TF600
FREQUENCY METER
SERVICE MANUAL

Part No. 48581-0670
Issue 2

CONTENTS

GENERAL

Service Handling Precautions

Service work or calibration 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.

Integrated circuits IC1 and IC6 are CMOS devices and care should be taken when handling to avoid damage by static discharge.

Dismantling the instrument

1. Invert the instrument and remove the 4 rubber feet.

2. Remove the 4 recessed and one surface screw.

3. Holding the case upper and lower together, turn the instrument the right way up and lift off the top, ensuring the the jack socket stays with the lower half of the instrument.

4. If further dismantling is required to replace components, proceed as follows:

   Remove the batteries and remove the two screws in the battery compartment; lift out the battery carrier.

   Remove the two countersunk screws that hold the battery carrier restraint and pcb to the case lower and remove the constraint. Remove the two other pcb retaining screws at the sides of the board.

   The complete pcb assembly can then be lifted out with the rear panel and front panel still attached, though these can be removed if necessary by desoldering the appropriate connections and, in the case of the front panel, by unscrewing the nut holding the earthing strip to the pcb stud.

5. Reassemble in the reverse order.

Note: It is essential that if testing is carried out with the instrument sitting on a ground plane (which will minimise any noise pick-up) then the earthing spring must make contact to that ground plane (as it does in the cased instrument) otherwise sensitivity will be worsened.

Calibration

It is not necessary to dismantle the instrument for recalibration only, see Calibration section.

TECHNICAL SPECIFICATION

FUNCTIONS

10MHz Range

Input:	Socket A
Frequency Range:	5Hz to 10MHz
Gate Times:	0.1 to 10 secs in 3 decade steps
Readout:	kHz
Resolution:	10Hz to 0.1Hz in step with gate times of 0.1 to 10 secs.
Accuracy:	+/- (1 count + timebase accuracy)

100MHz Range

Input:	Socket A
Frequency Range:	5MHz to 100MHz
Gate Times:	0.1 to 10 secs in 3 decade steps
Readout:	kHz
Resolution:	100Hz to 1Hz in step with gate times of 0.1 to 10 secs.
Accuracy:	+/- (1 count + timebase accuracy)

600MHz Range

Input:	Socket B
Frequency Range:	40MHz to 600MHz
Gate Times:	0.1 to 10 secs in 3 decade steps
Readout:	kHz
Resolution:	1kHz to 10Hz in step with gate times of 0.1 to 10 secs.
Accuracy:	+/- (1 count + timebase accuracy)

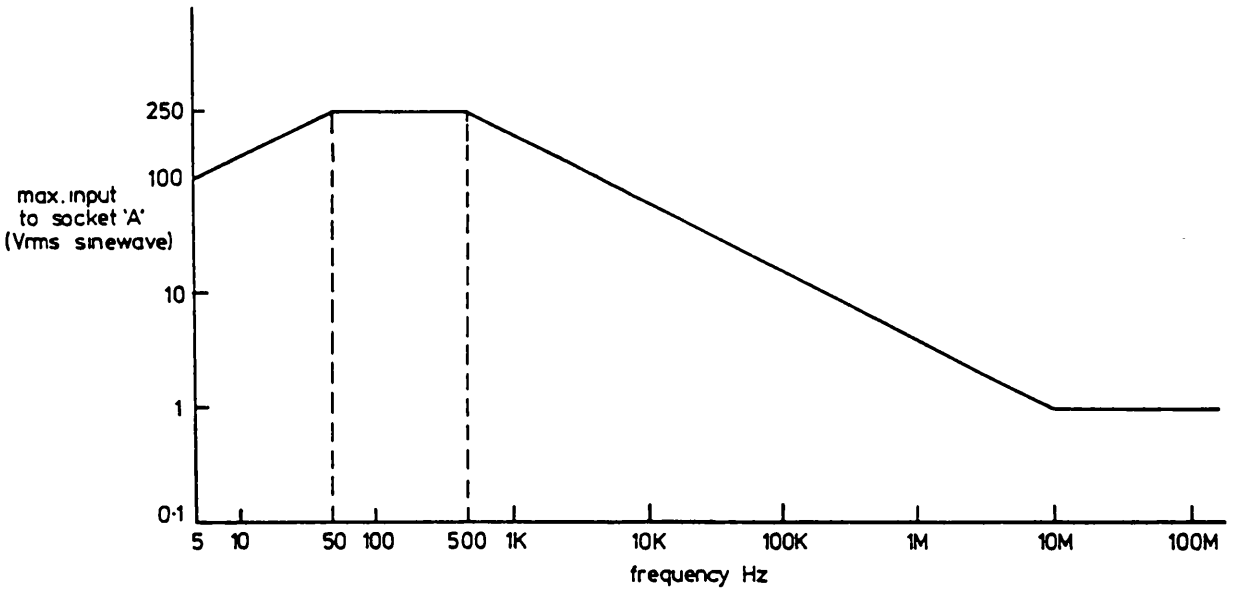
INPUTS

Socket A

Input Impedance:	1MOhm //25pF
Frequency Range:	5Hz to 100MHz
Sensitivity:	10mV rms sinewave 5Hz to 50MHz
	50mV rms sinewave 50MHz to 100MHz
Filter:	Low pass filter, -3dB at 40kHz nominal
Maximum Permissible	200V DC; 250V rms 50Hz, reducing to 1V rms
Input Voltage:	10MHz to 100MHz (see graph)

Socket B

Input Impedance:	50Ohm nominal
Frequency Range:	40MHz to 600MHz
Sensitivity:	10mV rms sinewave from 50 source
Maximum Permissible	1V rms from 40MHz to 600MHz,
Input Voltage:	250v rms 50Hz, 250V DC



TIMEBASE

Crystal Oscillator Frequency:	10MHz
Initial Oscillator Adjustment Error:	<+/-2ppm at 23°C
Oscillator Temperature Coefficient:	typically <+/-0.3ppm/°C 18 to 28°C, +/-10ppm -10°C to +60°C
Oscillator Ageing Rate:	<+/-10ppm per year

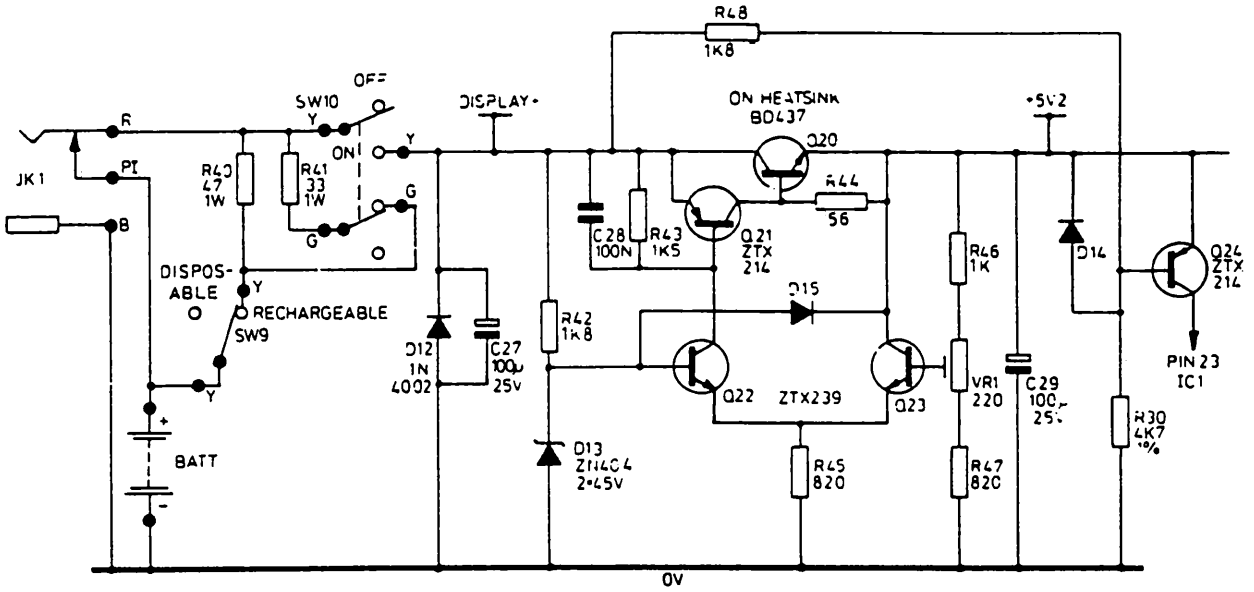
GENERAL

External Clock:	Rear panel socket and switch for external 10MHz reference input
Input Voltage Range:	2.5V to 5V peak to peak sinewave or squarewave.
Maximum Permissible Input Voltage:	6V DC, 6V peak to peak.
Overflow Indication:	Decimal point shows in MSD
Gate Open Indication:	Gate LED illuminated
Battery Type:	6 'C' size disposable or rechargeable cells. Set rear panel 'BATTERY TYPE' switch for correct type.
Charge current:	50mA approx. with ON/OFF switch ON 200mA approx. with ON/OFF switch OFF
Battery Life:	Typically 10-25 hrs (using 6 alkaline 'C' cells) depending on range and display.
Low Battery Indicator:	All decimal points illuminated.

Environmental Operating Range:	5°C to 40°C, 20% to 80% RH
Environmental Storage Range:	-40°C to +60°C
Size:	255 x 150 x 50mm
Weight:	800gms excluding batteries and mains adaptor 500gms mains adaptor only.

CIRCUIT DESCRIPTIONS

Power supply and low battery indicator

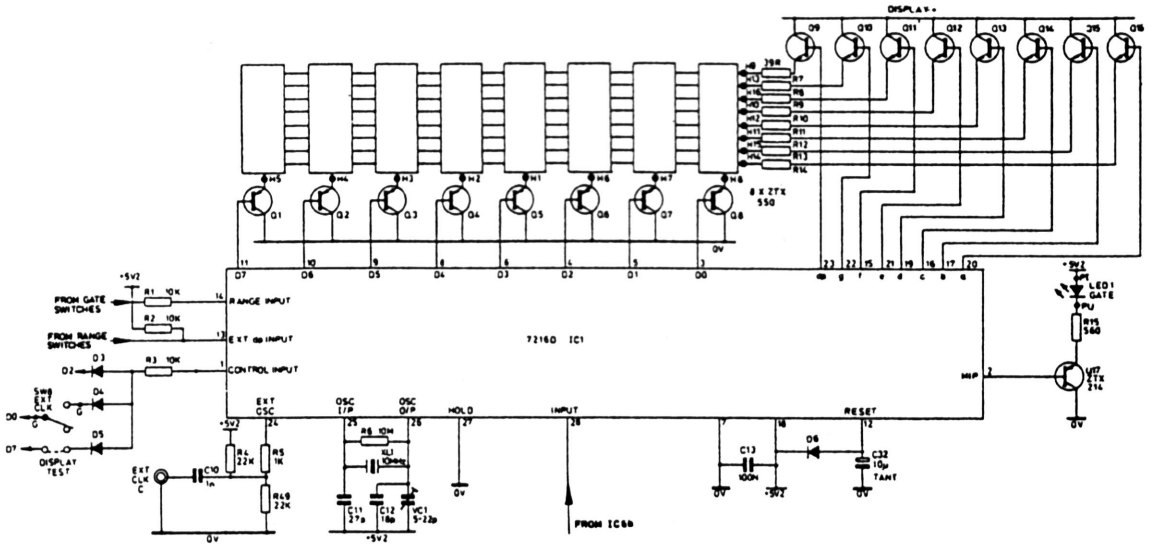


The series pass element is a compound pair Q20 and Q21 which is driven by the error amplifier Q22 and Q23. D13 is a 2.45V band gap reference diode which drives the base of Q22. The regulator output voltage is divided down by R46, VR1 and R47 and applied to the base of Q23, where it is compared against the reference voltage D13. The output of the error amplifier drives the series pass element. VR1 adjusts the output voltage which should be 5V2.

D15 protects the regulator against output short circuits by pulling the reference voltage down. Note: if the regulator output is momentarily shorted the regulator will shut down; turning the instrument off and then on again will restore normal operation.

R40 and R41 determine the charging current when rechargeable batteries are fitted. With the instrument switched on, R40 sets the charging current at approximately 50mA, with the instrument off R41 is switched in parallel with R40 increasing the charging current to approximately 200mA. R40 and R41 are calculated to give the stated charging currents when the instrument is powered from the mains supply via the adaptor supplied with the instrument.

R48 and R30 divide down the input voltage so that when the input voltage reaches approximately 6.5V the base of Q24 is approximately 4.6V. Since the emitter of Q24 is connected to the 5V2 regulated rail, the base emitter junction becomes forward-biased and Q24 turns on pulling pin 23 of IC1 high. This is the decimal point line and, because the display is multiplexed, illuminates all the decimal points. D14 clamps the base of Q24 preventing reverse breakdown of the base emitter junction when the input supply voltage is greater than 8 volts.



IC1 contains all the decade counters, timebase circuitry, decoders and multiplexed display drivers necessary for a complete 10MHz frequency counter.

XL1, R6, C11, C12 and VC1 together with an inverting amplifier inside IC1, form a 10MHz crytstal oscillator whose frequency is trimmed by VC1.

IC1 is designed such that the control (pin 1), external decimal point (pin 13) and range (pin 14) inputs must be time multiplexed by connecting to the appropriate digit line to select the required functions. Thus the gate time is selected by connecting D1, D2 and D3 to pin 14 to give gate times of 0.1s, 1s and 10 seconds respectively. R1 improves noise rejection.

Connecting various digit lines to the control (pin 1) selects the following functions:

D0 = External clock input
D2 = External decimal point programming (at pin 13)
D7 = Display test, light all segments

To illuminate a decimal point in any one digit, the appropriate digit line is connected to the external decimal point input (pin 13). This external decimal point programming is enabled by connecting the control input to D2 as described earlier. R2 helps prevent ghosting of the decimal points.

When the gate opens to take a measurement, pin 2 (measurement in progress, 'MIP') goes low, illuminating LED1.

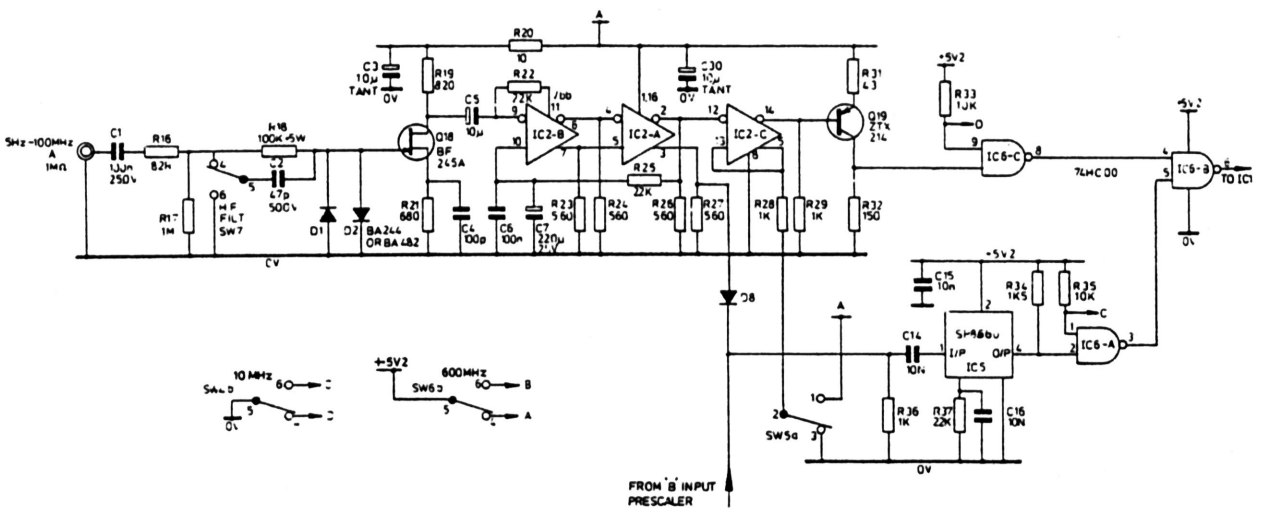
To ensure correct operation of IC1 at switch on, C32 holds pin 12 low (reset) until charged up by a 400kOhm pull up resistor inside IC1.

To improve the sensitivity of the external clock input (pin 24), R4 and R49 bias the input at half the supply voltage; the input signal is then ac coupled by C10. R5 provides some input protection for IC1.

Display

Transistors Q1 to Q8 buffer the digit outputs of IC1 to increase the digit sink current. Q9 to Q16 buffer the segment outputs of IC1 and source the segment current from the unregulated rail. The segment current is limited by resistors R7 to R14.

'A' Input Amplifier



C1 is the dc blocking capacitor; R18, D1 and D2 protect against accidental connection to the mains supply. C2 is for hf compensation across R18; when SW7 is depressed one end of C2 is grounded making R18 and C2 into a low pass filter.

Q18 is a FET and its gain is 1.2 determined by R19 and R21 at frequencies below 2MHz; C4 increases the gain above 2MHz by shunting R21. The voltage on the drain of Q18 is 3 to 5 volts determined by the I_{DSS} of the FET used; C5 could therefore be reverse biased and to overcome this a solid aluminium type is used.

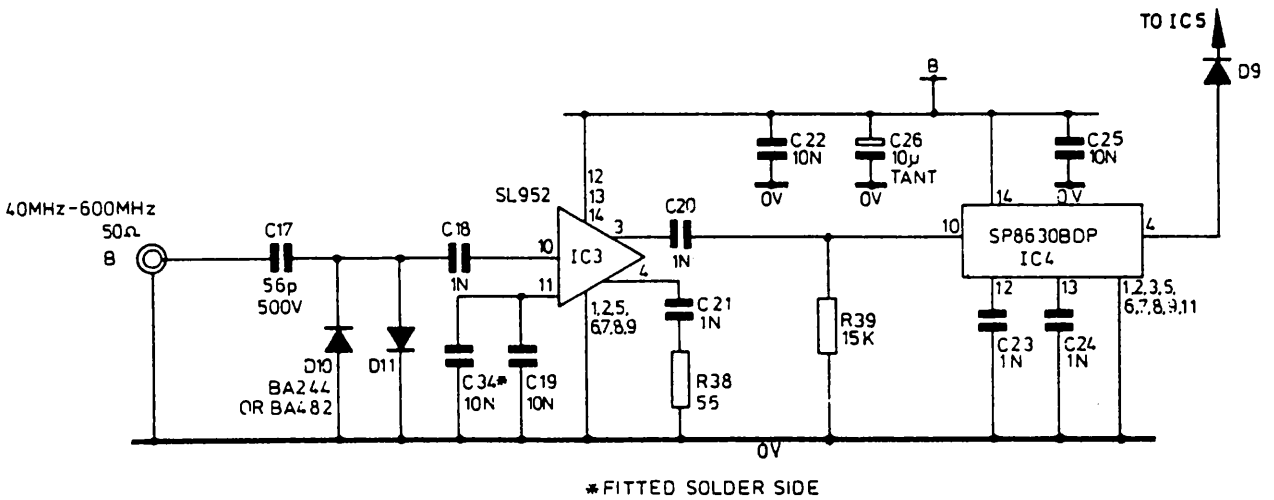
IC2 is an e.c.l. triple line receiver; each stage has differential inputs and outputs. Maximum output swing is 800mv peak to peak, from 3.5V to 4.3V. A reference voltage midway between these voltage levels, 3.9V, is generated inside the chip and is available on pin 11; this voltage is used to bias the input, pin 9, via R22. Feedback is applied via R25 to the other input, pin 10; only dc feedback is required and C6 and C7 remove any ac signal. This dc

feedback holds the outputs of IC2A at 3.9V but because of voltage drops across R22 and R25 due to base currents the voltage on the input pins is approximately 3.6 volts. When power is applied to the A amplifier there is a delay of some 10 seconds before the unit will count due to the large time constant of R25 and C7 which is necessary to maintain sensitivity down to 5Hz.

On the 10MHz range SW4 is depressed. One output of IC2A is connected to IC2C, which is connected as a Schmitt trigger. The output of IC2C is level shifted and amplified 3.5 times by Q19 to drive CMOS gate IC6C. SW4b grounds C disabling IC6A and opens D enabling IC6C such that the signal passes via IC6B to IC1.

When the 100MHz range is selected, SW5 is depressed. SW5a disables the Schmitt trigger and the signal from IC2A passes via D8, which is forward biased, to the input of e.c.l. divider IC5. D9 is reversed biased because the B amplifier is not powered up. IC5 divides the signal by 10 and drives IC6A. The output of IC5 is open collector; R34 is the pull up resistor. SW4b has grounded D disabling IC6C and opened C enabling IC6A such that the signal passes via IC6B to IC1. C15, C16 and R37 ensure stable operation of IC5.

'B' Input Amplifier



When the 600MHz range is selected, SW6 is depressed; SW6b removes the power from the A amplifier and powers up the B amplifier.

C17 is the dc blocking capacitor; C17, D10 and D11 protect against accidental connection to the mains supply. IC3 is the amplifier; it has a differential input and output but is used single ended. Pin 10 is the signal input; pin 11 must be well decoupled to prevent instability. C34 is mounted on the solder side of the pcb; all component leads must be kept short. C20 couples the signal from IC3 to IC4, which is a high speed e.c.l. divider with a division ratio of 10. The output of IC4 pass via D9, which is now forward biased, to IC5 where it is further divided by 10 and sent to IC1. Because the A amplifier supply has been removed, D8 is now reversed biased.

CALIBRATION

Recalibration of the crystal oscillator may be carried out without dismantling the instrument. Access to the multiturn trimmer is through a hole in the bottom of the instrument. Note: to avoid hand capacitance a non metallic trimming tool should be used. If only a metallic tool is available, allow for the frequency shift that the metal tool introduces whilst making the adjustment so that the meter reads correctly with the trimming tool withdrawn.

Allow the instrument to warm up with a full display for a minimum of 1 hour before making any adjustment.

Use a precision frequency standard or standard frequency receiver with a 1MHz or 10MHz output connected to the A input, 10MHz range.

If the internal power supply needs re-setting because components have been replaced, readjust VR1 to give 5.20 volts +/-10mV at the test point provided which is to the rear of VR1.

SERVICING NOTES

The low battery indicator should be off until the supply voltage falls to between 6.8V and 6.3V.

Current drain of the instrument excluding battery recharging current is:

10MHz or 100MHz range, 00 displayed	200mA maximum
10MHz or 100MHz range, 10,000,000 displayed	350mA maximum
600MHz range, 00 displayed	250mA maximum
600MHz range, 10,000,000 displayed	400mA maximum

The power supply should remain in regulation with input voltages down to 6.3 volts.

The wire between input socket B and the pcb must be very short.

Heatsink compound is applied between Q20 and its heatsink. Q20 must be mounted at the bottom of the slot in the heatsink to ensure maximum contact area between the transistor metal pad and the heatsink.

When reassembling the instrument, ensure that the earthing springs make contact with the case upper and lower screens by slightly bending the springs as necessary. Non connection will cause mis-counting with low level signals and noise pick-up with no input signal.

Note also that the switchbank metal bar is earthed via a metal strip under SW6 return spring and soldered to pin 1 SW7. The metal strip is also slotted between SW6 and SW7 and folded back behind SW4, 5 and 6 and soldered to the earth plane behind SW4. Incorrect fitting of this screen will allow the display multiplex signals on switches SW1 to SW6 to be picked up by the A input causing mis-counting with very low level signals.

PARTS LIST

PCB ASSEMBLY 44813-0050
consisting of:

Resistors

Ref	Description	Part No
R1	10KJ W25 CF	23185-3100
R2	10KJ W25 CF	23185-3100
R3	10KJ W25 CF	23185-3100
R4	22KJ W25 CF	23185-3220
R5	1K0J W25 CF	23185-2100
R6	10MJ W25 CF	23185-6100
R7	39RJ W25 CF	23185-0390
R8	39RJ W25 CF	23185-0390
R9	39RJ W25 CF	23185-0390
R10	39RJ W25 CF	23185-0390
R11	39RJ W25 CF	23185-0390
R12	39RJ W25 CF	23185-0390
R13	39RJ W25 CF	23185-0390
R14	39RJ W25 CF	23185-0390
R15	560RJ W25 CF	23185-1560
R16	82RJ W25 CF	23185-0820
R17	1M0J W25 CF	23185-5100
R18	100KJ W50 CF	23179-4100
R19	820RJ W25 CF	23185-1820
R20	10RJ W25 CF	23185-0100
R21	680RJ W25 CF	23185-1680
R22	22KJ W25 CF	23185-3220
R23	560RJ W25 CF	23185-1560
R24	560RJ W25 CF	23185-1560
R25	22KJ W25 CF	23185-3220
R26	560RJ W25 CF	23185-1560
R27	560RJ W25 CF	23185-1560
R28	1K0J W25 CF	23185-2100
R29	1K0J W25 CF	23185-2100
R30	4K7F W25 MF	23202-2470
R31	43RJ W25 CF	23187-0430
R32	150RJ W25 CF	23185-1150
R33	10KJ W25 CF	23185-3100
R34	1K5J W25 CF	23185-2150
R35	10KJ W25 CF	23185-3100
R36	1K0J W25 CF	23185-2100
R37	22KJ W25 CF	23185-3220
R38	56RJ W25 CF	23185-0560
R39	15KJ W25 CF	23185-3150
R40	47RJ 1W CF	23183-0470
R41	33RJ 1W CF	23183-0330
R42	1K8J W25 CF	23185-2180
R43	1K5J W25 CF	23185-2150
R44	56RJ W25 CF	23185-0560
R45	820RJ W25 CF	23185-1820
R46	1K0J W25 CF	23185-2100
R47	820RJ W25 CF	23185-1820
R48	1K8F W25 MF	23202-2180
R49	22KJ W25 CF	23185-3220
VR1	PS/H 220R CF	23377-1220

Capacitors

Ref	Description	Part No
C1	100NJ 250V P/E	23621-0312
C2	47PK 500V Cer	23450-0036
C3	10UF 16V Tant	23594-0219
C4	100PG 63V Cer	23427-0322
C5	10UF 6V3 Alum.	23578-0002
C6	100NM 63V Cer	23438-0007
C7	220UF 16V Elec	23557-0641
C8	Not used	
C9	Not used	
C10	1N0K 63V Cer	23427-0331
C11	27PG 63V Cer	23427-0355
C12	18PG 63V Cer	23427-0337
C13	100NM 63V Cer	23438-0007
C14	10NZ 63V Cer	23427-0325
C15	10NZ 63V Cer	23427-0325
C16	10NZ 63V Cer	23427-0325
C17	56PK 500V Cer	23424-0441
C18	1N0K 63V Cer	23427-0331
C19	10NZ 63V Cer	23427-0325
C20	1N0K 63V Cer	23427-0331
C21	1N0K 63V Cer	23427-0331
C22	10NZ 63V Cer	23427-0325
C23	1N0K 63V Cer	23427-0331
C24	1N0K 63V Cer	23427-0331
C25	10NZ 63V Cer	23427-0325
C26	10UF 16V Tant	23594-0219
C27	100UF 25V Elec	23557-0650
C28	100NM 63V Cer	23438-0007
C29	100UF 25V Elec	23557-0650
C30	10UF 16V Tant	23594-0219
C31	Not used	
C32	10UF 16V Tant	23594-0219
C33	Not used	
*C34	10NZ 63V Cer	23427-0302
VC1	Trimmer 5-20pF	23911-0016

*C34 is wired on underside of PCB

ZERO OHM Resistor (LK1-14)	14 off	23185-0000
PIN, PCB (for Test Points)	4 off	22469-0200

Semiconductors

Ref	Description	Part No
IC1	7216D1P1	27250-0403
IC2	10116	27300-1161
IC3	SL952	27126-0300
IC4	SP8630	27251-0007
IC5	SP8660	27251-0001
IC6	74HC00	27231-0000
Q1	ZTX550	25341-0215
Q2	ZTX550	25341-0215
Q3	ZTX550	25341-0215
Q4	ZTX550	25341-0215
Q5	ZTX550	25341-0215
Q6	ZTX550	25341-0215
Q7	ZTX550	25341-0215
Q8	ZTX550	25341-0215
Q9	BC338	25383-0505
Q10	BC338	25383-0505
Q11	BC338	25383-0505
Q12	BC338	25383-0505
Q13	BC338	25383-0505
Q14	BC338	25383-0505
Q15	BC338	25383-0505
Q16	BC338	25341-0505
Q17	ZTX214	25341-0214
Q18	BF245A	25601-0003
Q19	ZTX214	25341-0214
Q20	BD437	25381-0503
Q21	ZTX214	25341-0214
Q22	ZTX239	25380-0229
Q23	ZTX239	25380-0229
Q24	ZTX214	25341-0214
D1	BA482	25030-0905
D2	BA482	25030-0905
D3	IN4148	25021-0901
D4	1N4148	25021-0901
D5	1N4148	25021-0901
D6	1N4148	25021-0901
D7	Not used	
D8	1N4148	25021-0901
D9	1N4148	25021-0901
D10	BA482	25030-0905
D11	BA482	25030-0905
D12	1N4002	25115-0907
D13	ZN404	27161-0120
D14	1N4148	25021-0901
D15	1N4148	25021-0901
XTAL	10MHz	28500-0110
Display, Dual 7 Segment	2 off	25061-0120

Opto & Electro/Mechanical Parts

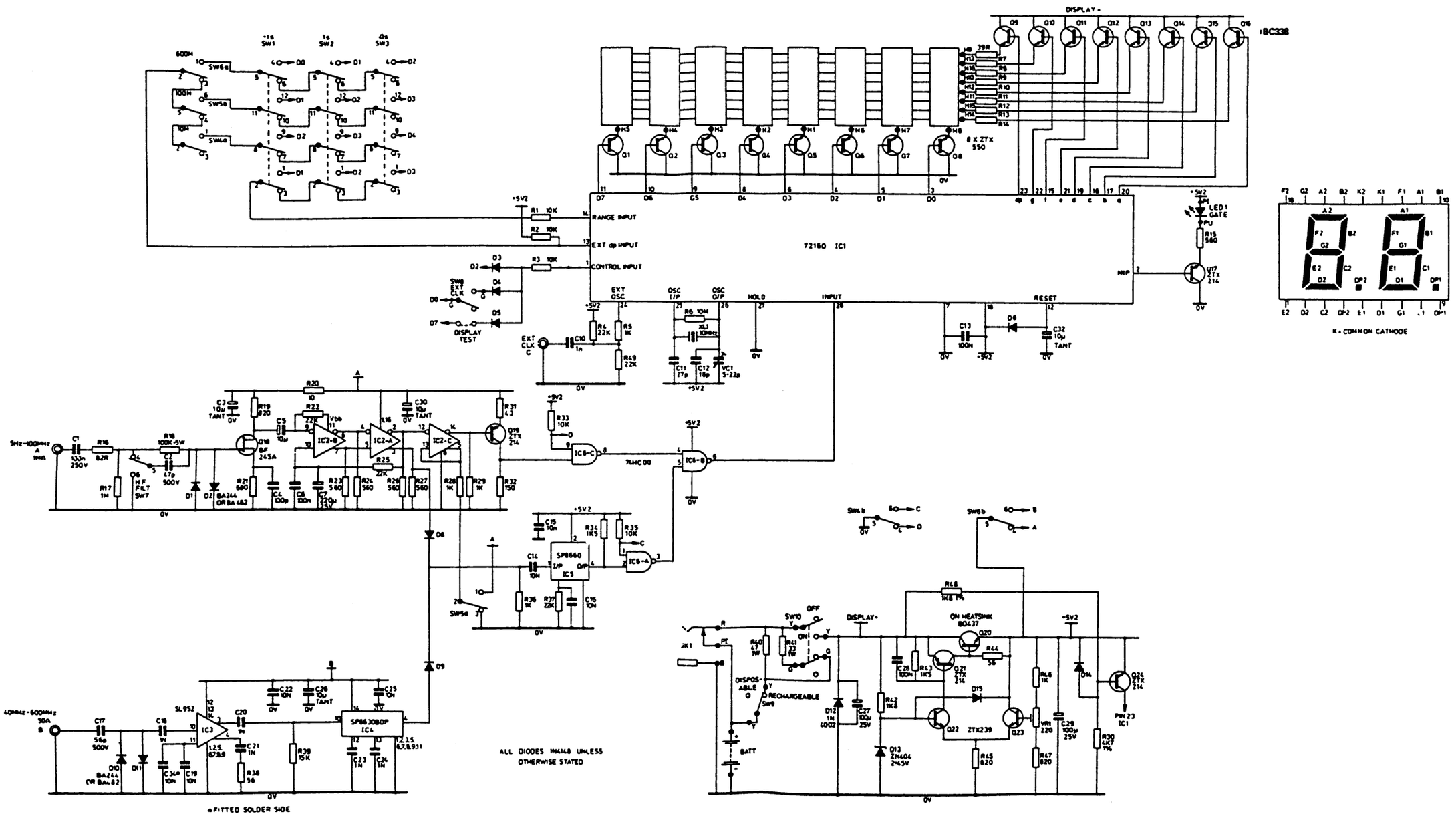
Description		Part No
Switchbank		22225-0590
Switch screen		31531-0090
Pushbutton, black	3 off	37113-0130
Pushbutton, grey	4 off	37113-0140
Stud 3mm x 8mm		20205-0600
Track pins	12 off	22469-0502
DIL Skt 14 pin	(for IC6)	22574-0119
DIL Skt 16 pin	(for IC2)	22574-0120
DIL Skt 28 pin	(for IC1)	22574-0122
Header 8 Way 2off cut from		22573-0019
Heatsink	(for Q20)	20670-0060
Screw M3 x 8mm (for Q20 (1) Earthing spring to case upper (1)	2 off	20234-0012
Washer M3 (for Q20 (1) Front panel earth strip to PCB (1) PCB to case lower (2))	4 off	20030-0263
Washer shakeproof M3 (for Q20 (1) Earthing spring to case upper (1) Front panel earth strip to PCB (1))	3 off	20210-0101
PCB		35555-0550
Earthing spring, PCB to case lower screen		35358-0480
Rear Panel		33331-0860
Power Jack Skt		22581-0514
Switch, slide (SW8,9,10)	3 off	22218-0205
Screw M2 x 5mm (for slide switches)	6 off	20234-0026
BNC Bulkhead socket	3 off	22588-0004
Earthing spring, case upper		35358-0490
Front panel		33331-0850
L.E.D.		25061-0200
Adhesive pad for LED		10300-0313
Battery holder		20656-0011
Constraint, battery holder		33145-0310
Screw M3 x 6mm Taptite c/s head (battery holder to constraint)	2 off	20062-0550

Opto & Electro/Mechanical Parts cont.

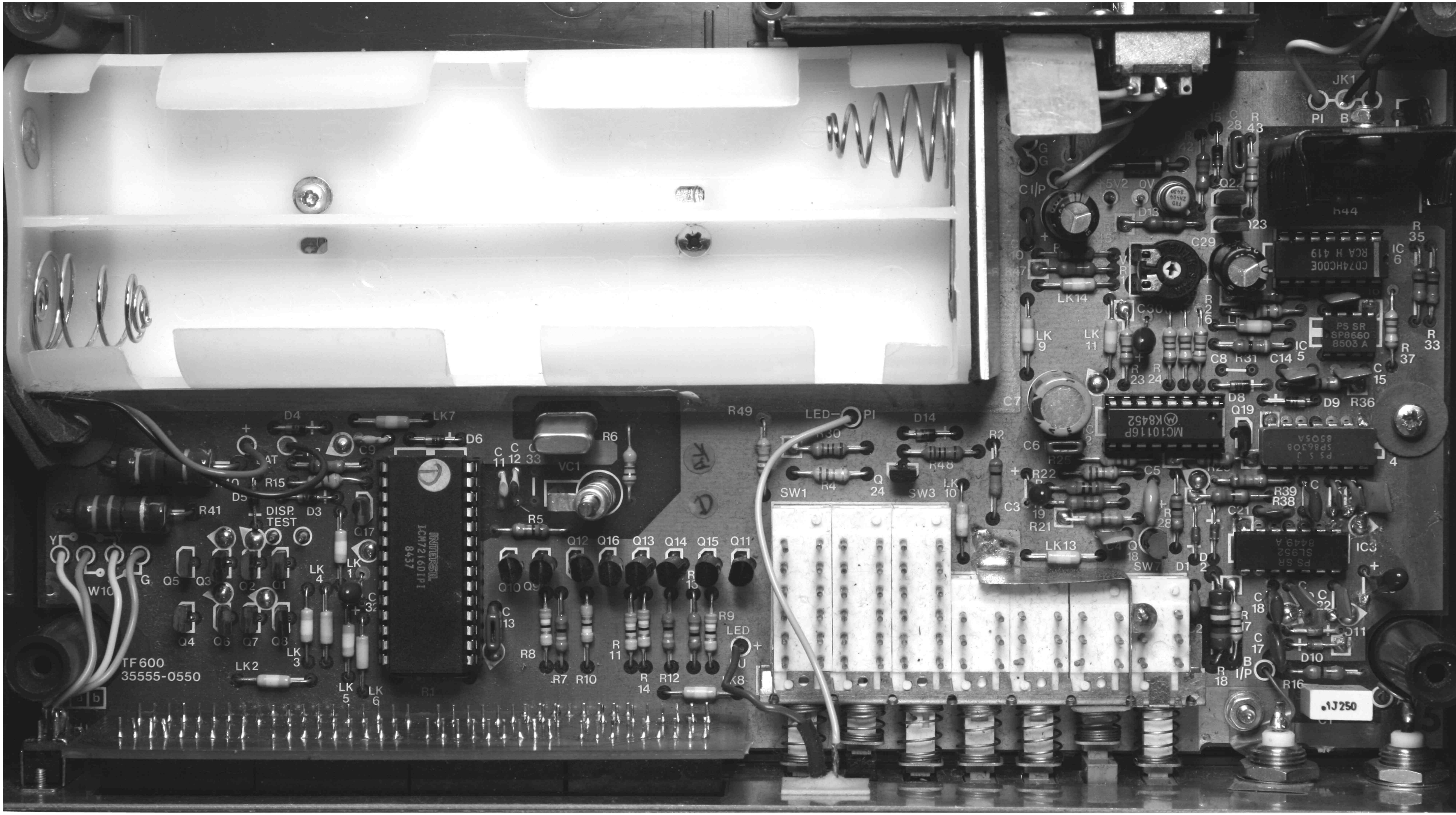
Description		Part No
Earth Strip, front panel to PCB		35358-0400
Screw 6BA x 3/16"L countersunk head (battery constraint to case)	2 off	20118-0002
Screw 6BA x 3/16"L pan head (PCB to case lower (2) Case upper to lower (4))	6 off	20134-0501
Screw 6BA x 1.25"L (Case upper to lower)		20134-0503
Washer, fibre 1/2" OD (PCB to case lower)	2 off	20612-0010
Foam pad 50 x 20mm (for battery compartment restraint)	cut from	10300-0304
Foam pad 120 x 40mm (battery restraint, case upper)		31333-0060
Case, lower		33537-0160
Foot, black	4 off	31748-0190
Case, upper		33537-0150
Logo label		37522-0010
Screen, case lower		31346-0050
Insulator, case lower		31346-0060
Screen, case upper		31346-0070
Handle		31336-0200
Side trim, front	2 off	31332-0490
Side trim, rear	2 off	31332-0500
Battery cover		33335-0060
Serial no. label		37522-0020
Instruction label		37558-0480

Packaging Parts

Description		Part No
Carton, outer		38113-0320
Carton		38113-0260
Aircap sheet	cut from	10612-0202
Instruction book		48581-0660
Guarantee card		48581-0230
Adaptor/Charger, flying mains lead or Adaptor/Charger, Euro plug Mains lead or Adaptor/Charger, USA plug Mains lead		51151-0560 51151-0570 51151-0590



Circuit diagram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35555-0550
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8437
MC10116P
K8452
CD74HC00E
RCA H 419
PS SR
SP8660
8503 A
SP8630B
8505A
SL952
8449 A
.1J250
JK1
SW1
SW3
DISP.
TEST
LED
R49
R41
R6
VC1
C29
C7
C6
LK7
LK13
LK14
D4
D6
D14
Q12
Q16
Q13
Q14
Q15
Q11
R5
R8
R10
R12
IC3
R16
D10
R44