Ratemeter RM6

This Manual was prepared for Units marked within Serial Nos. 591 - 690

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1. INTRODUCTION

The Ratemeter type RM6 is a simple, battery operated, portable instrument for use with scintillation and G.M. Probes.

The indicating meter has a 3½ - decade logarithmic scale covering 1 to 5000 counts per second, a linear scale for eht indication, and a sector for checking battery condition.

A click for each ionising event detected and an alarm tone under overload conditions is available from an internal loudspeaker. During overload the meter reading is always maintained above full scale deflection.

There is a coaxial socket for probes, a jack socket for connecting an external power supply and three controls which are:

1. A three position switch for probe selection and instrument ON/OFF.

2. A four position switch for meter function selection and audible indication ON/OFF.

3. A set eht adjustment potentiometer.

The instrument is housed in a plastic case fitted with a carrying handle. The instrument is powered by two internal 9V batteries type PP6 (I.E.C. desig. 6F50-2) or type PP3 (I.E.C. desig. 6F22).

2. SPECIFICATION

2.1 INPUT SENSITIVITY

Voltage

Less than 10 mV negative going.

2.2 COUNT RATE INDICATION

Visual

3½ decade quasi logarithmic scale extending from 1 to 5000 counts per second. The scale is subdivided at 1.5 and 2 through to 9 and its decimal multiples. Scale length 67 mm.

Audible

A click for each ionising event detected and tone for overload. The audible indication can be switched out.

2.3 ACCURACY

At 20°C the count indication is within ±20% at all parts of the scale. The error in countrate indication due to change in ambient temperature is typically +0.35% per °C.

2.4 DEAD TIME

Error in indicated reading for random input is approximately 5 % when the mean input rate is 5K c.p.s.

2.5 RESPONSE TIME

The times for 90% of a step change to be indicated are:

Increasing

1 to 10 c.p.s.	13 seconds
10 to 100 c.p.s.	2.5 seconds
100 to 1000 c.p.s.	1 second
500 to 5K c.p.s.	0.3 seconds

Decreasing

10 to 1 c.p.s.	18 seconds
100 to 10 c.p.s.	6.5 seconds
1000 to 100 c.p.s.	1.5 seconds
5K to 500 c.p.s.	1.2 seconds

2.6 CONTROLS

Function

Rotary switch marked BATT/EHT/CPS/ ON (Speaker ON and CPS)

Probe

Rotary switch marked SCINT/OFF/GM.

Set EHT

Screwdriver-slot preset adjustment.

2.7 EHT RANGE

Variable from approximately 300V to 1450V, 30 µA max. adjustable by screwdriver operated control situated adjacent to the function switch. The meter reads EHT when the switch is in the EHT position.

The accuracy of the EHT scale is ±20%.

2.8 OVERLOAD ALARM

Scintillation

Full scale deflection maintained and warning tone sounded if scintillation probe anode current exceeds 2-4 µA. This will occur in a very high radiation field or if the probe window is punctured.

Geiger

Full scale deflection maintained and warning tone sounded if ratio between Geiger tube mean current and output pulse rate exceeds a notional value. This will occur in a high radiation field.

2.9 TEMPERATURE RANGE

0°C to +40°C

2.10 BATTERIES

Two I.E.C. 6F50-2 (British type PP6) alternatively two I.E.C. 6F22 (British type PP3C).

Using 6F50-2 batteries the life is typically 120 hrs with intermittent use of 4 hours per day.

Using 6F22 batteries the life is typically 40 hours with intermittent use of 4 hours per day.

NOTE: Battery life is dependant on EHT setting and probe.

2.11 EXTERNAL POWER SOCKET

Miniature 3.5 mm.

Used for connecting the instrument to an external mains power unit. Internal batteries are switched out when the jack is inserted.

2.12 PROBE SOCKET

PET type 100

2.13 CONSTRUCTION

Tough plastic with separate battery compartment. A plastic carrying handle forms the lid to the battery compartment.

2.14 DIMENSIONS

Length	240 mm
Width	120 mm
Height	160 mm
Weight	1.6 kgs.

2.15 ACCESSORIES

The following MAINS/BATTERY ELIMINATOR units are available for connection to the external power socket of the RM6.

Type MBE1/A for 240V 50/60 Hz operation.

Type MBE1/B for 120V 50/60 Hz operation.

The units may be obtained from:

Nuclear Enterprises Ltd.,
Bath Road,
BEENHAM,
Reading,
England.
RG7 5PR.

Telephone: Woolhampton (073 521) 2121

Telex: 848475

3. OPERATION

NOTE: SINCE EHT VOLTAGE APPEARS AT THE OUTPUT SOCKET IT IS RECOMMENDED THAT THE UNIT IS SWITCHED OFF PRIOR TO CONNECTING OR REMOVING LEADS AND PROBES.

With unit switched 'OFF', connect suitable probe to the input socket.

Set the function switch to 'BATT' and probe switch to SCINT or GM as required and see that the meter reads in the battery check sector. If meter reads below this sector change the batteries.

When adjustment of the eht is required i.e., in the event of a probe change or repair, first turn 'SET EHT' control fully anti-clockwise. Set function switch to eht. Set probe switch to SCINT or GM as required, then set the eht as appropriate (see probes section, or probe manual).

3.1 BATTERY REPLACEMENT

1. Loosen the four handle retaining screws and remove the handle to reveal the battery compartment.

2. If batteries are fitted, remove them by lightly pulling the plastic tabs provided, and remove the connector from each battery.

3. Fit new batteries to attaching connectors and then inserting each battery with its connector uppermost into the battery compartment ensuring the plastic tabs fit beneath and round batteries.

4. Refit handle.

4. PROBES

The following paragraphs describe how to adjust the eht to the correct operating voltage for recommended probes.

TABLE 1 Scintillation Probes suitable for use with the Ratemeter RM6

Probe	Sensitive Area (cm²)	Counts/s for D.W.L. * of $10^{-5}\mu$ Ci/cm² α 10^{-4} μCi/cm² β	Counts/s for 1 mR/h	Approx. Window Thickness (mg/cm²)	Remarks
Alpha Sensitive (ZnS phosphor)					
AP2	49	3 (Am^{241})		1.1	1" dia.
AP3	100	6 (Am^{241})		1.1	PM tube
Beta Sensitive					
BP4	18	10 (C^{14}) 20 (Sr^{90} + Y^{90})	170 (Ra)	1.8	Anthracene Phosphor
BP5	49	40 (Sr^{90} + Y^{90})	120 (Co^{60})	7	Plastic Phosphor

* Derived Working Level

4.1 ALPHA SCINTILLATION PROBES AP2 AND AP3

To set the eht voltage a 'thin' alpha source of approximately 10^4 - 10^5 d/min (disintegrations per minute) is required, a calibrated source need not be used unless the probe detection efficiency is to be checked. Suitable sources available from the Radiochemical Centre, Amersham are:-

AMR2 Amercium 241, 3 x 10^4 d/min uncalibrated.

AMRC2 Amercium 241, 3 x 10^4 d/min calibrated.

1. Turn the 'SET EHT' control on the front panel fully anticlockwise to obtain minimum eht.

2. Set function switch to 'CPS' and probe switch to 'SCINT'.

3. Place the source close to the centre of the sensitive area of the probe.

4. Increase the eht by turning the 'SET EHT' control slowly clockwise until a setting is just reached where the meter reads. Note this countrate on the meter.

5. Switch function switch to 'EHT' and note the eht reading.

6. Now increase the eht by 50 V and then switch to 'CPS' again and note the count rate indicated for this eht.

7. Repeat 6 until sufficient information is gained to plot a countrate versus eht curve that shows a plateau.

8. Set the eht to a value at the centre of this plateau, and switch to CPS or CPS SPK ON.

9. Probe detection efficiency should be greater than 15%. (4π geometry)

$$\text{Detection Efficiency (\%)} = \frac{\text{Countrate x 100}}{\text{Source Disintegrations per Second.}}$$

4.2 BETA SCINTILLATION PROBE BP4

The correct eht setting is determined by using a C^{14} source (E_{max} = 0.16MeV) (e.g. Radiochemical Centre, Amersham, Code CFR4).
The surface emission rate of this thick source is quoted as approximately 1.6×10^3 counts per second, and the probe detection efficiency in a 2π geometry should be about 30%.

1. Set 'EHT' control on the front panel fully anti-clockwise to obtain minimum eht.

2. Switch function switch to 'CPS' and probe switch to 'SCINT'.

3. Place the source close to the centre of the probe face.

4. Slowly increase the eht until the meter reads; note the countrate.

5. Switch function switch to EHT and note the eht reading.

6. Now increase the eht by 25V and then switch to CPS and note the countrate indicated for this eht.

7. Repeat 6 until sufficient information is gained to plot a countrate versus eht curve that shows a plateau.

8. Set the eht to a value at the centre of this plateau and switch to CPS or CPS SPK ON for operation. The countrate indicated should be approximately 0.3 x source disintegrations per second.

9. Remove the source from the probe face and check that the background countrate is not greater than four counts per second for a typical background of 10 µR/h.

4.3 BETA SCINTILLATION PROBE BP5

The correct eht setting is determined by using a suitable beta source (e.g. Radiochemical Centre, Amersham, Code SIRC2). The surface emission rate of this thick source is quoted as approximately 10^3 counts per second and the probe detection efficiency in a 2π geometry should be about 50%.

1. Set 'EHT' control on the front panel fully anti-clockwise to obtain minimum eht.

2. Switch function switch to 'CPS' and probe switch to SCINT.

3. Place the source close to the centre of the probe face.

4. Slowly increase the eht until the meter reads; note the countrate.

5. Switch function switch to EHT and note the eht reading.

6. Now increase the eht by 25V and then switch to CPS and note the countrate indicated for this eht.

7. Repeat 6 until sufficient information is gained to plot a countrate versus eht curve that shows a plateau.

8. Set the eht to a value at the centre of this plateau and switch to CPS or CPS SPK ON for operation. The countrate indicated should be approximately 0.5 x source disintegrations per second.

9. Remove the source from the probe face and check that the background countrate is not greater than four counts per second for a typical background of 10 µR/h.

4.4 EHT ADJUSTMENT FOR GM PROBES

To set the eht voltage, a uranium disc source (e.g., Radiochemical Centre, Amersham, Code UAC 1623) is suitable.

1. Set the 'EHT' control on the front panel fully anticlockwise to obtain minimum eht.

2. Set probe switch to GM and function switch to CPS.

3. Place the source near the probe.

4. Slowly increase the eht, by turning the 'EHT' control clockwise until the meter reads; note the countrate.

5. Switch function switch to EHT and note the eht reading.

6. Now increase the eht by 50V and then switch to CPS and note the countrate indicated for this eht.

7. Repeat 6 until the eht has been increased by a total of 200V. Plot countrate versus eht and find the eht value at the centre of the flat portion of the curve. Set the eht to this value.

8. Switch function switch to CPS or CPS SPK ON to operate.

   NOTE: If the GM tube makers recommended operating voltage is known set the eht to this value.

4.5 GM OVERLOAD PROTECTION

When Geiger-Muller Beta/Gamma Probes are used at very high countrates, a point is reached when the GM tube saturates and the countrate from the monitor would also fall, perhaps even to zero. Saturation in the GM tube is detected by the monitor, the meter being held at full-scale deflection while the loudspeaker emits a continuous alarm tone.

4.6 DEAD TIME COUNTING LOSSES FOR GM TUBES

Indicated countrates above approximately 1000 counts/second will be inaccurate because of counting losses due to Geiger Probe deadtime (60-170 μs).
This error will be approximately 6 - 17% at 1000 counts/second indicated, but becomes impossible to estimate at much higher countrates.

4.7 SCINT OVERLOAD PROTECTION

When the instrument is used with a Scintillation Probe the current taken by the dynode resistor chain and PM tube anode is compared with an internal reference current and an overload state is indicated if the probe current exceeds the internal reference. A punctured window is readily detected.

5. CIRCUIT DESCRIPTION (Refer to Figure 1)

Pulses from a detector connected to the input socket are amplified and fed to a discriminator and the output of the discriminator toggles a flip-flop.

The flip-flop provides the drive to two diode pumps of different time constants, whose outputs are summed by an amplifier. The output of the amplifier supplies a 0 - 1 mA meter ME1 to give a $3\frac{1}{2}$ decade logarithmic indication of countrate. The output of the flip-flop is also processed to drive a loudspeaker housed in the instrument case and this provides a click for each ionising event occurring in the detector.

An overload detection circuit provides for G.M. and scintillation detectors. When a G.M. overloads, its output pulses often begin to decrease in amplitude as countrate increases and the mean current through the counter increases. In the ratemeter, a severe overload would be observed as a decreasing meter indication. To overcome this effect, a current proportional to the amplitude and number of G.M. pulses is derived from the output of the pulse amplifier and when the ratio of this current to the mean G.M. tube cathode current falls below a predetermined value an overload condition is recognised. Overload is recognised before the meter indication of countrate begins to decrease and extra current is fed to the meter to hold it above full scale deflection during overload. At the same time an overload warning is given by a continuous tone from the loudspeaker.

Photomultiplier tubes used in scintillation counters do not overload in the same way at the relatively low count rates as G.M. counters, but at extremely high countrates or when ambient light reaches the PM tube abonormally high anode current is drawn by the tube. The scintillation overload detecting circuit compares the total scintillation counter current (dynode resistor chain current + P.M. tube anode current) with an internal reference current and an overload is sensed if the total current to the scintillation counter exceeds the internal reference.

Power is supplied by two 9V PP6 or PP3 batteries wired in series to provide 18V from which a stabilised 9.6V rail is derived. The 9.6V rail is used to power the amplifier, discriminator, ratemeter circuit and part of the overload and loudspeaker drive circuit; the loudspeaker current is taken direct from the 18V supply. A dc converter driven from a variable voltage provides eht adjustable over the range 300V to 1450V.

6. DETAILED CIRCUIT DESCRIPTION (Refer to Circuit Diagram D33059)

6.1 INPUT AMPLIFIER AND DISCRIMINATOR

Pulses from a detector connected to input socket SK1 are amplified by TR7 and TR8 and fed to discriminator IC4. A pulse amplitude of approximately 65 mV is required at pin 3 of IC4 to trigger the discriminator and approximately 10 mV pulse height is required at SK1 to achieve this. The transfer characteristic of the amplifier is determined by R9, R11 and C5. D2 gives protection against excessive negative voltage excursions at the base of TR7 which may arise from breakdown of the connecting cable to the detector or short circuiting of SK1 by some other means.

6.2 RATEMETER DRIVE AND PUMP CIRCUIT

When the discriminator is triggered IC4 pin 6 outputs a positive going 0V to +9V pulse which is applied to the clock input of 'D' type flip-flop IC3-1 at pin 3. IC3-1 has its $\overline{Q}$ output connected to its D input causing it to toggle on the rising edge of each clock pulse. This corresponds with each ionising event at the detector and it follows that the mean frequency of the waveform at the output of IC3 will be one half of the mean pulse rate from the detector.

The Q output of IC3 drives two diode pumps each pump having different time constants·

1. Lower Pump (C19, D12, D15, C20 and R35) provides an output at low and high countrates.

2. Upper Pump (C18, D13, D14, C21 and R34) provides an output at high count-rates.

The output of each diode pump increases with increasing countrate and saturation is reached in the lower pump at approximately 100 Hz. Above 100 Hz the output of the upper pump becomes significant and continues to increase until it is nearly saturated at 5 kHz. The output of the lower pump is approximately 8.4 V when saturated and at 5 kHz the upper pump output is approximately 7.9V. In the diode pump circuit a logarithmic relationship between output voltage and input rate results from the fact that although the input capacitors C18 and C19 are charged to nearly the full amplitude of the waveform at IC3-1 pin 1 at each positive excursion, the charge transferred to C21 and C20 during the time the waveform has zero amplitude diminishes as the charge on C21 and C20 increases.

Current proportional to the output voltage of the upper and lower pumps flow in R34 and R35 to the virtual earth point of feedback amplifier IC1-1, 2, 4, and 5, IC1 being an array of 3 NPN and 2 PNP transistors. Negative feedback from the output of the amplifier causes the sum of the current from the pump circuits to flow through R41 and R46 producing an output voltage from the amplifier proportional to the product of the sum of the pump currents and the total resistance in the feedback path. The sum of the pump current is proportional to the logarithm of the input pulse rate hence, when switched to the output of the amplifier, meter ME1 indicates countrate on a logarithmic scale. Resistor R41 which is part of the feedback path alters the gain of the amplifier and is used to set scale calibration at 5 kHz.

The amplifier is required to provide near zero output for zero input but works without a negative supply line, to achieve this IC1-2 is biased to conduct and cause IC1-5 to pass sufficient current to make the amplifier function with only a few millivolts at its output. IC1-2 is suitably biased by adjustment of the potential at its base using R39. In practice this adjustment is used to set the scale calibration at 10 Hz and the meter will then read slightly upscale of zero when CPS is selected with no input from the counter.

The waveform at the $\overline{Q}$ output of IC3-1 is routed via negative logic 'OR' gate IC2-2 to ' Exclusive OR' gate IC5. Because of the integrating network R33, C23 supplying one input of IC5, IC5 produces pulses of approximately 1 mS duration on both rising and falling edges of the waveform originating in IC3-1. Each 1 mS pulse switches TR11 on to energise the loudspeaker. The loudspeaker is a piezo-electric device which produces a 3 kHz tone if continuously energised but gives a clicking sound when energised this way.

6.3 G.M. OVERLOAD PROTECTION

The behaviour of GM detectors when overloaded in a high radiation field is complex and the relationship between pulse amplitude, pulse rate and GM tube current varies considerably in different types of tube. The danger is that the ratemeter reading will fold back and indicate that the rate has fallen when the true rate has increased. In general, when overloaded, the GM tube current increases without the countrate increasing proportionally.

Both effects are monitored by the overload detection circuit comprised of TR9, TR10 and associated components. The principle is that the GM tube cathode current flows in the emitter circuit of grounded base stage TR9 causing an almost equal current to flow in the collector circuit. Pulses from the output of the input amplifier are applied to a diode pump circuit made up of C7, R18, D8, D9 and D10. The current output from the pump flows through R28 in opposition to collector current in TR9 and prevents TR10 from being switched on. The presence of zener diode D10 in the pump circuit makes the pump current fall rapidly if the GM tube output pulses fall much below their normal amplitude. If the GM tube output pulse rate is low or pulse amplitude is small relative to the GM tube current, these conditions being indicative of overload, TR10 is switched on and a '1' level (+9.6V) is applied to pin 1 of 'NAND' gate IC2-1. The 'NAND' gate outputs a 1 kHz square wave which routes via negative logic 'OR' gate IC2-2 to IC5. Because the input rate to IC5 is too high to allow it to produce 1 mS pulses at each edge of the square wave it passes on the complete squarewave to drive TR11 on and off at 1 kHz and produces a distinctive warning sound in the loudspeaker. At the same time the squarewave output from IC2-1 applied to R36 in the meter amplifier circuit causes IC1-5 to be switched on and off and apply a mean voltage of 4.8 V to the meter MF1 via R43. This ensures that the meter reading is maintained above f.s.d. during overload.

6.4 SCINT. OVERLOAD PROTECTION

The circuit used to sense scintillation probe current is similar to that for GM tube current but in this mode of protection the relatively large current taken by the dynode resistor chain is backed off by applying a potential proportional to eht to resistor R14. This enables the PM tube anode current to be sensed but because of differences which occur in the resistance of the dynode chain, due to the type of probe used and component tolerances, the increase of anode current required to call the alarm is not constant. It is typically 2 μA using a scintillation counter with 66 M ohm dynode chain at 1000 V eht. A punctured window is readily detected. The diode pump C7, R18 etc., is not active in the scint. overload mode because the pulse amplitdue at TR8 emitter is too small to make D10 conduct and no current can flow in the pump.

6.5 +9.6V STABILISER

This circuit comprises TR2, TR3, TR4 and associated components. TR2 provides a constant current through zener diode D1 and TR3 is used to enable the effective reference voltage to be varied. TR3 also provides temperature compensation for variations in base to emitter voltage of emitter follower TR4. The circuit action is as follows:

The voltage across R7 must equal the zener voltage of D1 since the base to emitter voltages of TR3 and TR4 cancel each other. It follows that the current through R7 will be constant and this constant current flows through R8, changing the value of R8 will therefore change the voltage at the emitter of TR4 and enable the +9.6V line to be set up.

6.6 EHT CONVERTER-

EHT is derived from the +18V supply by a dc converter. Its output is directly proportional to input, so that control and measurement of eht can be carried out at low voltage.

Transistor TR5 is a ringing choke converter, with its supply provided by emitter follower TR1. During its 'ON' period it saturates, and the voltage at the emitter of TR1 is defined across pins 3 and 4 of T1. During the 'OFF' periods of TR5, stored energy in the core of T1 causes TR6 to conduct and define the same voltage (less the volt drop of TR6) across pins 1 and 2 of T1.

Base drive of TR5 is provided by the $\overline{Q}$ output of flip-flop IC3-2, IC3-2 being toggled by pulses at a rate of approximately 2kHz by pulses applied to its clock input from the relaxation oscillator formed by IC1-3, IC2-3 and IC2-4.

The oscillator action is as follows·

Assume that IC1-3 conducts, its collector will go low and IC2-3 output will rise and IC2-4 output will fall. This causes the base current of IC1-3 to be sourced via C12 and the potential at the junction C12, R16 and R23 falls exponentially as C12 charges. Eventually IC1-3 cuts off and its collector goes high, this causes IC2-3 output to go low and IC2-4 output to go high thus cutting off current in D11 and allowing reverse current to flow in C12 to discharge it. Junction C12, R16, R23 will now rise exponentially until IC1-3 conducts to start a new cycle.

The eht is derived from a separate winding, pins 5 and 8, which feeds a two stage voltage multiplier D3-D6 and associated components.

The output of the circuit is fed via a filter network to SK1. The negative side of the eht supply is earthed via R26 and the emitter base junction of TR9 which allows the mean probe current to be monitored as already described. Control of output voltage is exercised by R1 which applies a voltage derived from the +9.6V line to the base of emitter follower TR1 and enables the eht to be varied over the range from below 300V to 1450V. The output at the emitter of TR1 provides the input voltage to the converter and is measured on meter ME1 to provide indication of eht.

7. MAINTANANCE

The only normal maintenance required is the periodic replacement of batteries (see Section 4). If, however, components have to be changed or the unit fails to function correctly, the following gives a brief account of fault finding procedure and the setting of various preset controls.

7.1 +9.6V STABILISER

Check that the +9.6V line is within ±0.02V of nominal and adjust if necessary using R8.

If the 9.6V line is low and cannot be set up, check voltage at TR4 collector, if it is greater than 12V, TR2 or TR4 may be faulty. If the battery voltage reads at the top of the BATT section but the voltage at TR4 collector is less than 10V there is probably a fault causing excessive current to be drawn from the +9.6V rail.

7.2 In the event of failurecheck that the drive waveform to TR5 at pins 9 and 12 of IC3 is a squarewave of approximately 9V amplitude and frequency of 1KHz. If incorrect check IC1-3, IC2-3 and 4, IC3-2 and associated circuit.

With no probe connected to SK1 check that a reading of 1450V can be achieved when the function switch is set to EHT and set EHT control, R1, is adjusted towards fully clockwise. Check that the voltage across R3 does not exceed 0.9V when R1 is fully clockwise. If the voltage across R3 is somewhat more than 0.9V check TR5 and transformer T1 and all components in the Cockcroft and Walton voltage multiplier. If it is not possible to obtain an EHT of 1450V check TR1 and R1.

When normal working is established insert a multimeter in one battery lead to measure the supply current to the instrument, turn the EHT control, R1, to maximum and adjust R23 (set osc. freq.) to obtain minimum current reading.

7.3 INPUT AMPLIFIER AND DISCRIMINATOR

To establish that the input amplifier and discriminator are working properly apply a 2 µS wide, 10mV negative going pulse at a pulse recurrence frequency of 5KHz to SK1 via a 1000pF capacitor, having first turned the EHT control, R1, fully anticlockwise. Observe that the waveform at pin 3 of IC3 is a positive going pulse of approximately 6V amplitude. Make sure to use an oscilloscope provided with a low capacity input probe for this purpose.

If the pulse is absent or low in amplitude check TR7, TR8, IC4 and associated components.

7.4 RATEMETER DRIVE AND PUMP CIRCUIT

With input signal provided as in previous paragraph check that a square waveform of greater than 9V amplitude appears at IC3 pin 1. Using a voltmeter having an input impedance greater than 10 M ohm measure the voltage at D14 anode with respect to the common line (0V). Note that the voltmeter reading is approximatel 7.7V.

Measure voltage at D15 anode with respect to 0V, note that reading is approximately 0.8V higher than previous reading.

If the input rate is varied the output of the individual pumps should vary as shown in Figure 2.

If the pump circuits are satisfactory but the CPS meter reading is not correct amplifier IC1-2, 4 and 5 and associated components should be checked.

7.5 SCALE CALIBRATION

Before setting scale calibration place the instrument on a level surface. Set Scint/Off/GM switch to off and adjust meter mechanical zero to bring the pointer to the zero mark on the scale.

Set probe selector switch to GM and function switch to CPS, ensure set EHT control is fully anticlockwise. Adjust R39 (set 10 Hz) so that meter reads slightly upscale of the mechanical zero mark.

Apply 2 µS wide 10 mV negative going pulse at a PRF of exactly 5 kHz via a 1000 pF capacitor to SK1.

Adjust R41 (set FSD) until meter reads exactly full scale deflection. Reduce frequency to 10 Hz and adjust R39 (set 10Hz) for meter to read exactly 10 Hz.

Repeat adjustments at 5 KHz and 10 Hz as previously described until both settings are correct.

7.6 CHECK OF OVERLOAD OPERATION

GM Operation

With the instrument switched off connect a 160 Mohm resistance (or AVO 8 on the 3KV range in with a 100 Mohm resistance) across SK1 and also apply a 2µS wide, 1V negative going pulse at a pulse recurrence frequency of 750 Hz to SK1 via a 1000pF 2KV dc wkg. Capacitor.

With the instrument switched off connect a 160M ohm resistor to SK1.

Apply a 2μS wide, 1V negative going pulse at a pulse recurrence frequency of 750Hz to SK1 via a 1000pF 2KV dc wkg. capacitor.

Set probe switch to GM and function switch to CPS.SPK.ON.

Turn EHT control clockwise until overload tone sounds and meter reads above FSD.

Turn function switch to EHT and note that the reading is between 600 and 1000V.

Scint Operation

With instrument switched off connect a 60M ohm resistor (or AVO model 8 on 3KV dc range) to SK1. Set EHT control fully clockwise and set probe switch to Scint and function switch to CPS SKP ON. Alarm tone should not sound.

Switch instrument off. Connect a 220M resistor in parallel with the 60M resistor already connected or alternatively disconnect the 60M resistor and connect a 47M ohm resistor in its place.

Switch to Scint, the alarm tone should sound and the meter should read above full scale deflection.

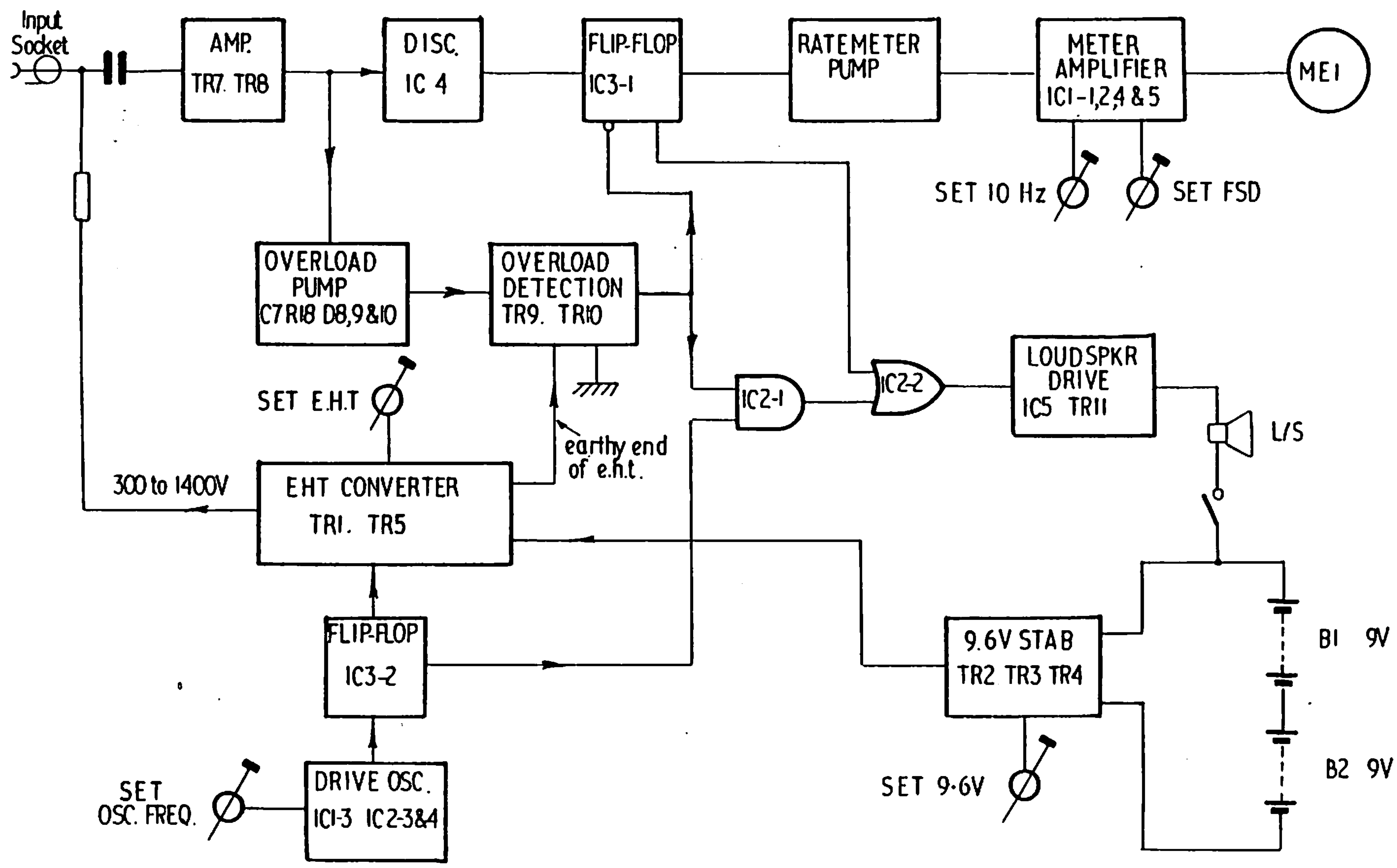


FIGURE 1

BLOCK DIAGRAM

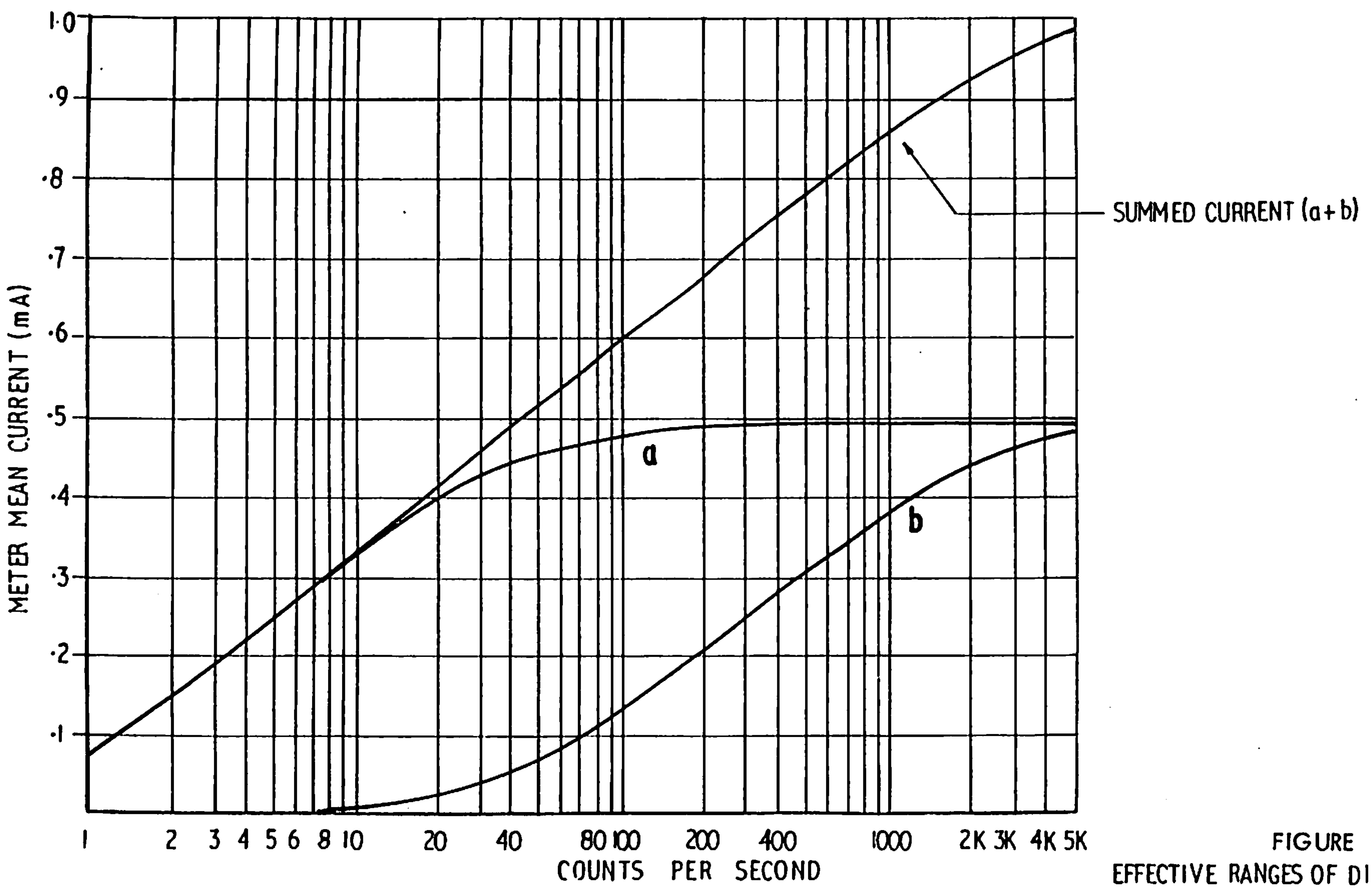


FIGURE 2
EFFECTIVE RANGES OF DIODE PUMPS

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
	RESISTORS				
R1	TRIMPOT 3059L-1-203M BOURNS	20K	10	1W	415869 LF
R2	R-M01/5	2K2	2	$\frac{1}{4}$W	408876 LB
R3	R-M01/5	150R	2	$\frac{1}{4}$W	408848 LB
R4	R-M01/5	220R	2	$\frac{1}{4}$W	408852 LB
R5	R-M01/5	22K	2	$\frac{1}{4}$W	408900 LB
R6	R-M01/5	330R	2	$\frac{1}{4}$W	408856 LB
R7	R-M01/5	22K	2	$\frac{1}{4}$W	408900 LB
R8	TRIMPOT CR 72PM BECKMAN	20K	10	$\frac{1}{2}$W	415876 LF
R9	R-M01/5	2K2	2	$\frac{1}{4}$W	408876 LB
R10	R-M01/5	68K	2	$\frac{1}{4}$W	408912 LB
R11	R-M01/5	39K	2	$\frac{1}{4}$W	408906 LB
R12	R-M01/5	47K	2	$\frac{1}{4}$W	408908 LB
R13	R-M01/5	150K	2	$\frac{1}{4}$W	408920 LB
R14	R-M01/5	360K	2	$\frac{1}{4}$W	408929 LB
R15	R-M01/5	4K7	2	$\frac{1}{4}$W	408884 LB
R16	R-M01/5	100K	2	$\frac{1}{4}$W	408916 LB
R17	R-M01/5	220K	2	$\frac{1}{4}$W	408924 LB
R18	R-M01/5	1K0	2	$\frac{1}{4}$W	408868 LB
R19	R-M01/5	220K	2	$\frac{1}{4}$W	408924 LB
R20	R-M01/5	220K	2	$\frac{1}{4}$W	408924 LB
R21	R-M01/5	2K2	2	$\frac{1}{4}$W	408876 LB
R22	R-M01/5	100K	2	$\frac{1}{4}$W	408916 LB
R23	TRIMPOT CR 72 PM BECKMAN	200K	10	$\frac{1}{2}$W	416752 LF

	DRN. D.M.				2	9.10.80	17059
	CHD.				1	11.9.79	DOI 5624
D33063					A	23.6.78	
Used on Drg. List	APPD.	3	14.4.83	17730	ISS.	DATE	DOI/MOD

NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.

TITLE: RATEMETER RM6	Sht 1 of 7	CIRCUIT COMPONENTS LIST D 33059

ADMEL 82728

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
R24	R-HV1/1	220M	20	¼W	411625 LE
R25	R-MO1/5	120K	2	¼W	408918 LB
R26	R-MO1/5	1KO	2	¼W	408868 LB
R27	R-MO1/5	220K	2	¼W	408924 LB
R28	R-MO1/5	820K	2	¼W	408938 LB
R29	R-MO1/5	56K	2	¼W	408910 LB
R30	R-MO1/5	56K	2	¼W	408910 LB
R31	R-MO1/5	1MO	2	¼W	408940 LB
R32	R-MO1/5	1KO	2	¼W	408868 LB
R33	R-MO1/5	270K	2	¼W	408926LB
R34	R-MF1/2/50	390K	1	¼W	675006 LB
R35	R-MF1/2/50	390K	1	¼W	675006 LB
R36	R-MO1/5	330K	2	¼W	408928 LB
R37	R-MO1/5	1MO	2	¼W	408940 LB
R38	NOT USED				
R39	RV-Cr1/3B	50K	20	½W	416321LF
R40	R-MO1/5	47K	2	¼W	408908 LB
R41	RV-Cr1/3B	50K	20	½W	416321 LF
R42	NOT USED				
R43	R-MO1/5	3K9	2	¼W	408882 LB
R44	R-MO1/5	9K1	2	¼W	408891 LB
R45	R-MO1/5	22K	2	¼W	408900LB
R46	R-MO1/5	82K	2	¼W	408914LB
R47	NOT USED				

	DRN. D.M.				2	9.10.80	17059
					1	11.9.79	D.O. 5624
	CHD.				A	23.6.78	
D33063	APPD.	3	29.3.82	17443	ISS.	DATE	DOI/MOD
Used on Drg. List	NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.						

TITLE: RATEMETER RM6

Sht 2 of 7

CIRCUIT COMPONENTS LIST D 33059

ADMEL 52728

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
	CAPACITORS				
C1	C-AE1	47uF	-10 +50	16V	483002 MA
C2	C-AE1	47uF	-10 +50	16V	483002 MA
C3	CAP, D/CER DD30 CENTRALAB	0.01uF	20	3KV	463348 MC
C4	C-MPt2	0.022uF	20	1KV	465529 MB
C5	C-mCe1	22pF	2	100V	436701 MC
C6	C-MPt2	0.022uF	20	1KV	465529 MB
C7	C-mCe3	4700pF	10	100V	453451 MC
C8	C-MPt2	0.022uF	20	1KV	465529 MB
C9	NOT USED				
C10	C-MPt2	0.022uF	20	1KV	465529 MB
C11	C-mCe4	0.1uF	-20 +80	50V	470081 MC
C12	C-mCe2	2200pF	10	100V	450653 MC
C13	C-STE2	4.7uF	20	10V	478175 MD
C14	CAP D/CER DD30 CENTRALAB	0.01uF	20	3KV	463348 MC

						ISS.	DATE	DOI/MOD
	DRN. D.M.					2	9.10.80	17059
						1	11.9.79	D.O.I. 5624
	CHD.					A	23.6.78	
33063	APPD.					ISS.	DATE	DOI/MOD
Used on Drg. List	NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.							

TITLE: RATEMETER RM6

Sht 3 of 7

CIRCUIT COMPONENTS LIST D 33059

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
C15	C-mCe4	0.1uF	-20 +80	50V	470081 MC
C16	C-AE1	2.2uF	-10 +50	63V	476651 MA
C17	CAP D/CER DD30 CENTRALAB	0.01uF	20	3KV	463348 MC
C18	C-Ps1	8200pF	2.5	30V	455951 MB
C19	CAP MPT MKS WIMA	0.47uF	2	63V	473411 MB
C20	C-STE2	10uF	20	35V	479560 MD
C21	C-STE2	2.2uF	20	35V	476776 MD
C22	C-AE1	100uF	-10 +50	25V	484504 MA
C23	C-mCe3	2200pF	10	100V	450751 MC
C24	C-mCe4	0.1uF	-20 +80	50V	470081 MC
	DIODES				
D1	DIODE/REF BZY88 C6V2 MULLARD				402287 NC
D2	DIODE/GEN IN914 MULLARD				403074 NC
D3	DIODE/RECT BYX10 MULLARD				402250 NC
D4	DIODE/RECT BYX10 MULLARD				402250 NC
D5	DIODE/RECT BYX10 MULLARD				402250 NC
D6	DIODE/RECT BYX10 MULLARD				402250 NC

	DRN. D.M.				2	9.10.80	170
					1	11.9.79	D.O 56
	CHD.				A	23.6.78	
D33063	APPD.	3	29.3.82	17443	ISS.	DATE	DOI/

Used on Drg. List

NUCLEAR ENTERPRISES LTD. EDINBURGH - BEENHAM.

TITLE: RATEMETER RM6	Sht 4 of 7	CIRCUIT COMPONENTS LIS[T] D33059

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
D7	NOT USED				
D8	DIODE/GEN IN914 MULLARD				403074 NC
D9	DIODE/GEN IN914 MULLARD				403074 NC
D10	DIODE/REF BZY88 C3V9 MULLARD				402282 NC
D11	DIODE/GEN IN914 MULLARD				403074 NC
D12	DIODE/GEN IN914 MULLARD				403074 NC
D13	DIODE/GEN IN914 MULLARD				403074 NC
D14	DIODE/GEN IN914 MULLARD				403074 NC
D15	DIODE/GEN IN914 MULLARD				403074 NC
D16	DIODE /REF BZY88 C3V3 MULLARD				402280 NC
	TRANSISTORS				
TR1	TR/NPN ZTX450L FERRANTI				401689 NB
TR2	TR/FET.N J201 -18 SILICONIX				401590 NB
TR3	TR/PNP ZTX530L FERRANTI				401686 NB
TR4	TR/NPN ZTX109L FERRANTI				401684 NB
TR5	TR/NPN ZTX109L FERRANTI				401684 NB
TR6	TR/NPN ZTX450L FERRANTI				401689 NB

					ISS.	DATE	DOI/MOD
	DRN. D.M.				2	9.10.80	17059
					1	11.9.79	D.O.I 5624
	CHD.	4	14.4.83	17730	A	23.6.78	
D33063	APPD.	3	29.3.82	17443			
Used on Drg. List	NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.						

TITLE: RATEMETER RM6

Sht 5 of 7

CIRCUIT COMPONENTS LIST D 33059

ADMEL 82728

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
TR7	TR/NPN ZTX314L FERRANTI				401704 NB
TR8	TR/NPN ZTX109L FERRANTI				401684 NB
TR9	TR/NPN ZTX109L FERRANTI				401684 NB
TR10	TR/PNP ZTX530L FERRANTI				401686 NB
TR11	TR/NPN ZTX107L FERRANTI				401676 NB
	INTEGRATED CIRCUITS				
IC1	IC/LIN CA3096AE RCA				400594 PA
IC2	IC/DIG CD4011AE RCA				400461 PB
IC3	IC/DIG CD4013AE RCA				400462 PB
IC4	IC/LIN CA 3080 RCA				401601 PA
IC5	IC/DIG CD4070BE RCA				400537 PB
	SWITCHES				
S1	SWITCH ROTARY 4P 3W				TO NE DRG NO. A34019
S2	SWITCH ROTARY 3P 4W				TO NE DRG NO. A34020
	TRANSFORMER				
T1	E.H.T. CONVERTOR				TO NE DRG. C33062

					ISS.	DATE	DOI/MI
	DRN. D.M.				2	9.10.80	1705
					1	11.9.79	D.O. 562
	CHD.				A	23.6.78	
D33063	APPD.						
Used on Drg. List	NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.						

TITLE:	Sht 6 of 7	CIRCUIT COMPONENTS LIST
RATEMETER RM6		D 33059

ADMEL 82728

REF	SPECIFICATION	VALUE	% TOL	RATING	DETAIL
	BATTERIES				
B1	BATTERY 9V PP6 EVER READY	9V			503053KJ
B2	BATTERY 9V PP6 EVER READY	9V			503053 KJ
	METERS				
ME1	METER				TO NE DRG C33064
	WARNING DEVICE				
WD1	AUDIBLE MODULE PCB MTG 249-794 RSCOMPS				407798KM
	SOCKETS				
SK1	FIXED CONNECTOR REAR 551142-000-111 PET				425713 KF
SK2	SOCKET JACK FIXED R322-100-00 BENDAR				425462 KF

						ISS.	DATE	DOI/MOD
	DRN. D.M.					2	9.10.80	17059
						1	11.9.79	D.O.I 5624
	CHD.					A	23.6.78	
D33063	APPD.	3	29.3.82	17443		ISS.	DATE	DOI/MOD
Used on Drg. List	NUCLEAR ENTERPRISES LTD. EDINBURGH-BEENHAM.							

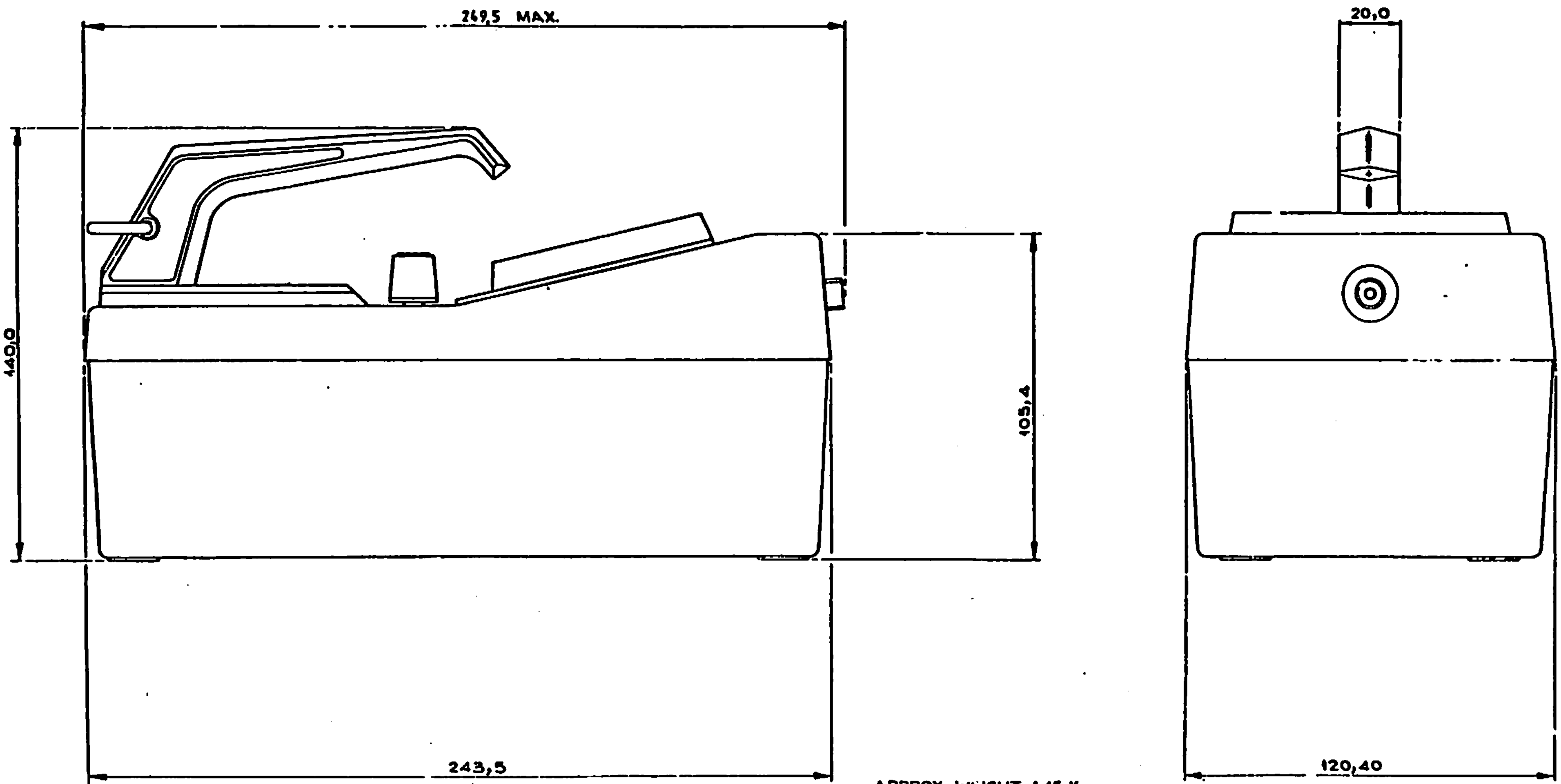
TITLE: RATEMETER RM6

Sht 7 of 7

CIRCUIT COMPONENTS LIST D 33059

NEL 8272D

THIRD ANGLE PROJECTION



APPROX. WEIGHT 1,15 Kg.

ISO THREADS CLASS 6g/6H

MATL.	TOLERANCES UNLESS STATED: METRIC 1DEC.PL. ± 0,4; 2DEC.PL. ± 0,15 / IMPERIAL	DRN. D.M.	2 — 20-10-80 — 17059
SPEC.	DIMENSIONS IN M.M.	CHKD.	1 — 8-10-79
FINISH. REMOVE ALL BURRS / SURFACE TEXTURE ✓ UNLESS STATED	SCALE 1-1	APPD.	DATE

NUCLEAR ENTERPRISES LTD. EDINBURGH — SCOTLAND

TITLE. OVERALL DIMENSIONS RATEMETER RM6

DRG. No. C33612

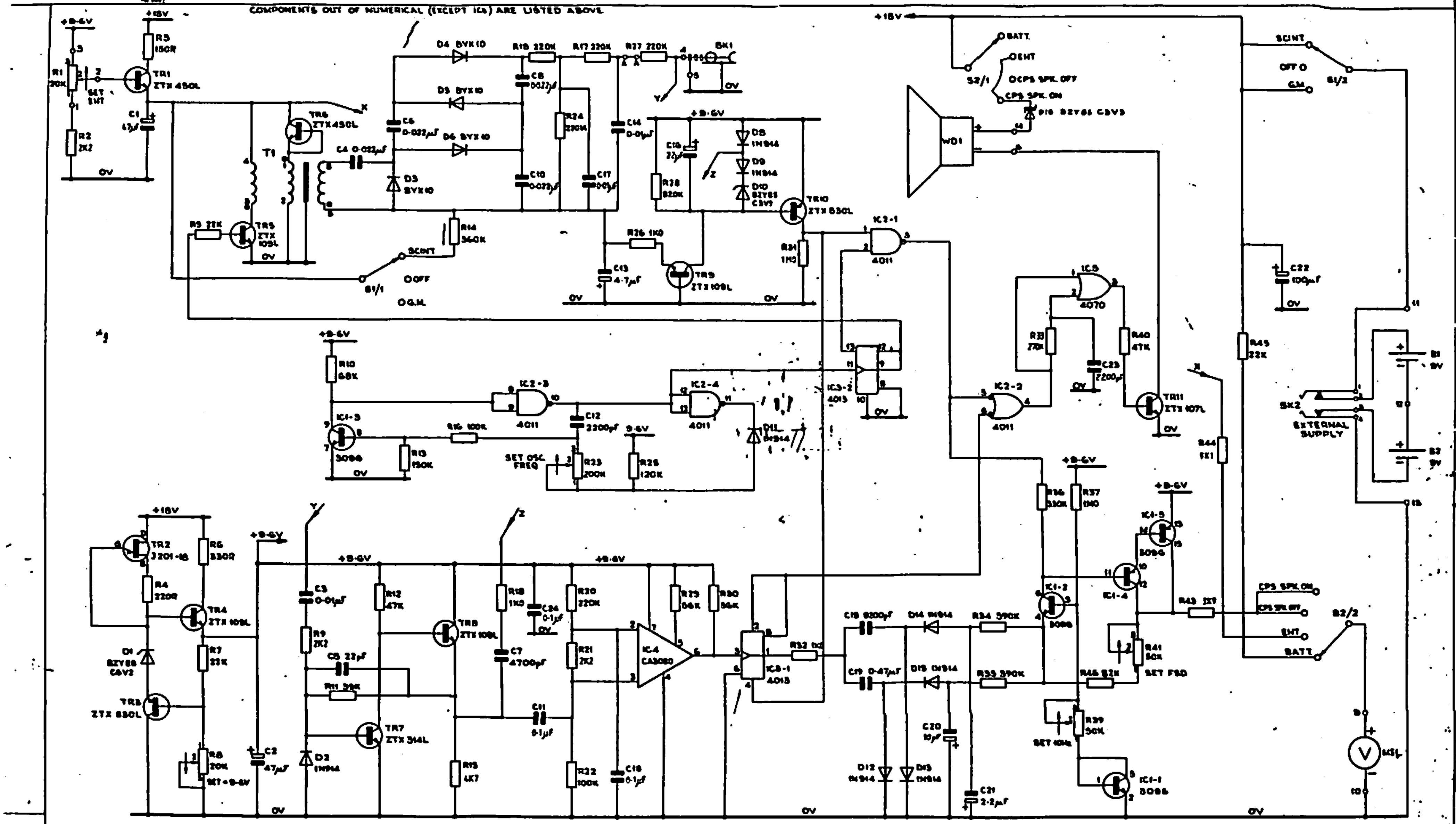
MANUFACTURE TO DIMENSIONS SHOWN FINISHING ALLOWANCE ALREADY DEDUCTED

C33612

D 33069

COMPONENTS OUT OF NUMERICAL (EXCEPT ICs) ARE LISTED ABOVE

R34 R17 C24 C17 R33 R46 C23



INTEGRATED CIRCUITS				
CCT. REF.	TYPE Nº	+9·6V	0V	GRID REF.
IC1	CA3096AE	13	2, 7, 16	F4, G12, G13, G13, H13
IC2	CD4011AE	14	7	C10, E6, E8, E12
IC3	CD4013AE	14	8, 6, 10	E10, H9
IC4	CA3080	7	4	H8
IC5	CD4070BE	14	7	D13

D33063

ASSOCIATED GENERAL ASSY :- D33063
ASSOCIATED PRINTED WIRING BOARD ASSY :- D33061
ASSOCIATED WIRING DIAGRAM :- C33093

MOD. 5 6 7 8

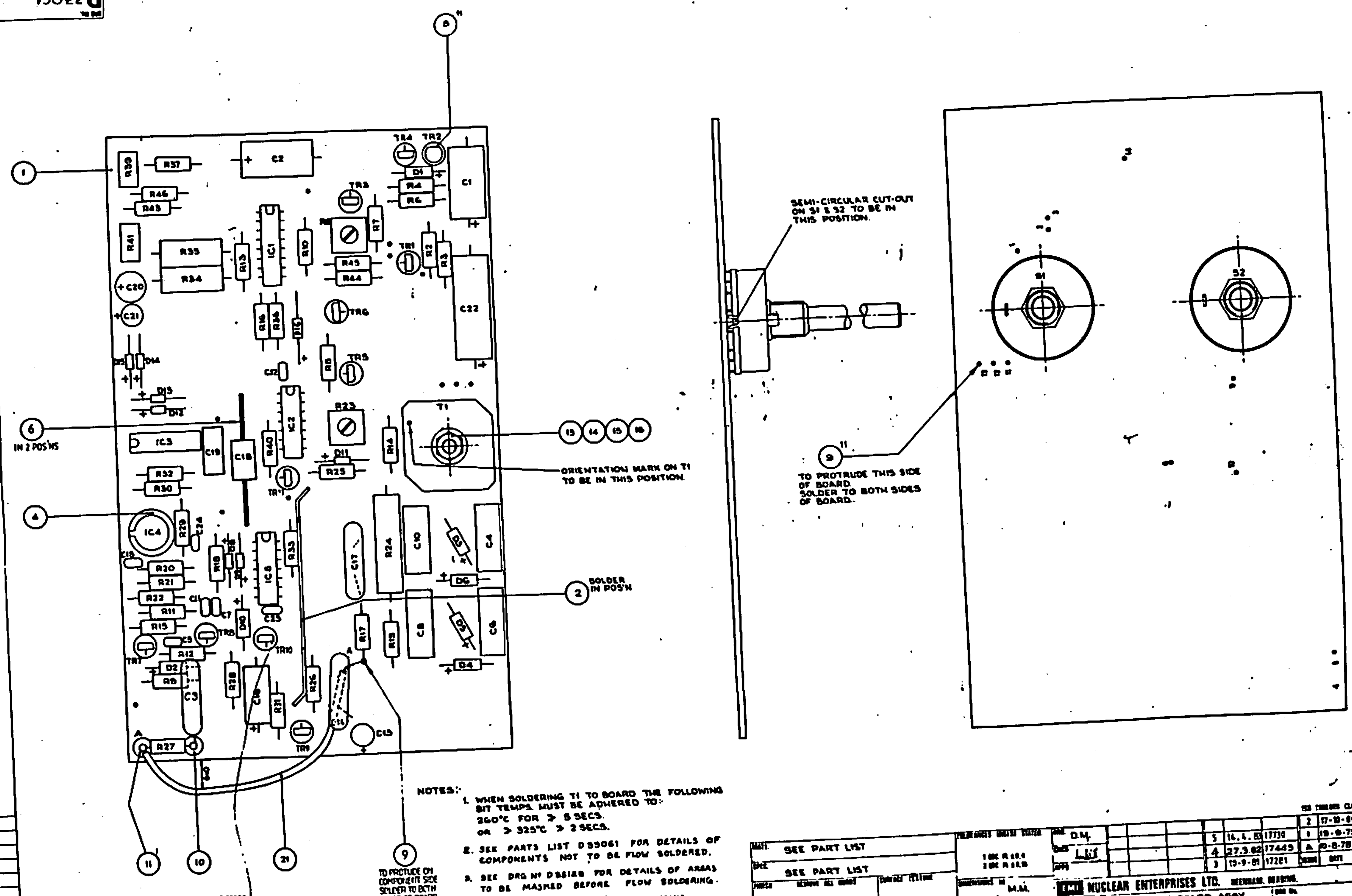
D.M.

4	14 6 83	17730	2	13·10·80	17059
3	29 3 82	17443	1	10·9·79	
			A	25·6·78	

NUCLEAR ENTERPRISES LTD.

CIRCUIT DIAGRAM
RATEMETER RM6

D 33069



NOTES:-

1. WHEN SOLDERING T1 TO BOARD THE FOLLOWING BIT TEMPS. MUST BE ADHERED TO:-
   260°C FOR > 5 SECS.
   OR > 325°C > 2 SECS.
2. SEE PARTS LIST D33061 FOR DETAILS OF COMPONENTS NOT TO BE FLOW SOLDERED.
3. SEE DRG Nº D38128 FOR DETAILS OF AREAS TO BE MASKED BEFORE FLOW SOLDERING.
4. ASSEMBLE S1 & S2 TO BOARD USING JIG T887-7 TO ENSURE SQUARENESS TO BOARD.

ASSOCIATED CIRCUIT DIAGRAM - D33059

D33063

MAT.	SEE PART LIST
	SEE PART LIST
	SEE PART LIST
SCALE	2-1
DRAWN	D.M.
	M.M.

NUCLEAR ENTERPRISES LTD.

PRINTED WIRING BOARD ASSY. RATEMETER RM6

D 33061

5	14.4.83	17730
4	27.3.82	17449
3	13-9-81	17281
2	17-10-80	17059
1	19-9-79	9824
A	10-8-78	
ISSUE	DATE	