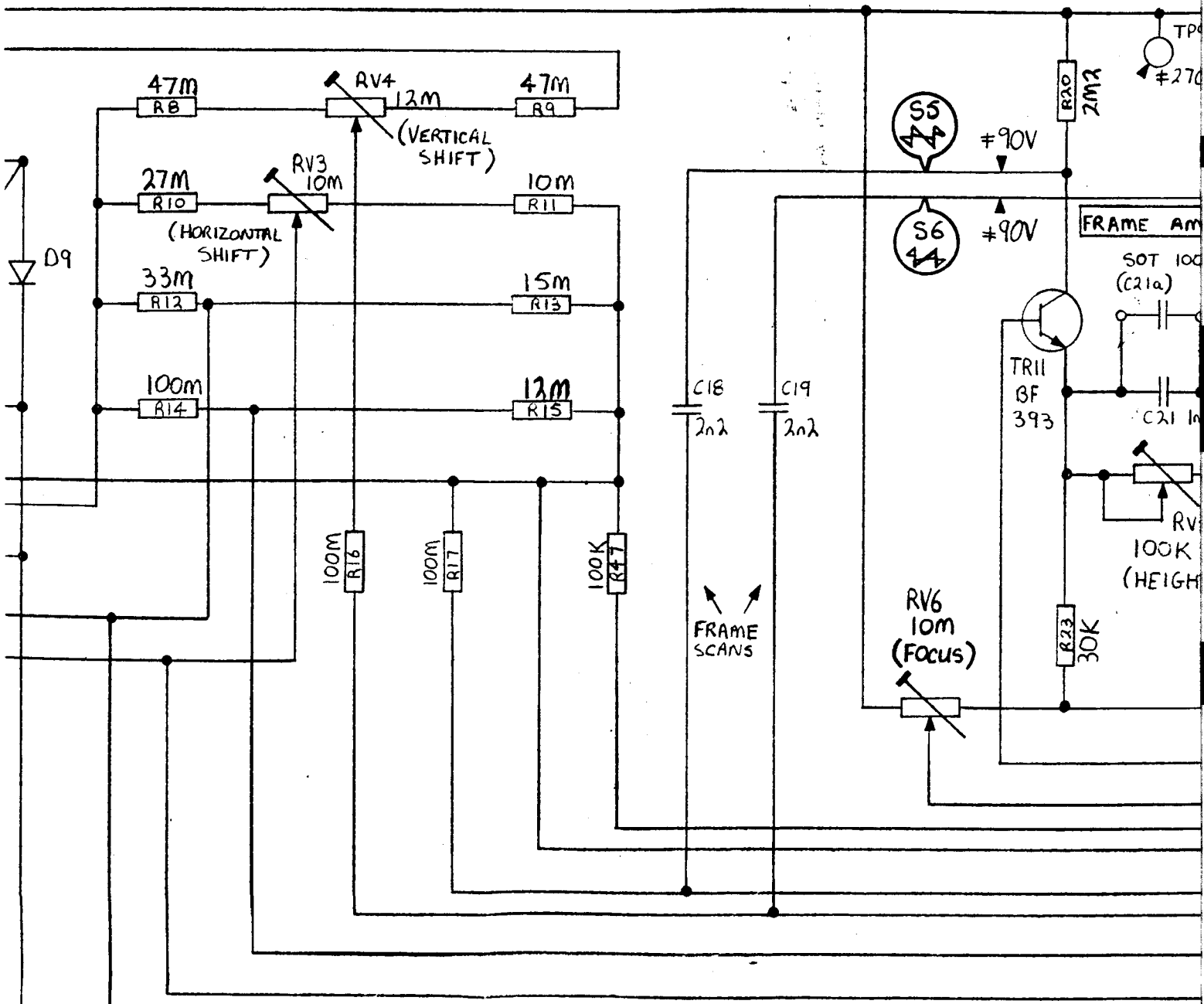
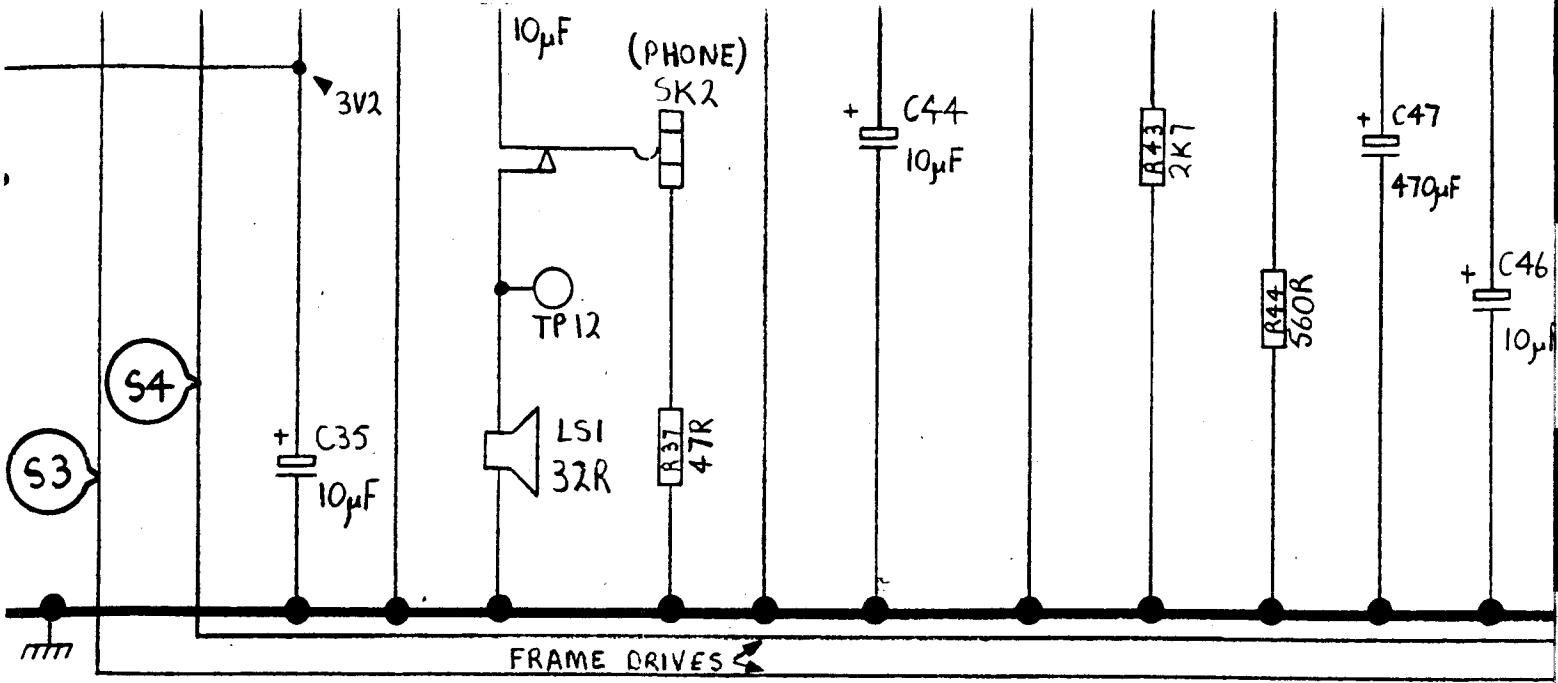


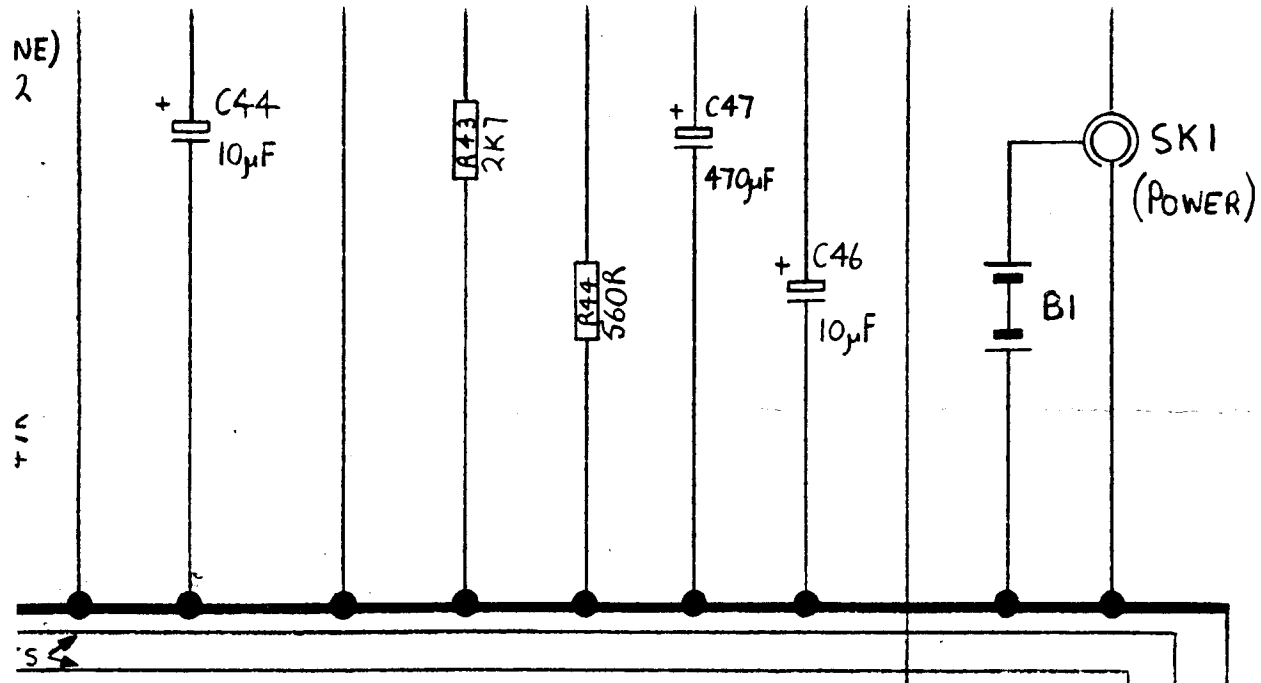
STACK STEP No1



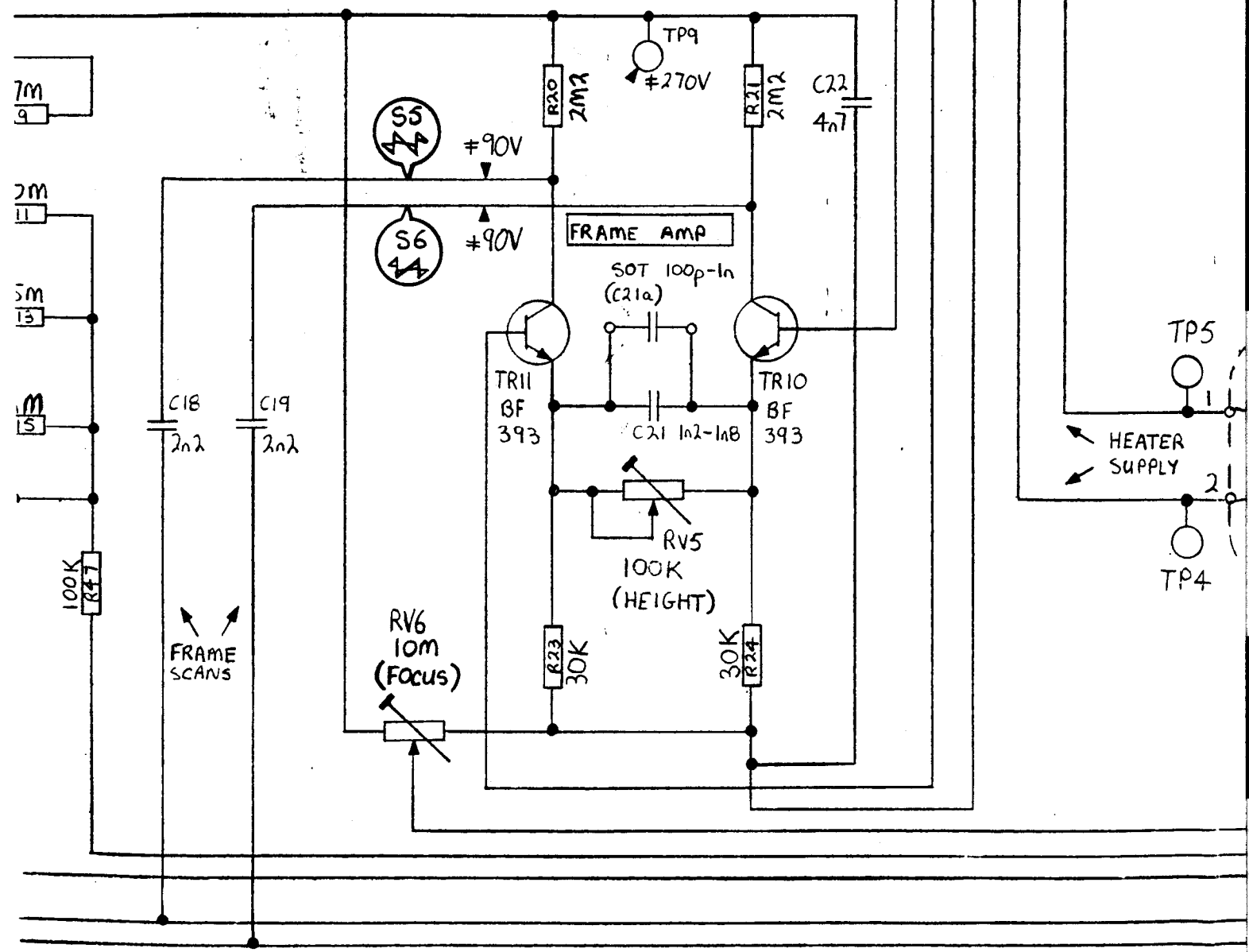
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COIL PIN
CONFIGURATIONS
UNDERSIDE OF BOARD.

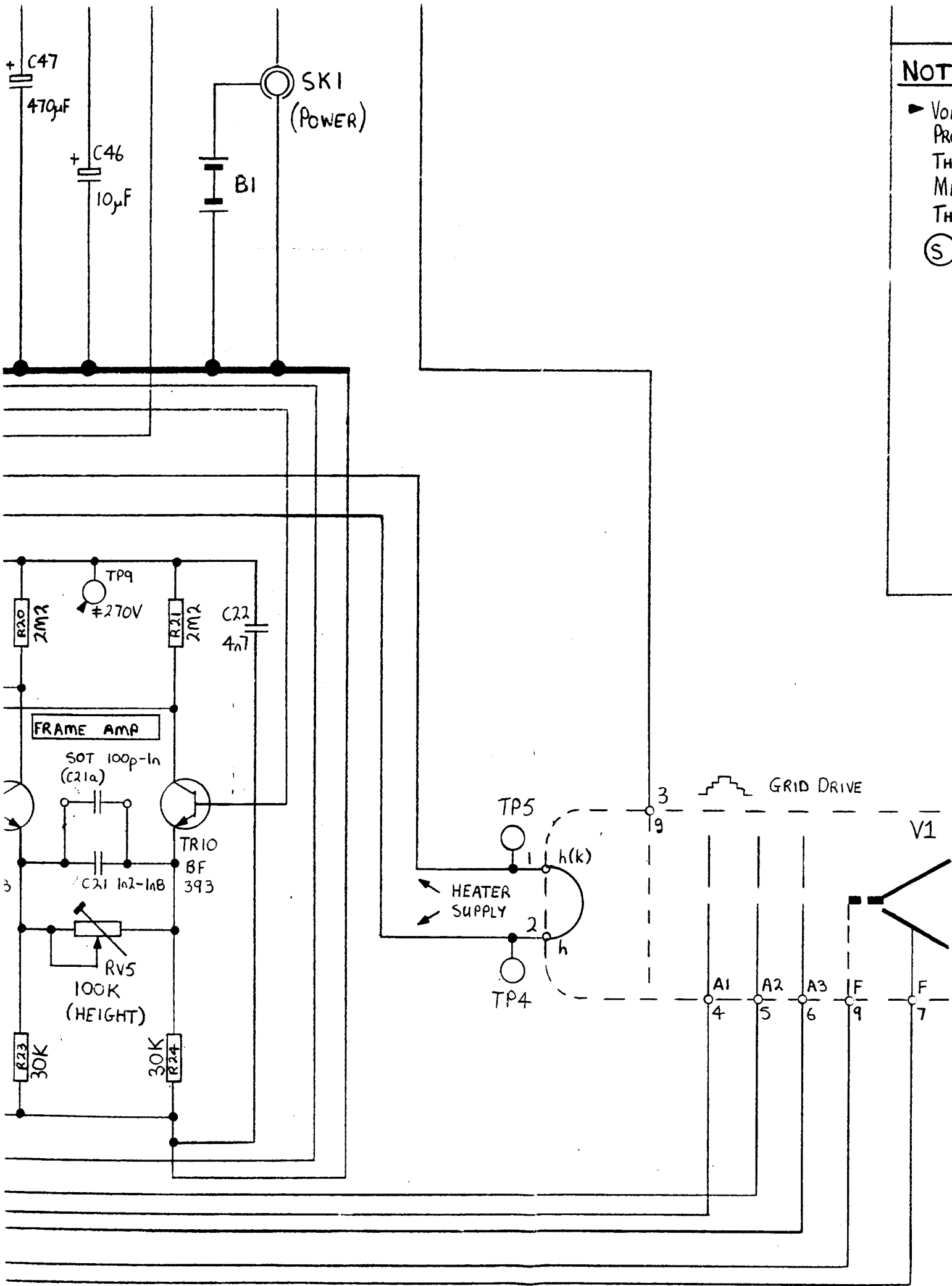




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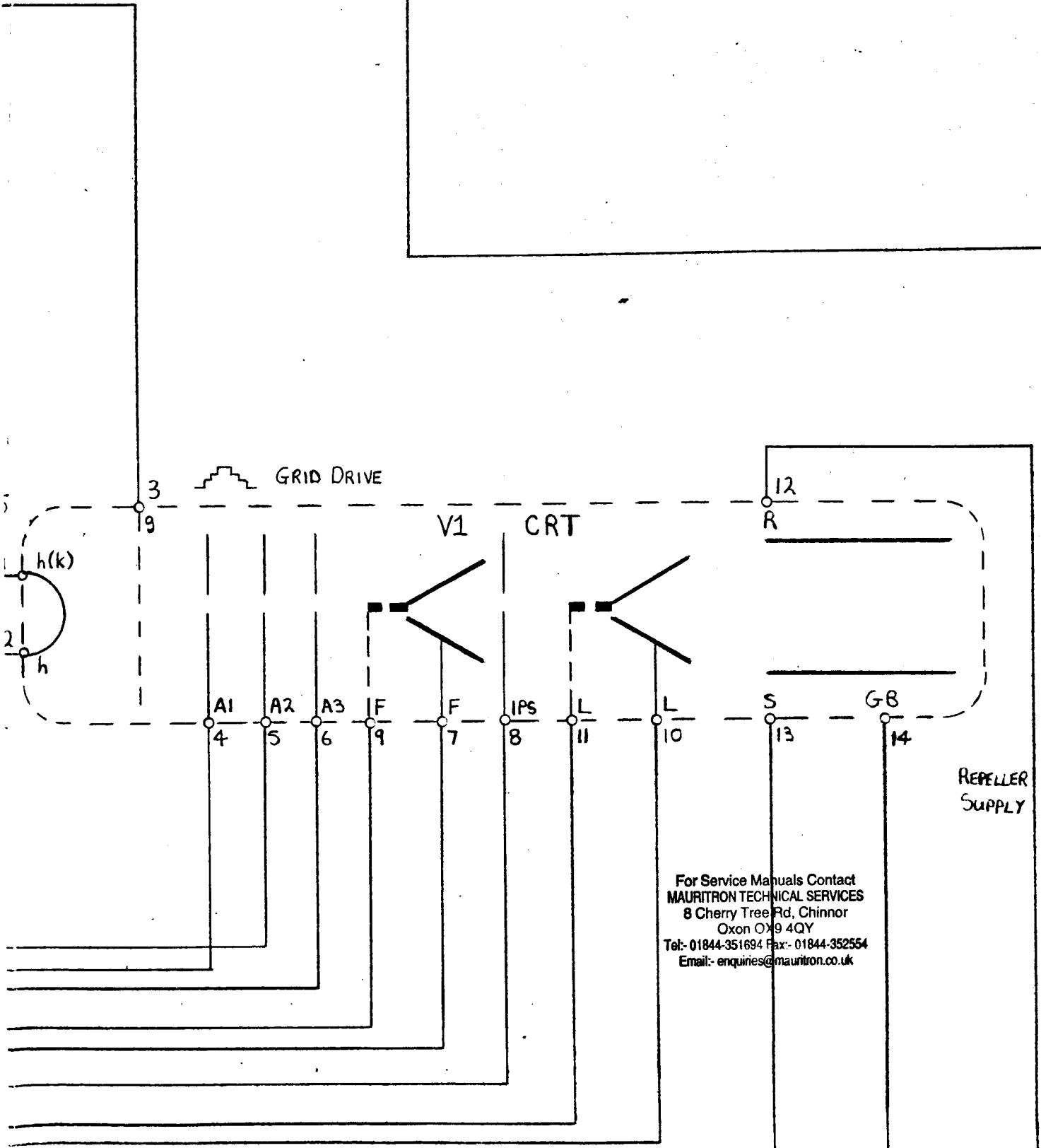
NOTE
 ▶ VOL: PRO: THC: ME: THC:
 (S)



NOTES

- ▶ VOLTAGES MEASURED AT 5.9 SUPPLY PROPORTIONAL TO BATTERY EXCEPT THOSE MARKED *
- MEASURED WITH $10M\Omega$ PROBE EXCEPT THOSE MARKED \neq ($1000M\Omega$).

Ⓢ SCOPE WAVEFORM.



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GND

S9 TP3

VIDEO SUPPLY

FRAME SUPPLY

STACK PULSE

± 460V

D3
IN
41
48

6M8
R1

C1
47nf

POWER
CONVERTER

L1
CANS
A1399
VUT

L2
CZNS

5044
FOT

D8
IN4937

100K
R3

C2
2p2

TR5
BC218P

S17

TR8
BF493

C4
4p7

3K3
R54

D6

BAV21

TR6
BC184P

S7,8

LINE
INTEGRATORS

RV7
100K
(WIDTH)

S15,16

3K3
R55

D7 BAV21

C3
2p2

C5
5p6

S23

D4
BAV21

S10

S20

C23
4n7

R2
100R

TR4
ZTX655

D5
BAV21

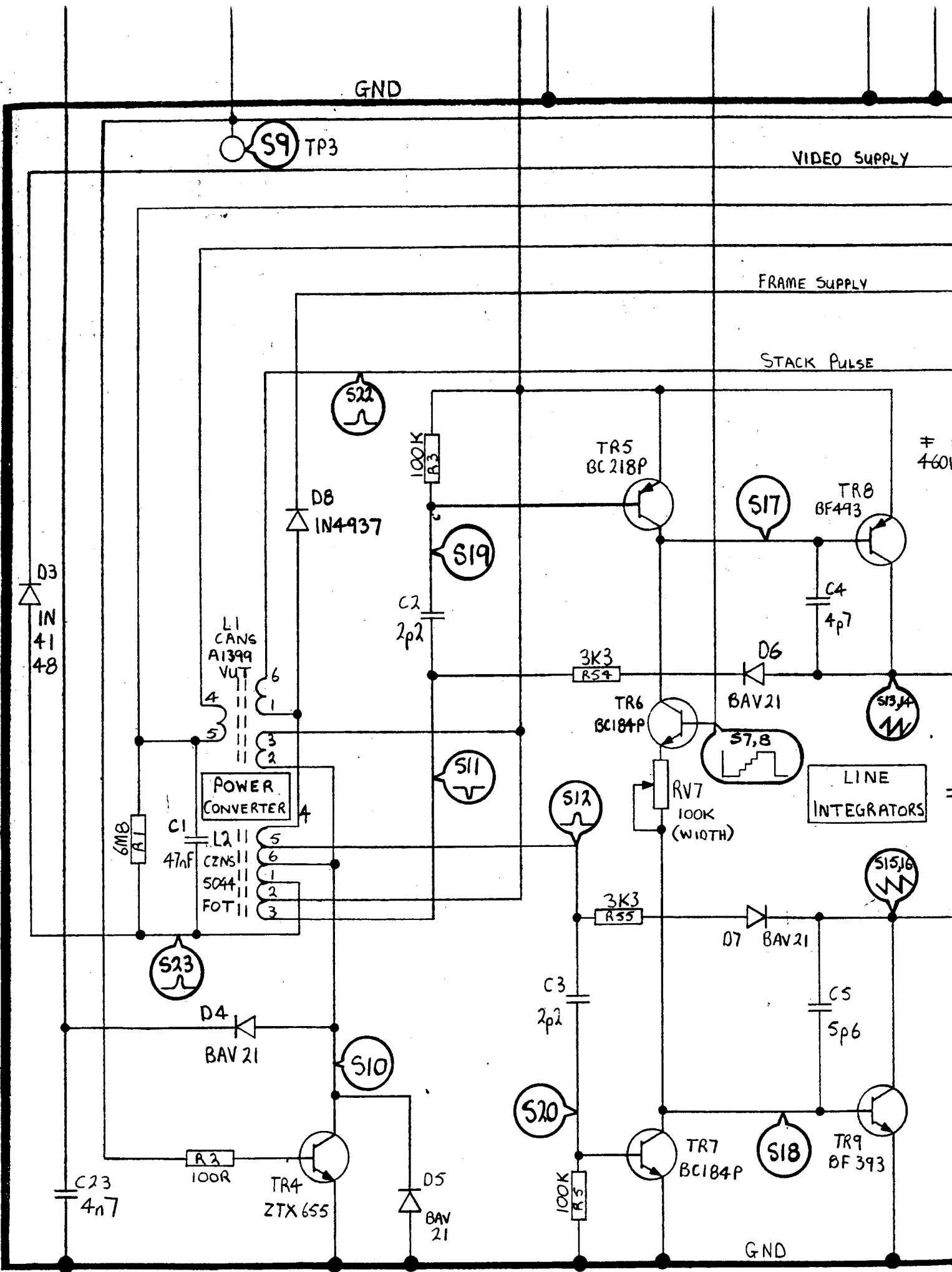
100K
R5

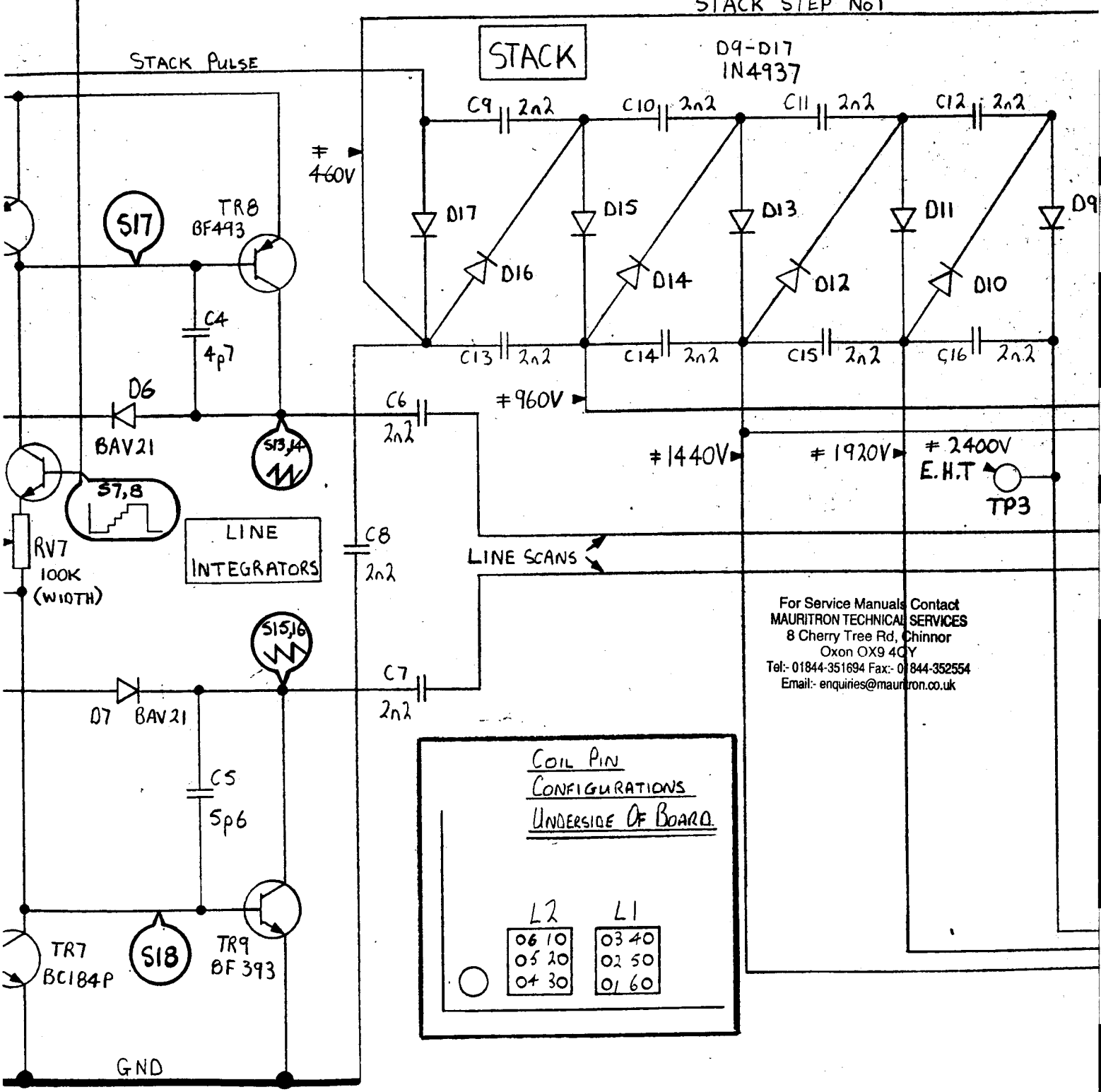
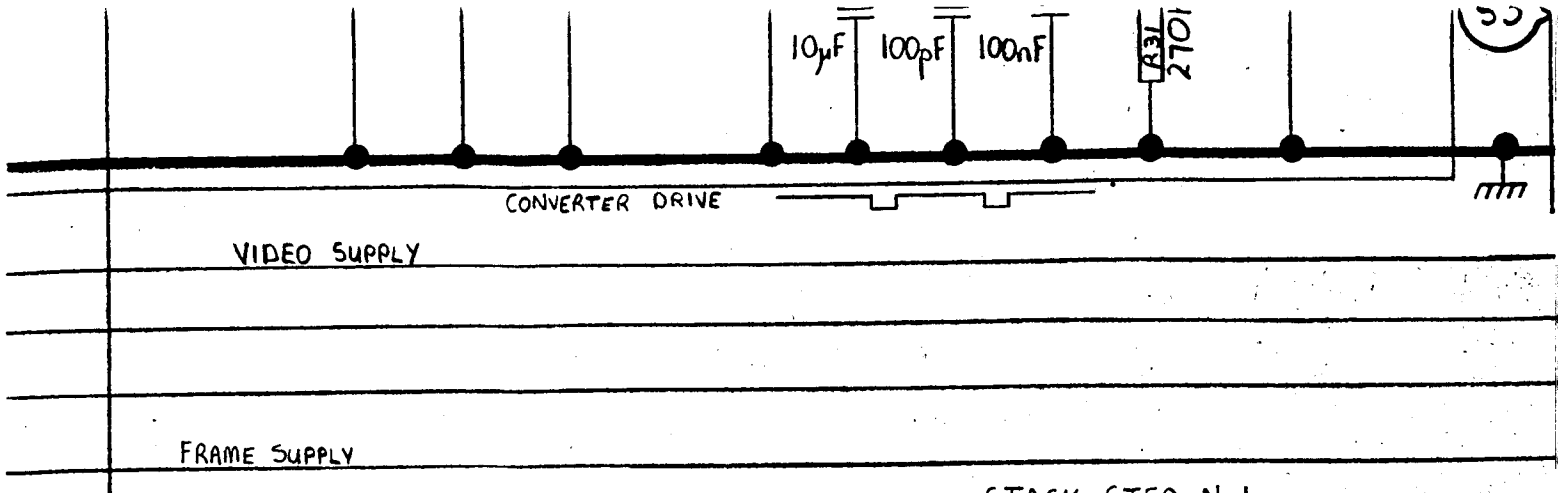
TR7
BC184P

S18

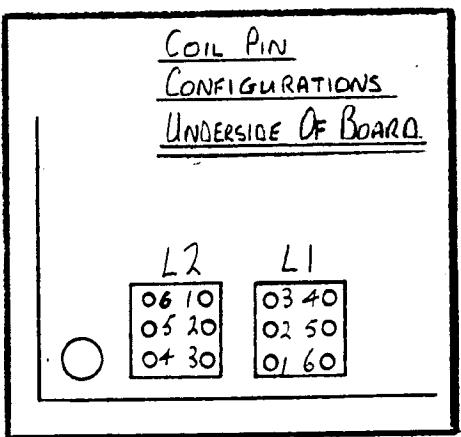
TR9
BF393

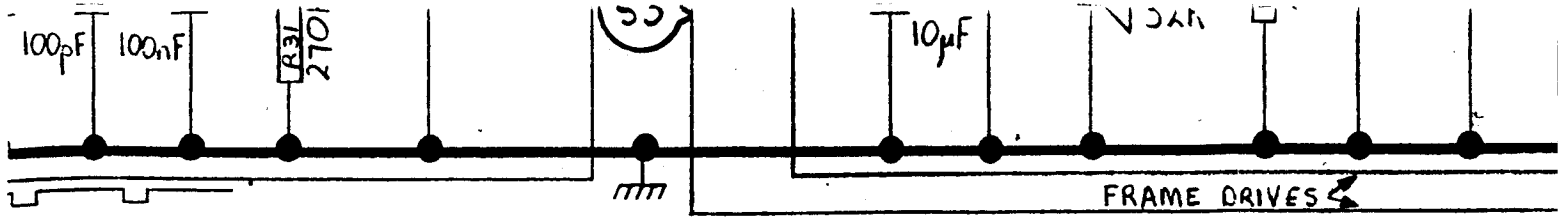
GND



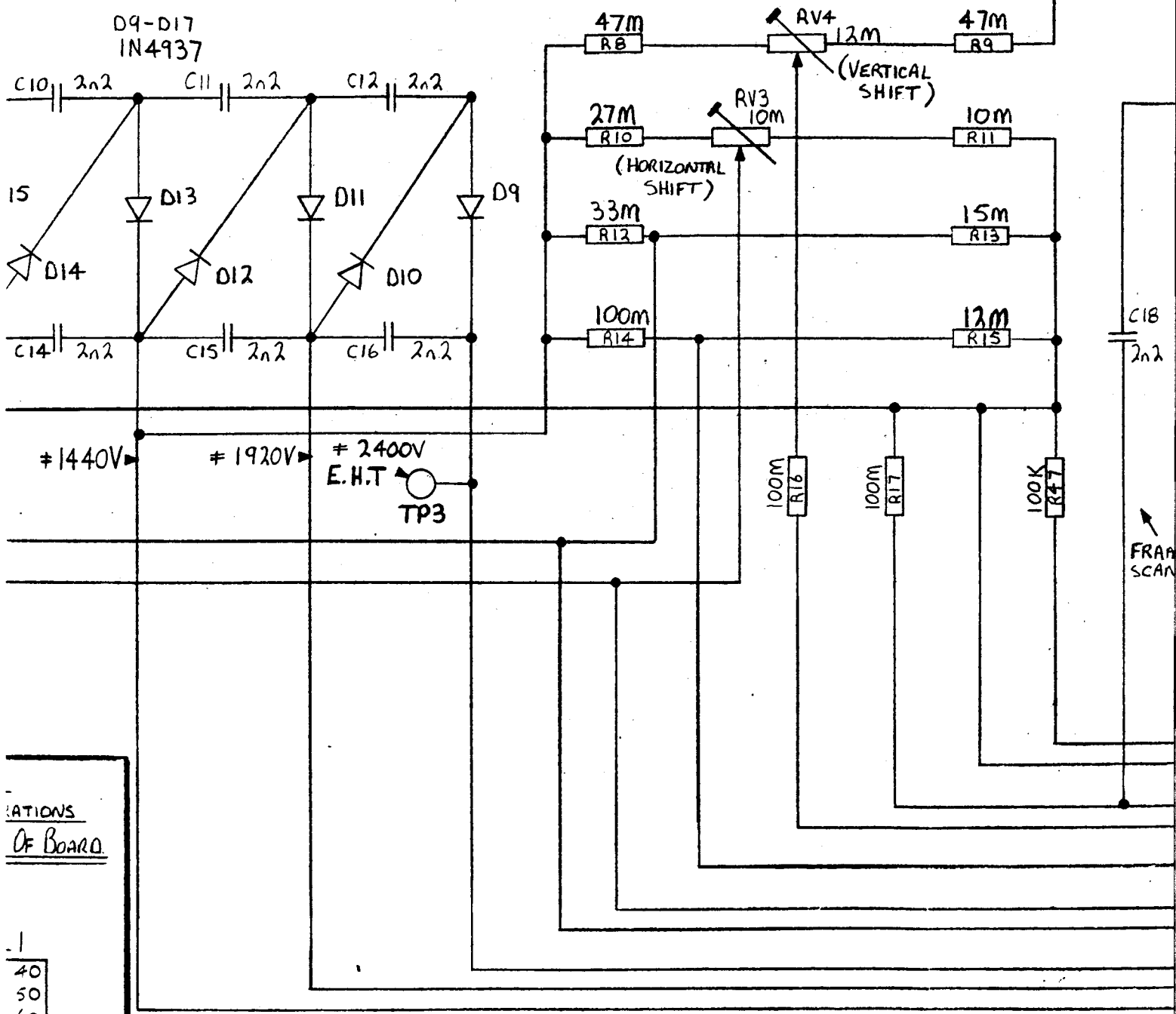


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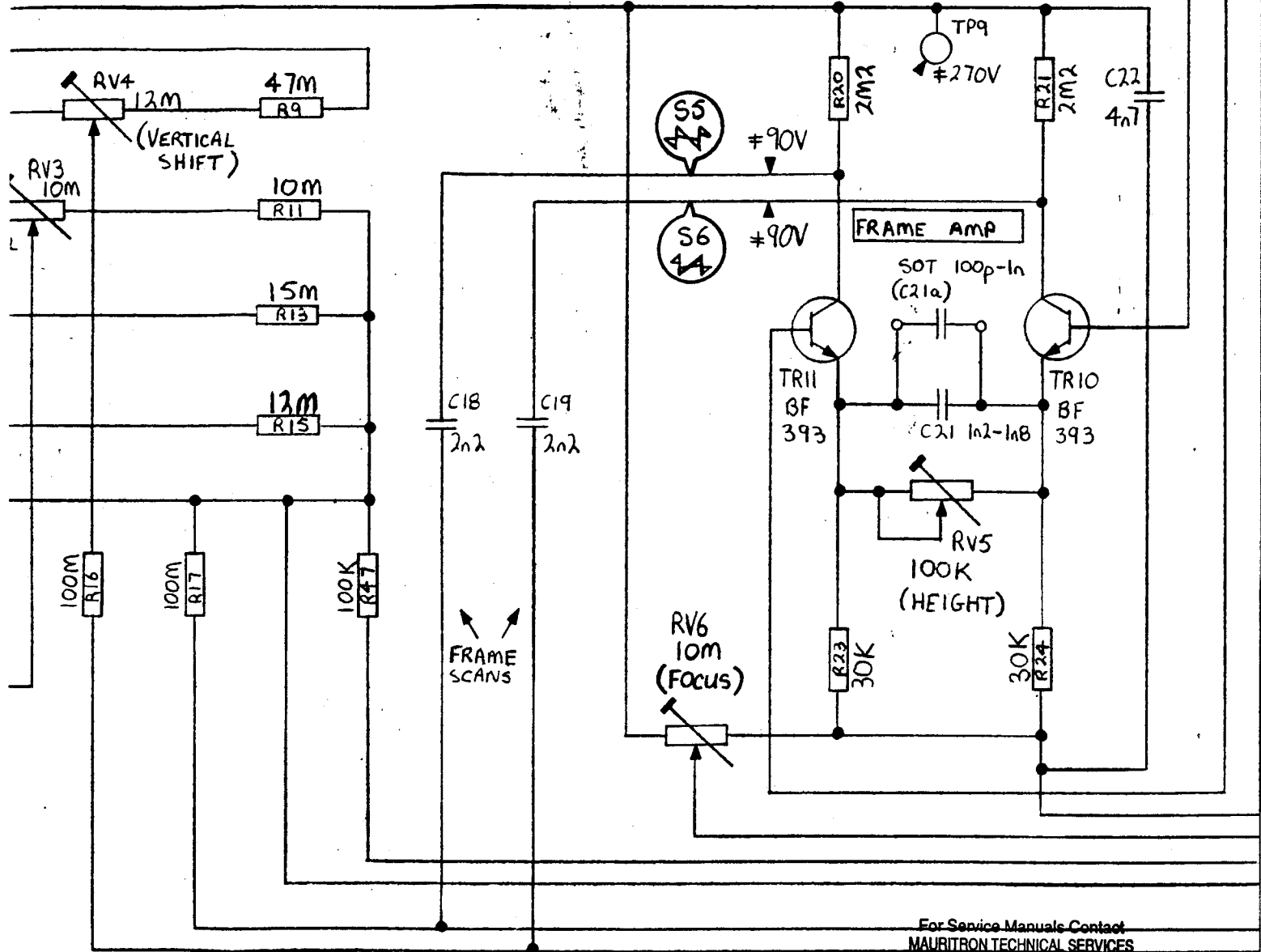
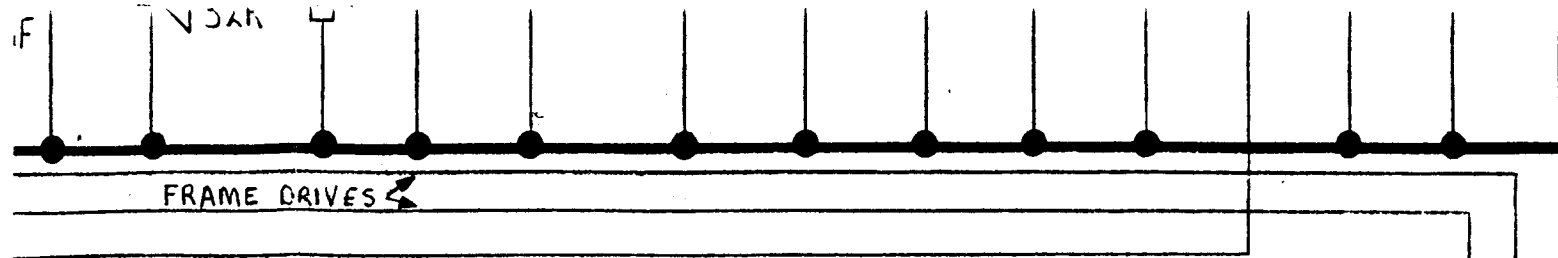


STACK STEP No 1

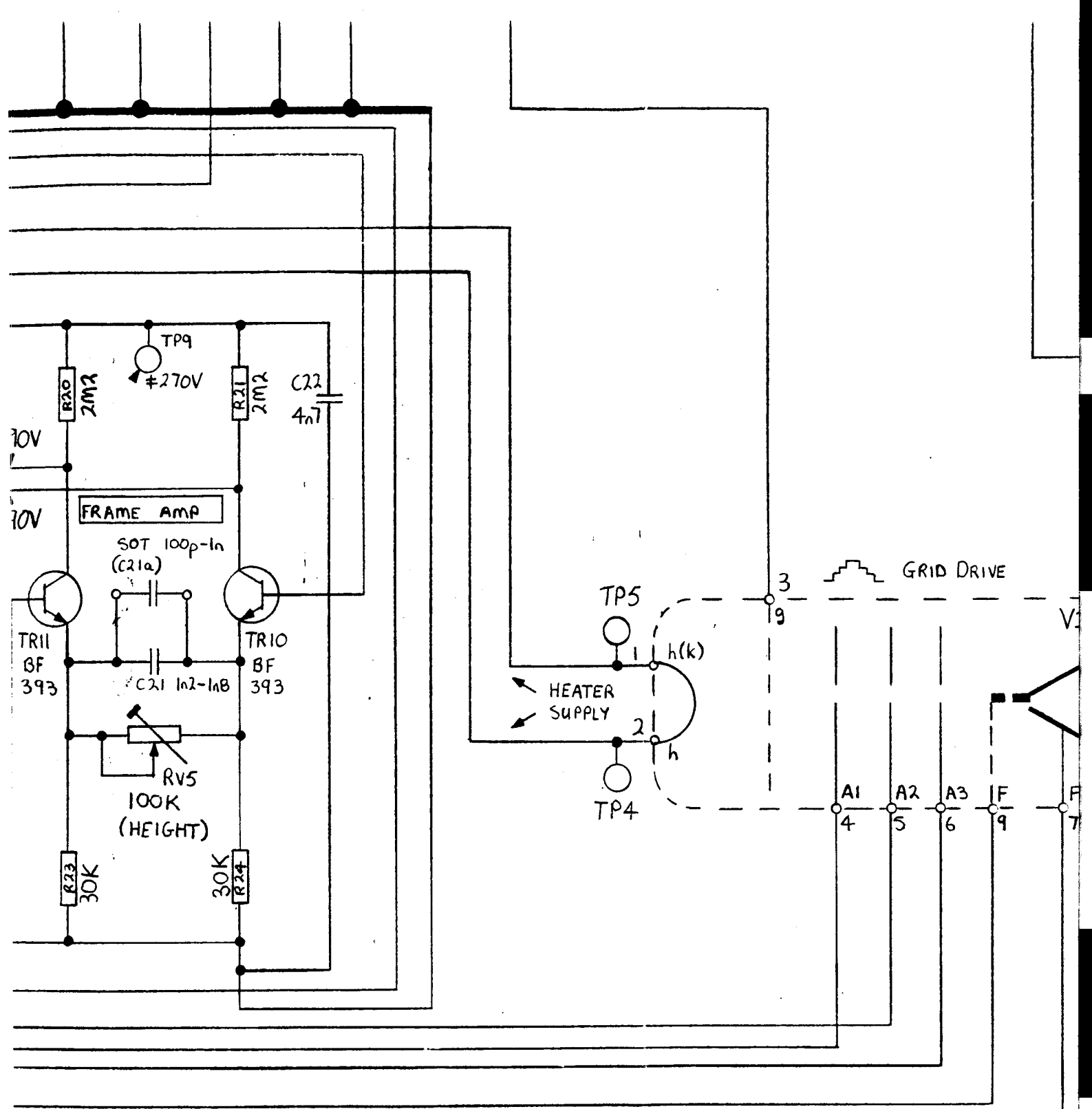


ATIONS
Of Board

- 40
- 50
- 60

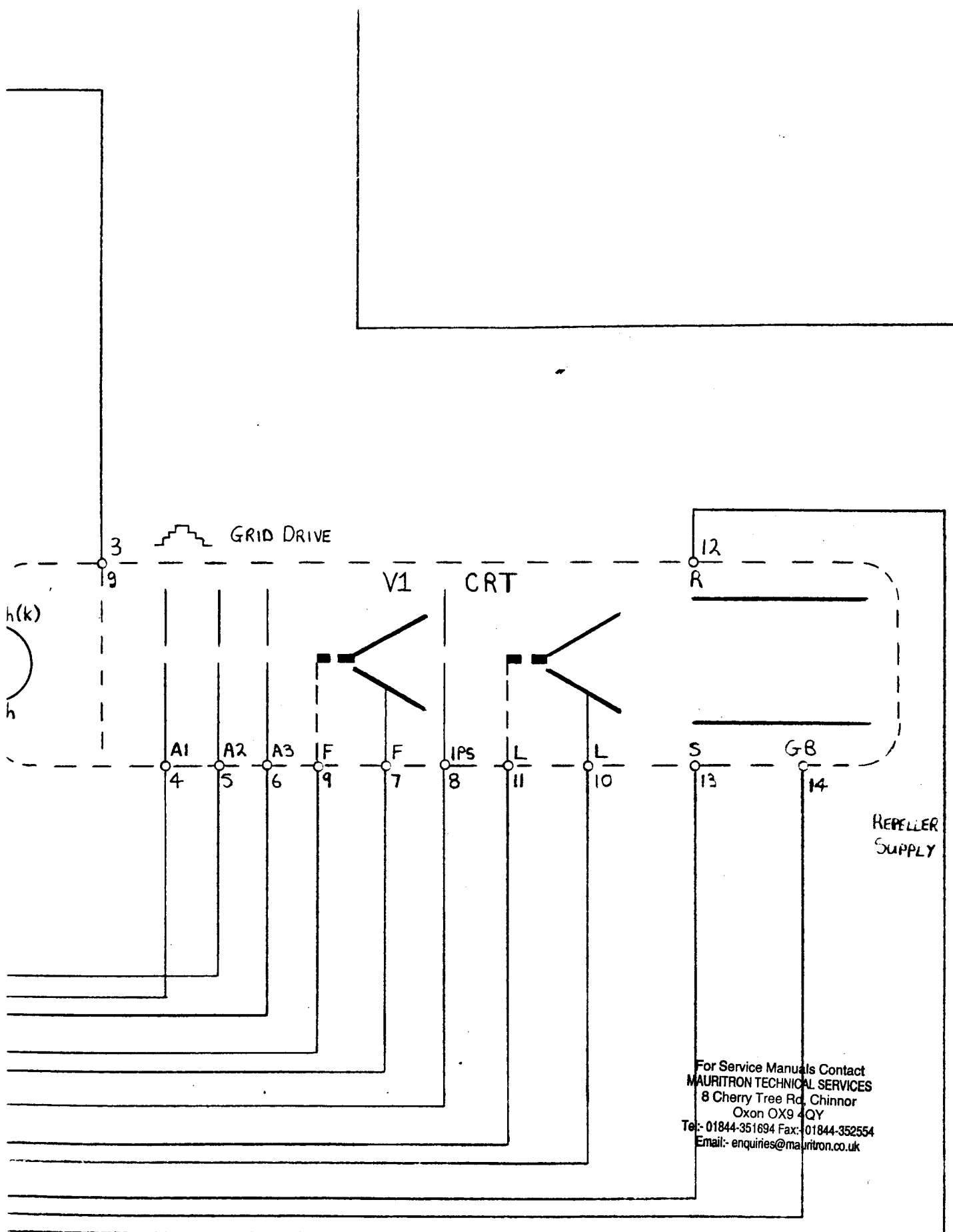


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 Email:- enquiries@mauritron.co.uk



NOTE-REF. TO SRL DWG NO
359-280108

DATE
TITLE
DIAG
FTV



To SRL DWG No
-280108

DATE 31/4/86	DRAWN G. KEARNAN
TITLE MICROVISION CIRCUIT DIAGRAM. FTV 2A 'EURO VERSION'	DRAWING NUMBER TDC 200062