thandar

SC110A OSCILLOSCOPE

SERVICE MANUAL

CONTENTS

Service Handling Precautions

Service work or recalibration should only be carried out by skilled engineers. Please note the following points before commencing work.

The tracks on the printed circuit board are very fine and may lift if subjected to excessive heat. Use only a miniature temperature controlled soldering iron and remove all solder (on both sides of the joint) with solder wick or suction before attempting to remove a component.

The integrated circuits IC2, IC4, and IC601 are CMOS devices and care should be taken when handling to avoid damage by static discharge.

Safety glasses must be worn at all times when dismantling and working on the instrument.

Dismantling the Instrument

1. Invert the oscilloscope and remove the 4 rubber feet.
2. Remove the 6 recessed screws and one surface screw and lift off the case lower. This gives access to all calibration adjustments.
3. If further dismantling is required to replace components, proceed as follows.

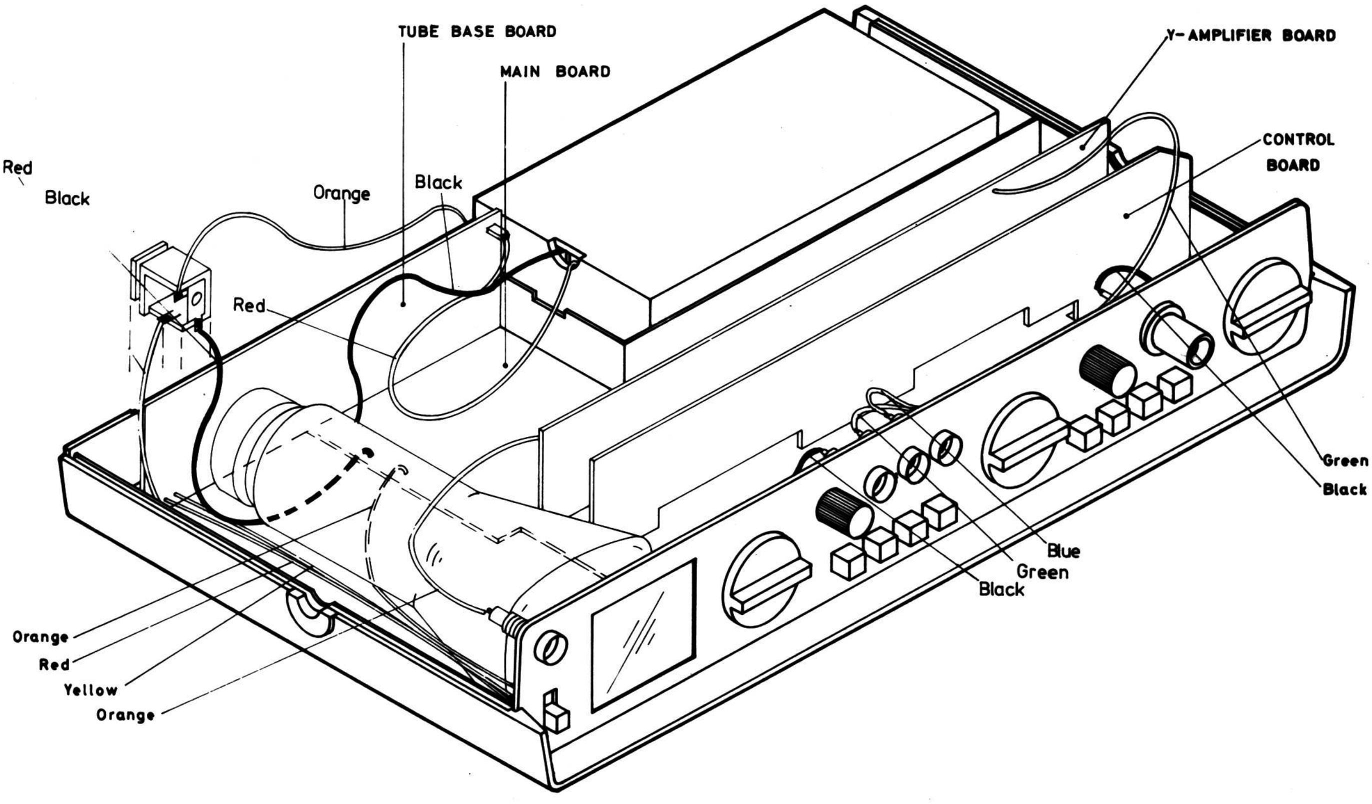
   Remove the front panel knobs. Desolder the connections to the BNC and 2mm sockets on the front panel and desolder the switch connections from the tube-base board and main board.

   Pull off the front panel, desolder the two trace rotate coil leads from the main board and carefully unplug the C.R.T.

   Remove the tube-base board by desoldering the right-angled header from the main board.

   Unplug the Y-amp and control board assembly. The control board can then be separated from the Y-amp by removing the V/DIV switchcup assembly and unscrewing both the switch nuts.

   Reassemble by reversing the procedure.



TECHNICAL SPECIFICATION

Display

Screen dimensions:-	32mmx26mm
Graticule divisions:-	5 horizontalx4 vertical (6mm)
Phosphor:-	Blue-white, medium persistence
External Adjustments:-	Intensity, Focus, Trace Rotate

Vertical Deflection (Y input)

Bandwidth:-	D.C. to 10MHz ± 3dB at 1 div.
Coupling:-	Switchable D.C., A.C. or ground A.C. coupling – 3dB at 2Hz
Sensitivity:-	10mV/div to 50V/div in 12 ranges Calibrational accuracy ± 3%
Input impedance:-	1MΩ in parallel with 47pF.
Maximum input:-	350V (D.C. + peak A.C.) provided D.C. component does not exceed 250V.

Horizontal Deflection (X Input) — switch selectable

Bandwidth:-	D.C. to 2MHz ± 6dB
Coupling:-	D.C.
Sensitivity:-	Approximately 0.5 volts/div.
Input impedance:-	1MΩ in parallel with 10pF
Maximum input:-	2.5 volts, protected to 250 r.m.s. 50/60Hz

Timebase — switch selectable

Sweep times:-	0.1μ secs/div to 0.5 secs/div in 21 ranges Calibrational accuracy ± 3% for 0.2μ secs/div to 0.5 secs/div ranges; ± 10% for 0.1μ secs/div.

Triggering Circuit

Source:-	Internal or external switchable
Coupling:-	A.C., D.C., TV Frame, or TV Line filtering.
Level:-	Continuously variable over waveform
Slope:-	+ or – selectable on level control.
Sensitivity:-	Less than 1 div. for internal trigger Less than 1 volt for external trigger

Modes:-

a) Bright line
Timebase free runs until synchronised by trigger circuit.

b) Trigger:
Timebase reset with display blanked until sweep initiated by trigger circuit.

c) Economy:
Instrument switches to a power saving mode with display blanked until timebase is started by trigger circuit.

d) External:
As for Bright Line but with external trigger input.

Calibrator

Square wave output of amplitude 1 volt pk-pk ± 5%.
Frequency 1kHz ± 30%

Power Requirements

4V to 10V D.C. via disposable cells, rechargeable cells, or A.C. adaptor.

Typical Power Consumption:

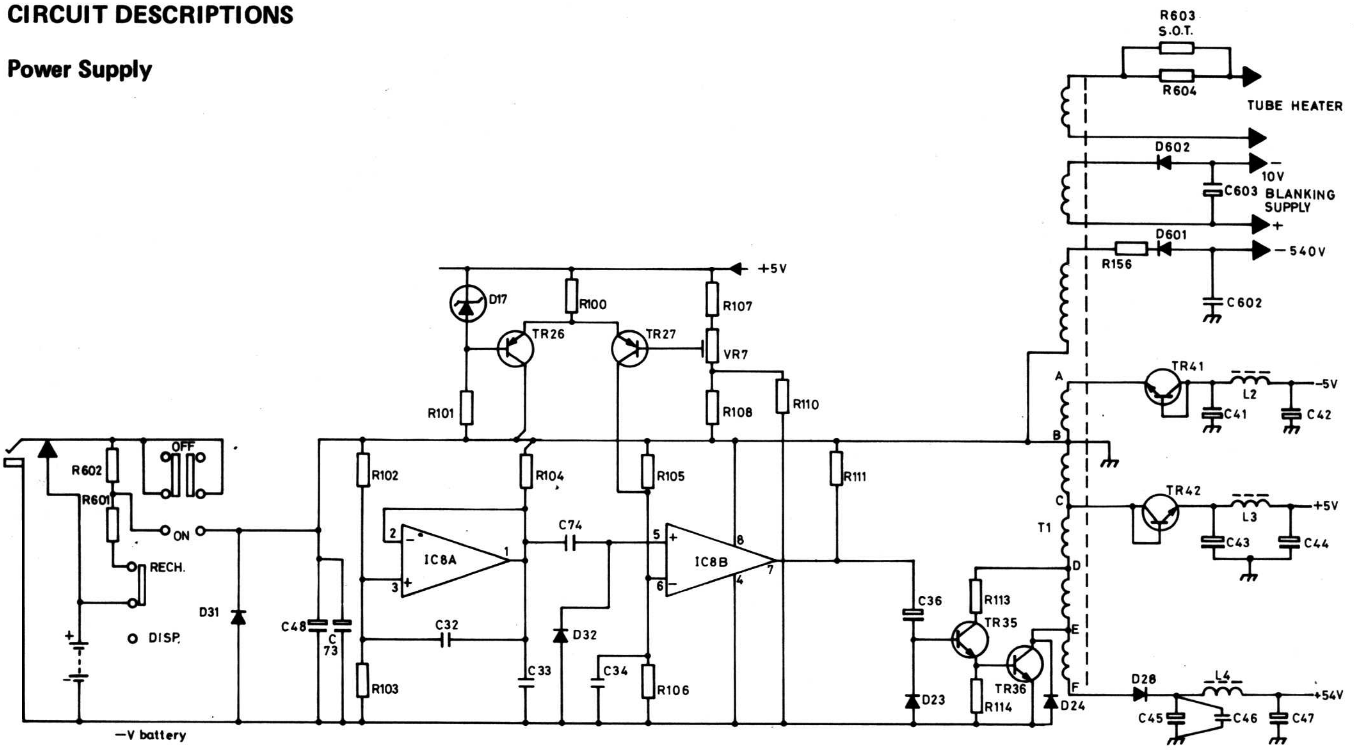
Bright Line - 900mW
10MHz – 1300mW
Economy – 350mW

Physical Details

Dimensions:-	255 x 150 x 50 mm
Weight:-	900 gms
Environmental operating range:	5^{o} to 40^{o}C, 20% to 80% RH
Environmental storage range:	- 40^{o} to 70^{o}C.

CIRCUIT DESCRIPTIONS

Power Supply



The power-supply is of the switched-mode type with regulation achieved by pulse-width modulation.

Comparators IC8A and IC8B both have open collector outputs.

IC8A and associated components form a sawtooth generator operating at about 20KHz. The positive input (pin 3) is held at approximately 1 volt above $-V_{battery}$ by R102 and R103. The negative input (pin 2) ramps positively from its starting voltage of $-V_{battery}$ as C33 charges through R104; when it reaches a voltage equal to that on pin 3, IC38A output goes low, discharging C33. C32 ensures that the voltage on pin 3 stays below that on pin 2 until C33 fully discharges; as C32 itself discharges, pin 3 rises to about 1 volt above $-V_{battery}$ again and the cycle repeats.

The sawtooth output of IC8A is coupled by C74 to the positive input (pin 5) of the comparator IC8B in the regulator circuit; the negative input (pin 6) is fed from the error amplifier TR26, TR27. When the power is first switched on pin 6 sits at a voltage close to $-V_{battery}$ determined by R105 and R106, there being no current supplied by TR27 into R106 because the +5V rail is still at OV. Pin 5 follows the output of IC8A as it starts to ramp upwards; when it exceeds the voltage on pin 6 IC8B output goes high, permitting TR35 and TR36 to be turned on by R111 through C36.

IC8A output continues to ramp upwards and collector current builds up in TR35 and TR36, storing energy in transformer T1; R113 prevents TR35 becoming the main carrier of output current which would impair efficiency. When the IC8A sawtooth output finally switches low, pin 5 of IC8B is pulled below the level of pin 6, IC8B output goes low and TR35, TR36 are turned off. D32, with C74, acts as a level clamp and ensures that pin 5 of IC8B always sees a ramp base voltage of –0.2 volts with respect to –Vbattery; consequently IC8B is always turned off at the beginning of the ramp even during the first few cycles after start-up when pin 6 is close to $-V_{battery}$. This is an advantage over the direct coupling of IC8A output to IC8B, where at start up IC8A output may not go sufficiently low until the full supply voltage has built up across IC8 resulting in a high current initially building up in the transformer.

As TR35 and TR36 turn off, their collectors fly more positive than ground (battery positive) and the transformer discharges energy into all the secondary loads, e.g. into C43 and C44 via TR42 for the +5V rail. When the positive input of IC8B starts to ramp again, following the output of IC8A, the cycle repeats itself.

Regulation is achieved as follows. The error amplifier TR26, TR27, R100 compares a proportion of the +5V regulated voltage rail, determined by R107, VR7 and R108, with a stable low temperature coefficient reference, D17. When the regulated rail is at too low a voltage, the base voltage on TR27 is lower than that on TR26 and the collector current of TR27 less than that at regulation. The voltage on pin 6 is therefore lower than at regulation and on the next cycle the ramp at pin 5 exceeds the level at pin 6 earlier, switching IC8B off and allowing TR35, TR36 to be on longer before the sawtooth resets. This extra energy is put into the voltage rails on that cycle; this is detected by the error amplifier which increases the collector current through R106 and reduces the time IC8B output is high on during the next cycle. Thus stabilisation is achieved by pulse-width modulating the on-time of TR35, TR36.

VR7 adjusts the +5V rail, by varying the proportion of the regulated rail which is compared with the reference voltage by the error amplifier.

R110 improves the rejection of input supply variations by feeding forward a small proportion of the input voltage into the error amplifier.

D23 clamps the negative excursion of the base of TR35 when IC8B output goes low to prevent damage.

D24 clamps the collector of TR36 when it flys negative as the transformer 'rings'. This has the advantage of putting otherwise wasted energy back into the unstabilised supply.

Only the +5V rail is regulated. All other voltage rails are defined only by the winding ratios of the transformer T1. This means that as the energy put into the +5 volt rail is increased to meet an increased load (e.g. at higher input signal frequencies) the other rails also receive more energy. The loading of the –5 volt rail roughly tracks that of the +5 volt rail so it remains fairly well stabilised, but the other rails can vary significantly as the load on the 5 volt rails changes or as their own load varies, e.g. the –540 volt rail will rise when the tube is blanked.

Inductors L2, L3 and L4 prevent power supply spikes getting onto the –5, +5 and +54 volt rails respectively.

When rechargeable batteries are fitted and the selector switch is in the rechargeable position, they can be charged by the external adaptor through R601 when the instrument is on and through R601 + R602 when it is off.

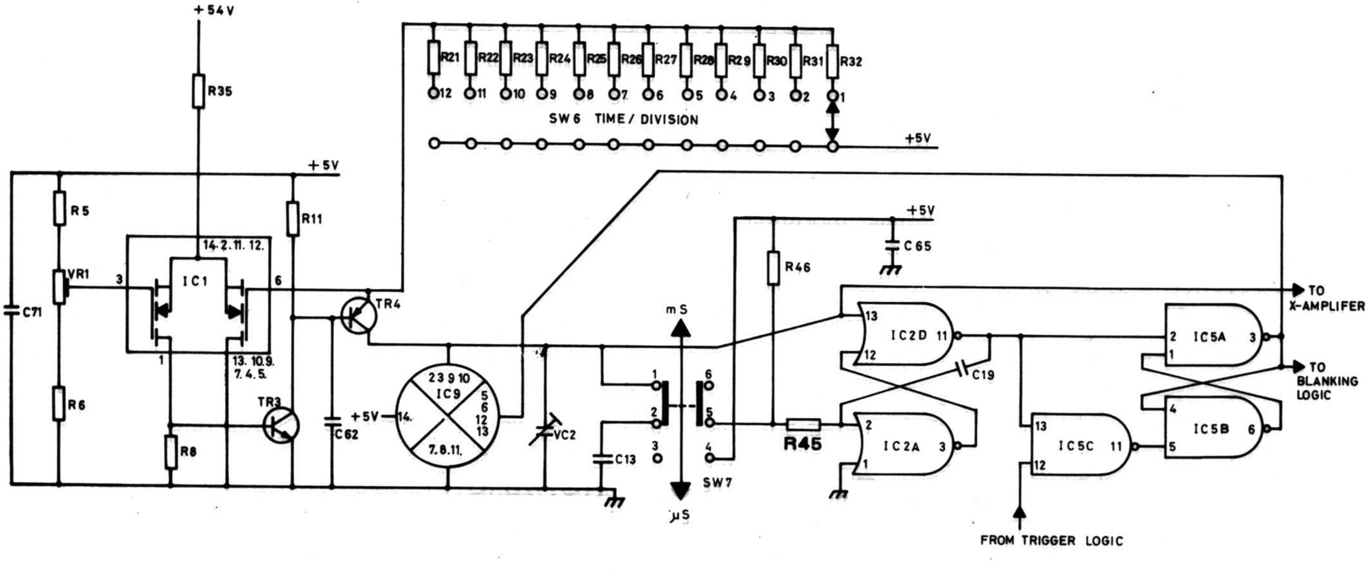
Timebase sweep generator

The purpose of the timebase sweep generator is to produce a linear ramp voltage of the required ramp rise time which will be amplified by the X-amplifier to drive the X-plates of the C.R.T.

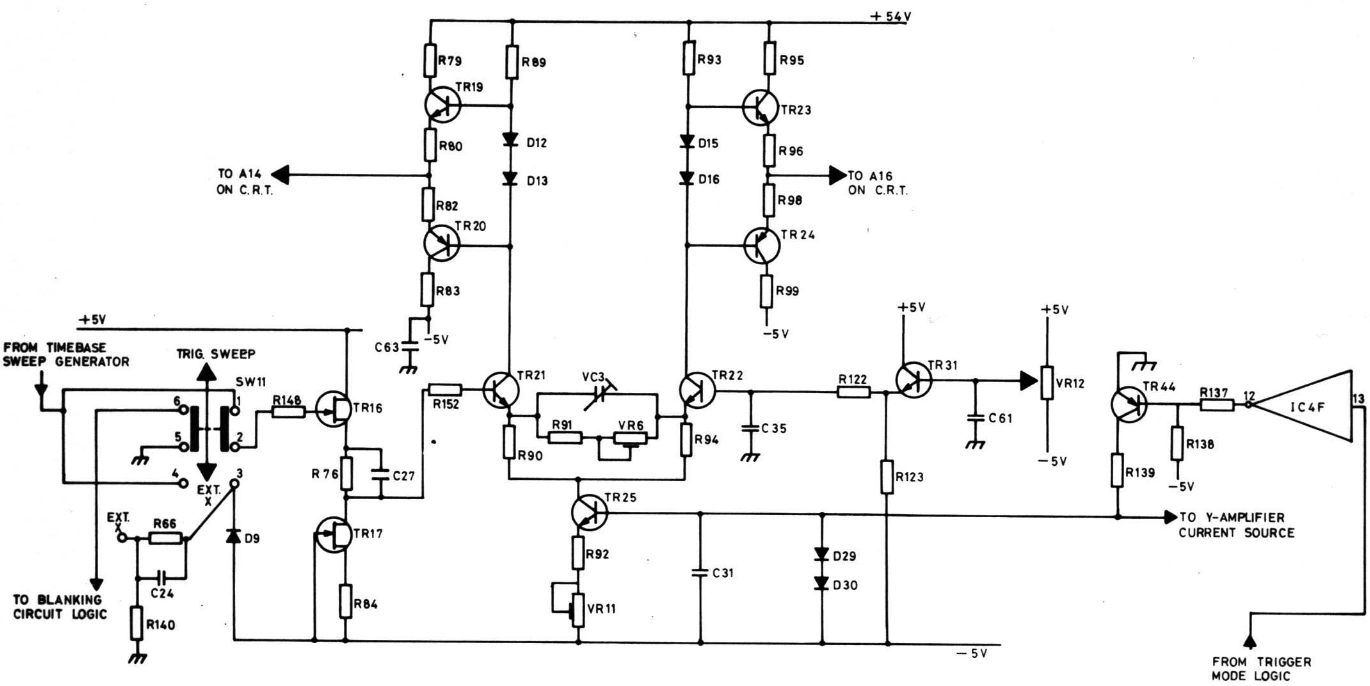
The linear ramp voltage is generated by charging a capacitor from the constant current source consisting of IC1, TR3, TR4 and the timebase resistors R21 to R32. The emitter of TR4 is held at a constant voltage below the +5V rail, adjustable by VR1; the emitter current defined by the timebase resistors is therefore constant which in turn means that the collector current which charges the timebase capacitor is also constant, since TR4 is not in saturation. VC2 is the capacitor charged on the microsecond range, C13 is switched in parallel by SW7 for the millisecond range. Across this capacitor combination is a CMOS analogue switch, IC9, which "closes" and discharges the capacitor at the end of the ramp. This "flyback" occurs when the voltage across the capacitor reaches the switching threshold of IC2D to which it is connected; at this point IC2D output goes from high to low, causing IC5A output to go high and turn on the analogue switch IC9 which discharges the timebase capacitor.

In the absence of trigger pulses from the trigger circuit, pin 12 of IC5C is permanently low forcing its output permanently high; when IC5A output goes high, therefore, IC5B output goes low and "latches" the state of IC5A. IC9 therefore remains on, holding the timebase capacitor at the start of its voltage ramp. A sweep is initiated when IC5C pin 12 is momentarily taken high by a pulse from the trigger circuit (which is described in a later section). This results in IC5C output going low, since IC2D output is also now high, setting the cross-coupled gates IC5A and IC5B into a state where IC5A output is low, turning IC9 off and allowing the voltage across the timing capacitors to ramp up. At the end of the sweep IC2D output resets IC5A and IC5B with a low pulse whose duration is set by the monostable action of IC2A and IC2D with C19 and R45, R46. While IC2D output is low further trigger pulses into IC5C cannot initiate a sweep, ensuring IC9 is on long enough to fully discharge the timebase capacitors; this is known as the hold-off period. It is necessary to have different hold-off periods for the two possible values of capacitance selectable with the millisecond/microsecond switch SW7. This is achieved by shorting out R46 with SW7 when the smallest value of capacitance is selected.

Calibration of the sweep speed is achieved on the millisecond range by adjusting the charging current with VR1, and on the microsecond range by adjusting the capacitance of VC2.



X-Amplifier



The ramp voltage from the timebase sweep generator is connected to the input of the X-amplifier when SW11 is in the TRIG SWEEP position.

TR16 is a high input impedance unity gain buffer with current source TR17 providing temperature compensation. TR17 is also matched with TR16 for I_{DSS} so that the DC operating point of the amplifier is approximately midway between the +5 and −5 volt rails.

TR21 and TR22 form a differential long tail pair amplifier with a constant current source TR25. TR19, TR20, TR23 and TR24 form complementary emitter follower output stages. VR11 in the emitter of TR25 sets the current through TR21 and TR22 and hence their collector voltages. VR11 is adjusted to set the differential outputs which drive the tube X-plates to the middle of the available swing under quiescent conditions (i.e. TR21 and TR22 conducting equally). VR6 adjusts the DC and LF gain. VC3 controls the HF performance of the amplifier and is used to adjust for correct linearity at the higher sweep speeds.

VR12 is the front panel X-shift control and can vary the base voltage of TR22 between approximately +5 and −5 volts via emitter follower TR31. If the voltage on the base of TR22 is taken more negative by VR12 than its "trace central" position then the ramp voltage on the base of TR21 will start less negative and finish more positive with respect to TR22 base than it would under "trace central" conditions. Thus the outputs to the X-plates start with a smaller reverse differential across them (less deflection to the left from the central spot) and finish with a larger differential in the other direction (greater deflection to the right from the central spot) i.e. the trace "shifts to the right. Taking VR12 positive shifts the trace to the left by the same mechanism.

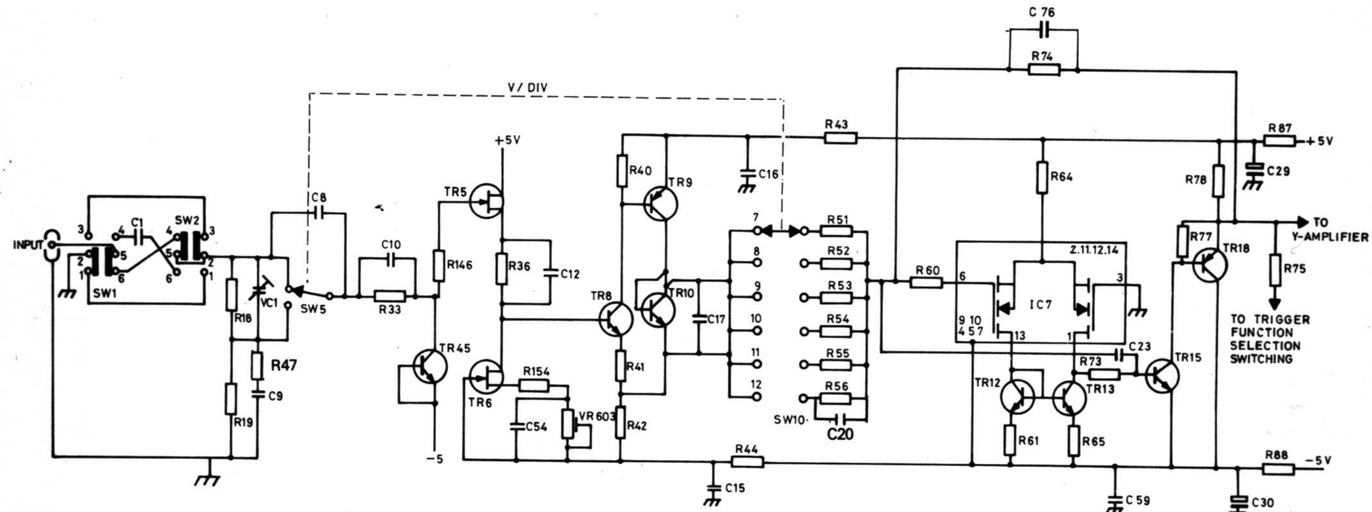
Under normal operating conditions the output of IC4 is low and TR44 conducts, providing base drive for TR25 (and the corresponding transistor, TR40 in the Y-amplifier output stage). In the economy mode the output of IC4 goes high in the absence of trigger pulses, preventing TR44 supplying base drive to TR25 and TR40. The amplifier output stages are thus completely switched off, and the outputs to the C.R.T. plates rise almost to the positive rail voltage, substantially reducing the current drain of the instrument.

When SW11 is switched to EXT X the output of the timebase generator is grounded and sweep control is through the external X input via R66 in parallel with C24. D9 provides overload protection.

Y - preamplifier and amplifier

The input to the Y-amplifier passes through the mechanically interlocked switches SW1 and SW2 which allow the selection of either direct signal coupling, AC coupling via C1, or grounding of the preamplifier input (both SW1 and SW2 depressed).

SW5 is ganged with SW10 and switches in a 100:1 attenuation of the signal when SW10 has completed its first six positions from 10mV/div to 500mV/div to give the 1V/div to 50V/div ranges. The frequency response of the attenuator R18, R19 is compensated by C9 and trimmer VC1. R47 ensures accurate attenuation is maintained beyond 10MHz. C8 compensates for possible variations of input capacitance that can occur when SW5 operates, due to input capacitance of TR5. When SW5 is in the direct position C8 is short-circuited and the input capacitance of TR5 and associated components is connected across the input; when SW5 selects the output of the attenuator the effect of TR5 input capacitance is removed and effectively replaced by C8.



TR5 is a source follower with temperature compensation provided by current source TR6, which is I_{DSS} matched with TR5. VR603, the rear panel DC offset control, adjusts the current source and therefore the DC level of TR8 base.

TR8, TR9 provide a second stage of buffering with adequately low output impedance to drive the gain stage of IC7, TR12, TR13, TR15 and TR18; TR10 provides temperature compensation for the V_{BE} of TR8. The gain stage is a feedback amplifier with R74 providing the feedback and resistors R51 to R56 defining a gain from unit to 50. C20 provides HF compensation in the X50 gain position. IC7 and current mirror TR12, TR13 ensure adequate DC performance but these are bypassed at higher frequencies (>50kHz) by C23. C76 provides high frequency compensation and reduces overshoot on fast edges (<20nS) at the expense of some bandwidth.

R87 and C29 provide +5V rail decoupling for the whole Y-pre-amplifier; R44, C15 and R88, C30 decouple the –5V rail.

The Y-amplifier is of exactly the same configuration as the X-amplifier already described but runs at higher currents to achieve the bandwidth required.

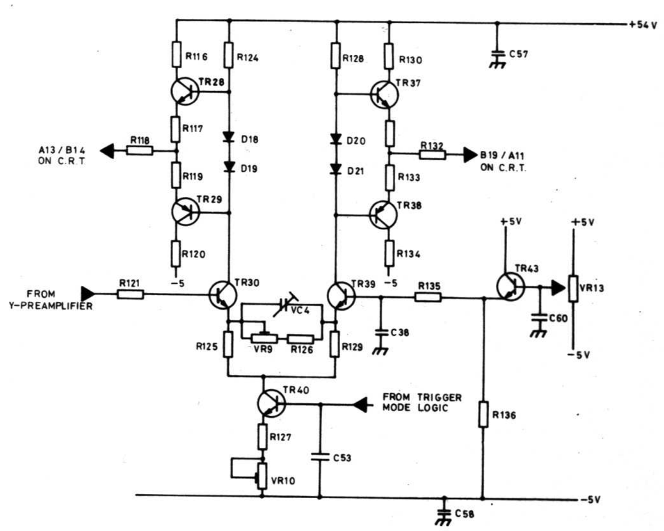
VR10 sets the DC level of the outputs to the middle of the available swing, as before. VR9 sets the DC and LF gain of the output stage and is the only available adjustment of Y-channel sensitivity. VC4 is adjusted to give the best compromise between HF gain and good square wave response. VR13 is the Y-shift front panel control.

The signal from the pre-amplifier is fed to TR30 through R121 which prevents spurious oscillations, as do R118 and R132.

TR44, controlled by IC4, supplies base current to TR40 and can turn off the whole amplifier in the Economy mode in the absence of trigger pulses, as explained in the X-amplifier description.

Trigger Circuit

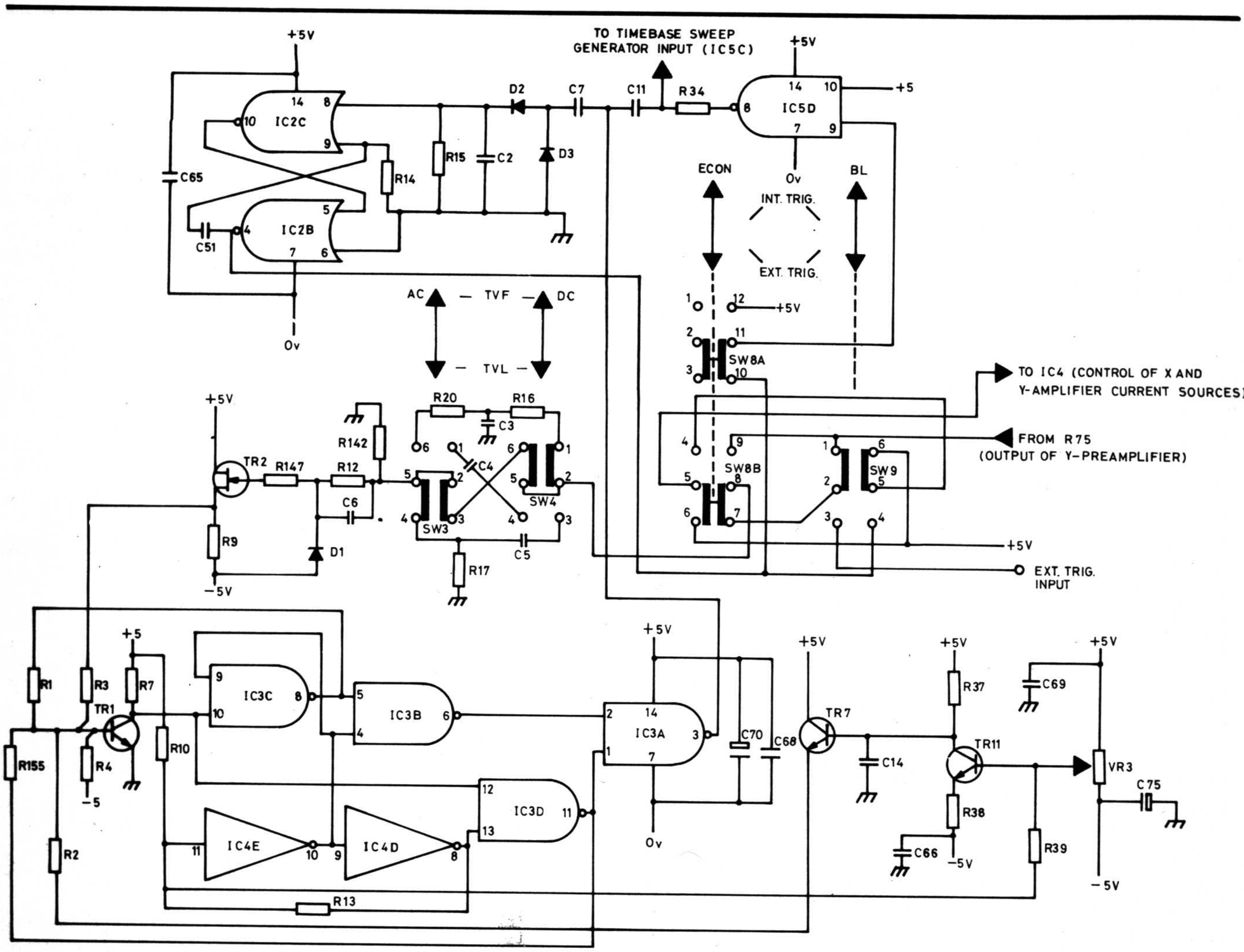
The trigger circuit provides the positive going edges to the input of the timebase sweep generator (IC5B pin 12) that initiate the sweep ramp in syncronism with the waveform to be displayed.



SW8/SW9 select either an internal trigger input signal (the output of the Y-preamplifier) or an external signal from the EXT TRIG input on the front panel. The trigger signal is fed to the trigger coupling selection switches SW3, SW4 which enable the signal to be AC or DC coupled or alternatively coupled by high pass filter C5, R17 or low pass filter R20, C3 for TV line and frame synchronism respectively. R16 prevents loading of the Y-preamplifier by C3 when AC coupling is selected.

The trigger signal passes to TR2, a high to low impedance buffer, with R12, C6, D1 providing protection against possible EXT TRIG overload.

From TR2 the signal passes to TR1 which together with either IC3C and feedback R1, or IC3D and feedback R2 forms a Schmitt trigger for triggering off positive or negative going trigger inputs respectively. Control of the DC operating conditions of TR1 permit selection of the point of the incoming waveform at which the Schmitt triggers change state; enabling IC3C or IC3D permits selection of triggering on either the positive or negative edge of the trigger waveform respectively. Both functions are combined into the single front panel TRIGGER LEVEL control VR3 which works as follows. When the VR3 wiper goes towards the +5V rail, IC4E output goes low, inhibiting IC3C, IC3B and IC4D output goes high enabling IC3D i.e. selecting negative edge triggering. As VR3 wiper goes more positive the collector of TR11 is pulled positive



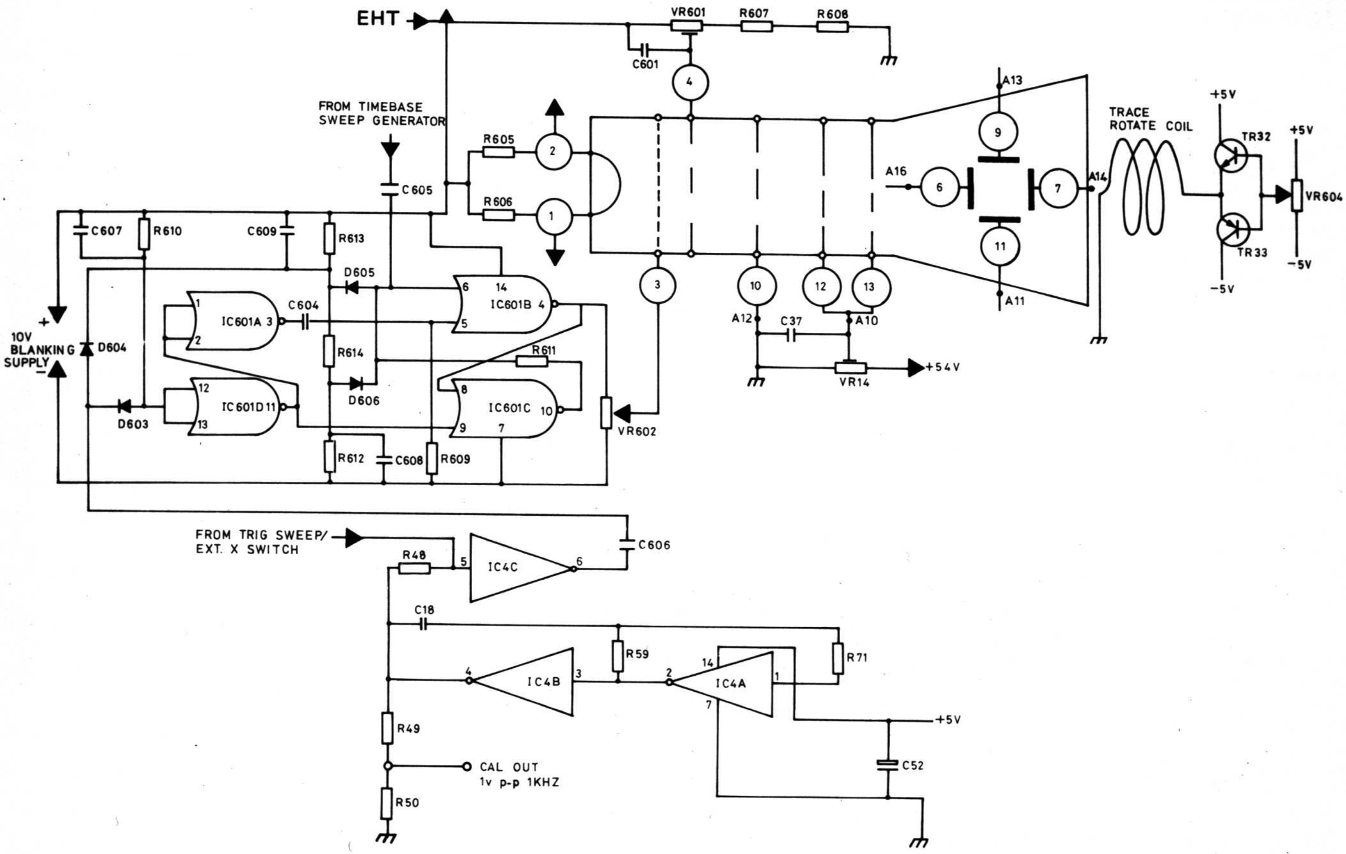
by approximately the same amount since TR11 is saturated and its base collector junction is forward biassed. The increase in voltage of TR11 collector pulls the DC level of TR1 base more positive via emitter follower TR7 and R2, thus requiring a more negative trigger input from TR2 through R3 to trigger the output of the selected Schmitt trigger TR1, IC3D from high to low. The negative going transition on IC3D output causes a positive going output from IC3A which is fed to the input (IC5C pin 12) of the timebase sweep generator via C11.

Conversely, taking the wiper of VR3 towards −5V enables IC3C, IC3B and disables IC3D, i.e. it selects positive edge triggering. As it goes more negative it takes the emitter of TR11 more negative, reducing the current through R38, and therefore R37, and causing the collector voltage of TR11 to rise towards the +5V rail by approximately the amount that VR3 has gone negative from its midway position. The base of TR1 is therefore again taken more positive via emitter follower TR7 and R2, decreasing the point at which a positive going trigger input from TR2 through R3 triggers the selected Schmitt trigger TR1, IC3C output from low to high. This transition causes a low to high transition at IC3A output which initiates a timebase sweep via C11 as before.

Thus VR3, as it moves away from its midway position, selects both the triggering edge and the triggering point on that edge. Note that since the output of the Y-preamplifier, used as the internal trigger input, is the inverse of the Y-input signal, triggering on the negative edge of the trigger waveform is in effect triggering on the positive edge of the input signal and vice versa. Thus the trigger control is marked to show positive triggering when the wiper moves towards +5V and vice-versa. Since the EXT TRIG signal is fed to the trigger circuit direct the trigger control is incorrectly marked for external trigger inputs.

Switches SW8, SW9 select not only between external and internal trigger modes but also one of three possible internal trigger options — Bright Line, Trigger, and Economy.

The Bright Line facility is realised by holding the timebase sweep generator input (IC5C pin 12) high and therefore allowing the timebase to free run. This is achieved by passing the low output of IC2B to the input of IC5D through SW8A when Bright Line is selected; IC2B output is low because in the absence of trigger pulses from IC3A the voltage across C2 is zero and the output of IC2C which is cross-coupled to IC2B is therefore high. When there are trigger pulses from IC3A output the voltage across C2 approaches +5V because of rectifier D2, D3 causing IC2C output to go low. IC2B output therefore goes high, IC5D output goes low and the sweep generator is then only triggered by positive edges from IC3A output via C11 as required. Monostable action via C51 holds IC2B, IC2C in this state until C51 discharges into R14, even in the absence of further pulses from IC3A, permitting flicker-free triggering down to low frequencies.



In the Economy mode IC5D output is held low because SW8A holds its input high; the timebase can therefore only be triggered by positive edges from the trigger circuit output IC3A. Monostable IC2C, IC2B is used instead to control the power to the X and Y amplifiers by feeding IC2B output to IC4F input. IC2B output is low in the absence of trigger pulses, as before, and the output of IC4F goes high, turning the output stages off; when a succession of trigger pulses cause IC2B output to go low the output stages are turned on by IC4F.

In the trigger mode (both SW8 and SW9 depressed) SW8/SW9 holds the input of IC4F high and the power to the output amplifiers on. SW8A holds IC5D output low so that only trigger pulses from IC3A can initiate a timebase sweep.

Tube drive and flyback blanking

The heater winding of the power supply transformer T1 is connected to the tube cathode and is referenced to the E.H.T. rail by R605 and R606 such that the average heater voltage is at E.H.T.

The differential outputs of the X and Y amplifiers are coupled directly to the X and Y plates.

Rear panel control VR601 controls FOCUS and VR14 ASTIGMATISM

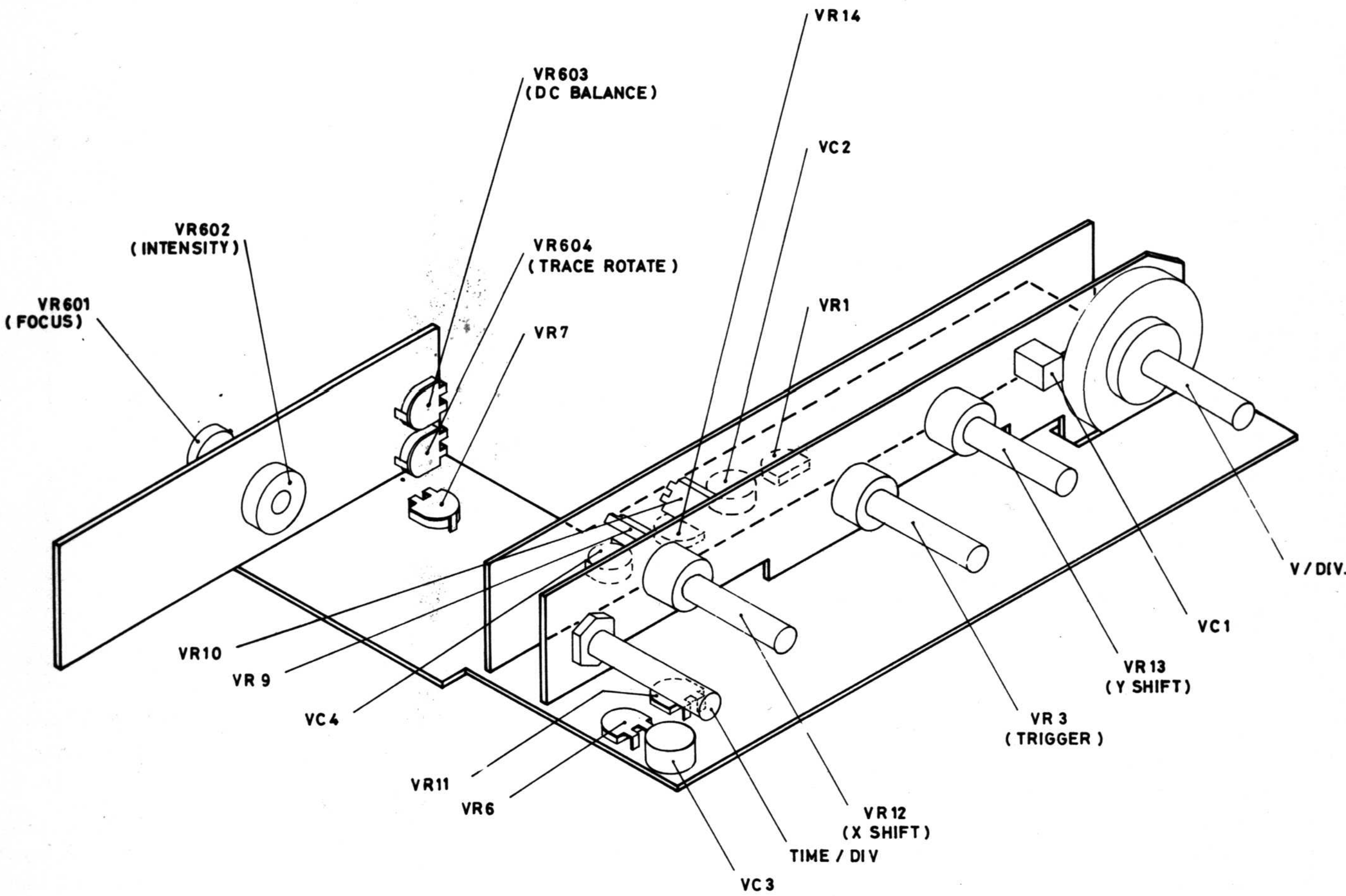
Rear panel TRACE ROTATE control VR604 controls the magnitude and direction of the current sourced by either TR32 or TR33 into the trace rotate coil fitted to the outside of the tube.

IC601 and associated components form the flyback blanking logic, the supply line for which is referenced to the E.H.T. rail. IC601B and IC601C form a simple set-reset flip-flop controlled by a single input from the timebase sweep generator via C605. Diodes D605, D606 together with potential divider R613, R614, R612 clamp this input to approximately midway between the IC601 supply rails. In triggered sweep mode IC4C input is grounded by SW11 holding IC4C output high; R610 theretore holds IC601D inputs high which in turn holds IC601C pin 9 input low. IC601B pin 5 input is held low under these steady conditions by R609. A low going pulse from the timebase circuit therefore sets the output of IC601B high, rear panel INTENSITY control VR602 determining the actual voltage applied to the tube. A high going pulse from the timebase circuit at the end of sweep resets IC601B output low and blanks the tube for trace flyback.

When external X-input is selected IC4C input is ungrounded and the output from the calibrate oscillator IC4A, IC4B is passed via IC4C and C606 to DC clamp D604 and rectifier D603. The input of IC601D therefore goes low and its output high causing the set-reset flip-flop output IC601B to set high. Thus the tube remains unblanked whilst external X is selected. To revert to a triggered sweep IC4C input is again grounded and R610 therefore pulls IC601D input high causing its output to go low. However this is not sufficient to reset the flip-flop IC601B, IC601C in the absence of pulses from the timebase generator through C604; to overcome this C604 provides a positive going reset pulse as triggered sweep is reselected and R609 restores the DC condition required on IC601B pin 5 for subsequent triggered sweep operation.

Calibrate Oscillator

The calibrate oscillator is made up of IC4A, IC4B and timing components C18, R59. The operating frequency is approximately 1kHz and the output swings within a few millivolts of ground and the stabilised +5V rail. Since this is set accurately, the 1 volt peak-peak calibrate output is adequately defined by the 1% resistors R49, R50.



The following is a complete check and calibration procedure for the instrument. It is recommended that this procedure is followed in full if any internal adjustments have been made to the unit because these might have affected other parameters: for example, adjusting the X-amplifier gain will require timebase recalibration.

The calibration source needs to provide a marker pulse train of from 20Hz to 10MHz in switched 5:2:1 ranges and a fast rise-time amplitude calibration square wave of up to 1MHz switchable in 5:2:1 ranges from 10mV to 100V. The accuracy of the source should be at least a factor of 10 better than the SC110, i.e. better than 0.3% on both time and amplitude; a suitable low cost unit is the Time Electronics 303. If a current consumption check at all voltages is desired then a bench power supply will be required.

Note that all references to the oscilloscope trace assume that the screen is being viewed upside down since the instrument will need to be this way up to gain access to the adjustments. The instrument should be tested and calibrated sitting in its case upper.

Supply rails

Set external supply to 5 volts, battery type to DISPOSABLE. Set TIME/DIV to .5μsec, V/DIV to .5, TRIGGER LEVEL central. Select TRIG SWEEP, BL, AC trigger coupling, and grounded (AC and DC both depressed) Y INPUT. Centre trace with Y SHIFT and X SHIFT controls.

Check operation of INTENSITY control (VR602); adjust for maximum intensity.

Adjust VR6 and VR11 until the trace is at least 5 divisions of the graticule (this is not a calibration adjustment at this stage).

Adjust VR601 for good focus.

Measure +5V supply rail with a 0.1% accuracy DMM and adjust to 5.00V (± 0.01V) with VR7. Check −5V rail is between −4.9V and −5.10V.

Set VR14 fully anticlockwise. Measure the +54V rail on the tube base board; check that it is between 53.5V and 55.0V.

Measure the −540V rail at the transformer end of R156, check that it is between −530V and −550V. The E.H.T. at the C.R.T. should then be -485V ± 15 V if R156 (22k) is fitted.

Measure the heater voltage on the tube base board with a True RMS voltmeter coupled to the heater pins via a 1:1 isolating transformer. Adjust the value of the Select on Test resistor R603 until the voltage is in the range .540V to .560V RMS.

Set the input supply voltage to 4V; check supply current is between 160 and 250mA.

Set the input supply voltage to 5V; check the supply current is between 130 and 210mA.

Set the input supply voltage to 8V; check the supply current is between 80 and 130mA.

Pre-calibration trace adjustment

Re-set the input supply voltage to 5V.

Set TIME/DIV to 100µsec and V/DIV to .01. Select AC coupled Y INPUT. Turn the TRIGGER LEVEL control slowly over the whole range and check that no waveform is displayed (i.e. no "noise" picked up) greater in height than twice the trace width. Ground the Y INPUT again (both AC and DC buttons depressed) and check that all noise picked up disappears.

This check can only properly be made with the case-lower in place and its earth screen making contact to the instrument ground.

Set TIME/DIV to 1msec and V/DIV to .5. Adjust VR601 for good focus.

Set VR6 fully anticlockwise (minimum trace length) and adjust VR11 for maximum trace length. Readjust VR6 to give a trace length the full width of the screen.

Adjust V604 (trace rotate) to give a horizontal trace.

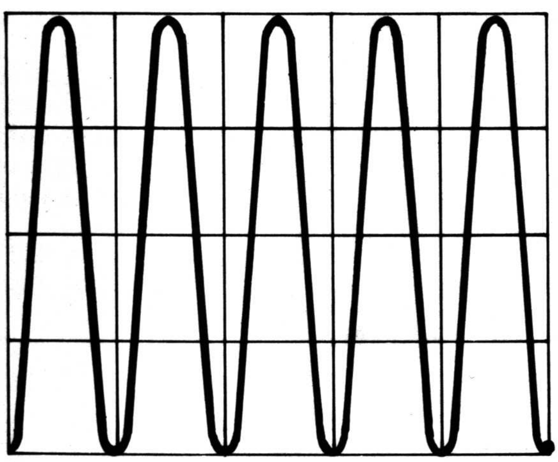
Y-amplifier calibration

i) DC offset:

Set V/DIV to 1. Adjust VR603 to recentre trace if necessary. Switch V/DIV back to .5 and check that trace does not shift. Repeat adjustment until there is no trace movement when V/DIV is switched between .5 and .1.

ii) Amplifier:

Set TIME/DIV to 1 msec, V/DIV to .1. Select AC Y-INPUT coupling. Connect the calibrator direct to the Y-input and select a 1kHz 0.4V peak-peak sine-wave. Adjust TRIGGER LEVEL to get a waveform similar to the diagram.



(TRUE TOP L.H. CORNER)

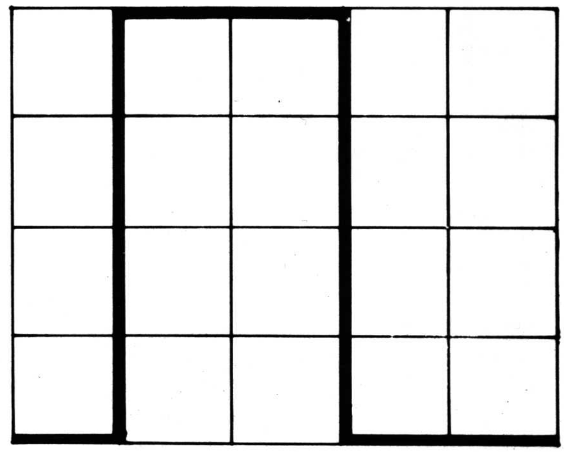
Adjust VR14 for no astigmatism. Re-adjust VR5 for best focus if necessary.

Adjust VR9 for a trace height of approximately 4 divisions and then adjust VR10 for maximum trace height with minimum distortion (this optimises the operating point of the Y output amplifier). Then readjust VR9 for a trace height of 4 divisions to calibrate. Y-shift may be adjusted to centralise trace as necessary.

Check Y SHIFT control can shift trace to extremes of screen so that there is a maximum of half a graticule division of trace showing.

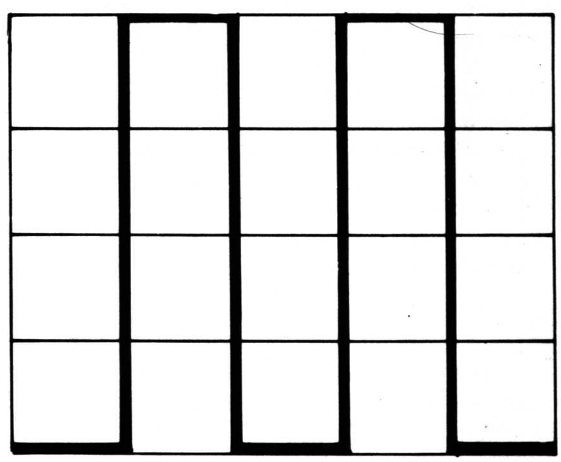
Check the TRIGGER LEVEL can vary the start point of the trace (right hand side) by at least 2 vertical divisions on both positive and negative edges before trace break-up.

Set TIME/DIV to .1msec. Select 2.5kHz square wave of 0.4 volts peak-peak. Adjust TRIGGER LEVEL to obtain a waveform similar to the diagram.



Readjust VR9 for a trace height of 4 divisions if necessary. Switch the TIME/DIV switch through all the ranges round to 500 and check that there is a linear progression in the change of the waveform displayed.

Set V/DIV to .2, TIME/DIV to .2msec. Select 2.5kHz 0.8volts peak-peak square wave. Adjust trigger level control for triggering off positive edge to get a waveform similar to the diagram.



Adjust VC1 to get squarest possible trace (corners may be very slightly rounded).

Turn V/DIV switch from 1 to 50 and back again checking for linear progression in waveform height.

Timebase calibration

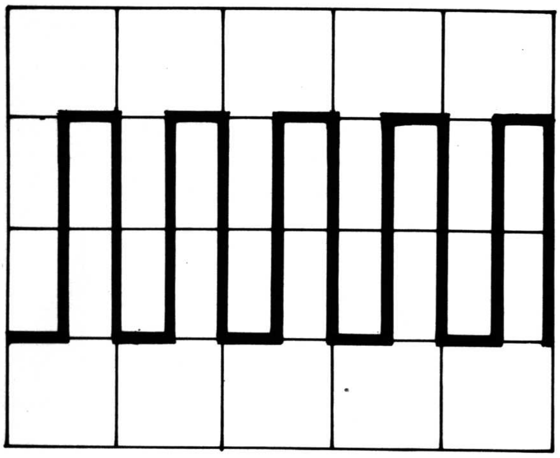
i) millisecond range:

Adjust the X-SHIFT so that the trace starts at the right hand side of the screen as shown in the diagram.

Adjust VR1 to get 1 cycle in 2 divisions, i.e. exactly as previous diagram.

ii) microsecond range:

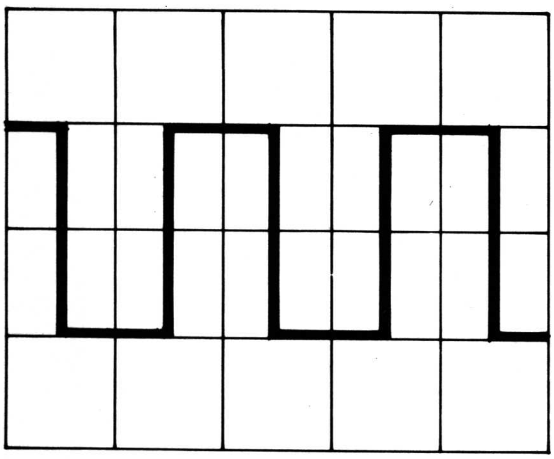
Set V/DIV to .5, TIME/DIV to 1usec. Adjust TRIGGER LEVEL to get waveform similar to diagram.



Adjust X-SHIFT so that trace starts at right hand side of the screen. Adjust VC2 for 1 cycle in 1 division at the left hand end of the trace.

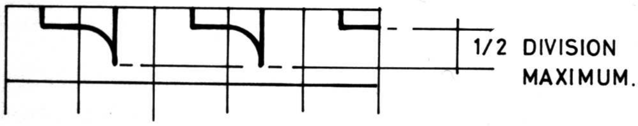
Y-amplifier HF adjustment

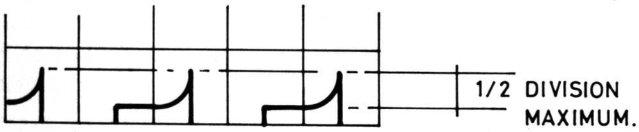
Set TIME/DIV to .5µsec. Adjust TRIGGER LEVEL to get waveform similar to diagram.



Adjust VC4 for best possible square wave.

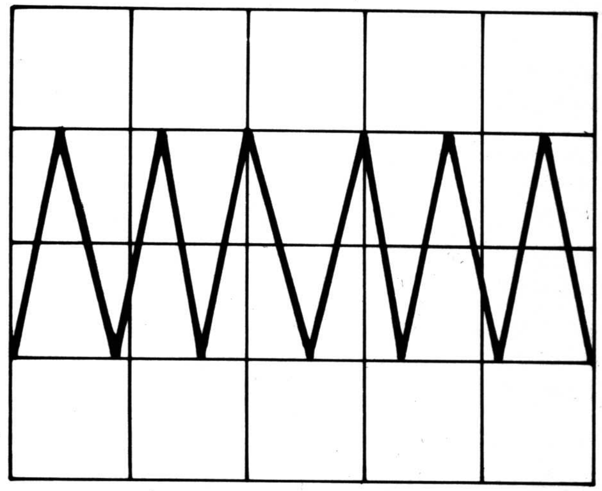
Adjust Y SHIFT over full graticule checking that waveform does not overshoot on the edges by more than half a division top or bottom as per diagram.





X-amplifier final calibration and HF adjustment

Set TIME/DIV to .1usecs. Select 10MHz 0.8 peak-peak square wave. Adjust trigger level control to obtain a waveform similar to the diagram.



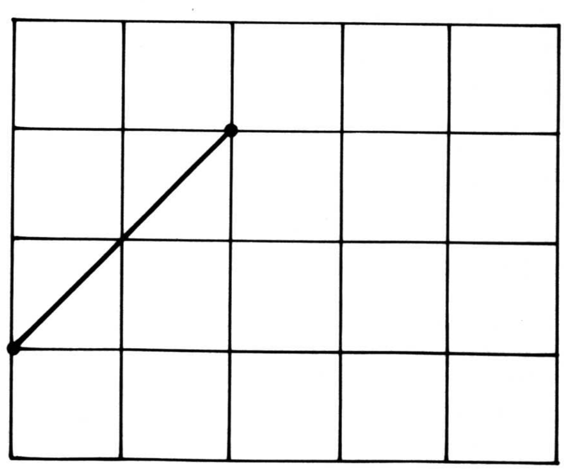
Adjust VC3 for best linearity (i.e. most even spaces between peaks). Adjust VR11 for maximum trace width at left hand end of the trace.

Using the X SHIFT to line up a peak with the RH outer line of the graticule check that the leftmost peak is within half a graticule of the LH outer graticule line, i.e. that calibration is within the 10% specified for this range. If the unit does not meet spec. then readjust VR6 for best trace width; it will then be necessary to return to the Timebase Calibration (microsecond range) section and repeat the procedure from there.

CAL output, EXT X and EXT TRIG inputs check

Set V/DIV to .5, TIME/DIV to .5 msec. Using a split lead, connect the CAL output to Y INPUT, EXT X and EXT TRIG. Adjust TRIGGER LEVEL control. Check that the trace has a height of 2 divisions and a cycle length of 2 divisions ± half a division. This checks the CAL output.

Release the TRIG SWEEP/EXT X button to get EXT X. Check that the Lisajoux figure shown in the diagram appears. This checks EXT X.



Re-select TRIG SWEEP. Select ECONOMY trigger mode. Adjust to TRIGGER LEVEL control until the trace locks, then turn until the trace disappears. Check that the current drain is less than 70mA. This checks ECONOMY mode.

Select TRIG mode (both BL and ECON pressed). Adjust the TRIGGER LEVEL control to check that trace can both be locked or can disappear. This checks TRIG mode.

Select EXT trigger mode (both BL and ECON pressed). Adjust the TRIGGER LEVEL control and check that the trace can both lock and "bright line" when unlocked.

Trigger coupling selection and GROUND input check

Select BL, and in each of the following trigger modes check that the TRIGGER LEVEL control can be adjusted to give a locked trace and a "Bright Line" when unlocked.

i) DC coupling
ii) TVF (both AC and DC pressed)
iii) TVL (both AC and DC released)

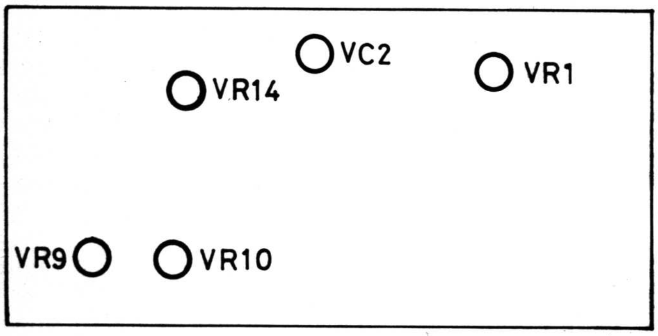
Re-select DC and check that the trace moves down by 1 division with respect to (iii).

Select AC and check that the trace moves up by 1 division.

Connect the Y-INPUT to the GROUND input and check that there is a single straight line on the screen.

Fully cased adjustments

To simplify minor calibration adjustments the following presets are accessible through holes covered by the instruction label on the case lower: VR9, VR10, VR14, VC2, VR1.



PARTS LIST

Fixed Resistors

Ref	Description		Part No
R1	180KJ	W25 CF	23186-4180
R2	3K3J	W25 CF	23186-2330
R3	2K2J	W25 CF	23186-2220
R4	10KJ	W25 CF	23186-3100
R5	3K3J	W25 CF	23186-2330
R6	33KJ	W25 CF	23186-3330
R7	5K6J	W25 CF	23186-2560
R8	120KJ	W25 CF	23186-4120
R9	3K3J	W25 CF	23185-2330
R10	220KJ	W25 CF	23186-4220
R11	27KJ	W25 CF	23186-3270
R12	100KJ	W25 CF	23185-4100
R13	2M2J	W25 CF	23186-5220
R14	10MJ	W25 CF	23185-6100
R15	10MJ	W25 CF	23185-6100
R16	100KJ	W25 CF	23186-4100
R17	100KJ	W25 CF	23185-4100
R18	1M0F	100PPM MF	23205-0310
R19	10KF	50PPM MF	23202-3100
R20	100KJ	W25 CF	23185-4100
R21	1K5F	50PPM MF	23202-2150
R22	3K0F	50PPM MF	23202-2300
R23	7K5F	50PPM MF	23202-2570
R24	15KF	50PPM MF	23202-3150
R25	30KF	50PPM MF	23202-3300
R26	75KF	50PPM MF	23202-3750
R27	150KF	50PPM MF	23202-4150
R28	300KF	50PPM MF	23202-4300
R29	750KF	50PPM MF	23202-4750
R30	1M5F	50PPM MF	23202-5150
R31	3M01	100PPM MF	23202-5301
R32	7M5F	100PPM MF	23202-5750
R33	100KJ	W25 CF	23185-4100
R34	1K0J	W25 CF	23186-2100
R35	5M6J	W25 CF	23185-5560
R36	680RJ	W25 CF	23185-1680
R37	47KJ	W25 CF	23186-3470
R38	47KJ	W25 CF	23186-3470
R39	220KJ	W25 CF	23186-4220
R40	2K7J	W25 CF	23186-2270
R41	100RJ	W25 CF	23186-1100
R42	4K7J	W25 CF	23186-2470
R43	100RJ	W25 CF	23186-1100
R44	100RJ	W25 CF	23186-1100
R45	56KJ	W25 CF	23186-3560
R46	2M7J	W25 CF	23186-5270
R47	3R3J	W25 CF	23185-0033
R48	100KJ	W25 CF	23186-4100
R49	39KF	50PPM MF	23202-3390
R50	10KF	50PPM MF	23202-3100
R51	10KF	50PPM MF	23202-3100
R52	4K02F	50PPM MF	23202-2402
R53	2K0F	50PPM MF	23202-2200
R54	1K0F	50PPM MF	23202-2100
R55	392RF	50PPM MF	23202-1392
R56	187RF	50PPM MF	23202-1187
R57			
R58			
R59	39KJ	W25 CF	23186-3390
R60	1K0J	W25 CF	23186-2100

Ref	Description		Part No
R61	2K7J	W25 CF	23186-2270
R62			
R63			
R64	10KJ	W25 CF	23185-3100
R65	2K7J	W25 CF	23186-2270
R66	100KJ	W25 CF	23185-4100
R67			
R68			
R69			
R70			
R71	56KJ	W25 CF	23186-3560
R72			
R73	1K0J	W25 CF	23186-2100
R74	10KF	50PPM MF	23202-3100
R75	100RJ	W25 CF	23186-1100
R76	1K0J	W25 CF	23185-2100
R77	680RJ	W25 CF	23186-1680
R78	1K5J	W25 CF	23186-2150
R79	220RJ	W25 CF	23186-1220
R80	220RJ	W25 CF	23186-1220
R81			
R82	220RJ	W25 CF	23186-1220
R83	220RJ	W25 CF	23185-1220
R84	1K0J	W25 CF	23186-2100
R85			
R86			
R87	10RJ	W25 CF	23186-0100
R88	10RJ	W25 CF	23186-0100
R89	27KJ	W25 CF	23186-3270
R90	1K5J	W25 CF	23185-2150
R91	1K0J	W25 CF	23185-2100
R92	150RJ	W25 CF	23185-1150
R93	27KJ	W25 CF	23185-3270
R94	1K5J	W25 CF	23185-2150
R95	220RJ	W25 CF	23186-1220
R96	220RJ	W25 CF	23186-1220
R97			
R98	220RJ	W25 CF	23186-1220
R99	220RJ	W25 CF	23185-1220
R100	4K7J	W25 CF	23186-2470
R101	39KJ	W25 CF	23186-3390
R102	470KJ	W25 CF	23185-4470
R103	100KJ	W25 CF	23185-4100
R104	270KJ	W25 CF	23185-4270
R105	680KJ	W25 CF	23186-4680
R106	15KJ	W25 CF	23185-3150
R107	3K9J	W25 CF	23186-2390
R108	15KJ	W25 CF	23186-3150
R109			
R110	330KJ	W25 CF	23186-4330
R111	10KJ	W25 CF	23185-3100
R112			
R113	10RJ	W25 CF	23186-0100
R114	220RJ	W25 CF	23186-1220
R115			
R116	220RJ	W25 CF	23186-1220
R117	33RJ	W25 CF	23186-0330
R118	100RJ	W25 CF	23186-1100
R119	33RJ	W25 CF	23186-0330
R120	220RJ	W25 CF	23185-1220

Ref	Description			Part No
R121	100RJ	W25	CF	23185-1100
R122	220RJ	W25	CF	23186-1220
R123	22KJ	W25	CF	23185-3220.
R124	15KJ	W25	CF	23186-3150
R125	1K0J	W25	CF	23186-2100
R126	470RJ	W25	CF	23185-1470
R127	47RJ	W25	CF	23185-0470
R128	15KJ	W25	CF	23185-3150
R129	1K0J	W25	CF	23186-2100
R130	220RJ	W25	CF	23185-1220
R131	33RJ	W25	CF	23186-0330
R132	100RJ	W25	CF	23186-1100
R133	33RJ	W25	CF	23186-0330
R134	220RJ	W25	CF	23185-1220
R135	220RJ	W25	CF	23185-1220
R136	22KJ	W25	CF	23186-3220
R137	180KJ	W25	CF	23186-4180
R138	220KJ	W25	CF	23186-3220
R139	10KJ	W25	CF	23185-4180
R140	1M0J	W25	CF	23185-4220
R141				
R142	1M0J	W25	CF	23185-5100
R143				
R144				
R145				
R146	1K0J	W25	CF	23185-2100
R147	1K0J	W25	CF	23185-2100
R148	1K0J	W25	CF	23186-2100
R149				
R150				
R151				
R152	100RJ	W25	CF	23185-1100
R153				
R154	470RJ	W25	CF	23185-1470
R155	180KJ	W25	CF	23186-4180
R156	22KJ	W25	CF	23185-3220
R157				
R158				
R159				
R160				
R601	47RJ	W25	CF	23185-0470
R602	33RJ	W25	CF	23185-0330
R603		SOT		
R604	3R9J	W25	CF	23185-0039
R605	220RJ	W25	CF	23185-1220
R606	220RJ	W25	CF	23185-1220
R607	10MJ	W25	CF	23185-6100
R608	10MJ	W25	CF	23185-6100
R609	10KJ	W25	CF	23186-3100
R610	10MJ	W25	CF	23185-6100
R611	1M0J	W25	CF	23186-5100
R612	33KJ	W25	CF	23186-3330
R613	33KJ	W25	CF	23186-3330
R614	22KJ	W25	CF	23186-3220

R603 - SELECT ON TEST FROM

	2R2J	W25	CF	23185-0022
	3R9J	W25	CF	23185-0039
	4R7J	W25	CF	23185-0047
	5R6J	W25	CF	23185-0056
	6R8J	W25	CF	23185-0068
	8R2J	W25	CF	23185-0082
	12RJ	W25	CF	23185-0120
	15RJ	W25	CF	23185-0150
	18RJ	W25	CF	23185-0180
	22RJ	W25	CF	23185-0220
	27RJ	W25	CF	23185-0270
	33RJ	W25	CF	23185-0330
	39RJ	W25	CF	23185-0390

Variable Resistors

Ref	Description		Part No
VR1	10K	PS/H CF	23377-3100
VR2			
VR3	100K	LIN POT	23347-0026
VR4			
VR5			
VR6	4K7	PS/H CF	23377-2470
VR7	1K0	PS/H CF	23377-2100
VR8			
VR9	2K2	PS/V CF	23378-2220
VR10	100R	PS/V CF	23378-1100
VR11	470R	PS/H CF	23377-1470
VR12	100K	LIN POT	23347-0027
VR13	100K	LIN POT	23347-0027
VR14	470K	PS/H CF	23377-4470
VR601	4M7	PS/H CF	23376-0080
VR602	10K	PS/H CF LIN	23376-0072
VR603	1K0	PS/H CF	23377-2100
VR604	1M0	PS/H CF LIN	23377-5100

Capacitors

Ref.	Description	Part No.
C1	100NJ 250V POLY/E	23633-0002
C2	100NM 63V CER	23438-0007
C3	1N0S 500V CER	23424-0436
C4	100NJ 250V POLY/E	23633-0002
C5	150PK 400V CER	23427-0535
C6	1N0S 500V CER	23424-0436
C7	100NM 63V CER	23438-0007
C8	15PJ 500V CER	23424-0230
C9	3N0J 160V POLY/S	23647-0509
C10	1N0S 500V CER	23424-0436
C11	47PJ 63V CER	23427-0526
C12	100NM 63V CER	23438-0007
C13	100NJ 100V POLY/E	23620-0207
C14	10NZ 63V CER	23427-0302
C15	100NM 63V CER	23438-0007
C16	100NM 63V CER	23438-0007
C17	100NM 63V CER	23438-0007
C18	10NK 50V MYLAR	23619-0208
C19	100PG 63V CER	23427-0300
C20	33PG 63V CER	23427-0357
C21		
C22		
C23	1N0K 100V CER	23427-0331
C24	1N0S 500V CER	23424-0436
C25		
C26		
C27	100NM 63V CER	23438-0007
C28		
C29	10UF 16V TANT	23594-0219
C30	10UF 16V TANT	23594-0219
C31	1N0K 100V CER	23427-0331
C32	100PG 63V CER	23427-0300
C33	1N0K 100V MYLAR	23619-0301
C34	10NZ 63V CER	23427-0302
C35	10NZ 63V CER	23427-0325
C36	1U0F 63V ELEC	23557-0609
C37	100NM 63V CER	23438-0007
C38	10NZ 63V CER	23427-0325
C39		
C40		
C41	22UF 10V TANT	23594-0225
C42	47UF 16V ELEC	23557-0631
C43	22UF 10V TANT	23594-0225
C44	47UF 16V ELEC	23557-0631
C45	4U7F 63V ELEC	23557-0634
C46	100NJ 100V POLY/E	23620-0207
C47	4U7F 63V ELEC	23557-0634
C48	10UF 16V TANT	23594-0219
C49		
C50		
C51	100NM 63V CER	23438-0007
C52	22UF 10V TANT	23594-0225
C53	1N0K 100V CER	23427-0331
C54	10NZ 63V CER	23427-0325
C55		
C56		
C57	100NM 63V CER	23438-0007
C58	100NM 63V CER	23438-0007
C59	100NM 63V CER	23438-0007
C60	100NM 63V CER	23438-0007
C61	100NM 63V CER	23438-0007
C62	10NZ 63V CER	23427-0302

Ref.	Description	Part No.
C63	10NZ 63V CER	23427-0325
C64		
C65	10NZ 63V CER	23427-0302
C66	100NM 63V CER	23438-0007
C67		
C68	10NZ 63V CER	23427-0302
C69	100NM 63V CER	23438-0007
C70	2U2F 16V TANT	23594-0221
C71	100NM 63V CER	23438-0007
C72		
C73	220UF 16V ELEC	23557-0641
C74	10NZ 63V CER	23427-0302
C75	22UF 10V TANT	23594-0225
C76	0.50PF 500V CER	23424-0233
C601	10NJ 400V POLY/E	23621-0310
C602	47NK 630V POLY/E	23633-0001
C603	10UF 16V TANT	23594-0219
C604	10NZ 63V CER	23427-0325
C605	1N0S 1KV CER	23424-0437
C606	1N0S 1KV CER	23424-0437
C607	10NZ 63V CER	23427-0325
C608	10NZ 63V CER	23427-0325
C609	10NZ 63V CER	23427-0325
VC1	TRIMMER CAP 2-18P CER	23911-0013
VC2	TRIMMER CAP 4-64P POLY/P	23984-0001
VC3	TRIMMER CAP 4-64P POLY/P	23984-0001
VC4	TRIMMER CAP 4-65P POLY/P	23984-0007

Semiconductors

Ref.	Description		Part No
D1	DIO	1N4148	25021-0901
D2	DIO	OA91	25003-0201
D3	DIO	OA91	25003-0201
D4			
D5			
D6			
D7			
D8			
D9	DIO	1N4148	25021-0901
D10			
D11			
D12	DIO	1N4148	25021-0901
D13	DIO	1N4148	25021-0901
D14			
D15	DIO	1N4148	25021-0901
D16	DIO	1N4148	25021-0901
D17	DIO	(I/C) ICL8069DCZR	27161-0007
D18	DIO	1N4148	25021-0901
D19	DIO	1N4148	25021-0901
D20	DIO	1N4148	25021-0901
D21	DIO	1N4148	25021-0901
D22			
D23	DIO	1N4148	25021-0901
D24	DIO	IS923	25115-0901
D25			
D26			
D27			
D28	DIO	IS923	25115-0901
D29	DIO	1N4148	25021-0901
D30	DIO	1N4148	25021-0901
D31	DIO	1N4002	25115-0907
D32	DIO	OA91	25003-0201
D601	DIO	BA158	25115-0913
D602	DIO	IS923	25115-0901
D603	DIO	1N4148	25021-0901
D604	DIO	1N4148	25021-0901
D605	DIO	1N4148	25021-0901
D606	DIO	1N4148	25021-0901

Ref.	Description	Part No
TR1	TRAN NPN ZTX 313-L5	25380-0230
TR2	TRAN FET BF245 SELECTED	25601-0106
TR3	TRAN PNP ZTX 239-L5	25380-0229
TR4	TRAN PNP ZTX 214-L5	25341-0214
TR5) TR6)	MATCHED PAIR BF 245A	SEE NOTE BELOW
TR7	TRAN NPN ZTX 239-L5	25380-0229
TR8	TRAN NPN BF199	25388-0207
TR9	TRAN PNP BF506	25341-0315
TR10	TRAN NPN ZTX 239-L5	25380-0229
TR11	TRAN NPN ZTX 239-L5	25380-0229
TR12	TRAN NPN ZTX 239-L5	25380-0229
TR13	TRAN NPN ZTX 239-L5	25380-0229
TR14		
TR15	TRAN NPN BF199	25388-0207
TR16) TR17)	MATCHED PAIR BF 245A	SEE NOTE BELOW
TR18	TRAN PNP BF506	25341-0315
TR19	TRAN NPN BF199 SELECTED	25388-0800
TR20	TRAN PNP BF506 SELECTED	25341-0400
TR21	TRAN NPN BF199 SELECTED	25388-0800
TR22	TRAN NPN BF199 SELECTED	25388-0800
TR23	TRAN NPN BF199 SELECTED	25388-0800
TR24	TRAN PNP BF506 SELECTED	25341-0400
TR25	TRAN NPN ZTX 239-L	25380-0229
TR26	TRAN PNP ZTX 214-L	25341-0214
TR27	TRAN PNP ZTX 214-L	25341-0214
TR28	TRAN NPN BF199 SELECTED	25388-0800
TR29	TRAN PNP BF506 SELECTED	25341-0400
TR30	TRAN NPN BF199 SELECTED	25388-0800
TR31	TRAN NPN ZTX 239-L	25380-0229
TR32	TRAN NPN ZTX 239-L	25380-0229
TR33	TRAN PNP ZTX 214-L	25341-0214
TR34		
TR35	TRAN NPN ZTX 239-L	25380-0229
TR36	TRAN NPN ZTX 650-L	25388-0206
TR37	TRAN NPN BF199 SELECTED	25388-0800
TR38	TRAN PNP BF506 SELECTED	25341-0400
TR39	TRAN NPN BF199 SELECTED	25388-0800
TR40	TRAN NPN ZTX 239-L	25380-0229
TR41	TRAN NPN BC489-18-C	25388-0205
TR42	TRAN NPN BC489-18-C	25388-0205
TR43	TRAN NPN ZTX 239-L	25380-0229
TR44	TRAN PNP ZTX 214-L	25341-0214
TR45	TRAN NPN ZTX 239-L	25380-0229
IC1	CD4007UBE	27226-0071
IC2	HEF4001BP	27227-0010
IC3	SN74LS00N	27223-0001
IC4	CD4069UB	27226-0690
IC5	SN74LS00N	27223-0001
IC6		
IC7	CD4007UBE	27226-0071
IC8	CA3290E	27103-0001
IC9	CD4066B	27226-0660
IC601	HEF4001BP	27227-0010

NOTE

TR5 & TR6, TR16 & TR17 are matched pairs; and colour coded viz.

BF245A	SELECTED - RED	25601-0103
BF245A	SELECTED - GREEN	25601-0104
BF245A	SELECTED - BLUE	25601-0105
BF245A	SELECTED - YELLOW	25601-0106

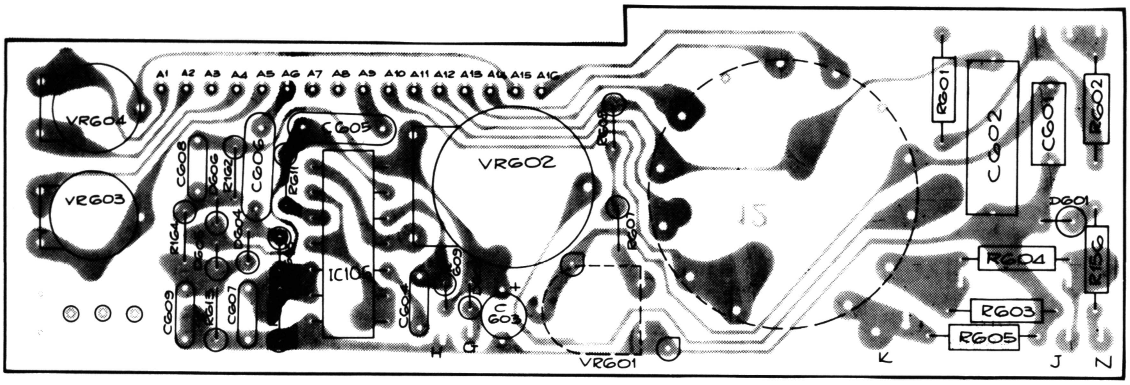
Electro/Mechanical, Mechanical and Packaging Parts

Description	Qty	Part No
Cathode Ray Tube		25811-0103
Socket - CRT		22571-0410
Tube Neck Shield		31334-0040
Mu Metal Shield		31366-0030
Trace Rotate Coil		35731-0240
Convertor Transformer Assy-T1 — Double-White or Red Spot		43751-0900
SW1, 2, 3, 4 Switchbank 4 Way		22225-0512
SW7, 8, 9, 11 Switchbank 4 Way		22225-0513
SW6 Rotary Switch 1P12W		22220-0002
SW10 Rotary Switch 2P6W		22220-0003
On/Off Switch		22218-0205
Screw M2 x 5	2 off	20234-0026
Recharge/Dispos Switch		22218-0002
SW5 Switch Insert - Ganged with SW10		22220-0501
Switch Cup for SW5		31122-0210
Collar - 3 off		31225-0012
Grubscrew M2 x 2.5mm	3 off	20220-0001
Main and Tube Base PCB		35555-0160
Y Amp PCB		35555-0200
16 Way Right Angle PCB Header made from		22573-0019
Control PCB		35555-0170
Switch Screen		31531-0080
Y Amp Screen		31345-0030
Foam Pad 25x20x6mm (Tube support - upper front, lower front)	3 off	Cut from 10300-0319
Foam Pad 14x30x6mm (Tube support - rear, upper & lower)	2 off	Cut from 10300-0304
Foam Pad 40x15x9mm (battery compartment)		Cut from 10300-0320
Screen - Case Lower		31346-0050
Screen - Case Upper		31346-0070
Case Upper		33537-0150
Case Lower		33537-0160
Side Trim, front	2 off	31332-0490
Side Trim, rear	2 off	31332-0500
Panel, long, Batt. Comp.		33335-0070
Panel, short, Batt. Comp.		33335-0080
Logo Label		37522-0010
Battery Compartment		20656-0010
Grommet Black		22443-0001
L2, L3, L4 - RF Choke	3 off	43741-0060

Description	Qty	Part No
Spindle Knurled for RV602		22221-0001
Sockets - Black	4 off	22571-0655
BNC Socket		22588-0004
Power Socket 2.5mm		22581-0506
Front Panel		33331-0510
Tube Screen - Graticule		37634-0210
Push Button - Grey - 4 off		37113-0080
Push Button - Blue - 4 off		37113-0090
Knob, Rotary - Grey	3off	37151-0270
Knob, Aluminium, 6mm shaft	2 off	37151-0240
Knob to Shaft Clips	3 off	20620-0009
Fibre Washer 12.5x8mmx2mm	7 off	20612-0009
Washer M3 - PCB to Case lower	2 off	20030-0263
Fibre Washer 1/2" x 1/8" x 1/32"	2 off	20612-0010
Screw 6BA x 1.25"		20124-0503
Screw 6BA x 3/16"	6 off	20134-0501
Bush, Grey	3 off	31122-0190
Rear Panel		33331-0520
Battery Cover		33335-0060
Handle - Sleeved		31336-0200
Feet - Black	4 off	31748-0190
Earthing Tag	2 off	35358-0480
Track Pins	61 off	22469-0502
Pin, Long, Gold Plated	28 off	22574-0200
Socket, Gold Plated	28 off	22574-0101
Vero Pin	3 off	22469-0200
Aircap packing cut from		10612-0202
Serial No Label		37522-0020
Instruction Label		37558-0110
Carton		38113-0260
Printed Sleeve		38181-0140
Guarantee Card		48581-0230
Instruction Booklet		48583-0062
Leaflet "Read This First"		48583-0080

COMPONENT LAYOUTS

Tube Base PCB



NOTES:

DRAWN FROM COMPONENT SIDE

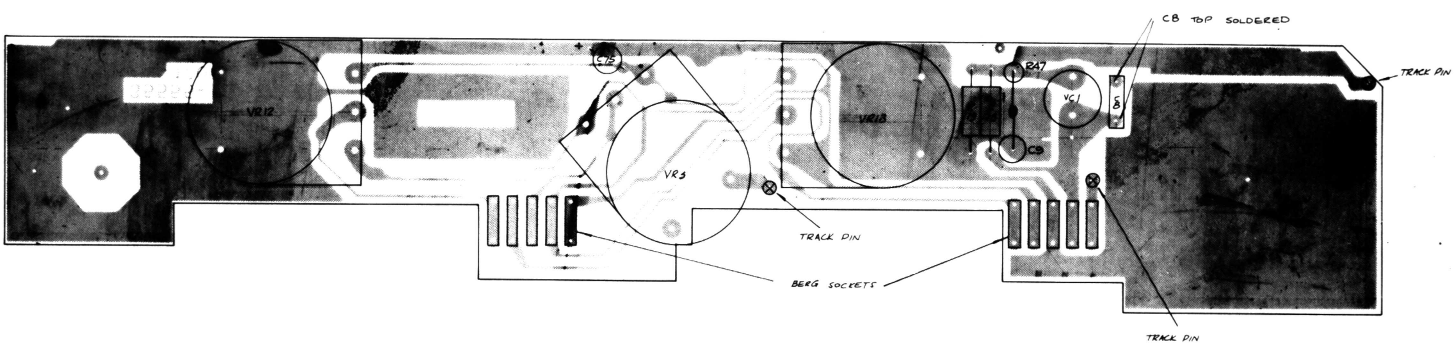
● TOP SOLDERED CONNECTIONS

⊗ TRACK PINS

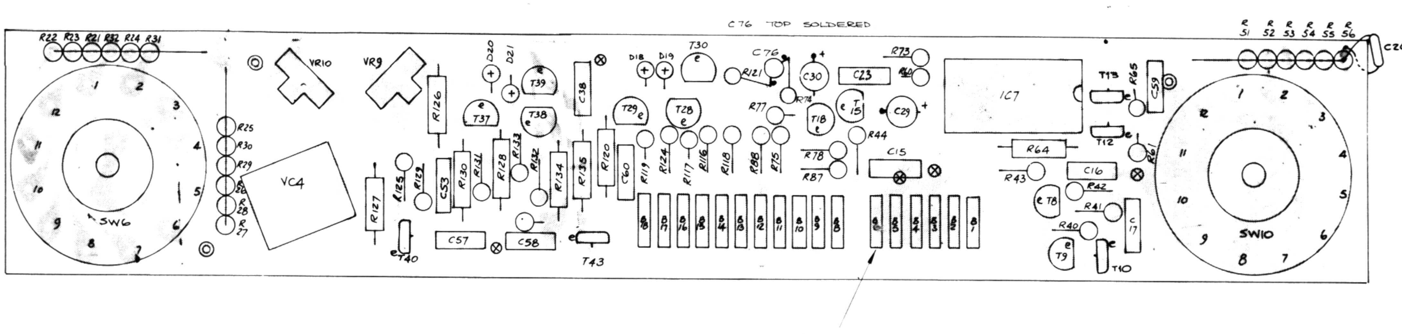
◎ HARNESS CONNECTIONS

N,J,K,G and H — TRANSFORMER LEAD ANNOTATIONS

Control PCB



Y-amplifier PCB



NOTES:

DRAWN FROM COMPONENT SIDE

● DENOTES TOP SOLDERED CONNECTIONS

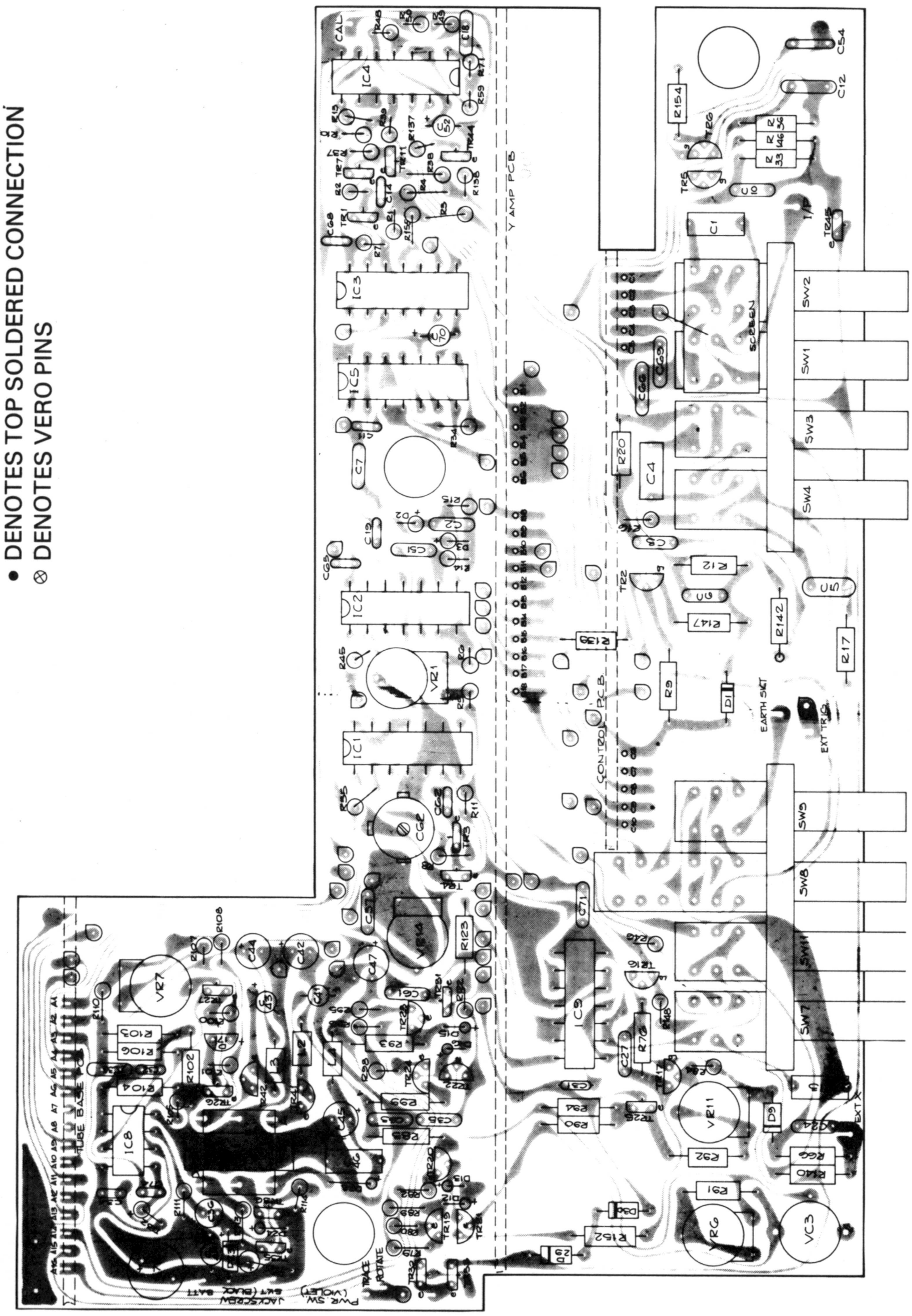
⊗ DENOTES TRACK PIN

◎ DENOTES VERO PINS

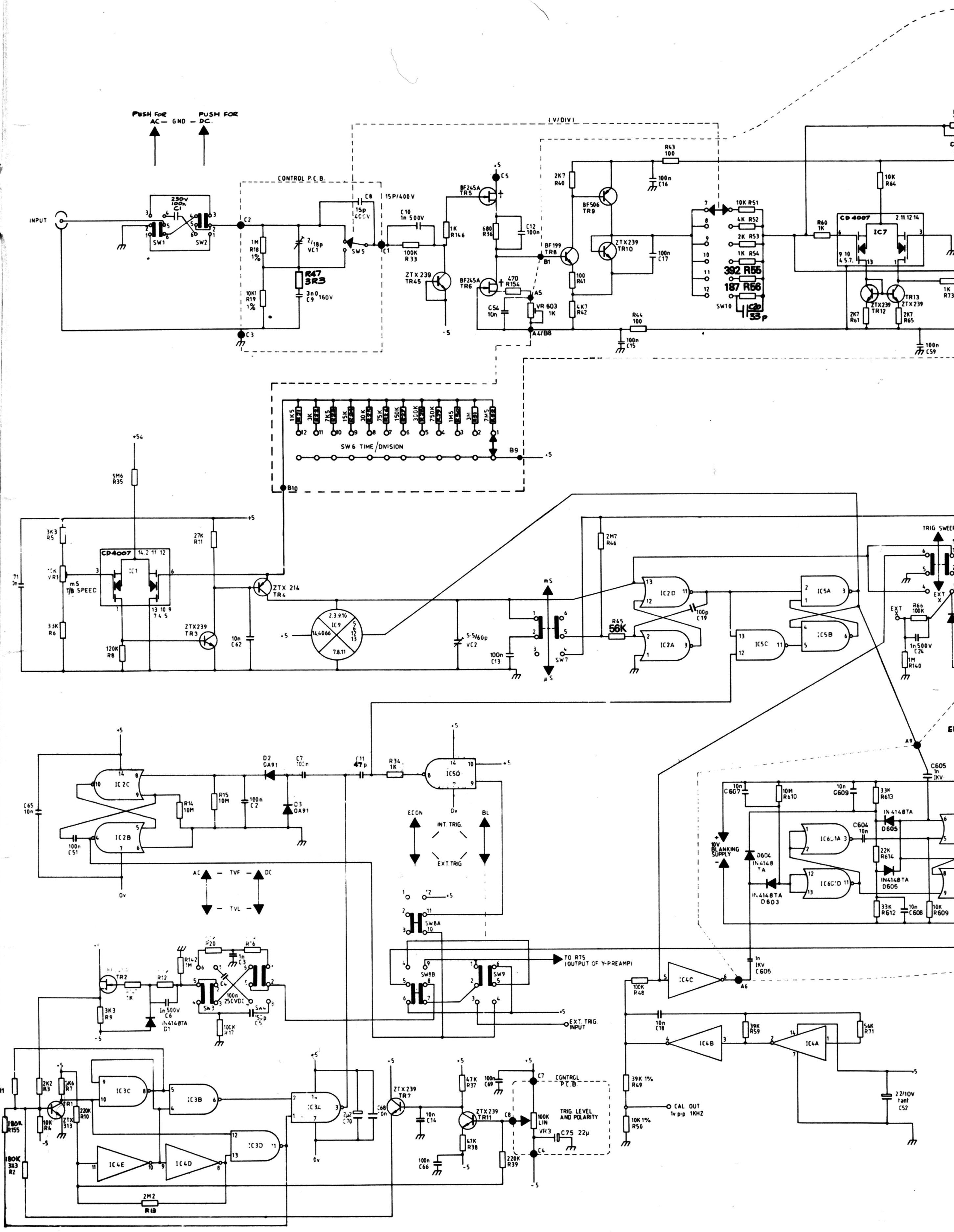
NOTES:

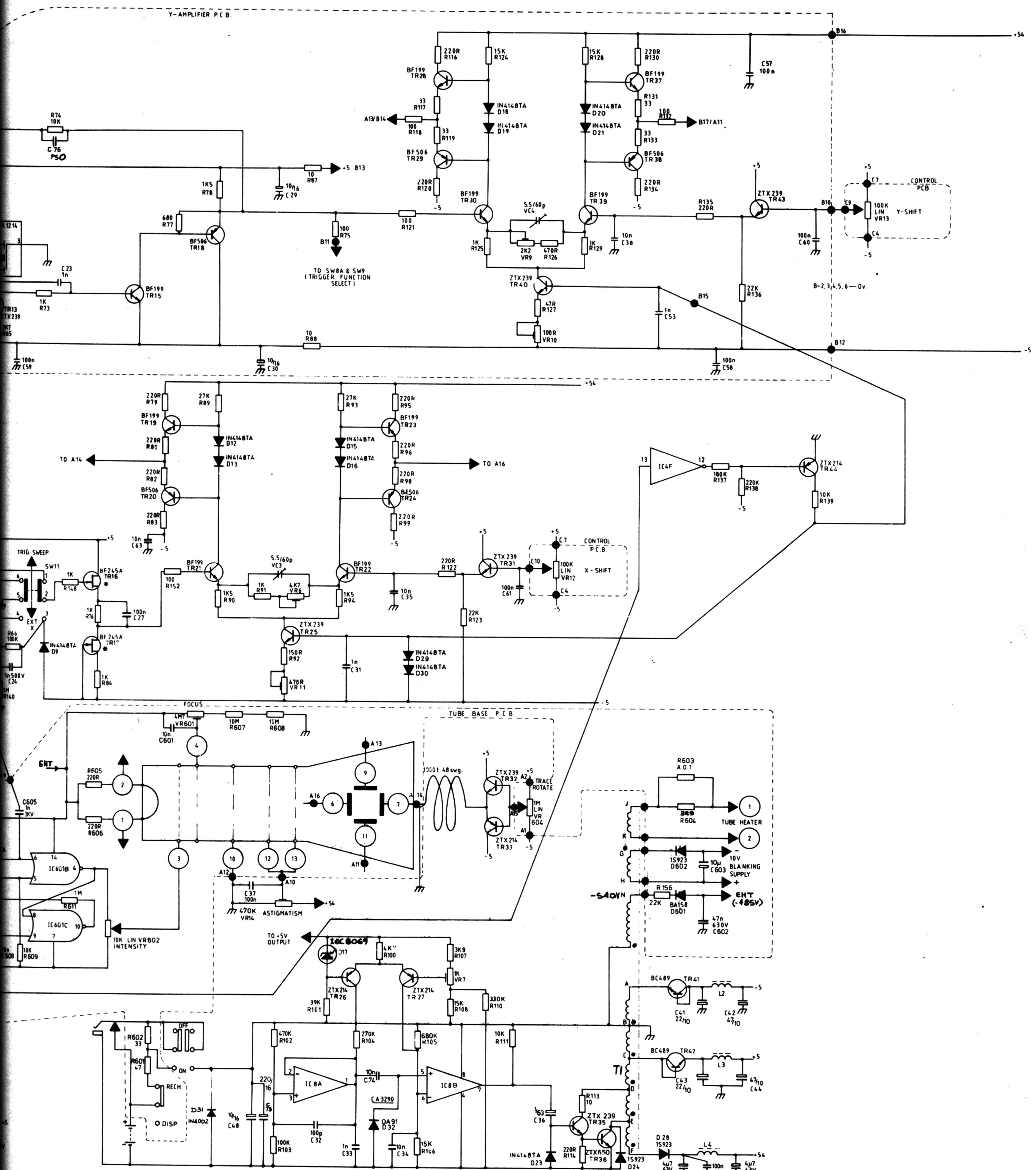
DRAWN FROM COMPONENT SIDE.

- • DENOTES TOP SOLDERED CONNECTION
- ⊗ DENOTES VERO PINS



CIRCUIT DIAGRAM





* } SELECTED PAIRS
† }