

**PRM 4150**  
**Portable High Speed Data Station**



**OPERATORS' INSTRUCTIONS**

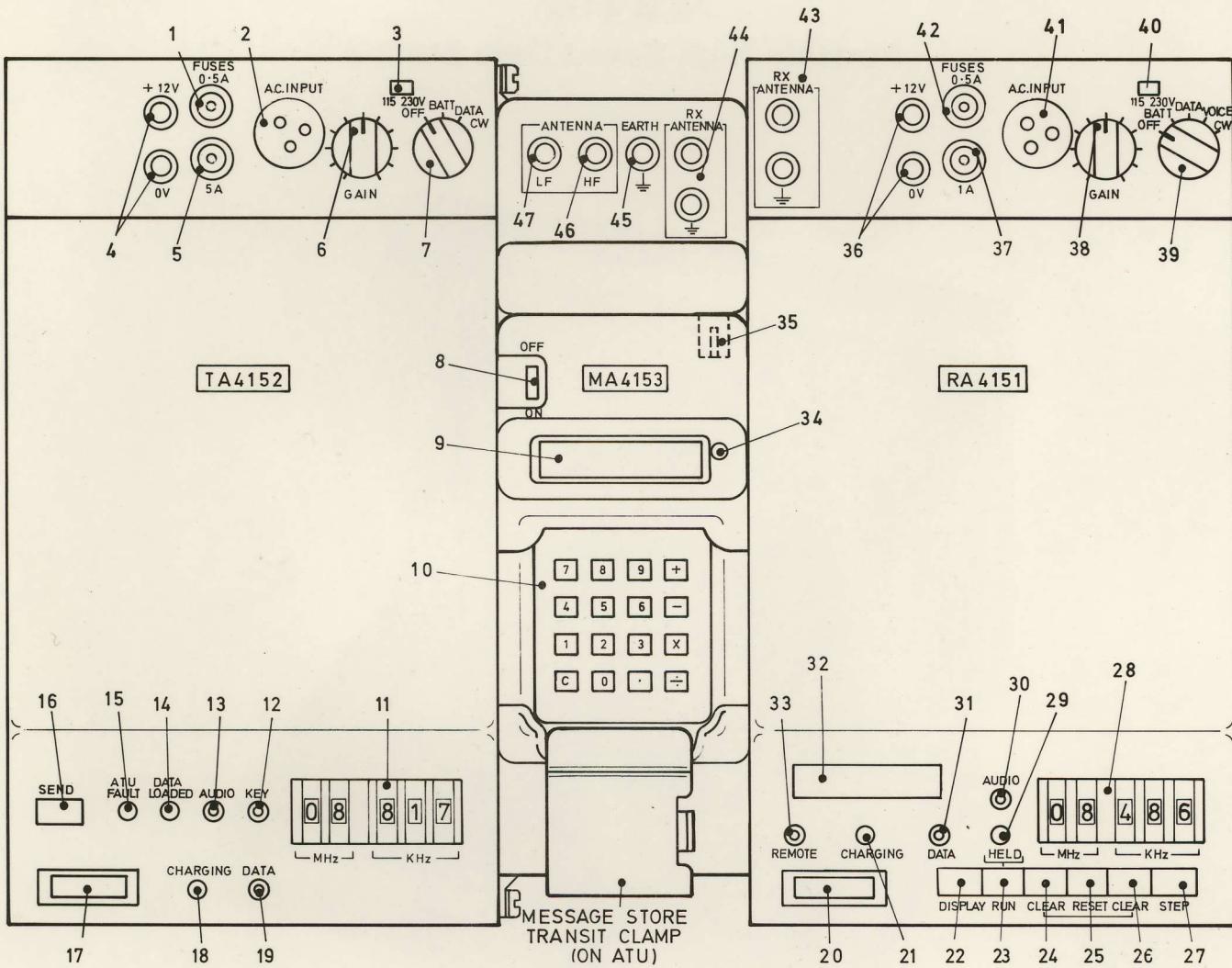


Fig.1

PRM.4150 Controls, Indicators and Connectors

#### GENERAL INFORMATION

##### INTRODUCTION

1. The PRM4150 Portable High Speed Data Station is a self-contained transceiver station which operates in SSB FSK and CW modes over the frequency range 2.0MHz to 29.999MHz in 1kHz steps. The equipment comprises of three independent units, plus accessories, housed in a standard executive style briefcase.
  - (a) **MA4153 Message Store:** This is a message compilation and storage unit capable of storing a coded message of up to 1020 numeric characters for periods in excess of seven days when switched OFF. These are displayed as pairs of 5 figure groups.
  - (b) **TA4152 Transmitter (with an external automatic antenna tuning unit):** The Transmitter accepts data messages from the Message Store or from an external Data Unit (e.g. RACAL MA4245 Portable Cipher Unit) and transmits these messages as a two-tone FSK signal on the selected frequency channel at a rate of 50 characters per second (equivalent to 600 groups per minute). Facilities are provided for morse transmission.
  - (c) **RA4151 Receiver:** This self-contained unit, when set to DATA, is capable of receiving a data message on a selected frequency channel and storing this message until reset by the user. The stored message can be recalled to the receiver display at any time up to at least 7 days after reception. Facilities are included to process the data message out to a Data Unit (e.g. RACAL MA4245 Portable Cipher Unit) as it is being received. When VOICE or CW are selected the Receiver acts as a standard radio receiver with frequency pre-selection capable of receiving Voice (LSB or AM LSB) or CW (morse).

## POWER SUPPLIES

2. All 3 units are fitted with internal rechargeable batteries. These batteries can be recharged from an external 12V d.c. supply or from a 115V or 230V single phase a.c. supply in the case of the Transmitter or Receiver. The Message Store battery can be charged by fitting the Message Store to the Transmitter while the Transmitter is being charged, or by connecting the Message Store to an external 12V d.c. supply.
3. The Transmitter and Receiver can be operated either from internal batteries or from an external 12V d.c. supply. When charging from a 115V or 230V a.c. supply the Transmitter and Receiver can be operated briefly, but continuous operation will discharge the batteries faster than the charging circuit can charge them. Similarly operating the Message Store while it is being charged causes the battery to be discharged faster than the charging circuit can charge it.

## ACCESSORIES

4. The following list details the accessories supplied with the equipment:

|                                   |   |   |
|-----------------------------------|---|---|
| Stethoscope headset               | 2 off   | *NOTE:<br>Mains plugs suitable for connection to the local mains supply will be required for the a.c. charging leads. These should be connected as follows: |
| Electrical Screwdriver (POZIDRIV) | 1 off   |   |
| Pliers sidecutting                | 1 pair  |   |
| Spare fuses (0.5A, 1A, 5A)        | 3 off each  |   |
| AC charging lead*                 | 2 off   |   |
| DC charging lead (Message Store)  | 1 off   |   |
| Wire                              | Live — Brown                                      |   |
| Cord                              | on Neutral — Blue<br>5m card Earth — Green/Yellow |   |

## OPERATING INSTRUCTIONS

NOTE: In the following procedures, numbers in brackets refer to the key legend on Fig. 1.

## SETTING-UP INSTRUCTIONS

5. Set the equipment up for operation as follows:
  - (a) For common antenna working connect a suitable antenna (see paras 20-25) to the appropriate antenna connector on the ATU (46) or (47). Connect a good earth (e.g. water pipe) to the earth connector on the ATU (45) and connect wire links between the Rx ANTENNA connectors on the ATU (44) and the Rx ANTENNA connectors on the Receiver (43).
  - (b) For separate antenna working replace the wire link to the Rx ANTENNA connector on the Receiver (43) with a second antenna (see para 20-25).
  - (c) For operation or charging from an external 12V d.c. supply, connect the external 12V d.c. supply to +12V and OV connectors on the Transmitter (4) and Receiver (36) ensuring that the polarity is correct. Check that the CHARGING lamp glows green (18) and (21).
  - (d) For charging from an a.c. mains supply, set the 115-230V switch on each unit (3) and (40) to the correct voltage and secure the locking plate. Using the a.c. charging leads supplied connect the a.c. mains supply to the a.c. INPUT connector on each unit (2) and (41). Check that CHARGING lamp glows green (18) and (21). If the CHARGING lamp glows red disconnect supply immediately and reset 115-230V switch to 230V. If CHARGING lamp does not glow disconnect supply and check availability of a.c. supply. Recheck setting of 115-230V switch (3) and (40).
  - (e) Connect stethoscope headset to AUDIO connector on each unit (13) and (30).
  - (f) If intending to transmit a morse message connect a morse sender (see para 8) to the KEY connector on the Transmitter (12).
  - (g) If using an external Data Unit, connect the Data Unit output to the DATA connector on the Transmitter (19) and the Data Unit input to the DATA connector on the Receiver (31) using the cables supplied with the Data Unit.
  - (h) If the Receiver is to be remotely controlled connect the remote control device (e.g. timeswitch) to the REMOTE connector (33) on the Receiver.

## MESSAGE COMPILATION (MESSAGE STORE)

6. Message compilation can be performed either with the Message Store connected to, or remote from, the Transmitter.

**CAUTION: When removing Message Store, slide it towards clamp to clear connector, before lifting.**

### Procedure

- (a) Set Message Store ON-OFF switch (8) to ON.
- (b) Press and hold + key, then press and hold - key until display (9) shows a flashing marker with both keys held.
- (c) Enter first message line using 0-9 keys (10).
- (d) Check displayed line is correct.
- (e) Press Decimal (.) key to transfer displayed line into store.
- (f) Enter remainder of message, line-by-line, as described in para 6 (c) to (e).
- (g) Set Message Store ON-OFF switch (8) to OFF to conserve battery life.

### NOTES:

Flashing marker indicates store cleared.

Message line comprises 10 numeric characters (2 x 5 figure groups). Display accepts only 10 figures. Further operation of 0-9 keys has no effect.

If incorrect, press key C and enter line again. Key C clears only the displayed line.

Displayed line must contain a full 10 characters to be transferred. Spaces are not valid characters.

Store holds 102 lines (1020 numeric characters). When display shows 1 marker store is  $\frac{1}{4}$  full, 2 markers  $\frac{1}{2}$  full, 3 markers  $\frac{3}{4}$  full and 4 markers full. Once 4 markers are displayed, further attempts at entry will have no effect.

A message can be checked by resetting display to first line by pressing key X then stepping through message by pressing Decimal (.) key to check each line. Message store will retain message for over 7 days when switched off.

## DATA TRANSMISSION

7. (a) Set Transmitter Mode Switch (7) to BATT.  
(b) Check that meter (17) reading is well into green scale.  
(c) Set frequency selector (11) to required channel.

If reading is low, recharge battery in accordance with battery charging procedure (see para 18).

#### **Procedure**

- (d) Set Mode Switch (7) to DATA/CW.
- (e) Fit the Message Store to the connector (35) on the ATU and set the Message Store ON-OFF switch (8) to ON.  
**CAUTION: Hold the Message Store level while sliding fully home on connector (35) and ensure the internal micro switch is heard to operate.**
- (f) Press key X on Message Store to transfer message into Transmitter Store.
- (g) Alternatively if message is to be from a Data Unit (e.g. MA4245 Portable Cipher Unit) connect the Data Unit output to the DATA connector (19) and set the Data Unit ON-OFF switch to ON.
- (h) Operate the data transfer control on the Data Unit (Refer to Data Unit Operators Handbook).
- (j) Check that the DATA LOADED lamp (14) glows green.
- (k) Switch OFF Message Store or Data Unit as appropriate.
- (l) Press SEND button (16).
- (m) Check that a single tuning tone followed by two-tone FSK signal is heard in headset.
  
- (n) When message transmission is completed set the mode switch (7) to OFF to conserve battery life.

#### **MORSE TRANSMISSION**

NOTE: Although the facility for transmitting morse exists it is only intended for emergency use. Continuous transmission in this mode, on internal batteries, will fully discharge the battery in approximately 10 minutes.

#### **8. Constructing a Morse Sender**

If morse sender is not available, one can be manufactured by using the lead from a headset. The co-axial plug of the lead is fitted to the KEY connector (12) on the transmitter. The sender is made by short circuiting the two pins of the earpiece connector with a knife blade or similar conductive object.

- 9. (a) Perform procedure detailed in para 7 (a) to (d).
- (b) Connect morse sender to KEY connector (12).
- (c) Operate SEND button (16). A brief tuning tone will be heard on headset.
- (d) Send morse message using sender.
- (e) On completion of transmission set mode switch (7) to OFF.

#### **DATA RECEPTION AND STORAGE**

- 10. The reception and storage of data messages is an automatic function of the receiver once it is set to receive data signals. The receiver can be set-up and left running in an unmanned situation and a data message received and stored. Alternatively the receiver can be left in an unmanned situation with a remote ON-OFF switch.

#### **11. Local Control**

- (a) Set the receiver mode switch (39) to BATT.
- (b) Check that meter (20) reading is well into green scale.
- (c) Set frequency selector (28) to the required channel.
- (d) Set mode switch (39) to DATA. A brief out-of-lock tone followed by receiver noise will be heard on headset and HELD lamp (29) should glow red.
- (e) If drive to an external Data Unit is required connect the Data Unit input to the DATA connector (31) on the receiver and set the Data Unit to operate.
- (f) Set the DISPLAY pushswitch (22) to the ON position (OUT).
  
- (g) If it is required to check a stored message carry out the procedure detailed in para 13.

#### **NOTES:**

If a frequency below 2.0MHz is selected a warning tone will be heard continuously in headset. Volume of audio signal can be adjusted using GAIN control (6).

Wait at least two seconds after moving switch to DATA/CW before pressing key X.

After approximately 1s with Message Store or 15s with Data Unit.

If ATU FAULT lamp (15) lights try antenna in alternative connector (47) or (46). If lamp still lights adjust antenna. Meter will climb to peak while Tuning, maintain a high level while Transmitting message, then fall back to zero when transmission ceases. The meter gives an indication of antenna current.

**DO NOT ATTEMPT TO RELOAD A MESSAGE OR TO RETRANSMIT A MESSAGE WITHIN 20 SECONDS OF OPERATING THE SEND BUTTON AS THERE IS A 20 SECOND LOCK-OUT PERIOD.**

A message loaded into the transmitter store will remain in store, regardless of how many times the SEND button (16) is operated, until overwritten by a new message or the mode switch (7) is set to OFF or BATT.

If ATU FAULT lamp (15) lights, try antenna in alternative connector (46) or (47). If lamp still lights adjust antenna. Meter (17) reading will climb to a peak, indicating antenna current, while ATU tunes then falls to zero.

Sidetone will be heard in headset and meter (17) reading will rise and fall as sender is keyed.

If reading is low recharge battery in accordance with battery charging procedure (see para 18).

If a frequency below 2.0MHz is selected a warning tone will be heard continuously on headset. The volume of the audio signal can be adjusted using GAIN CONTROL (38).

The display (32) will show the first line of any message contained in the receiver store. If the receiver is unmanned and running, the display is normally left switched OFF to avoid unnecessary drain on the battery.

#### **Procedure**

- (h) Operate the RUN pushswitch (23). The HELD lamp (29) should extinguish. This permits the reception of data.
- (j) Check that during data reception a two-tone FSK signal is heard on the headset.
- (k) Check that during MESSAGE reception the display ripples through at a fast rate. 20 seconds after the start of message reception the red HELD lamp (29) lights indicating the store is full and blocking further reception.
- (l) If immediate message recovery is required carry out the procedure detailed in para 13. If not, to conserve the battery power the receiver mode switch (39) may be set to OFF.

#### **12. Remote Control**

NOTE: The remote control device can be either a manually operated ON-OFF switch or an automatic pre-set timeswitch. When using the REMOTE connector (33) the mode switch (39) must be left in the OFF position.

- (a) Set the receiver up for operation (see para 5).
- (b) Set the frequency selector (28) to the required channel.
- (c) Connect the remote control device to the REMOTE connector.
- (d) If the remote control device is a timeswitch set the ON-OFF timing pre-set controls as required.
- (e) If the remote control device is an ON-OFF switch check that operation of the switch controls the receiver.

The receiver store should be checked between subsequent switching ON operations for any received messages. If this is not done a received message may be overwritten by a subsequent message and be lost.

#### **MESSAGE RECOVERY (Receiver)**

13. Message recovery from the receiver store can be carried out at any time up to at least 7 days after receipt of message.

- (a) Set the receiver mode switch (39) to BATT.
- (b) Check that the meter (20) reading is well into green scale.
- (c) Set mode switch (39) to DATA, HELD lamp (29) should light.
- (d) Set DISPLAY pushswitch (22) to ON position (OUT). A line of figures should appear on the display (32).
- (e) Step the display through the stored message using the STEP pushswitch (27).
- (f) The stored message can be cleared if required by operating and holding CLEAR pushswitch (24) then operating and holding CLEAR pushswitch (26) until a flashing marker appears on the display with both switches held.

If reading is low, recharge battery in accordance with battery charging procedure (see para 18).

#### **VOICE (LSB or AM)/CW (Morse) RECEPTION**

NOTE:

- (1) These modes are provided for emergency use and are not likely to be used in normal conditions.
- (2) AM will be received on LSB and must therefore be accurately in tune to be received intelligibly.

- 14. (a) Set the receiver mode switch (39) to BATT.
- (b) Check the meter (20) reading is well into green scale.
- (c) Set the frequency selector (28) to the required channel.
- (d) Set the mode switch (39) to VOICE. A brief out of lock tone followed by receiver noise will be heard on headset.
- (e) Alternatively set mode switch (39) to CW.
- (f) If Morse signal cannot be heard, or is very weak, try resetting the mode switch (39) to VOICE to receive Morse message.
- (g) After receipt of expected Morse message, set mode switch (39) to OFF to conserve battery life.

If reading is low, recharge battery in accordance with battery charging procedure (see para 18).

If frequency below 2.0MHz is selected a warning tone will be heard continuously on headset. The volume of the audio signal can be adjusted using GAIN control (38). Comments of para 14 (d) apply.

On CW a narrow band filter is brought into circuit therefore if Morse message is somewhat off frequency better reception will be obtained with the wider band VOICE position selected.

#### **NOTES:**

The display will continue to show the first line of any stored message, unless the receiver starts to receive a CALL CODE signal which can be transmitted continuously by a base station. The CALL CODE is displayed steadily by the receiver and, since it is not entered into store, the HELD lamp is not illuminated.

The receiver store looks for a full 20 second message (1020 characters). However an actual message may be considerably shorter than this and, as a result, when the message ends, the receiver continues to receive random data, containing many spaces, until the full 20 second period elapses. A received message may contain spaces, but these are errors caused by poor reception conditions such as weak signal, or interference. Any message in the receiver store will be retained for at least 7 days while the receiver is switched OFF, or until cleared by the user.

## ROUTINE MAINTENANCE

### GENERAL

15. Routine maintenance on the PRM4150 is limited to good housekeeping, battery charging and occasional functional tests.

### HOUSEKEEPING

16. Good housekeeping consists of keeping the equipment dry, free from dust and dirt and generally keeping the accessories in good condition.

### BATTERY CHARGING

17. The transmitter and receiver units have identical charging circuits and can be charged either from an external 12V d.c. supply or from a 115V or 230V single phase a.c. supply.

The Message Store battery is charged automatically when the message store is fitted to the transmitter with the transmitter on charge. Alternatively the Message Store battery can be charged independently from an external 12V d.c. supply.

#### NOTE:

- (1) When using an external d.c. supply the Transmitter and Receiver can be operated and charged at the same time.
- (2) When using an external a.c. supply the Transmitter and Receiver can be operated, but this will discharge the batteries faster than they can be charged. To actually charge the batteries the Transmitter and Receiver should be set to OFF or BATT.
- (3) Operating the Message Store while on charge (in all charging conditions) discharges the battery faster than it can be charged. The Message Store should be set to OFF to actually charge the battery.
- (4) On the Message Store a flashing display indicates a discharged battery. A display that will not light can also indicate a discharged battery.

### 18. Battery Charging Procedure

#### (a) Transmitter / Receiver DC Source

- (i) Connect an external 12V d.c. supply to the +12V and OV connectors on the transmitter (4) and/or the receiver (36) ensuring that the polarity is correct.
- (ii) Check that the CHARGING lamp (18) and (21) glows green. If not replace the d.c. input fuse (5) or (37).
- (iii) If Message Store is fitted to transmitter check that message store charging lamp (34) glows green.
- (iv) Leave battery on charge for up to 14 hours depending on the initial state of charge of the battery.
- (v) Set mode switch (7) and (39) to BATT and check that meter (17) and (20) readings are well into green scale.
- (vi) Set mode switch (7) and (39) to OFF.

#### (b) Transmitter / Receiver AC Source

- (i) Check voltage of external a.c. supply.
- (ii) Set 115V-230V selector switch (3) and (40) to the a.c. supply voltage.
- (iii) Connect the a.c. supply to the AC INPUT connector (2) and (41) using leads supplied.
- (iv) Switch ON a.c. supply, CHARGING lamp (18) and (21) should glow green.
- (v) If CHARGING lamp (18) or (21) glows red, switch OFF a.c. supply (disconnect) immediately and reset 115-230V selector (3) or (40) to 230V.
- (vi) If CHARGING lamp (18) or (21) does not glow, check and replace a.c. input fuse (1) and (42). If lamp still does not glow check availability of a.c. supply and recheck setting of 115-230V selector (3) and (40).
- (vii) If the Message Store is fitted to the transmitter check that the message Store charging lamp (34) glows green.
- (viii) Continue as detailed in para 18 (a) (iv) to (vi).

#### (c) Message Store (Independent)

- (i) Check that ON-OFF switch (8) is set to OFF.
- (ii) Connect Message Store connector (35) to external 12V d.c. supply using lead supplied. Charging lamp (34) will glow green.
- (iii) Leave on charge for up to 14 hours.
- (iv) Disconnect the 12V d.c. supply.

#### NOTES:

Some of the antenna wire may be used to connect an external 12V d.c. As the supply is connected an internal relay may be heard to close.

Tx 5A Rx 1A.

A fully discharged battery will be fully charged after 12-14 hours.

If either reading is still low battery is unserviceable and requires replacing.

Loosen locking plate, set switch and refit locking plate.

AC charging leads supplied will require suitable mains plug for local supplies (see para 4).

Tx and Rx 0.5A.

Message Store can be independently charged only from a 12V d.c. supply; a lead is supplied for this purpose. DO NOT CONNECT THE MESSAGE STORE TO THE A.C. MAINS. OBSERVE POLARITY (RED + BLACK -).

A fully discharged battery will be fully charged after 12-14 hours.

## FUNCTIONAL TEST

19. This functional test is intended to show that the PRM4150 is working.

### Procedure

- (a) Set the equipment up for separate antenna operation.
- (b) Set the mode switch on both transmitter (7) and receiver (39) to BATT.
- (c) Check that meter (17) and (20) readings are well into green scale.
- (d) Compile a short (5 line) message on the Message Store.
- (e) Set frequently selectors (11) and (28) to same unused channel (e.g. 15950).
- (f) Set mode switches (7) and (39) to DATA. A brief out-of-lock tone will be heard in both headsets.
- (g) Set the receiver to receive and store data messages.
- (h) Fit Message Store to transmitter and set ON-OFF switch (8) to ON.
- (j) Transmit data message.
- (k) Check HELD lamp (29) lights.
- (l) Recover message from receiver store.
- (m) Confirm recovered message is identical to that compiled in para 19 (d).
- (n) Set mode switches (7) and (39) to OFF.

### NOTES:

See setting-up procedure para. 5. A short length of wire (0.5m) will suffice for antennas.

If readings are low, recharge batteries in accordance with battery charging procedure (see para 18).  
See para 6.

See para 11 (f) to 11 (k).

See para 7 (f) to 7 (n).

## ANTENNAS

### GENERAL COMMENTS

20. To obtain maximum effectiveness from the PRM4150 antenna, the following factors must be considered:

- (a) The most suitable antenna layout for the distance between the PRM4150 and its base station.
- (b) The most practical antenna layout for the PRM4150 site.

Normally the antenna layout chosen will be a compromise.

21. The PRM4150 is designed to operate with a long wire antenna. In general the lower the frequency channel the longer the antenna and vice versa. A good earth should be connected to the equipment; this is particularly important when short wire antenna are used. A good earth can normally be obtained from a clean waterpipe when operating indoors or from a long conductive probe stuck in damp earth outdoors.

22. If the PRM4150 is set up in the vicinity of a strong radio source (e.g. a medium wave broadcast station) receiver blocking may occur. This situation can be alleviated by using a separate short wire antenna (1-2m) for the receiver.

23. A 25m length of wire on card is supplied with the PRM4150. This is intended for use in making the following:

- (a) Antenna: The antenna is made by unwinding a sufficient length from the card leaving the remainder wound on the card and still attached to the end of the antenna. Should a separate antenna be required for the receiver a sufficient length for this purpose should be cut off the card.
- (b) DC charging leads.
- (c) Earth leads.
- (d) Short wire links between Transmitter (ATU) and Receiver (Rx ANTENNA).

NOTE: To rejoin short lengths of wire, remove the insulation from one end of each length, twist the bare wires together and bind joint thus made with suitable insulating tape.

### 24. Antenna Configurations

The propagation of radio signals follows two main paths, namely:

- (a) Ground wave propagation: This is used for short distance propagation (up to about 20km). The radio signals follow the earth from transmitter to receiver. (See Fig. 2).
- (b) Sky wave propagation: This is used for medium (20km-2000km) and long (over 2000km) distance propagation. The radio signals are 'bounced' off the ionosphere at an angle, thus reaching round the curvature of the earth (See Fig. 3).

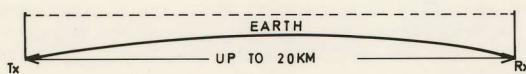


Fig.2    Ground Wave Propagation

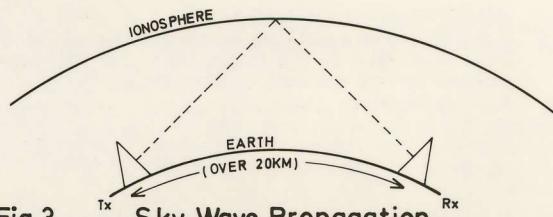


Fig.3    Sky Wave Propagation

Certain antenna configurations are preferred according to the propagation distance required. These are based on the fact that propagation occurs at right angles to the length of a wire antenna. Three main configurations are used as described below:

#### (a) Vertical Antenna:

This type of antenna is preferred for short (up to about 20km) and long (over 2000km) distance propagation where practicable. For short distances the radio signals are propagated by ground wave, while for long distances propagation is by sky wave, 'bouncing' off the ionosphere at shallow angles.

(b) **Sloping Antenna:**

This type of antenna is preferred for medium (20km-2000km) distance propagation where practicable. The antenna is constructed with one end higher than the other with the downward slope pointing in the required propagation direction. Since propagation of the radio signals is by sky wave, the angle of the slope is generally related to propagation distance (i.e. shorter distance, shallower angle and vice-versa). This determines the angle of bounce at the ionosphere. The transmitter can be connected to either end of the antenna.

(c) **Horizontal Antenna:**

This type of antenna is a general purpose type that can be used where the preferred type is impractical. This antenna is best set up at right angles to the required direction of propagation.

**25. Antenna Siting**

(a) **General Comments:** In general the following points should be considered when selecting antenna sites:

- (i) Outdoor sites are generally better than indoor sites.
- (ii) The higher the antenna can be positioned the better the performance.
- (iii) A brick built building is a better transmission site than a modern pre-fabricated reinforced concrete building.
- (iv) A clear propagation path in the required direction is preferable.

(b) **Outdoor Sites:** These generally provide facilities for all antenna configurations as follows:

- (i) High trees, poles, etc. can be used for constructing vertical or sloping antennas.
- (ii) Upper floor windows, etc. can be used to assist in constructing sloping antennas.
- (iii) Horizontal antennas can be constructed along washing lines or between buildings.

(c) **Indoor Sites:** These can provide a difficult choice of antenna configuration depending upon building structure and location of antenna site. If the user is restricted to a single room it is important that this room should be on the side of the building facing in the direction of required propagation, and is located as high in the building as possible to obtain reasonable propagating conditions.

- (i) In a single room, the most practical antenna configurations are normally either:
  - (1) A horizontal or L-shaped antenna across a window, especially in a concrete building, or
  - (2) A sloping antenna from the top of the wall on one side of the room sloping down towards the bottom of the wall on the window side of the room.
- (ii) Access to a loft will enable a good horizontal antenna to be constructed, providing care is taken to avoid water tanks and pipes other than for equipment earth.
- (iii) The outer braid of an individual TV antenna feeder, disconnected from the TV set, may form an ideal vertical antenna in a brick building, especially if the antenna feeder is on the side of the building facing in the required propagation direction.
- (iv) From a room high in a building, a vertical antenna can be constructed by hanging the wire out of the window, providing the antenna wire is kept at least 1 metre from the wall of the building. A length of broom handle, or fishing rod, with the wire bound to one end is ideal for achieving this.

NOTE: When erecting antennas care must be taken to keep the antennas clear of walls or metal objects by judicious use of the cord supplied and the holes in the card.