All Time Electronics' instruments are subject to continuous development and improvement and in consequence may incorporate minor detail changes from the information contained herein.

D.C. VOLTAGE CALIBRATOR 2003S

and

D.C. VOLTAGE POTENTIOMETER/CALIBRATOR 2003N

TECHNICAL MANUAL.

The 2003 incorporates several novel circuit design features for which patents have been applied.

TIME ELECTRONICS LIMITED.

BOTANY INDUSTRIAL ESTATE, TONBRIDGE, KENT.

TONBRIDGE (0732) 355993.

TELEX NO. 95481.

2003 TECHNICAL MANUAL.

CONTENTS.

SECTION PAGE

SECTION 1.

GENERAL DESCRIPTION, SPECIFICATIONS.

1.1 GENERAL DESCRIPTION:

The 2003 is available in two versions. As a voltage source (order code 2003S) only or as a voltage source and potentometer (order code 2003N). The 2003N is a 2003S plus a null balance amplifier and meter display. For potentiometric operation the output of the voltage source section is balanced against the unknown voltage.

The main advantage of the 2003N over conventional potentiometers are:

a) No standardisation is required.

b) It can be operated in any position.

c) Up to 20mA output current without loss of accuracy.

d) Digital readout.

e) Electronic Null with microvolt sensitivity.

A precision zener reference diode is used as a basic reference source and low temperature coefficient resistors are used. Power is provided by 10, U2 size cells or alternatively a mains/rechargeable battery power unit. A front panel indicator monitors the battery condition. The completely solid state circuit design provides automatic standardisation against the internal reference and allows up to 25mA output current with less than 0.1 ohms output resistance. Short circuit overload protection and a normal-off-reverse switch are provided. The null balance section incorporates a high gain, low noise amplifier to enable a 1 uV resolution null to be obtained. The null sensitivity and zero are adjusted by front panel controls and the null indicator is graduated with a linear scale which enables direct reading in uV or mV after suitable adjustment of the sensivity control.

1.2a SPECIFICATION:

Ranges:
0-9.9999V in 5 ranges, 0-9.9999V in 0.1mV steps: 0-999.99mV in 10uV steps : 0-99.999mV in 1 uV steps : 0-9.9999mV in 0.1uV steps . 0-999.99uV in 0.01uV steps.

Accuracy:

10V 1V ranges: +/- 0.02% of setting +/- 0.005% of range
100mV, 10mV Ranges +/- 0.05% of setting +/- 0.005% of range
1mV range : +/- 0.25 uV

Setting Resolution:
5 digits.

Output resistance :
Less than 0.1 ohm (typ 0.05 ohm) on 10V. 1V and 0.1V ranges.
1 ohm on lower ranges.

Maximum Output current:
25mA max. on 10V, 1V 0.1V ranges (an internal short circuit current limit is set at approx 35mA). Lower ranges can be loaded up to the short circuit current value although it should be noted that loads less than 1000 ohms will give greater than 0.1% error.

Maximum Overload:
The instrument can withstand a continuous short circuit on the output for all ranges.
Output Voltage Stability :
Less than 30 ppm/oC (0oC to +50oC)
Less than 20 ppm/V variation in supply voltage.
Less than 75 ppm/year not cumulative.
Less than 10 ppm/hr at constant temperature.

Output Polarity:
Positive or negative switch selected. A centre 'off' position on this switch provides a short circuit on the output for 2003S voltage source. The potentiometer version 2003N has open circuit for the centre position

Output Noise Level:
10, 1 0.1V ranges, less than 10 ppm of setting +/- 2uV (0-10 c/s)
10mV 1mV ranges, less than +/- 0.2uV (0.2uV (0-10 c/s)

Null Detector:
Null balance display is on a front panel meter. Zero and sensitivity controls are provided.
Maximun sensitivy : +/-25uv f.s.d. (2uv/div).
Input resistance : Greater than 10M ohm at balance

Overall dimensions:
220 x 160 x 190 mm.

Weight:
Approximately 3.3kg with batteries.

Power Units:

The 2003 can be supplied with one of two types of power unit. Both are located inside the 2003.
a) BATTERY POWER UNIT:
10, 1.5V U2 size batteries. A front panel display provides a continuous indication of the battery state, a minimum level indicating when the batteries should be changed. Access to the battery compartment is from the instrument rear.
b) MAINS POWER UNIT PU2:
The PU2 provides either battery or mains operation. The battery is automaticaly charged when mains operation is used.

1.2b SHORT TERM STABILITY CURVE.

1.3 CIRCUIT DESCRIPTION:

The calibrator employs a temperature compensated zener diode as the basic reference source. This provides the input to a FET chopper amplifier system which operates in a feed-back stabilised mode, and has a gain value determined by a set of precision metal film resistors which are selected by a 5 decade thumbwheel switch. The output voltage is variable from 0 to 9.9999 volts in 5 ranges. An output resistance of typically 0.05 ohms is maintained on the top three ranges; the maximum output current that can be drawn on these ranges is automatically limited to 35mA - this is to prevent damage to the circuitry in the event of accidental short circuit etc. The lower ranges have an output resistance of 1 ohm and will supply current up to the short circuit value. To ensure complete reliability the range switch employs two contacts in parallel for each position - even if a contact fails the 2003 still functions correctly.

1.4 APPLICATIONS:

The uses of the instrument include the calibration applications of conventional voltage potentiometers. A 2003S in these applications has the advantage of requiring no standardisation and being able to supply much higher output currents without loss of accuracy. Long term stability is inherent since standardisation is not required.

The 2003N with null detector can be used to make accurate voltage measurements by comparing the unknown voltage with the calibrator setting.

Other applications as a precision voltage source include calibration, linearity and gain stability measurements, etc., on D.C. amplifiers, digital and electronic voltmeters, transducers and as a variable low current power supply or backing-off voltage. The 10 ppm/HR stability and low noise levels are of particular interest when an extremely stable voltage is required rather than a high accuracy calibration source.

SECTION 2.

OPERATING INSTRUCTIONS.

2.1 OPERATING POSITION:

Unlike many potentiometers and devices incorporating Standard Cells, the 2003 DOES NOT require operation or transportation in a particular position.

2.2 OUTPUT VOLTAGE. (2003S or 2003N (Source Mode)).

a) OUTPUT TERMINALS.
When the 2003N or 2003S is used as a voltage source the output voltage is connected to the front panel terminals which are suitable for normal wire compression connection or 4 mm 'wander' plug insertion. When used as a potentiometer the null system is switched in series with the source voltage and the voltage to be measured should be connected to the output terminals.

b) CASE TERMINALS:
The case terminal is connected only to the instrument case and is isolated from the circuitry. The case provides an overall electrostatic screen for the 2003 and can be earthed as required to improve rejection of noise pick-up.

c) POLARITY:
Selected by a front panel toggle switch. The centre position is off and for 2003S voltage source provides a short circuit on the output terminals. For 2003N (Potentiometer version) the off position gives open circuit on the output terminals - this is to prevent accidental shorting of the voltage being measured.

d) RANGES:
Selected by front panel rotary switch.

e) ACCURACY:
As specification.

f) OVERLOAD:
As specification.

g) OUTPUT CURRENT:
As specification.

h) OUTPUT NOISE:
The electrical noise on the output voltage consists of chopper intermodulation, thermal noise and random variations. Thermal noise becomes more significant on the lower ranges (see Thermal EMFS). In general the total noise level is less than 20ppm of setting +/- 2 uV for the 10v, 1v and 100mV ranges over the frequency range 0 - 10 Hz and less than +/- 0.2uV (0-10 Hz) for the lower ranges. Lower noise levels can be obtained by connecting a low pass filter on the output terminals.

i) COMMON MODE NOISE:
Additional noise and variation of the output voltage can be caused by large common mode voltages. These occur when the 2003 is used to calibrate (or measure) any input which is above ground potential or has an a.c. component with respect to ground. The battery powered version of the 2003 has inherently a very high d.c. common mode rejection, but it is not recommended that 100V d.c. common mode be exceeded. The a.c. common mode rejection is determined by the capacitive unbalance to ground of the output terminals and associated connections. The 2003 is checked before despatch with 30 Vp-p 50 Hz common mode voltage on the output terminals.

j) THERMAL EMFS:
When the 2003 is used to provide (and measure) precision voltages of less than about 1 mV, care must be exercised to avoid errors due to thermal emfs. These occur where temperature differences are present at the junctions of dissimilar metals, e.g. a normal solder to copper junctions has a thermal emf of approximately 3 uV/oC. Errors inside the 2003 under temperature stable conditions are typically less than +/- 0.2uV.

2.3 FRONT PANEL CONTROLS.

The following are common to the 2003S and 2003N.

a) SUPPLY ON/OFF:
A miniature toggle switch interrupts the supply line to the circuit module. Indication of supply on/off is provided by the battery level indicator.

b) OUTPUT POLARITY:
A change-over toggle switch enables the output polarity to be reversed. A centre position provides a short circuit on the 2003S output terminals and an open circuit on the 2003N

output terminals. The open circuit condition for 2003N is to prevent inadvertent shorting of a voltage being measured.

c) BATTERY LEVEL:
The battery level is continuously monitored on a front panel indicator which also serves as a supply on-off indication. A minimum mark indicates when the batteries need replacing or recharging.

d) OUTPUT VOLTAGE RANGE:
Selected by a 5 position rotary switch.

e) OUTPUT LEVEL:
Selected on a 5 digit thumbwheel switch. The resolution of setting is 0.01% of full scale.

THE FOLLOWING APPLY ONLY TO THE 2003N.

f) FUNCTION SWITCH.
A three position toggle switch for selection of operating mode.

CAL (or SOURCE) Mode:

Allows 2003N to be operated as a 2003S. The null amplifier in this mode is disconnected from the output circuit. The null sensitivity control should be set to minimum for this mode of operation.

NULL (or POT) Mode :

Allows operation as a potentiometeric voltmeter with a measuring resolution of greater than 1 microvolt. Due to extreme sensitivity of the null detector, it is important to ensure that it is correctly zeroed before attempting accurate measurements.

ZERO Mode :

For setting the NULL detector zero prior to measurements.

g) NULL BALANCE DISPLAY:

Edgewise meter scaled 20-0-20, displays the output of the null amplifier.

h) SENSITIVITY:

Adjusts gain of null amplifier. Max +/- 25uV f.s.d. Min +/- 250mV f.s.d.

i) ZERO:
Adjusts null amplifier zero.

2.4 OPERATING PROCEDURE. a) 2003S.
Operation of the 2003S is self explanatory from the front panel controls and specification. Normal precautions concerning overload and incorrect range etc., should be observed. Battery condition should be checked on the front panel display before and during use.

b) 2003N.

Operation of the 2003N as a voltage source is by selection of the 'Source' Mode position of the function switch. The procedure is then as described in 2.4a. It is normal practice to set the NULL SENSITIVITY control to the minimum position for Source operation to prevent small meaningless indications on the null display meter.

Operation of the 2003N as a potentiometric voltmeter is by selection of the 'POT' Mode position on the function switch. It is IMPORTANT to ensure that the null amplifier is correctly zeroed before attempting accurate measurements. It is also wise to re-check the zero occasionally if the maximum sensitivity of the null is being used.

ZERO SETTING PROCEDURE.

a) Set function switch to 'ZERO'.

b) Set RANGE switch to required range.

c) Set all digits to zero.

d) Set sensitivity control to maximum fully clockwise.

e) Adjust zero control for zero reading on null display meter.

NOTE : The latest versions incorporate a modification which enables the zero to set without operation. (c). (i.e. it is not necessary to set all digits to zero). This speeds up the zero setting procedure.

MEASURING PROCEDURE. a) Set function switch to 'Pot' mode

b) Set output polarity switch to normal

c) Set sensitivity control to minimum - fully anti-clockwise

d) Connect unknown voltage to output terminals (in the same polarity)

e) Adjust output digits and null sensitivity for null balance as required.

IMPORTANT NOTE:

The output polarity switches of the 2003S and 2003N are different.

2003S provides a short circuit on the output terminals for 'OFF' position.

2003N provides OPEN circuit on the output terminals for 'OFF' position.

The reason for this is that it prevents the 2003N inadvertently shorting (by incorrect switch selection) of the voltage under measurement.

2.5 FUSES:

The power supply and output fuses are mounted on the INSIDE of the front panel printed circuit board. Access is by removing the instrument front panel as described in Section 3. Both are 16 mm (5/8") 250mA types. Spare fuses can be obtained directly from Time Electronics or the fuse manufacturer: Belling-Lee Limited, 540, Great Cambridge Road, Enfield, Middlesex. - their order code is: L562/250mA size 00 or alternatively from your local supplier or authorised distributor.

2.6 BATTERY UNIT:

Access to the battery unit is via the rear of the instrument.

a) BATTERY REPLACEMENT PROCEDURE.

1) Remove the battery unit locating screws.

2) Remove battery unit by extracting rearwards from the instrument (handle provided).

3) Disconnect press-stud connectors.

4) Replace the 10 cells, taking care to ensure that they all seat correctly in the holders with the spring contacts centrally located on the cell bases, rotating the cells when they are in position helps to centralise the spring contact. It is easier to withdraw the 'stud' end of the cell first when removing the cells, and when replacing them to compress the spring contact before inserting first the 'base end'.

NOTE: The spring contact always connects with the battery negative.

5) Reconnect the press stud connectors - ensure these are a tight fit, bend 'female' connectors slightly if necessary.

6) Replace battery unit in instrument.

b) RECOMMENDED BATTERY TYPES:

Any U2 size (60mm L, 33mm D) cell can be used to power the instrument. It is recommended that the sealed type of battery be used in the instrument since leakage can cause corrosion of the battery unit contacts. The following are estimates of the operational life of one set of cells under typical laboratory usage (6 hrs/day):-

Mallory Manganese Alkaline Type No. MN1300 - approx., 4 months.

Ever Ready U2 (Zince Carbon) - 2 - 3 months.

The Zinc-Carbon type of cell are probably the most economical type to use for the intermittant operation of the instrument. Manganese Alkaline are clearly best for long term performance and will outlast the Zinc-Carbon type in operation and shelf life by a factor of 3 - 4 times. Rechargeable cells may be attractive in some cases.

IMPORTANT NOTE: It is strongly recommended when Zinc-Carbon batteries are used they are replaced every six months irrespective of condition. This is because the limited shelf life of commercially available types is only 6-9 months and the risk of leakage is much greater after this period. A small percentage of the so-called LEAKPROOF cells have also been found to be unsatisfactory after long periods.

For this reason it is also important to ensure when replacing cells that they are all 'brand new'.

The above caution is not necessary with Manganese Alkaline or rechargeable types.

2.7 MAINS POWER UNITS.

a) TYPE PU2 (240V)

The PU2 incorporates a rechargeable Nickel-Cadmium battery and electronics charge control circuitry. The circuitry is arranged to enable the PU2 to provide power directly from the mains if the mains input is connected or alternatively form the rechargeable battery if mains is not connected.

When the mains is connected the charging circuitry provides the correct charge current (40-45mA) for the battery and

automatically reduces this to a trickle rate (3 - 4mA) when the battery is fully charged. This means that it is impossible to overcharge the battery.

The D. C. performance is as follows:

With mains connected,

D.C. output 15.5 - 17V (0 - 100mA load).

With mains disconnected (and battery fully charged)

D.C. output 14.5 - 15.5V (0 - 100mA load)

Mains input range is 200 - 250V a.c. 40 - 60 hz.

The capacity of the rechargeable battery is approximately 450mA Hrs. This allows about 40 - 50 hrs. continuous use of the 2003. To fully recharge the battery requires 14 - 16 hrs with mains connected.

b) TYPE PU2 (110V)

This unit is identical to PU2 (240V) but is for use on 100 - 125 a.c. 40 - 60 Hz mains. Mains and d.c. performance are as PU2 (110V).

It is important to specify 110V on ordering.

c) CONSTRUCTIONAL DETAILS PU2.

The P.C.B. is located on the rear panel by 4 6BA screws and is spaced off approx., 10 mm. A metal cover protects and screens the P.C.B. and components. The output connectors and output fuse are located outside the cover. The cover is fixed to the rear panel by a 4 6BA screws. Circuit and layout diagrams are given in Section 4. Later versions of PU2 have fuse located inside cover.

IMPORTANT NOTE :

It is extremely important to take care when checking and dismantling a PU2. Even though disconnected from the mains, there is still sufficient power stores in the rechargeable battery to cause catastrophic damage to the electronic circuitry if inadvertent short circuits occur. These can easily occur when the metal cover is being removed.

d) 240V TO 110V MAINS CONVERSION:

The PU2 mains transformer has tappings for 240V or 110V a.c. mains. The following procedure should be adopted to convert from 240V to 110V mains. Refer to PU2 P.C.B. layouts in Section 4.

1) Remove mains power unit from 2003

2) Remove P.C.B. metal screening cover.

TAKE CARE NOT TO SHORT TO ANY PART OF THE CIRCUITRY IF CONVERTING A PU2.

3) Connect mains transformer windings in parallel by rewiring the mains input to the transformer (as shown on the side of the transformer.)

4) Replace metal screening cover.

2.8 100 VOLT OUTPUT UNIT.

For use with Type 2003 Voltage Calibrator.

The unit is mains powered and operates external to the 2003 . It enables the output capability to be extended to 100V .

It is connected to the calibrator's output terminals and accurately multiplies the output by a factor of 10X.

SPECIFICATION.

Input: 0 to + 12V.

Output: 0 to + 120V.

Accuracy: Transfer accuracy and linearity better than .002%

Max output current: 10mA. The output current is automatically limited to approximately 15mA.

Max overload: The unit can withstand continuous short circuit.

Output polarity: Positive or negative switch selected. A centre 'off' position provides a short circuit on the output.

Output Noise: Less than 20ppm of setting +/- 20uV (0-10 Hz).

Power: 210/250V 50 Hz. or 100/120V 60 Hz optional.

Dimensions: 100 | 90 x 190 mm 1.5 kg.

SECTION 3.

CONSTRUCTIONAL LAYOUT DETAILS.

The complete instrument assembly (except the Power Unit) is mounted on the front panel. A printed circuit board which carriesthe components and range switch is located immediately behind the front panel. The panel and p.c.b. can be removed as follows: 1) Remove Power Unit - located in instrument rear by 4 screws.

2) Disconnect supply - connected to power unit by 2 press stud connectors.

3) Remove front panel locating screws.

4) Withdraw front panel and p.c.b. - the power supply lead can also be withdrawn through a hole in the plastic power supply cover.

Access to the components parts of the 2003 is now straight forward. Component layout details are given in Section 4.

For recalibration the power supply can be connected without rehousing in the case.

3.1 CHOPPER AMPLIFIER MODULE.

a) Description:

The module contains the F.E.T. Chopper amplifier, precision zener and associated circuitry. It is a fully encapsulated module and connections are via a 16 pin connector moulded into it. The modular form of the 2003's basic circuitry protects it from damage due to adverse conditions and thermal gradients which could give rise to thermal emf errors. A replacement procedure should be adopted in the case of failure or malfunctioning of the module - see Section 3.4 Type 2003S and 2003N use the same circuit module.

b) Module Replacement:

1) Remove and disconnect power unit located in instrument rear by 4 screws.

2) Remove front locating screws.

3) Carefully withdraw the front panel and associated printed circuit board (p.c.b.). The Power supply lead can also be withdrawn through a hole in the plastic supply cover.

4) Remove 4 6BA nuts which locate the module on the p.c.b.

5) Withdraw the module from the p.c.b.

6) Remove 4 6BA nuts remaining on module mounting studs. Put these nuts on the new module. Replace new module in reverse order ensuring the connector pins align correctly - it may be necessary to bend slightly the 6BA mounting studs in order to obtain smooth alignment of the 16 pin plug and socket. It is important not to overstress the plug and socket, since poor connection will result.

(3.1 b) Module Replacement.

7) Adjust the position of the module above the p.c.b. with the 6BA nuts on the module side of the p.c.b. When the module is parallel the plug and socket just closed, the nuts on the opposite side of the p.c.b. can be tightened. It is important to ensure that no strain is put on the connector when the nuts are finally tightened.

8) Set Module zero and recalibrate as described in 3.1c.

Recalibration. This is performed with the panel and p.c.b. outside the case.

A. ZERO.

The F.E.T. chopper amplifier zero must be set before calibration can be done. The zero is set when the instrument is manufactured and under normal operation will not require readjustment. If a new circuit module is fitted or readjustment is found necessary, the following procedure should be adopted.

1. For 2003N select Source mode.

2. Connect power supply.

3. Select 99.999mV range.

4. Set all digits to zero.

5. Set output polarity to normal.

6. Connect a null meter to output terminals. The meter sensitivity should be +/- 100uV f.s.d. with a resolution of better than 10uV. It is possible to use another TIME ELECTRONICS 2003N or 2004 for this purpose, although any micro-volt null meter or sensitive D.V.M. may be used.

7. Adjust the zero trimming pot on the module for less than +/- 10uV reading on the meter. The zero trimmer is marked on the module label.

8. Check the zero reading for the other 4 ranges. The readings should be as follows:

999.99uV range less than +/- 0.25uV
9.9999mV " " " +/- 0.75uV
999.99mV " " " +/- 40uV
9.9999V " " " +/- 100uV.

NOTE: It is not possible to use the null amplifier system on the 2003N for setting up the module zero.
B. Fine adjustment of the 2003 output voltage is provided by 4 trimmers. One is located on the module is marked 'CAL' and provides equal adjustment of the output voltage for ranges. The other 3 trimmers are located on the front panel p.c.b. and provide individual adjustment for the 10V, 100mV and 10mV ranges. Since a commom attenuator is used for the 10mV and 1mV ranges the 1mV range is automatically calibrated when the 10mV range is calibrated.

All the trimmers are set up when the instrument is manufactured and normally will not need readjustment. If a new circuit module is fitted or readjustment found to be necessary the procedure below should be adopted.

It is important to note that the maximum range of adjustment provides about +/- 0.2% variation in the output voltage. If errors of greater than this magnitude are occuring there is no point in attempting to recalibrate using the trimmers and a fault condition will be occuring somewhere in the unit.

CALIBRATION PROCEDURE.

1. Ensure zero has been set as in 3.1c.

2. For 2003N select SOURCE mode.

3. Connect power supply.

4. Select 999.99mV range, normal output polarity, and output digits to 99999.

5. Connect a suitable accuracy voltage standard with microvolt null meter to the output terminals. The voltage standard should have 0.005% accuracy or better and ranges from 10mV to 10V f.s. The null meter should have a resolution of better than 1uV and preferably have calibrated ranges. The TIME ELECTRONICS type 2004 is a suitable instrument (see opposite). Alternatively a high performance D.V.M. can be used for calibrating.

NOTE 1:
It is possible to use the null meter system in a 2003N in place of an external null but where possiible a higher performance external instrument should be used. The TIME ELECTRONICS type 202 is a suitable instrument.

NOTE 2:
It is possible to calibrate against another 2003 but the inaccuraces in that unit (if known) need to be taken into account.

6. Adjust the CAL trimmer on the module for better than 50uV null balance against an output of 999.99mV from the standard. Note that the maximum range of adjustment of this trimmer is 0.3%.

7. Select 9.9999V range and adjust the 10V range trimmer (VR4 sec component layout diagram), for less than 500uV null balance against an output of 9.9999V from the standard. Maximum range of adjustment of this trimmer is 0.08%.

8. Select 99.999mV range and adjust the 100mV range trimmer (VR5) for less than 5uV null balance against an output of 99.999mV from the standard.

9. The specification allowances for these 3 ranges are as follows:

9.9999V range +/- 2.5mV.

999.99mV range, +/- 250mV.

99.999mV range, +/-55uV

3.1.d. 10mV AND 1mV RANGE CALIBRATION:

The two ranges are obtained by resistive attenuation of the 10V and 1V ranges. The attenuation factor is 1000:1. The calibration of the attenuator is via the 10mV range trimmer (VR3). Maximum range of adjustment is 0.16%.

The attenuator is set up when the 2003 is manufactured and normally requires no further adjustment. If, however, any of R2-R5 have been damaged by overload they will require replacing with equivalent types.

After replacing the resistors recalibration may be necessary beyond the range of the 10mV trimmer. The 2003 output should be checked against a 9.9999mV output from the standard and adjusting resistors (either R6 or R7) selected to bring the calibration within the range of adjustment of the trimmer, which can then be adjusted for the final

calibration as described above.

The calibration should be done on the 9.9999mV range and due account taken of any thermal emf's generated in soldering the adjustment resistor in position.

NOTE:
It is important to ensure that the zero and calibration (3.10) have been set before commencing 3.1.d.

The specification allowances for these ranges are as follows:-

9.9999mV range : +/- 5.75uV.

999.99uV range : +/- 0.75uV.

3.2 DIGIT SWITCH ASSEMBLY.

a) DESCRIPTION.

It consists of 5 decade edge switches with gold plated contacts. Nine resistors are mounted on each switch. After several years of heavy usage, the contact system used in the switches sometimes need cleaning. If the 2003 has been in a dusty or corrosive environment, contamination of the contacts is more likely. Contamination causes the contact to become open circuit or intermittently open circuit in one or more switch positions. This fault condition causes the output to rise to the supply voltage (12-16 vdc) on the top three ranges.

b) REPAIR.

If the 2003 has been in service for some time it is usually best to return the complete unit to Time Electronics for repair. In addition to repairing the switch the 2003 will be completely overhauled, updated where possible and recalibrated. Where this is not possible, the digit switch assembly can be removed from the front panel as described below and returned to Time Electronics for repair.

c) CLEANING THE SWITCH CONTACTS.

Where it is not possible to return either the complete unit or the switch assembly to Time Electronics, it is possible for the customer to overhaul the assembly provided suitable tools and the correct cleaning materials are available.

DIGIT SWITCH REMOVEL AND DISMANTLE PROCEDURE.

Remove front panel from unit (see section 3)

2. Unsolder the 2 wires connecting the p.c.b. to the switch assembly.

3. Remove 2 6BA studs which pass through all 5 switch sections.

4. Compress spring clips which locate the assembly on the front panel

and push the complete assembly out through the panel aperture. NOTE 1 :

Earlier versions of the 2003S incorporate a different type of digit switch which is located on the front panel by 2 brackets. These need to be removed to allow the assembly to be removed. 3. and 4., above are not necessary.

NOTE 2 :

Dismantling the digit switch sections for cleaning requires removing the plastic pips which locate the switch p.c.b., on the switch casing. This can be done with a sharp knife. The functional parts of the switch can then be removed for cleaning. CARE must be taken to note the exact position of the parts so that they can be reassembled correctly. The p.c.b. is relocated on the plastic studs by melting the top of the stud with a hot iron or alternatively by covering the stud and surrounding p.c.b. with a small amount of expoxy adhesive.

NOTE 3 :

The correct cleaning fluid for this type of switch is general purpose degreasant with a trichlorethane base. TAKE CARE NOT TO LET THIS FLUID TOUCH THE PLASTIC PARTS OF THE SWITCH. It is good practice to coat the contacts with silicom switch grease. A supplier of cleaning fluid and grease is: R. S. Components Limited, P.O. Box No. 427, Epworth Street, LONDON, EC2P 2HA.

3.3 NULL AMPLIFIER (2003N ONLY).

a) DESCRIPTION.

The null amplifier consists of a high performance amplifier with a resolution of better than 1uV. Zero and sensitivity controls are provided on the front panel. Null display is on a front panel indicator graduated 20-0-20. The circuitry is located on the main printed circuit board below the digit switch. Since the operation of the null amplifier circuitry is linked with the 2003 circuit module, faulty operation of this circuit requires 2003 to be returned to Time Electronics for repair.

b) PRESET CONTROLS (Ref: 2003N layout diagram, Section 4).

Preset trimmers are provided on the null aplifier.

1.
A coarse adjustment of the null zero - this should be adjusted to give the front panel zero control equal swing either side of zero. It is important to check that the 2003 circuit module has been correctly zeroed (see Section 3.1c) before setting the null zero.

2.
The null amplifier offset current can be adjusted to zero by trimmer control on the null amplifier (see 2003N layout diagram Section 4). It is important to have a low offset current since errors can be introduced when measurements are to be made from high impedance sources.

The null amplifier input resistance is also affected by large offset current.

The current offset is adjusted by setting null zero as in 2.4b then:

I) Connect a 47K ohm resistor across the input terminals

II) Select the POT (or NULL) mode

III) 9.9999mV range

IV) Set all digits at zero.

V) Adjust offset trimmer for zero reading on the nulll display - the null sensitivity can be gradually increased to maximum during the adjustment.

NOTE :

Both trimmers in I) and II) are set up when the 2003N is manufactured and normally do not require readjustment.

If a new circuit module has been fitted, they will require adjustment.

SECTION 4.

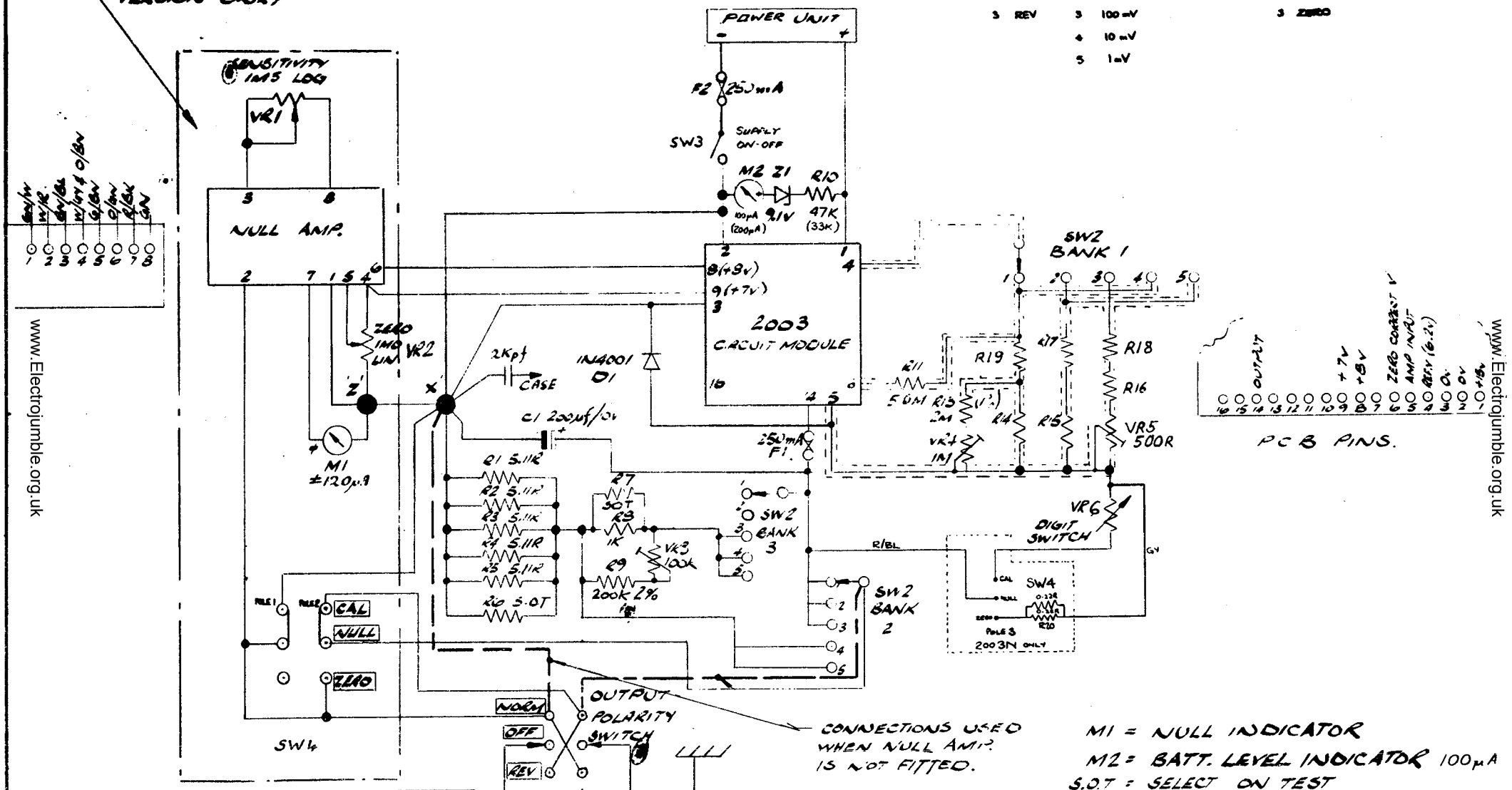
CIRCUIT AND LAYOUT DIAGRAMS.

DRG. No C45

TITLE CIRCUIT DIAGRAM (ZENER) F/PANEL 2003 Z.

THESE COMPONENTS FITTED ON 2003N NULL CALIBRATOR VERSION ONLY

SW1	SW2 RANGE	SW3	SW4
1 NORM	1 10v	1 ON	1 CAL
2 OFF	2 1v	2 OFF	2 NULL
3 REV	3 100 mV		3 ZERO
	4 10 mV		
	5 1 mV		



M1 = NULL INDICATOR

M2 = BATT. LEVEL INDICATOR 100μA

S.O.T = SELECT ON TEST

R13 = 9 × 1K 0.02% RATIO R14 = GK19
9 × 100Ω 0.05% R15 = GK19
9 × 10Ω 1% R16 = 61.9K
9 = 1Ω 5%
9 = 0.1Ω 10%
RATIO MATCH ± 0.05%
R14+R19 = GK29
R15+R17 = 62K9
R18+R16 = 628K9

NOTE DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED REMOVE ALL BURRS AND SHARP EDGES

ISSUE	A	B	C
MOD Nº	—	-	
DATE	9/11/75	16.4.76	3.5.76

TOLERANCES 00 ± .1 0 ± .4

DRAWN E.E.C

APPRD

MATERIAL —

FINISH —

3rd ANGLE PROJECTION

SCALE —

USED ON

SCHEDULE

TIME ELECTRONICS LIMITED

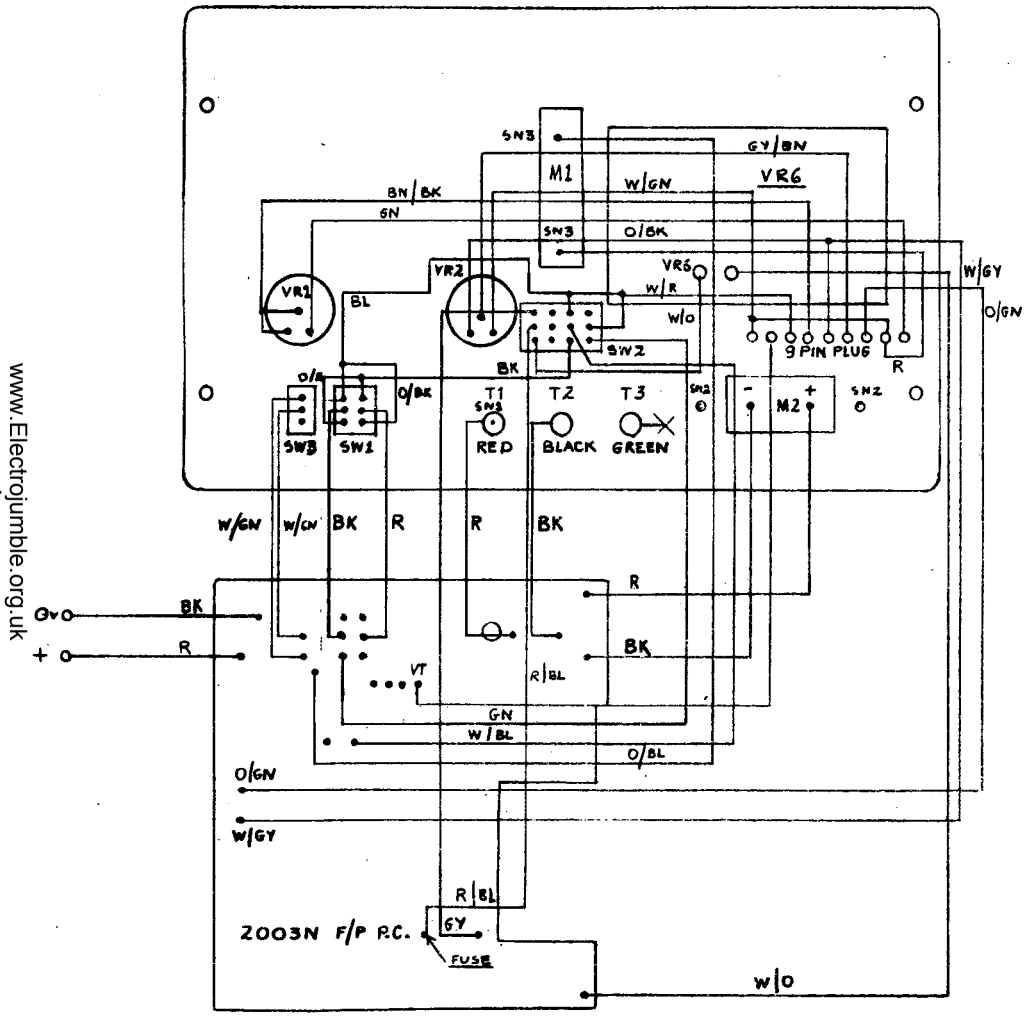
DRG.Nº C45

A2

www.Electrojumble.org.uk

L55

TITLE 2003N ASSEMBLY / WIRING DIAGRAM



ASSEMBLY PROCEDURE

1) ASSEMBLE HARNESS
2) WIRE TOGGLE SWITCHES
3) ASSEMBLE PARTS TO FRONT PANEL
4) WIRE HARNESS TO FRONT PANEL
5) WIRE PC TO FRONT PANEL
6) FIT PC TO FRONT PANEL AND TIGHTEN NUTS
7) WIRE IN DECADE SWITCH
8) FIT KNOB

REF NO.	DESCRIPTION	STORE No.
M2	B.L.I	7214
T1	4MM TERMINAL	6298
T2	" "	6296
T3	" "	6297
SW1	C + K 7203	6348
SW2	C + K 7411	6561
SW3	C + K 7101	6846
VR1	PLESSE 1M5 LOG.	1864
VR2	" 1MO LIN.	1868
VR6	5 DIGIT SWITCH	9525
M1	ERN. TURN. 120-0-120 μA	
	2003N FRONT PANEL	8704
	" P/C BOARD (F/P)	7408
SN1	4 BA SPACER	8727
SN1	(1) 4BA BOLTS	8441
SN2	(2) 8 BA BOLTS C/S 5/8"	5405
SN2	(2) 8 BA NUTS	8501
SN2	(2) 8 BA WASHERS	8601
SN3	(2) 8 BA BOLTS 1 1/4"	8405
SN3	(6) 8 BA NUTS	8501
SN3	(4) 8 BA WASHERS	8601
	9 PIN PLUG	6295

WIRES REQUIRED

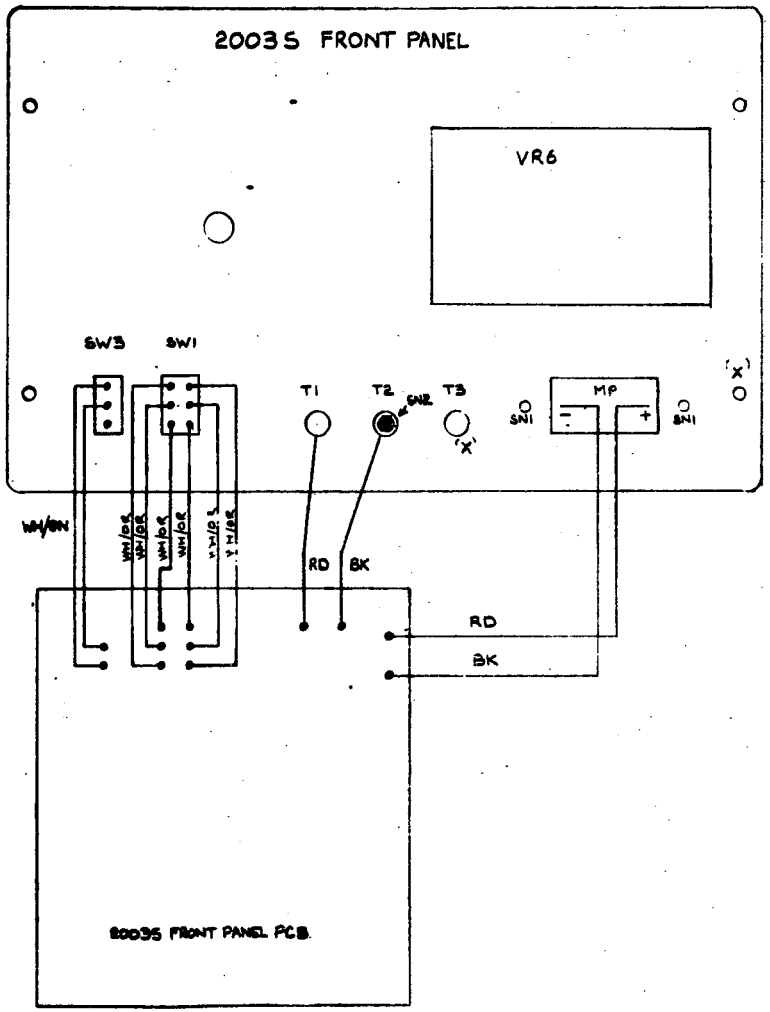
QTY		LENGTH
1	W/GY	7"
1	O/GN	7"
1	GY/BN	5"
1	W/BL	5"
1	O/BL	6"
1	VT	6"
1	BN/BK	6"
2	O/BK	7"
1	O/BK	5"
1	GN	2"
1	GN	3"
4	R	4"
3	BK	4"
3	W/GN	4"
1	R/BL	6"
1	W/O	8"
1	W/O	4"

NOTE DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED — REMOVE ALL BURRS AND SHARP EDGES

ISSUE		THE CONTENTS OF THIS DRG MUST NOT BE COPIED OR USED WITHOUT PRIOR WRITTEN CONSENT OF Wm. ELECTRONICS LTD.	3rd ANGLE PROJECTION
MOD No			SCALE
DATE	5-1-75		USED ON
TOLERANCES ·00 ±·1 ·0 ±·4		MATERIAL / FINISH	SCHEDULE
DRAWN	R.A.M.	TIME ELECTRONICS LIMITED	DRG. No. L55
APPRD			

L54

TITLE 2003S FRONT PANEL ASSEMBLY/WIRING



ASSEMBLY PROCEDURE

1) WIRE TOGGLE SWITCHES AND METER
2) GRIND OFF PAINT AT POINT 'X'
3) ASSEMBLE TERMINALS TO FRONT PANEL AND WIRE
4) ASSEMBLE SWITCHES AND METER TO FRONT PANEL
5) WIRE FRONT PANEL ASSEMBLY TO P.C.B.
6) FIX FRONT PANEL TO PC B BY USING SN2+ SWITCH NUT
7) FIT KNOB
8) WIRE IN VR6

REF No.	DESCRIPTION	STORES No.
M2	B.L.I.	7714
T1	4MM TERMINAL	6286
T2	" "	6286
T3	" "	6287
SW1	C+K 7101	6344
SW2	" 7211	6342
	NUTS FOR C+K (4)	6318
	WASHERS " " (2)	6341
SN2	4 BA SPACER	6344
SN1	8 BA SCREW (2)	6308
SN1	" " NUTS (2)	6301
SN1	" " WASHERS (4)	6306
	PKR KNOB	6001
	2003 FRONT PANEL	9703
	" " " LABEL	2803
VR6	5 DIGIT SWITCH	9525

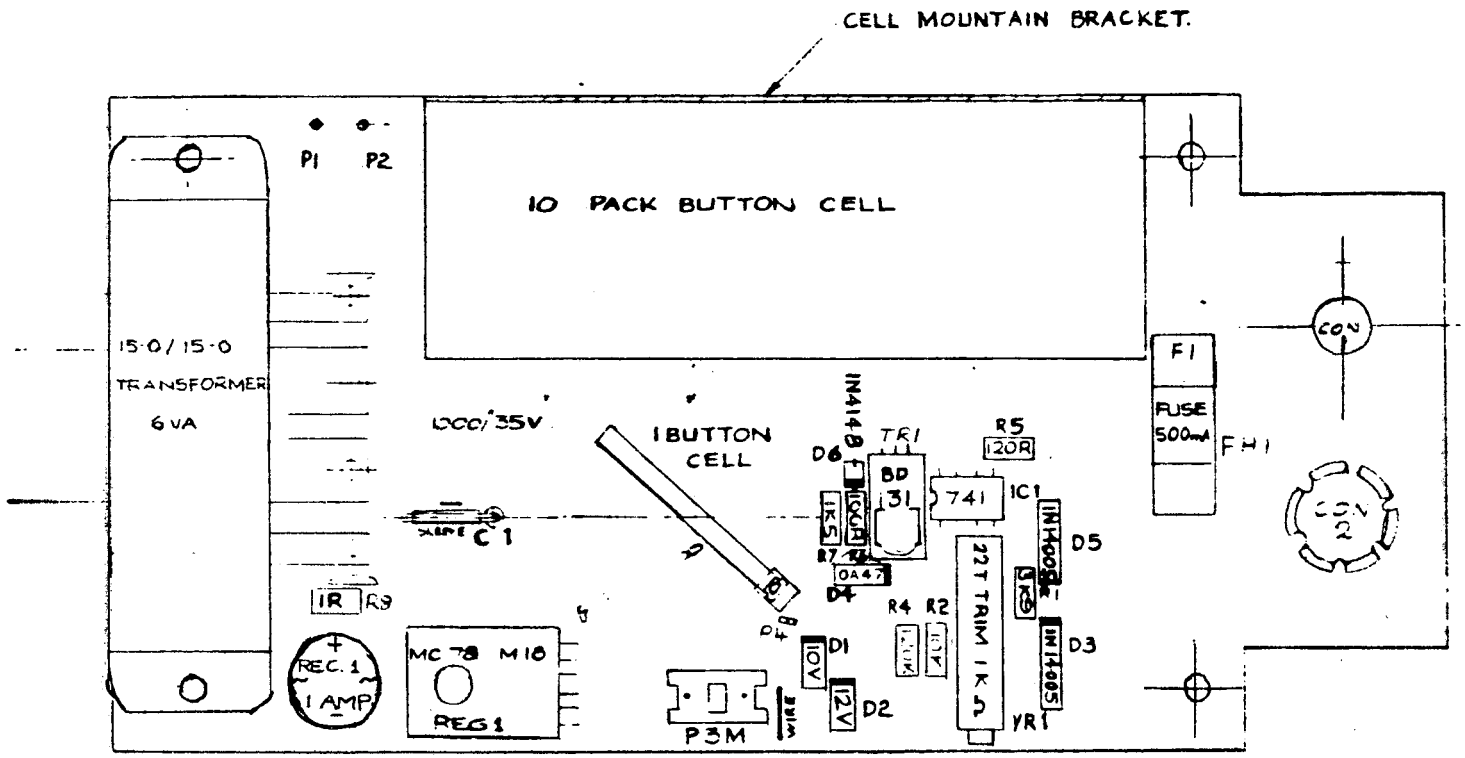
QTY	WIRES REQUIRED	LENGHT
2	WH/GN 7/0.2	1¼"
6	WH/OR 14/0.2	1¼"
1	RD 14/0.2	1½"
1	BK 14/0.2	1½"
1	RD 7/0.2	6"
1	BK 7/0.2	6"

NOTE DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED — REMOVE ALL BURRS AND SHARP EDGES

ISSUE	A									THE CONTENTS OF THIS DRG MUST NOT BE COPIED OR USED WITHOUT PRIOR WRITTEN CONSENT OF TIME ELECTRONICS LTD.	3rd ANGLE PROJECTION
MOD No											SCALE
DATE	10/4/78										
TOLERANCES .00 ± .1 .0 ± .4					MATERIAL					FINISH	USED ON
DRAWN					TIME ELECTRONICS LIMITED						DRG No. L54
APPD											

www.Electrojumble.org.uk

TITLE PU2 R LAYOUT



NOTE DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED REMOVE ALL BURRS AND SHARP EDGES

ISSUE	A	B					THE CONTENTS OF THIS DRG MUST NOT BE COPIED OR USED WITHOUT PRIOR WRITTEN CONSENT OF TIME ELECTRONICS LTD	3rd ANGLE PROJECTION
MODIFY		M.B.E.						SCALE
DATE	2-10-78	10-8-78						USED ON
TOLERANCES .00 ± .1 .0 ± .4			MATERIAL				FINISH	SCHEDULE
DRAWN	A.J.T.	M.E. & C.G.	TIME ELECTRONICS LIMITED					DRG Nº L 49
CHK								

Ref No	Comp Value	Store Code
R1	3K9	1144
R2	10K	1149
R3	1R	1101
R4	120K	1162
R5	120R	1126
R6	100R	1125
R7	1K5	1139
C1	1000/35V	3538
D1	10V ZENER	4014
D2	12V ZENER	4016
D3	IN4005	4103
D4	OA47	4106
D5	IN4005	4103
D6	IN4148	4105
IC1	741C	4403
TR1	BD 131	4206
F1	500mA A/B	6103
VR1	1K 16V	1807
1 BUTTON CELL	VARTA TYPE	7610
10 BUTTON CELL	10 Ni CAD.	7611
TRANSFORMER	15V/15V 6VA	7514
REG 1.	MC 78M18CP	4312
REC 1.	1 AMP BRIDGE	4107
WIRE	22 s.w.g. 8"	8541
SLEEVE	2" SILICON SLEEVING	8611
BOARD	PU 2 P.C.B.	7420
FH1	FUSE HOLDER	6125
P3M	3 PIN SOCKET	6298
P1-2	C-I SOLDER PIN	5532
P4	SOLDER POST	5520
Con1	PLUG	6275
Con2	SOCKET	6276

www.Electrojumble.org.uk