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POLAR ELECTRONICS LIMITED

USER MANUAL

TONEOHM

600A

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SPECIFICATIONS

The instrument is protected up to ± 15V between probes in all ranges and modes.

AC RESISTANCE:	4 ranges: 30mΩ, 100mΩ, 300mΩ, 1Ω. Accuracy: ± 3% FSD Injection Signal: 100mV pk max. open circuit. 10mA max. short circuit. Injection frequency: 350Hz approx. Meter readout and Tone indication of resistance. Tone output: 40Hz to 3kHz approx.
DC RESISTANCE:	4 ranges: 30mΩ, 100mΩ., 300mΩ, 1Ω. Accuracy: ± 10% FSD Injection Signal: 100mV max. open circuit. 10mA max. short circuit. Meter readout and Tone indication of resistance. Tone output: 40Hz to 3kHz approx.
DC MICROVOLTS:	3 ranges ± 50uV, ± 500uV, ± 5mV. Accuracy: ± 15% FSD ± 15uV. Measurements may be made on lines up to ± 30V to ground. Centre zero meter readout.
CURRENT SOURCE:	10mA ± 20% (on front panel). Open circuit voltage 0.7V (approx.)
SUPPLY VOLTAGE:	90-130V or 200-250V set by internal links. Consumption approx. 12VA.
CASE:	ABS plastic with 6 position tilt stand. Height 85mm. Width 252mm. Depth 262mm.
ACCESSORIES:	i) LOW IMPEDANCE EARPIECE. ii) LEADS FOR CONNECTING CURRENT SOURCE TO P.C.B. UNDER TEST. iii) RESISTIVE LEAD FOR STIMULATING FAULTY LINE ON POWERED P.C.B. UNDER TEST. iv) DETACHABLE MAINS LEAD WITH MOULDED IEC CONNECTOR.

GENERAL DESCRIPTION

The TONEOHM 600A has been designed to physically locate two of the most common and complex fault conditions in modern electronic equipment, the short circuit and stuck node (bus fault).

Conventional methods of locating the source of these faults include p.c.b. track cutting, detailed visual examination of the p.c.b., systematic removal of I.C's (often requiring unsoldering with consequent damage to p.c.b.'s).

The TONEOHM locates these faults using its milliohmeter with audio and visual readout and microvoltmeter with centre zero meter readout.

Its areas of use include:-

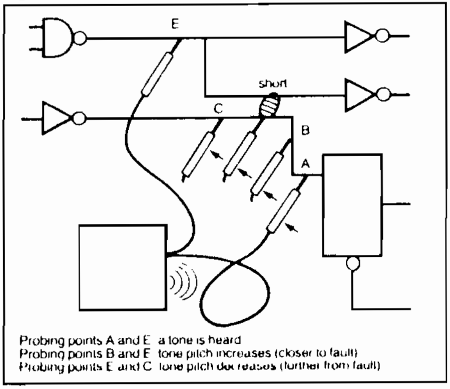
a) POST ATE: ATE systems will indicate that two tracks are shorted together, or that a particular node is stuck high or low — but the operator then has to find the physical location of these faults. The 600A is an ideal instrument for this and is invaluable when used in post A.T.E. troubleshooting.

b) PRODUCTION TESTING: Units that are faulty in the Test areas again suffer from the above faults — the 600A will allow a technician or engineer to quickly locate the fault and have it corrected.

c) COMPONENT BURN IN: I.C.'s that are being burnt in have their inputs connected in parallel. Thus when one I.C. fails — it can hold all the inputs high or low, preventing correct exercising of the I.C.'s under test. The 600A allows rapid identification of the faulty I.C., without I.C.'s having to be removed individually until the fault is located.

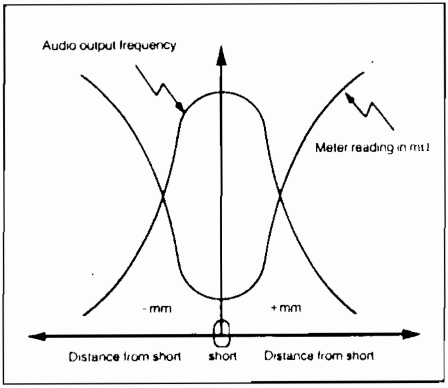
d) Other areas of use include:
FIELD SERVICE.
COMPUTER BACKPLANE.
LABORATORY.

Fig 1. Short-circuit location.



Probing points A and E a tone is heard
Probing points B and E tone pitch increases (closer to fault)
Probing points E and C tone pitch decreases (further from fault)

Fig 2. TONEOHM output characteristics.



APPLICATIONS

USE OF MILLIOHMETER

Short Circuit Location

Short circuits account for the majority of faults found on p.c.b.'s and they mainly originate from solder bridges (especially after flow solder machines) or incomplete etching between tracks in the manufacturing process.

The 600A has an accurate meter readout of resistance, and also a tone output whose frequency is proportional to resistance. The tone is available either from a speaker within the 600A or an earpiece (supplied) which plugs into a front panel jack socket.

The short is located using the following technique.

1. Ensure that the unit under test is Off.
2. Select either AC or DC milliohms mode (DC for power supply shorts).
3. Select the 100m Ω range.
4. Probe the two shorted tracks; a tone should be heard.
5. Move one of the probes along the track and note the change in the pitch of the tone (or in the meter reading). A higher pitch (or a lower meter reading) means that the probe is moving closer to the fault – See Figs. 1 & 2. (page 2)
6. Repeat as necessary to find the position of highest tone pitch (or minimum meter reading), switching to the 30m Ω range to give more sensitivity if required. Final resolution can best be made by watching the meter for the null.
7. The probe tip will now be within, at most, a few mm of the fault, which will be visually obvious.

As mentioned above, the DC Ω mode should be selected if the short occurs between two tracks that are coupled by capacitance (e.g. power supply rails). This is to avoid the shunting of the test current by the capacitance, which causes confusion when attempting to trace a fault.

It should be noted that the maximum open circuit probe tip voltage is 100mV, which ensures that semiconductor junctions are not turned on or damaged.

Resistance Measurements

For maximum accuracy, the AC Ω mode should be selected. Errors in the DC Ω are primarily due to thermoelectric voltages that can be generated between the probes and the device under test.

By selecting the relevant range, contact resistances of relays, connectors, etc. can be measured.

USE OF MICROVOLTMETER

General

The microvoltmeter is used to trace current flow through tracks on either powered boards or unpowered boards stimulated by the current source on the 600A front panel.

This technique is valuable in locating either a partial short (e.g. 1 Ω to 100Ω) or a short which only exists when a system is under power.

I.C. substrate shorts, faulty electrolytic capacitors (e.g. tantalum) etc. can be located using this method – present methods of locating faults of this type often involve track cutting, I.C. removal, etc.

The microvoltmeter measures the track voltage drops and in this way the faulty device which is sinking or sourcing excessive current can be identified.

Bus Failure

A common fault in microprocessor or complex digital systems is a node stuck high or (more frequently) low, with many devices connected on it.

A typical fault is shown in fig. 3.

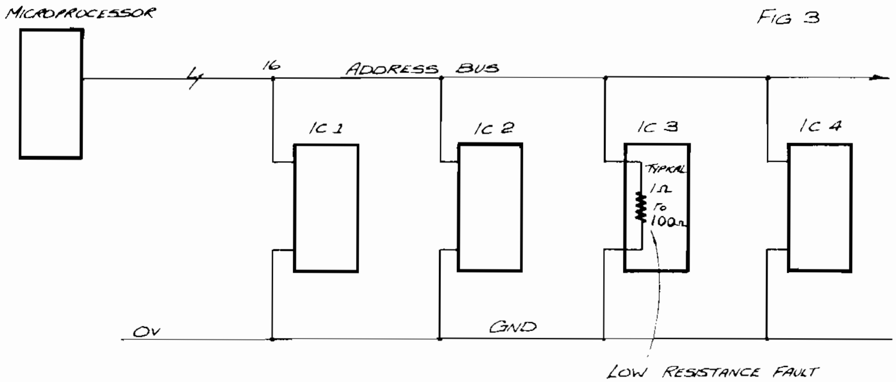


FIG 3

where the low input resistance of I.C. 3 sinks the bulk of the available drive current from the microprocessor thus preventing the address line from going high.

There are two methods which can be used to trace which I.C. on the address line is keeping the node low:-

(i) With the p.c.b. powered, current is driven into the faulty node. The microprocessor address line is put into its open state, either by unplugging it or taking its HOLD pin high, (a lead is provided for this).

Current is then driven into the node from the p.c.b. supply using the 600A yellow resistive lead so that the circuit of figure 4 is obtained.

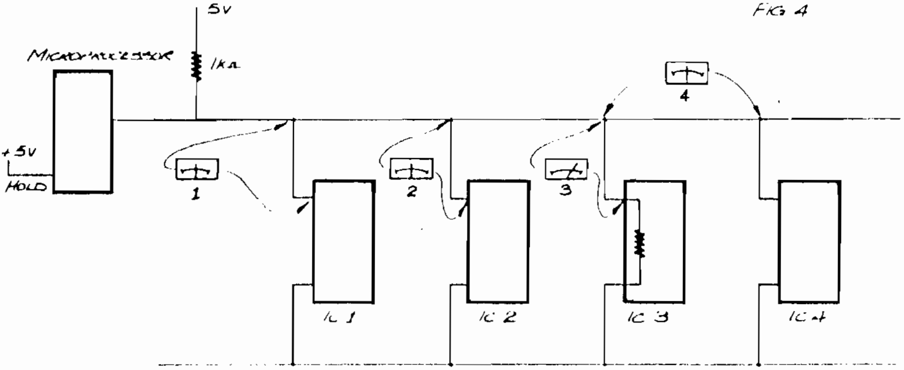


FIG 4

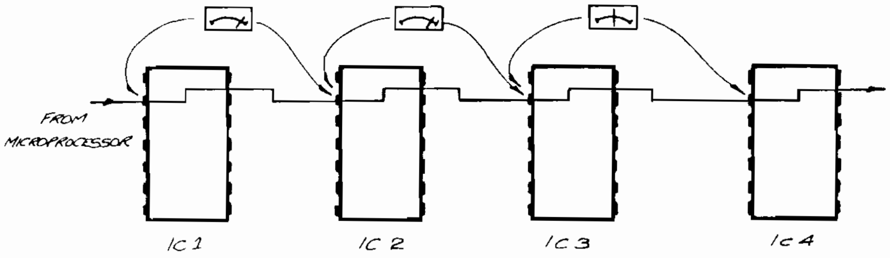
Measurements can now be made on the above circuit as above.

Select 600uV range, (this is usually the most appropriate range).

1. Measurement 1 indicates that little or no current is being taken by I.C. 1
2. Measurement 2 — as in measurement 1.
3. Measurement 3 — this indicates that I.C. 3 is sinking a large amount of current and is thus the faulty device.
4. Measurement 4 indicates that subsequent I.C.'s are not sinking excessive current, confirming that I.C. 3 is faulty.

   Note that the track layout frequently allows all measurements to be made between I.C. pins as shown in figure 5 (next page).

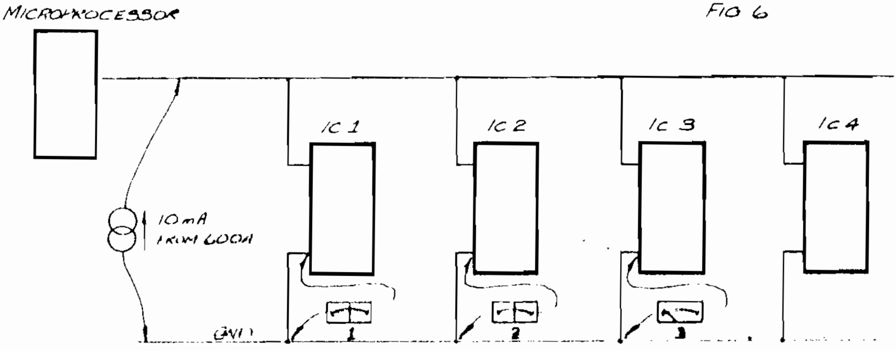
TRACK LAYOUT FOR PIN 2 SHOWN FIG 5



FAULT ON IC 3 PIN 2

(ii) With the p.c.b. unpowered, current (10mA) is injected into the faulty node from the 600A front panel current source, using the red and black leads provided, <u>this method is usually the easiest to use since current is only flowing through the faulty circuit.</u>

FIG 6



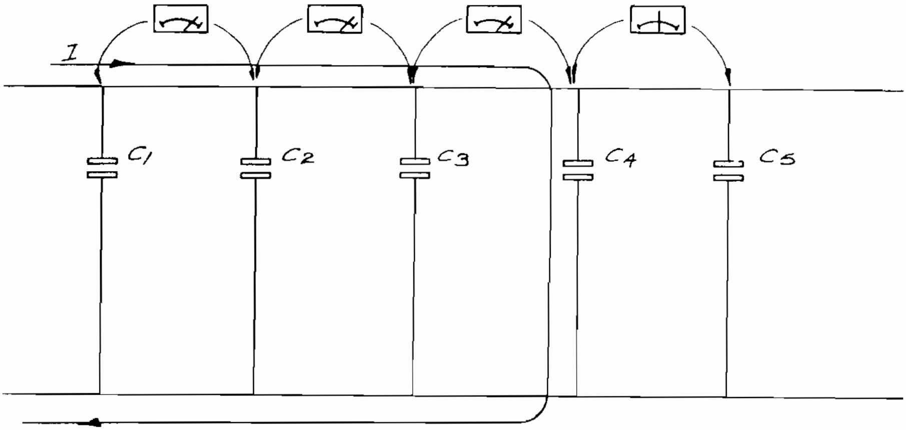
Fault location then proceeds as for a powered board with the addition that measurements can also be made on the ground lead of the I.C., if more convenient.

Capacitor Failure

Electrolytic capacitors (notably tantalum) can go low-resistance at any time during a products life, holding the power supplies low. The technique for locating the faulty capacitor is very similar to that for locating a faulty I.C. described earlier.

Referring to figure 7 it can be seen that C4 is faulty and is sinking the bulk of the supply current. By making measurements on the track as shown, C4 is isolated.

FIG 7



The current can either originate from the power supply of the unit under test, or the 600A 10mA source.

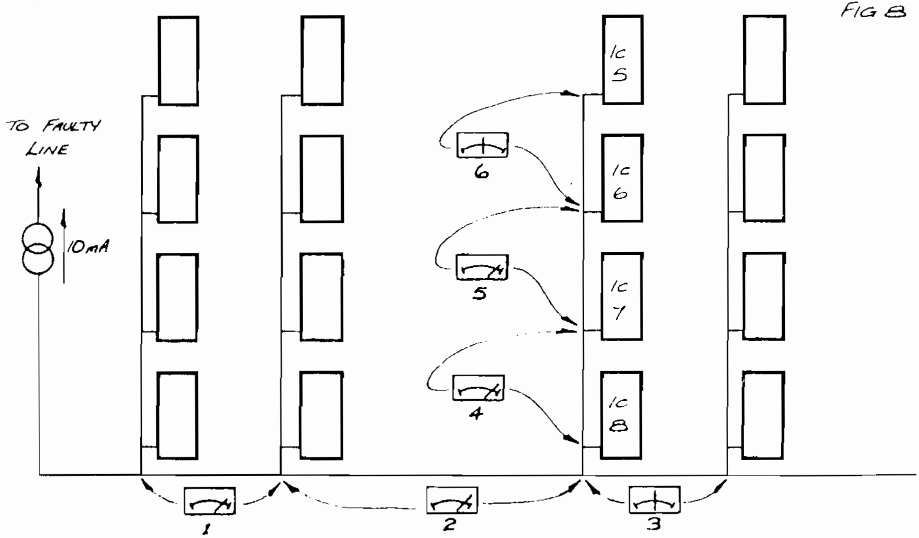
The 5mV range will be found of particular use in tracing power supply faults because of the larger track voltage drops from the high supply currents.

Burn In Boards

When I.C.'s are subjected to an operating burn in, there can be as many as 50 with their input (address) pins connected in parallel. If one I.C. becomes faulty it is both tedious and time consuming to fault find by removing each I.C. in turn until the fault is removed.

Figure 8 shows a typical part of a board and the 600A allows the faulty I.C. to be quickly located.

FIG 8



The board is unpowered and connected to the 600A current source. Measurements are then made between I.C. pins.

1. Measurement 1 shows that column 1 is not sinking current.
2. Measurement 2 does the same for column 2.
3. Measurement 3 shows that the current does not reach column 4, i.e. column 3 must contain the faulty I.C.
4. Measurement 4 clears I.C. 8.
5. Measurement 5 clears I.C. 7.
6. Measurement 6 indicates that current does not reach I.C. 5, i.e. I.C. 6 must be faulty.

These tests can be performed by non skilled personnel who quickly grasp the principles involved.

Analogue Circuits

The 600A can be used to trace current in analogue circuits, and this can aid trouble-shooting of the p.c.b. particularly if I.C.'s and transistors are soldered in.

The applications are varied but tend to rely on comparison with a known good board.

Input Protection

The 600A is protected against accidental connection of up to ± 15V between the probes. However its low input resistance (approx. 100Ω) causes it to draw appreciable current from the rail touched and this heats the 600A input resistor.

Even after disconnection of the ± 15V, the remaining heat in the resistor can cause thermal offsets within the 600A, which can be as large as 100uV, causing the meter to read F.S.D. with no input.

If this condition is encountered, the operator must wait a minute or so (depending on how long the overload was present) for the heat to be dissipated and the meter to return to centre zero.

Calibration

If calibration of the 600A is required it is advised that this procedure is followed in full.

1. With the 600A off adjust the meter mechanical zero to line the pointer to 0 on the LHS of the scale.
2. Switch the 600A on and allow it to run for 15 minutes before making adjustments.
3. Adjust R51 such that the squarewave on U6 pin 8 has a frequency of 375 Hz for a mains supply of 50 Hz (adjust for 390 Hz for mains supply of 60 Hz).
4. Select AC m Ω mode, 1 Ω range. Short the probes together and adjust R14 for a meter reading of zero.
5. Connect the probes across the 1 Ω CAL RES on the rear panel and adjust R31 for F.S.D.
6. This procedure has now calibrated both AC Ω and DC Ω.
7. Select *u*V mode ± 5mV range. Adjust R21 for centre zero reading.
8. Select ± 50*u*V range and short the probes together, taking care not to touch them as this can introduce thermal errors. The meter should be within ± 5*u*V of centre zero.
9. To check the voltage calibration (there is no adjustment) connect the probes across a 1 Ω 1% resistor which is supplied from a 4-6 volt power supply via a series resistor. The two resistors form a voltage divider and allow F.S.D. to be checked.

   The required resistors are:

   5mV - 1K Ω 1%
   500*u*V - 10K Ω 1%
   50*u*V - 100K Ω 1%

   Note that when making any voltage measurements, thermoelectric voltages can cause errors — hence it is advisable to avoid any heat source near the probes, e.g. do not touch the metal tips of the probes when taking readings.

CIRCUIT DESCRIPTION

Main Amplifier

The amplification of the signal to drive the meter is performed by U2 and U3. U2 is operated as a chopping amplifier in the *u*V and DCm Ω modes via U4 and U5. The clock signal is generated from U6c running at approx. 380 Hz (set by R51).

*u*V Mode

When *u*V is selected U5d is enabled and thus the input voltage is chopped and applied to U2.

R1 sets the input resistance of the amplifier and R2, D1, D2 limit the maximum voltage that is presented to U4 and U2 in overload conditions.

The gain of U2 is switched by the range switch and set by R3, R4, R5 and R6.

The output of U2 is coupled via C4 to U4 which references the signal to ground and couples it to the filters R12, C5 and R13, C11.

This DC voltage level is converted into a meter current by U3 and R15. Q2 is on, supplying approximately 0.5mA of offset current so that the meter has a centre zero, R21 is used to adjust this value.

DC Milliohms

As above U5d is enabled and the action of the circuit is as for the *u*V mode. The gain of U2 is set by R3 and R7 in parallel with R8, and the filter R13, C11 is removed by the mode switch. Q2 is not supplying offset current.

Q1 is designed to limit the voltage to which C5 charges when the probes are open circuit. This improves the response time when a measurement is made.

AC Milliohms

In this mode U5d is disabled, converting U2 into a standard amplifier with its gain set by R3 and R7.

Its output from C4 is converted into a DC level by U4 and U5a and applied to filter R12, C5. U3 and R15 convert the DC voltage to a meter current — R16 limits the maximum meter current and sets the signal level on U3 pin 6.

D3 limits the positive excursion on the output of C4 when the probes are open circuit, this in conjunction with Q1, ensures a rapid reading when the probes are connected to a low resistance R14 is used to adjust for zero reading with the probes shorted in the 1 ohm range (AC ohms mode).

Current Source

In AC milliohms U5b is enabled, coupling the clock signal to the current source U6d.

The output voltage of U6d is set by R31, and the current is set by the range switch and R35, R36, R37 and R38. R34, R33, D4, D5 and D9 are to protect U6d if the probes are inadvertently connected to a voltage source in AC or DC milliohms.

In DC milliohms U5b output is high, causing U6d output to remain at a positive DC level (set by R31) and thus inject a DC current.

Voltage Controlled Oscillator (VCO)

In both AC and DC milliohms the voltage on U3 pin 6 is connected to Q3 via R39. This voltage is proportional to the meter reading and thus the current through Q3 is also proportional to meter reading.

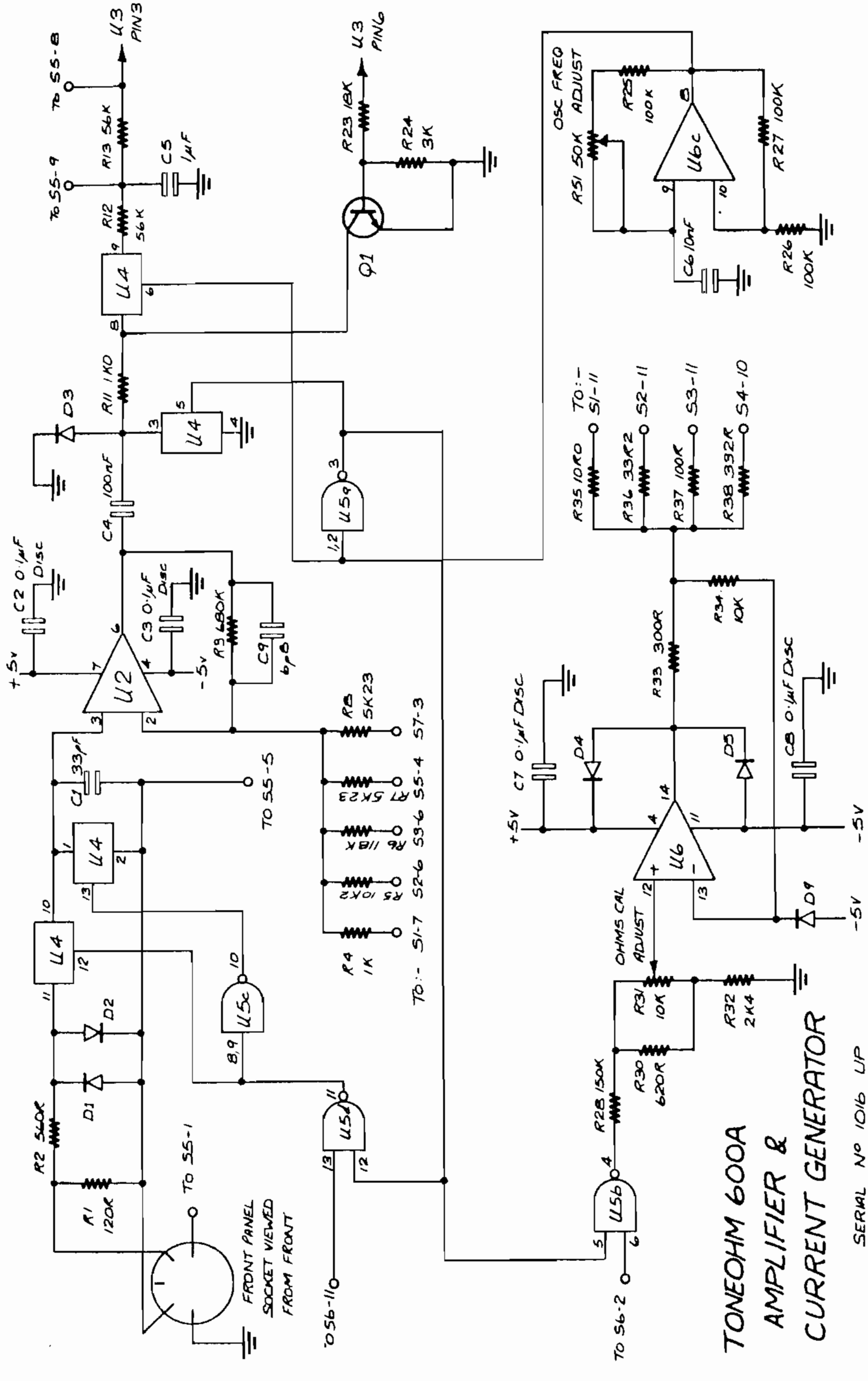
U6a is connected as an oscillator with the charge time of C13 set by Q3 current and the discharge time set by R43.

At meter f.s.d. there are pulses on U6a output at frequency of approximately 6KHz.

These are divided by U7 to form a symmetrical square wave which are coupled via the front panel volume control (R52) to output amplifier U6b, which drives either an earpiece or speaker inse

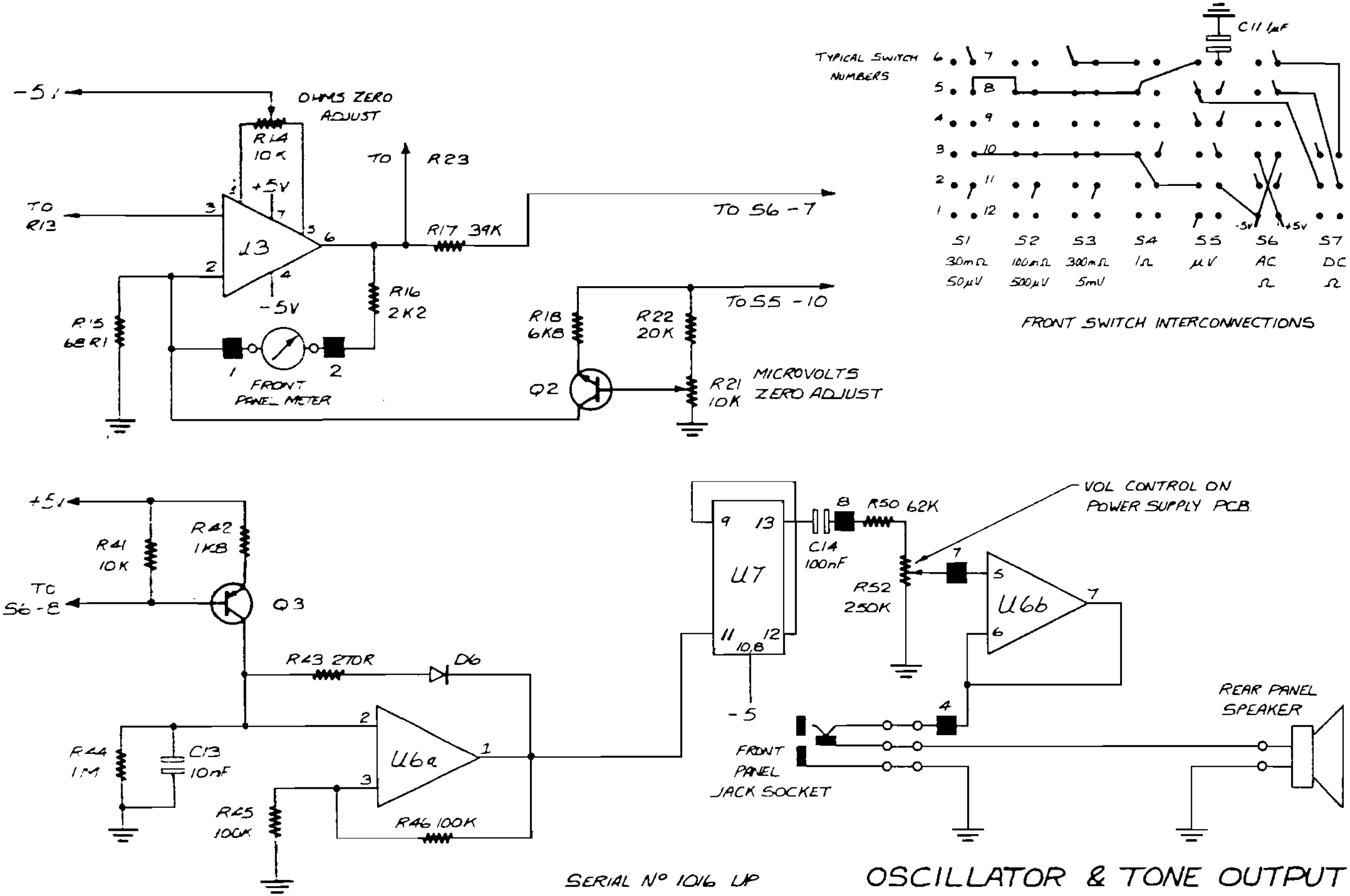
Power Supplies

The main supplies are derived from the mains transformer, full wave rectified by D8 and applied to voltage regulators U9 and U10 to produce the regulated + 5v and − 5v supplies. Voltage from an isolated winding is rectified and applied to regulator U11 connected as a constant current source of 10mA. D7 (silicon) and D12 (Germanium) limit the maximum open circuit voltage to approx. 0.7v.



TONEOHM 600A
AMPLIFIER &
CURRENT GENERATOR

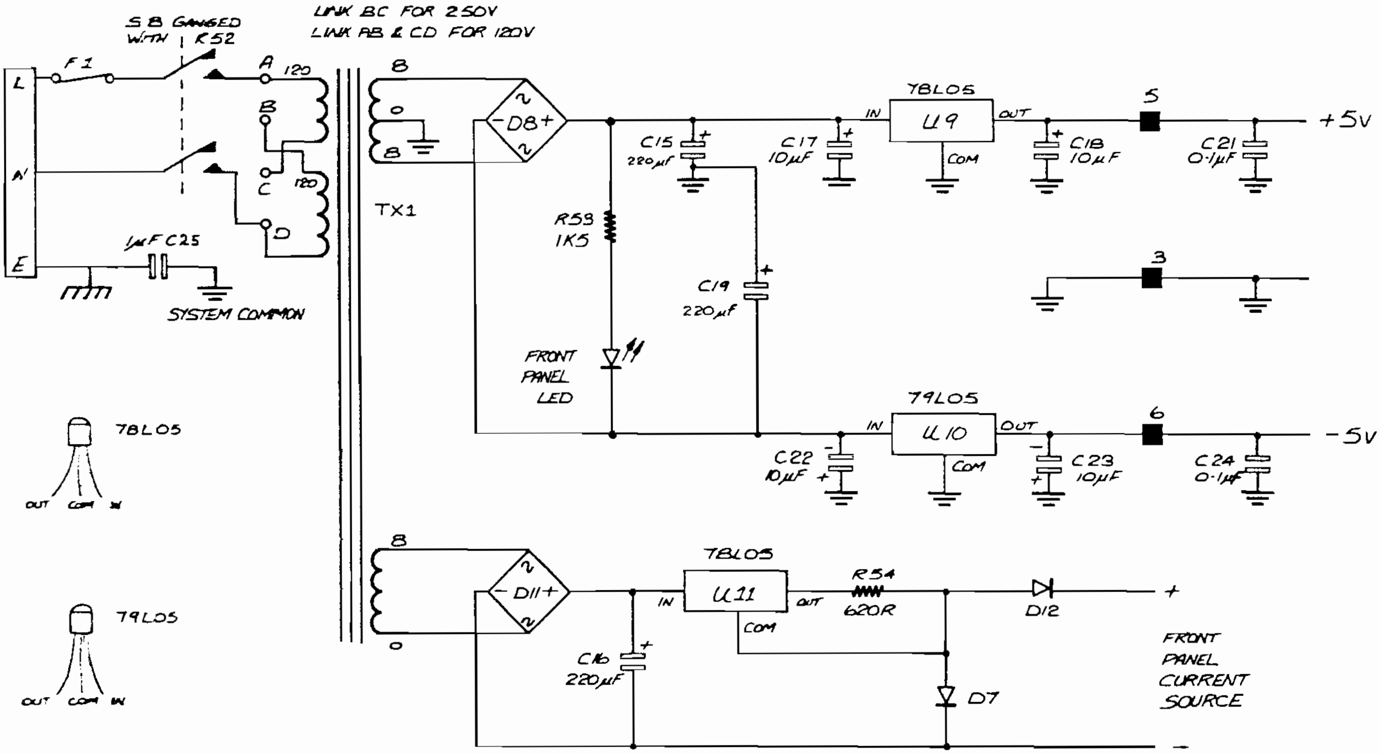
SERIAL No 1016 UP



FRONT SWITCH INTERCONNECTIONS

SERIAL Nº 1016 UP

OSCILLATOR & TONE OUTPUT



SERIAL No 1016 UP

TONEOHM 600A POWER SUPPLY

600A PARTS LIST

When ordering spares please state instrument type (600A), serial number (found on the rear panel), circuit reference and/or description of the parts required.

CIRCUIT REFERENCE	DESCRIPTION	VALUE/TYPE
C1	Polystyrene capacitor	33pF
C2, C3, C7, C8, C21, C24	Disc ceramic	0.1uF
C4, C14.	Polyester capacitor	100nF
C5, C11, C25.	Polyester capacitor	1uF
C10, C13.	Polyester capacitor	10nF
C9	Ceramic capacitor	6p8
C15, C16, C19.	Electrolytic capacitor	220uF 16V
C17, C18, C22, C23.	Tantalum capacitor	10uF 16V
D1 to D7, D9.	Silicon diode	1N4148
D8, D11	Bridge	WO-005
D12	Germanium diode	OA47
Q1,Q2.	NPN transistor	BC184L
Q3.	PNP transistor	BC212L
R1.	Carbon film 1W 5%	120R
R2.	Carbon film 5%	560R
R3.	Metal film 1%	680K
R4.	Metal film 1%	1K00
R5.	Metal film 1%	10K2
R6.	Metal film 1%	118K
R7, R8.	Metal film 1%	5K23
R11.	Carbon film 5%	1K00
R12, R13.	Carbon film 5%	56K
R14.	Multiturn preset	10K
R15.	Metal film 1%	68R1
R16.	Carbon film 5%	2K2
R17.	Carbon film 5%	39K
R18.	Carbon film 5%	6K8
R21, R31.	Cermet preset	10K
R22.	Carbon film 5%	20K
R23.	Carbon film 5%	18K
R24.	Carbon film 5%	3KO
R25, R26, R27, R45, R46.	Carbon film 5%	100K
R28.	Carbon film 5%	150K
R30.	Carbon film 5%	620R
R32.	Carbon film 5%	2K4
R33.	Carbon film 5%	300R
R34, R41.	Carbon film 5%	10K
R35.	Metal film 1%	10RO
R36.	Metal film 1%	33R2
R37.	Metal film 1%	100R
R38.	Metal film 1%	332R
R42.	Carbon film 5%	1K8
R43.	Carbon film 5%	270R
R44.	Carbon film 5%	1MO
R50.	Carbon film 5%	62K
R51.	Cermet preset	50K
R52.	Switch pot	250K
R53.	Carbon film 5%	1K5
R54.	Carbon film 5%	620R
R56.	Metal film 1%	1ROO
U2.	I.C.	LF156H (selected)
U3.	I.C.	LF351N
U4.	I.C.	4016
U5.	I.C.	CD4011

U6.	I.C.	LF347N
U7.	I.C.	CD4013
U9, U11.	I.C.	78L05
U10.	I.C.	79L05
TX1.	Transformer	8-0-8V, 0-8V
S1-S7.	Switch bank	

Probes

Replacement tips are available for the standard probes supplied with each instrument. De Luxe, needle sharp probes for piercing solder resist are available as an accessory.

LIMITED WARRANTY

For a period of one year from the date of its purchase new and undamaged from Polar Electronics Ltd., POLAR ELECTRONICS LTD. or its authorized distributors will, without charge, repair or replace at its option, this product if found by it to be defective in materials or workmanship, and if returned to POLAR ELECTRONICS LTD. or its authorized distributors transportation prepaid. This limited warranty is expressly conditioned upon the product having been used only in normal usage and service in accordance with instructions of POLAR ELECTRONICS LTD. and not having been altered in any way or subject to misuse, negligence or damage, and not having been repaired or attempted to be repaired by any one other than POLAR ELECTRONICS LTD. or its authorized distributors. EXCEPT FOR THE FOREGOING EXPRESS WARRANTY OF REPAIR OR REPLACEMENT POLAR ELECTRONICS LTD. MAKES NO WARRANTY OF ANY KIND, INCLUDING BUT NOT LIMITED TO, ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND POLAR ELECTRONICS LTD. SHALL NOT BE LIABLE FOR ANY DAMAGES, WHETHER DIRECT OR NOT OR OTHERWISE, BEYOND REPAIR OR REPLACING THIS PRODUCT.

POLAR ELECTRONICS LIMITED

P.O. Box 97, Lowlands Industrial Estate,
St. Sampson's, Guernsey, Channel Islands.
Telephone: Guernsey (0481) 48129.

Guernsey Press Co. L.