SECTION 4

OPERATING INSTRUCTIONS

4-1 Introduction

This section introduces the user to the main display and operating modes, together with suggestions for the care of the instrument. Instructions and advice on how to best use the resistance meter in the field are given in Section 5. It is advisable to read section 2-2, which describes the physical layout before reading this section.

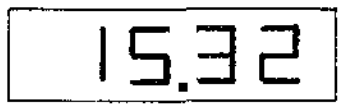
4-2 Switching on for the first time

Before switching on for the first time make sure the battery pack has been given a full charge (see section 3-3 for charging instructions). To switch the resistance meter on, rotate the ON/OFF switch clockwise one position. This will select the 2000 ohm range. In fact, three ranges are provided : (a) 2000 ohm full scale deflection (FSD), (b) 200.0 ohm FSD, and (c) 20.00 ohm FSD. A typical display for each range (providing the instrument is connected to probes in the ground) is :

(a) 2000 ohm range

(b) 200.0 ohm range

(c) 20.00 ohm range



(If the instrument is not connected to probes or contact resistance is too high, then the display will show three decimal points and a low resistance reading instead).

Each decrease in range FSD produces an increase in resolution. For general work with the 0.5m Twin array select the 2000 ohm range, which gives a resolution of 1 ohm and the fastest reading settling time of about 1 second. The 200.0 ohm range may be used where the background resistance reading is low (for example < 50 ohm) and more resolution is required. The 20.00 ohm range is usually used with probe arrays other than the 0.5m Twin. Suggestions for Range settings with different probe arrays are discussed in more detail in section 5.

4-3 LCD Display

The primary function of the LCD display is to show the measured earth resistance, as illustrated above. Note that there will be a small zero offset appearing as a constant offset in the least significant digit - its value may be found by removing the probe connections and noting the reading. However, this zero error will have no effect on Twin probe surveys since one is concerned with measuring changes on an arbitrary background. For more specialist applications, requiring an absolute value, subtract the zero offset subtracted from the readings. The LCD display also has several other functions :

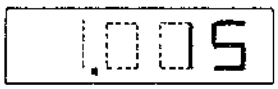
1 High Contact Resistance

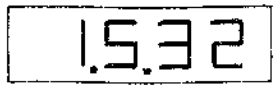
If the current probes are out of the ground or poor electrical contact is made then the RM4 will over-ride the display and show three decimal points (and a low resistance reading) :

The probes should be either inserted into the ground, pushed further into the ground or repositioned to obtain a reading.

2 Contact Resistance Indicator

If the current probe contact resistance plus soil resistance is greater than approximately 4 Kohm then the leading decimal point will be on as well as any other deciaml points displayed for a normal resistance reading :





This indicator can be used to provide an indication of whether the mobile probes of a Twin array have been inserted deep enough into the ground to give low contact resistance and hence the most reliable readings possible. However, do not worry if the indicator does not go out, since the RM4 is designed to minimise the effects of high contact resistance. Rather, take advantage of this indicator which, in wet weather, will often indicate that the probes need only be inserted half an inch into the ground to achieve low contact resistance - this will considerably reduce the survey time, since pushing the probes deep into the ground can add seconds to each reading time. The indicator also shows when the remote probes of a Twin array have been inserted deep enough into the ground (see Section 5).

WARNING

Do not waste time trying to insert the mobile probes deep enough to make the contact resistance indicator disappear.

3 Battery Low Indicator

When the batteries are running low an indication appears in the top left hand corner as a warning:

If you are using Nicad batteries, this indiactes that there is about 1/2 hour of operation left. With primary batteries, this indicates that there is about 2 hours of operation left. Besides having only a limited operation time left, this also means that the ability to deal with high contact resistance is proportionately reduced. In wet weather this is unimportant but in very dry conditions it can, on occassions mean a reading cannot be taken whereas with a new set of batteries it would have been possible. See section 3 for a guide to maintaining the batteries at an adequate operational charge.

4 Over-Range Indicator

If the resistance reading is too great for the range selected then the display will show :

The range change switch should be turned anti-clockwise until a correct reading is obtained.

5 Negative Readings

Should probe configurations other than the Twin be used, and the recommended probe connections are inadvertently swapped around then a negative reading may occur, depending on the arrangement. Negative readings should not occur with the standard 0.5m Twin probe configurations (made using the PA1 or PA5), though if you are using very wide Twin spacings with the PA5 (> 1.5m) and remote probe contact resistance is high, then you may observe a negative reading, even with the probe connections properly made - see Appendix H for more details.

4-4 Filter Switch

Two filter time constants are provided, "Rural" and "Urban". The "Rural" time constant results in a reading settling time of 1S, whereas the "Urban" time constant results in a reading settling time of 2S. Under normal operating conditions the "Rural" setting should be selected. However, on some urban sites, underground mains earth currents can cause interference with the readings - evidenced by a flickering of the display or in severe case, the readings will slowly oscillate up and down. If this is the case then the "Urban" setting should be used to stabilise the reading (see Appendix J for further details on Interference).

On the 2000 ohm range, the "Rural" setting will suffice for most sites, even urban, since earth current noise will not show at the resolution of 1 ohm. However, on urabn sites with the 200 ohm range selected, the "Urban" setting will generally be required. Whichever Filter setting is selected, it should not be changed during the course of a survey, since there will be a small, but constant reading difference between settings.

4-5 High Contact Resistance Mode

If conditions are so dry that you are unable to take readings with the standard 1mA constant current range, then the High Contact Resistance (HCR) Mode may be activated to improve the compliance of the RM4 constant current circuit. It is primarily designed for use with the Twin array. The HCR mode is selected by a switch located inside the RM4 at the top of one of the printed circuit boards, figure 4-1.

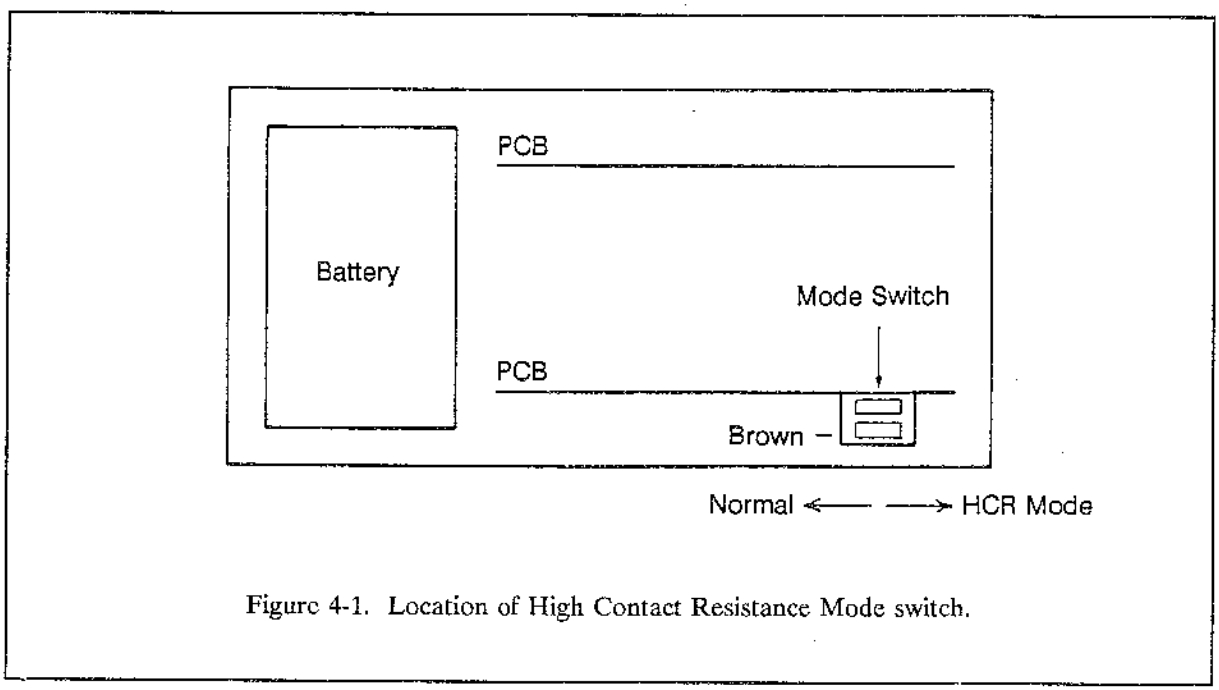


Figure 4-1. Location of High Contact Resistance Mode switch.

The transparent lid and aluminium front panel must be removed to gain access to the mode change switch - see section 3-2 on gaining access to the batteries. In practice, you may not need to entirely remove the aluminium front panel, but just loosen the two screws holding it in place - this will allow you to insert the screw-driver supplied with the RM4 into the gap to adjust the switch slider as shown in figure 4-1. Note that only the outer (brown) slider need be adjusted - the inner (red) slider has no effect. Remember to reset the switch back to the normal mode after an HCR mode surveying session.

The HCR mode reduces the 1mA constant current of the RM4 by approximately one third, whilst still maintaining the same output voltage, resulting in a three fold increase in the constant current compliance, from 40 Kohm to about 120 Kohm. Because the instrument gain is unchanged, displayed readings will be approximately 1/3 of their true value. For example a true reading of 1000 ohms will be observed in HCR mode as approximately 330 ohms. When the HCR mode is required, the terrian will usually produce a true backround reading of 300 ohms or more with a 0.5m Twin. Since these will now be observed in the HCR mode as readings of 100 ohms or more, significant changes of 1% can still be resolved on the 2000 ohm range. This mode of operation is possible since, with the Twin array, one is looking for changes in a backgound resistance which may have any arbitrary value.

Note that the HCR mode should not be used as an alternative to ensuring the remote probe contact resistance is low. Remote probe contact resistance must still be low (< 20 Kohm, via watering in, deep insertion etc) to ensure that offset errors due to the remote cable capacitance and contact resistance are still controlled (see section 5). Rather, use the HCR mode as a last resort to obtain proper readings, whilst still observing the normal procedures outlined in section 5.

4-6 Use of the Analogue Output

The analogue output may be used for driving a chart recorder , useful for model studies (though the 1S response may be a limiting factor). It may also, in certain circumstances, be used to trigger external data loggers. The output is available at the connector labelled (4) in figure 2-1. See Appendix B for connection details.

The analogue output is calibrated to give +/-2 V fsd corresponding to 20.00 ohms, 200.0 ohms, 2000 ohms depending on which gain or current range is selected - thus 1mV equals 0.01 ohm, 0.1 ohm, 1 ohm respectively. Although the nominal analogue output is +/-2V, to match the displayed reading, the actual swing can be between +4 V and -4 V, giving a larger dynamic range than the displayed reading.

Normally, the analogue output provides a signal proportional to the measured resistance, but if the current circuit is broken (for example when the current probe on a Twin mobile frame is lifted out of the ground) the analogue output reduces to virtually zero volts. This can be used by data loggers possessing only an analogue to digital convertor to detect when the mobile probe pair is reinserted into the ground and enables automatic logging of the reading (allowing a 1 or 2 second wait period for the reading to settle). The alternative way to trigger an external data logger is by means of the Range Status bits, but unless you are prepared to construct interface circuitry to the RM4 (see Appendix C) then use of the analogue output as a trigger is probably more convenient.

Note, that this system of automatic logging can only be used when the resistance changes are superimposed on a constant sign background resistance. If other probe configurations, which can give a change of sign of the reading, are used, then the zero analogue output condition cannot be used as an indicator of when the a current probe is out of the ground.

The output impedance of the analogue signal is 220 ohm and ripple (at 137.5 Hz) is less than 1% of reading. Any instrument connected to this signal should have a high input impedance (> 22 Kohm for less than 1% error) to reduce loading errors and should be capable of rejecting the ripple content.

Any instrumentation attached to the analogue output connector **MUST** be isolated from ground for correct measurements. If it is not properly isolated leakage currents may flow through your body, causing severe measurement errors.

WARNING

Always isolate any equipment connected to the analogue output from ground otherwise you may experience severe measurement errors.

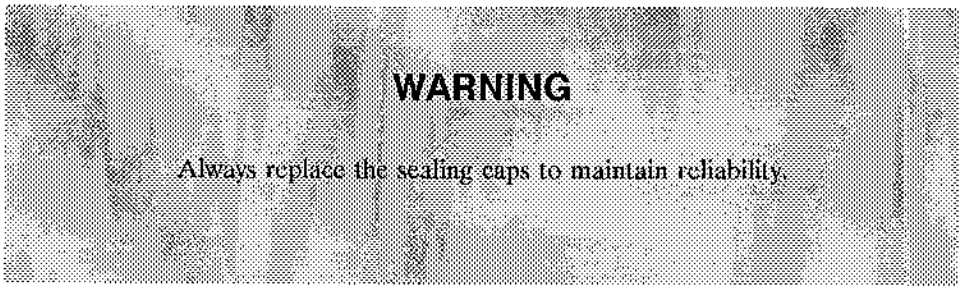
4-7 Care of the Instrument and Accessories

1 Although the RM4 and accessories have been designed to be waterproof and robust, they should still be treated as carefully as possible to maintain reliability. In particular, do not subject the instrument to banging or jolting. You should at all times transport the RM4 in some sort of protective case.

2 If the front panel becomes dirty it should be cleaned gently with a very wet tissue soaked in tapwater. Wipe the panel in one direction only and leave to air dry. If you rub hard, and fine, sharp particles of soil

are present, they will scratch the transparent lid.

3 Always replace the sealing caps on the black connectors, both on the instrument and cables. The caps are required to maintain a waterproof seal - if they are left undone then moisture may enter the instrument and cables, greatly reducing reliability. If the sealing caps will not easily screw back on, it is likely that small particles of dirt are trapped in the threads. They may be dislodged by using a sharp point and then blown clear. Do not be tempted to just leave a cap off because the thread is clogged up - clean it as above and do not try to force it on otherwise you may strip the thread.



4 When surveying with the Twin array, always use the releasable cable ties to provide strain relief for the cable that plugs into the "Remote Probes" socket, and better still, hold the cable in your hand also. Failure to do so will eventually cause the wires inside the plug to break, or even worse, a sharp pull on the cable could crack the case of the RM4. Remember to disconnect the remote probes from the cable drum prior to rewinding the cable.

5 Do not store the probes in a damp and muddy condition, since this will lead to corrosion of the steel frame. If the probes are oiled or greased for long term storage then it is imperative that all traces are removed prior to surveying since they will act as insulators, inhibit current flow and cause high contact resistances. Should the protective seal over the bolts that secure the steel frame to the wooden cross-beam be damaged then reseal with a rubberised car body underseal - it is imperative that a conductive path between the probes should not be allowed to form in wet weather. Although there are several other insulating layers and assemblages to prevent this occuring, it is a wise precaution to maintain this outer sealing system in good order.

6 For best long term reliability, if you find any component on the RM4 becomes loose then you should tighten this up as soon as possible or immediately report the problem to your technician. If you do something about the problem straight away then there should be no long term damage. However, if you do nothing about it then the problem will only get worse until eventually you may find the instrument fails whilst in the middle of a survey. Worse still, if a component such as a connector becomes loose and you do nothing about it, moisture may enter the instrument and in the long term cause corrosion to the circuitry. This will usually not be repairable and will require that most of the internal circuitry be replaced, a very expensive option which could be avoided by taking simple remedial action BEFORE it becomes a major problem.