



RFInnovations

Leaders in Wireless Data

RF Innovations Pty Ltd
ABN 97 065 523 579

22 Boulder Road Malaga 6090
Western Australia

Telephone: +61 8 9209 0900

Facsimile: +61 8 9248 2833

Email: sales@rfinnovations.com.au

Web: www.rfinnovations.com.au

RFI-148 250W VHF PAGING TRANSMITTER



USER MANUAL

STI-GLOBAL GROUP

Offices: ★ Sydney ★ Perth ★ Madrid

RFI-148 250W VHF Paging Transmitter

User Manual

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1. Introduction

The RFI-148 250 is a high power output paging transmitter operating in the VHF band.

- VHF band operation (138 MHz – 174 MHz) with 2 MHz switching bandwidth.
- 250 W (54 dBm) maximum transmit power
- Compatible with:
 - POCSAG 512, 1200, 2400 bps (2-level FSK).
 - FLEX 1600 (2-level FSK), 3200 (2- or 4-level FSK), 6400 bps (4-level FSK).
- Windows GUI for configuration and diagnostics over serial or network (Cruise Control).
- SNMP diagnostics.
- DSP precision modulation.
- Integrated isolator.
- RF diagnostics port for in-rack receiver.
- Remote firmware update capability.
- Software selectable frequency offset.
- Adjustable absolute delay correction.
- Hardware alarm outputs.
- Front panel indicators for power output and diagnostics.
- High frequency stability and external reference option.



2. Installation

2.1 General Considerations

There are a number of rules to observe when installing a paging transmitter.

Antenna selection is vital to a good RF link. Different antennas are required depending on the application. Please contact your antenna manufacturer or RF Innovations for correct antenna selection.

Antenna placement has a significant impact on RF link performance. In general, higher antenna placement results in a better communication link. A vantage point should be chosen to clear the propagation ellipsoid. An unobstructed, line-of-sight link will always perform better than a cluttered or obstructed link.

Obstructions, such as walls and poles, will distort the antenna radiation pattern and VSWR, resulting in less efficient transmission and reception.

Antennas in close proximity are potential sources of mutual interference. A transmitter can cause overload of a nearby receiver, if due precautions are not taken in antenna location. Moreover, transmitters in close proximity may cause intermodulation. Slight adjustments in antenna placement may help solving interference problems.

All items of radio equipment, such as antennas, are sources of RF radiation. They should thus be placed away from electrical equipment, such as computers, telephones or answering machines.

Serial cable runs between radio modem and attached terminal equipment (eg RTU or PC) should be kept as small as possible. A maximum cable capacitance of 2,400 pF is recommended for transfer rates up to 19.2 kbit/s. If a non-shielded, 30 pF / foot cable is used, the maximum length should be limited to 80 feet (approximately 24m). For higher interface speeds, the length of the serial cable should be shortened.

Long serial cables should also be avoided in areas with frequent lightning activity or static electricity build-up. Nearby lightning strikes or high levels of static electricity may lead to interface failure.

RF Innovations supplies a range of external data interface converters for applications requiring long cable runs.

2.2 External Antennas

Long antenna feed lines cause RF loss, both in transmission and reception levels, and degrade link performance. When long cable runs are required use a suitable low-loss cable.

As an example, RG58 (tinned-copper braid) will exhibit a loss of 7.1 dB / 30 m at 148 MHz – 174 MHz, whereas RG58 CellFoil will exhibit 3 dB less (4.2 dB / 30 m).

Antennas should not be located within close reach of people, due to radiation hazard. Exposure guidelines should be followed at all times.

Use extreme caution when installing antennas and follow all instructions provided. Because external antennas are subject lightning strikes, RF Innovations recommends protecting all antennas against lightning strike by using lightning surge arrestors.

2.3 Product Installation

The back panel of the paging transmitter is shown below in Figure 1.

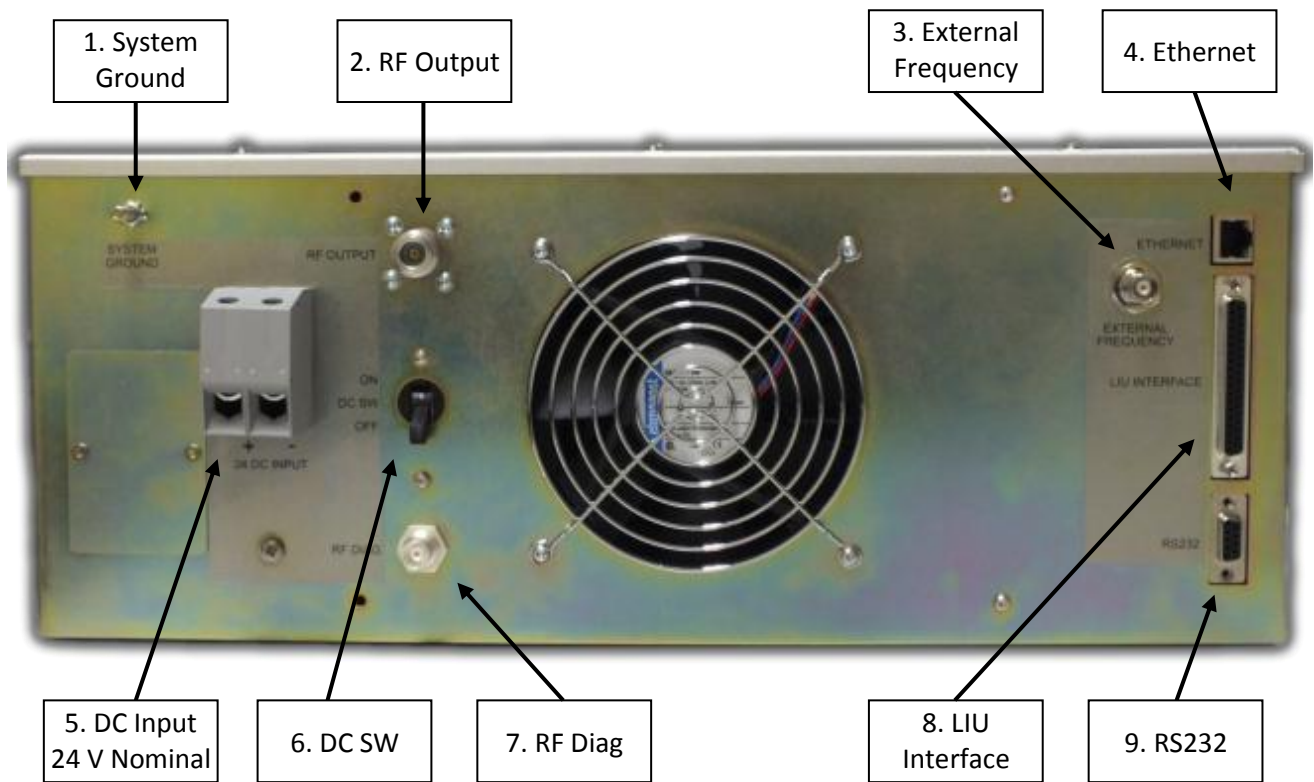


Figure 1: Paging Transmitter Back Panel

1. **System Ground:** External connection for system ground.
2. **RF Output:** Modulated RF output from the paging transmitter. N-type female connector.
3. **External Frequency:** External reference input for accurate channel synthesis. BNC female connector.
4. **Ethernet:** Ethernet connection for configuration and diagnostics over UDP. RJ45 connector.
5. **DC Input 24 V Nominal:** 20-31.2 V DC Input voltage. Terminal block connector.
6. **RF Diag:** Sniffer port for diagnostics. BNC female connector.
7. **DC SW:** Power switch.
8. **LIU Interface:** Combined alarm and encoder interface. DC-37 female connector.
9. **RS-232:** Main serial port. DE-9 female connector.

2.4 Safety and Compliance

2.4.1 Human Exposure to Emissions

To limit human exposure, the following guidelines need to be observed:

1. Take reasonable precautions in any installation to maintain a clearance from the antenna of no less than 4 m (four metres) to the general public and 2 m (two metres) to service and maintenance personnel.
2. Do not apply power to the device unless the clearance described in 1 above has been allowed.

The guidelines above apply when transmitting at maximum power, with an antenna gain of up to 13 dB.

For further information on human RF exposure, contact your local health department. For example, Health Canada's Safety Code 6 provides a comprehensive set of guidelines.

2.4.2 Modifications

CAUTION: Changes or modifications not expressly approved by RF Innovations may void the user's authority to operate the equipment legally, as well as any warranty provided.

3. Configuration

3.1 Overview

The RFI-148 250 provides six interfaces that allow the transmitter to be configured and diagnostic information to be monitored:

- ***Cruise Control management interface:*** All configuration and diagnostics parameters can be accessed using the Windows-based Cruise Control Graphical User Interface (GUI).
- ***SNMP interface:*** Support for diagnostics using SNMP.
- ***Terminal menu interface:*** A navigable menu system is available that has all the configuration and diagnostics that Cruise Control provides.
- ***AT command interface:*** The AT command interface provides a subset of the configuration and diagnostic information available over Cruise Control with ASCII Hayes attention commands.
- ***Front panel interface:*** The front panel consists of five status LEDs and a transmit power gauge.
- ***LIU interface:*** The combined LIU interface has digital inputs and alarm outputs for limited configuration and diagnostic output.

3.2 Cruise Control

The following sections briefly outline how to use Cruise Control with the paging transmitter. For more information see the Cruise Control User Manual. Figure 2 below is a typical screenshot of the Cruise Control interface running on Windows 7.

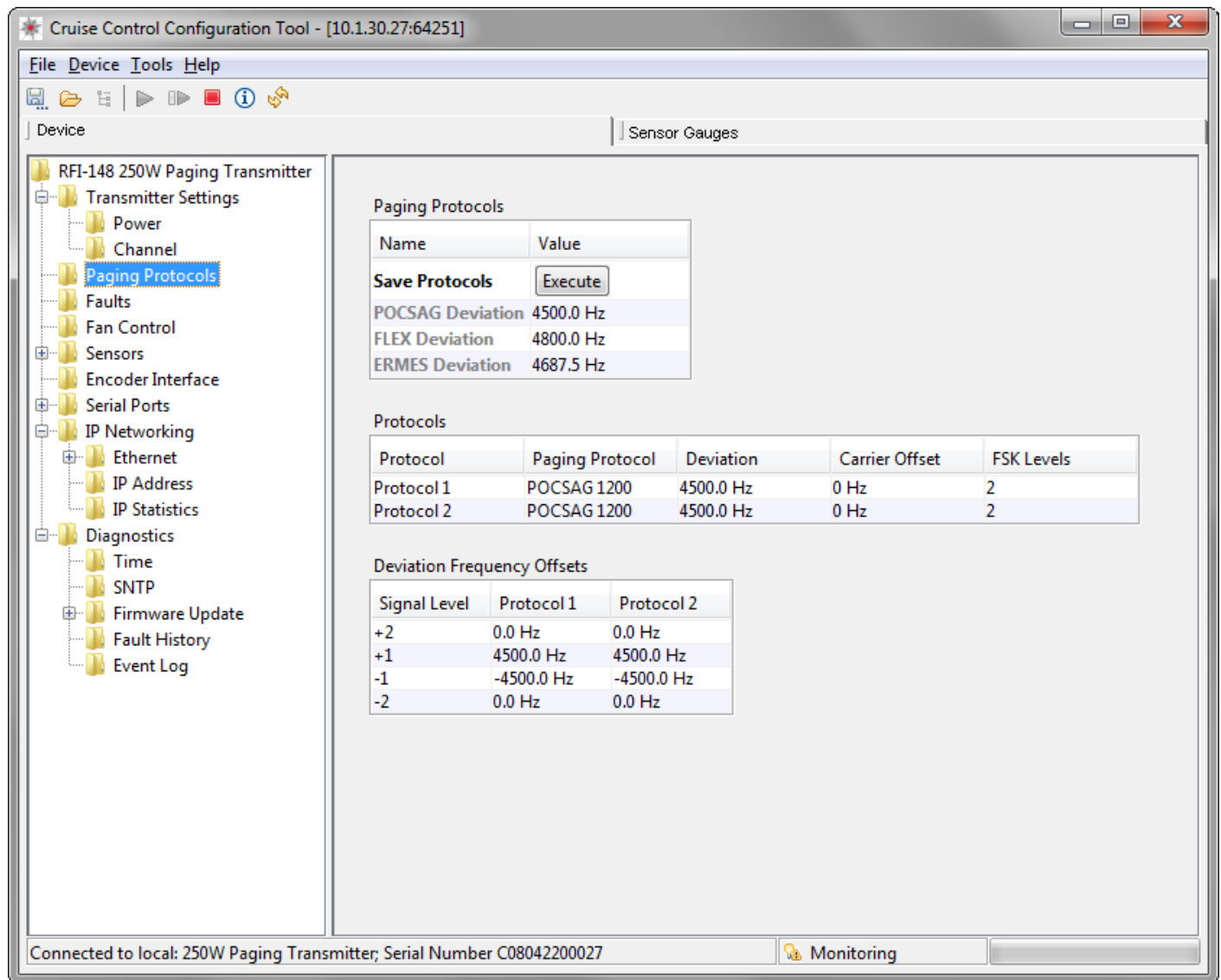


Figure 2: Cruise Control Interface

3.2.1 Installation

The requirements for using the Cruise Control application are:

- Pentium III+ Processor.
- Windows XP (x86) or Windows 7 (x86 and x64).
- At least 1 available serial port or a network connection to the device.

3.2.2 Connecting to the Paging Transmitter

SERIAL

To connect to a device with RS-232, attach the paging transmitter to the PC running Cruise Control via a serial port. Configure the Cruise Control communication settings using Device -> Configure

Communications, ensure that Serial is selected from the dropdown box and enter in the serial settings (19200 8N1 by default).

Use the Device -> Connect to Local Device menu item to connect to the local device.

ETHERNET

To connect to a device over a network, the device IP address must be known. Configure the Cruise Control communication settings using Device -> Configure Communications, ensure that UDP is selected from the dropdown box and enter the device IP address. For the UDP port, enter 64250, 64251 or 64252.

The paging transmitter listens on UDP ports 64250, 64251 and 64252 for data and will not allow more than one simultaneous session per port. If the paging transmitter does not respond to Cruise Control on a UDP port, try another port as a connection could already be active on that port.

Use the Device -> Connect to Local Device menu item to connect to the device.

3.2.3 Device Navigation

Once all the settings have been downloaded from the device, the available configuration groups are displayed in a tree on the left. The items that can be configured in each group are displayed in tables on the right.

The names of editable items are displayed in black. Read only items have their names in grey.

3.2.4 Sensor Gauges

Cruise Control can provide real-time operational information for paging transmitters using the Sensor Gauges plugin. An example of diagnostic information provided by the Sensor Gauges plugin is shown below in Figure 3.

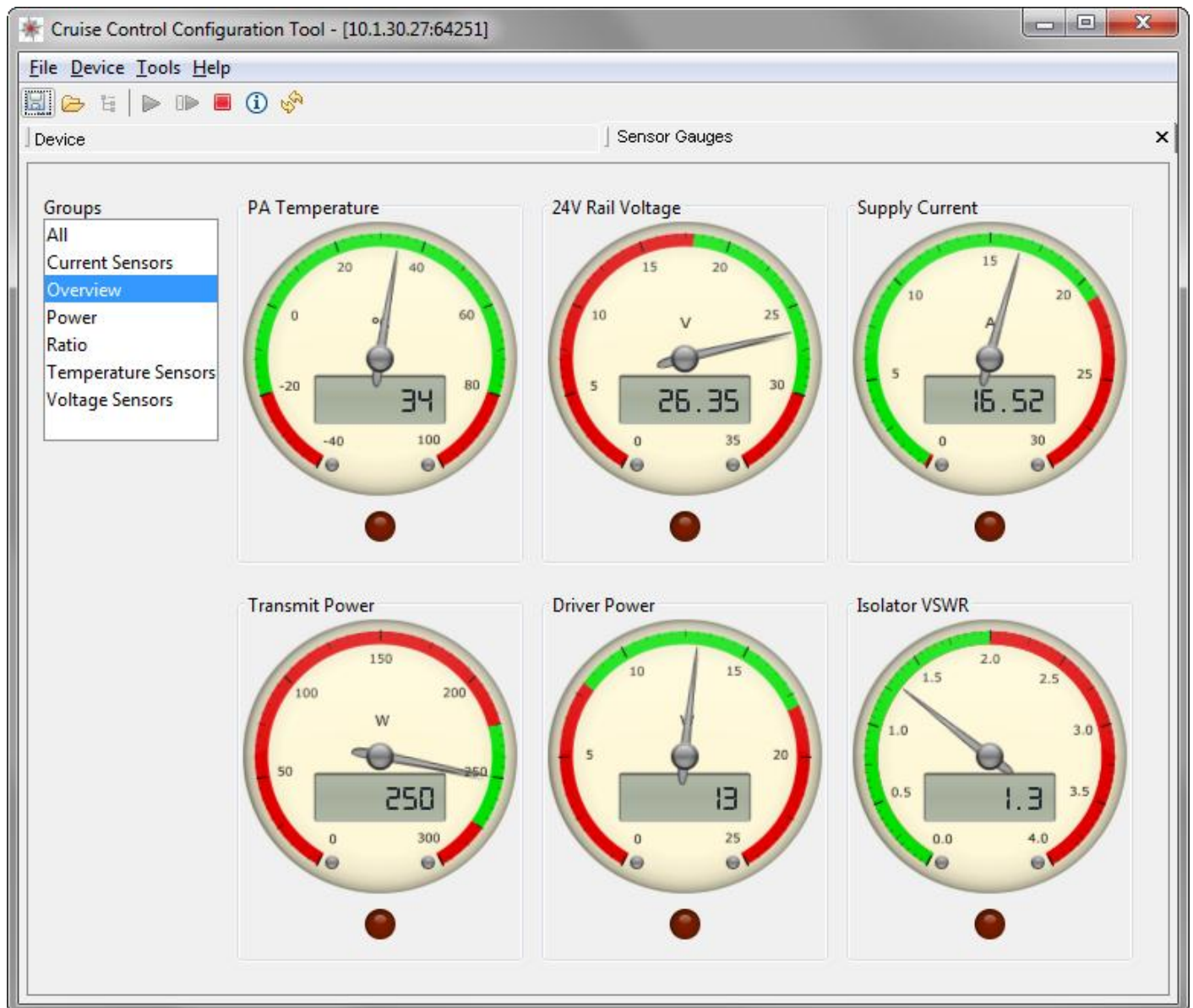


Figure 3: Cruise Control Sensor Gauges Plugin

To view Sensor Gauges for a paging transmitter, first connect to the paging transmitter using Cruise Control. Then use the Tools -> Plugins -> Sensor Gauges menu item to open the Sensor Gauges plugin.

The Sensor Gauges will automatically update, with the needles showing the current value of the gauge parameter. The green region indicates the expected normal operating value for the parameter. The upper and lower cut-off values for the sensor (see section 5.1) determine the range of the green region. There is a red indicator below each gauge which turns on when the parameter exceeds the upper or lower cut-off value.

The Groups option box on the left shows the different groups of gauges available, grouped by the unit of measurement of the sensor. There are also two additional groups, overview and all. The overview group provides a subset of the most informative gauges for quick diagnostic troubleshooting. The all group shows all of the gauges.

3.2.5 Firmware Update

Cruise Control supports the updating of device firmware from Motorola S-Record image files (*.mot). Cruise Control will only allow firmware images that are compatible with the paging transmitter to be uploaded.

To upload a firmware image use the `Device -> Load Firmware` menu item. A windows explorer dialog will open, navigate to where the firmware image is on the computer, select the image and click upload. The progress bar at the bottom right will show the progress of the firmware update.

Once the upload has finished the paging transmitter will reset to apply the update. While updating the paging transmitter cannot key up or respond to queries. Cruise Control will automatically reconnect once the update is complete.

For information on this feature as related to the paging transmitter firmware, which includes the firmware recovery mechanism, see section 5.3.

3.3 SNMP

The paging transmitter includes a built-in SNMP agent. Not all configuration and diagnostic parameters may be queried via SNMP. See Appendix C.2 for a list of values which may be queried via SNMP.

SNMP versions 1 and 2c are supported. The community string ‘public’ should be used when issuing SNMP requests. The agent responds on UDP port 161 is compatible with standard SNMP managers and other SNMP client applications.

An SMI MIB file defining OIDs for this product is available.

3.4 Terminal Menu Interface

The terminal menu provides access to all configuration parameters in the radio.

To access the terminal menu execute the `AT?` command at the Hayes AT command interface. See section 3.5 on page 13 for information on executing AT commands. The terminal menu will not be started if it is open on another port, instead the `BUSY` response is returned.

The terminal menu is available over serial, UDP (ports 64250, 64251 and 64252) and TCP (port 23).

3.5 Hayes AT Command Interface

The paging transmitter supports Hayes ATtention commands. These are used to query and change device configuration and probe performance parameters. AT commands are available via serial port, and via TCP port 23 on the Ethernet interface.

The format for the query and configuration AT command is:

```
ATxxx<[I1, I2, ... In]><=value><TERM>
```

Where:

- AT is the attention code. All AT commands must be prefixed with AT. This is case insensitive, so At, aT, or at can also be used.
- xxx is the actual command. The list of valid AT commands is given in Appendix D on page 33.
- <[I1, I2, ... In]> is an optional section that allows the specification of an index. Indexes are used to access one of an array of similar items. For example, the Crescendo radio has two serial ports which can both have different configurations. The command `ATS52[0]=1004` set the point-to-point destination on the main port, while the command `ATS52[1]=1004` will set the point-to-point destination on the auxiliary port.
- <=value> is an optional section that is used to set the value of a configuration parameter. If this section is omitted, then the value of the configuration parameter will be displayed.
- <TERM> is the terminator for the AT command. A terminator can consist of a carriage return (ASCII value 13_{Decimal}) or a carriage return followed by a line feed (ASCII value 10_{Decimal}).

For each AT command that is issued a response is generated. The list of responses to AT commands is shown in Table 1.

Response Code	Response Number	Description
OK	0	Returned whenever a command is entered that is executed correctly.
ERROR	4	Returned whenever a command is invalid or could not be executed.
BUSY	7	Returned when an attempt is made to enable the menu via AT? but the menu system is already enabled on the other serial port.

Table 1: AT command response codes

3.6 Front Panel Interface

The front panel interface consists of 6 status LEDs and a transmit power gauge. The panel is illustrated in Figure 4 and the function of each LED is described in Table 2.

LED	Colour	Description
Transmit On	Green	Turns on when the transmitter is on.
Fault	Red	Turns on when any fault is active.
Low Power	Red	Turns on when the sensed transmit power is lower than the lower cut-off value as specified in the sensor parameters.
High VSWR	Red	Turns on when the isolator VSWR is higher than the higher cut-off value as specified in the sensor parameters.
Serial/Ethernet	Green	Flashes when serial or Ethernet data is transmitted or received.
Power	Green	Turns on/off at 1 Hz while power is supplied.
Power Gauge	Green/Red	A bar graph displaying current transmit power.

Table 2: Front panel LED descriptions

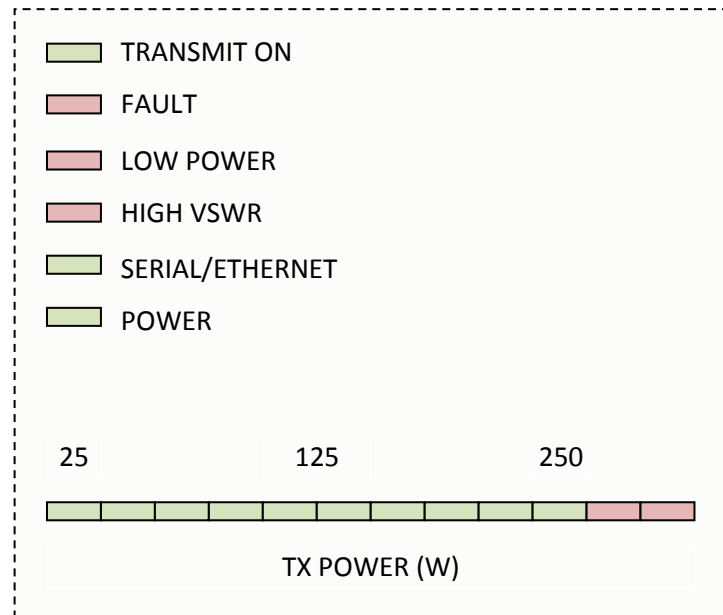


Figure 4: Front panel display

3.7 LIU Interface

The LIU interface is a DC-37 female connector at the rear of the paging transmitter. The LIU interface has the following connections:

Nine digital inputs:

- Frequency Select 1
- Frequency Select 2
- Frequency Select 3
- Frequency Select 4
- Protocol Select
- Hardware PTT
- Tx Data L-bit
- Tx Data H-bit
- Transmit Clock

Fourteen alarm outputs:

- Power Supply Alarm
- Reference Out-of-Lock Alarm
- Reference Switchover Alarm
- High Output Power Alarm
- Low Output Power Alarm
- High VSWR Alarm
- High Temperature Alarm
- Fan Failure Alarm
- Exciter Out-of-Lock Alarm
- Combined Alarm

- Spare Alarm 1
- Spare Alarm 2
- Spare Alarm 3
- Spare Alarm 4

Use of the hardware PTT, protocol select and frequency select inputs are all optional and may be disabled in software. The use of the transmit clock is optional for 2-level protocols, but required for 4-level protocols.

The pin-out for the LIU Interface can be found in Appendix A.4

4. Operation

4.1 Serial Port Operation

4.1.1 Overview

The RFI-148 250 has two DCE RS-232 serial ports. The front serial port has a female DE9 connector (DCE) and the rear serial port has a male DE9 connector (DTE). The serial port pin outs can be found in Appendix A.3 on page 26.

The main port (at the back of the transmitter) supports:

- TX, RX, and GND.
- RTS and DTR inputs.
- CTS and DCD outputs.

The auxiliary (at the front of the transmitter) port supports:

- TX, RX, and GND.

4.1.2 Configuration

Both main and auxiliary serial ports support the following configuration options:

- Baud rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200.
- Data bits: 7 or 8
- Parity: None, odd, or even
- Stop bits: 1 or 2

4.1.3 Statistics

Statistics are maintained for both serial ports. These statistics are listed in Table 12 in Appendix C.1. All statistics are reset if power is removed.

These statistics may be useful in troubleshooting. For example, Rx framing errors may indicate that the serial port configuration does not match the serial port configuration of the DTE.

4.2 Ethernet Operation

4.2.1 Overview

The paging transmitter has one 10BASE-T/100BASE-TX Ethernet port. Auto-negotiation of link speed is supported, including duplex mode. There is also a software override for forcing the parameters of the link.

4.2.2 IP Addressing

The paging transmitter supports IPv4. The IP address may be configured with a single static address. A subnet mask and default gateway may be configured to allow communication across sub-networks.

4.3 Transmitter Operation

4.3.1 Transmit Power

The RFI-148 250 supports transmit power from 20 to 250 Watts in 1 Watt increments.

4.3.2 Channel Selection

The transmitter supports four channel rasters: 5 kHz; 6.25 kHz; 10 kHz; and 12.5 kHz, and has up to sixteen configurable channels. The transmit frequency of each channel can be configured using the Cruise Control GUI. The current operating channel can be selected using the Cruise Control GUI, Hayes AT commands, a terminal interface or the LIU Interface.

4.3.3 Push-To-Talk (PTT)

There are three methods available to turn the transmitter on:

- **Software PTT:** Software PTT is available using Hayes AT commands, through the Cruise Control GUI, or through the terminal menu interface.
- **Hardware PTT:** Hardware PTT is available through the LIU connector. Hardware PTT can be configured to be active high or active low.
- **Auto PTT:** Auto PTT is performed by detecting a change in the data bits on the LIU and turning on the transmitter.

PTT TURN OFF DELAY

The unit has the option to leave the transmitter on for a set duration after receiving a PTT off signal. This delay is driven by software and typically accurate to 100 ms.

TRANSMIT TIMEOUT

The unit can automatically raise a fault if the transmitter has been left on for too long. By default a transmit timeout fault is raised if the transmitter is on for greater than 600 seconds (10 minutes). The default action configured for the transmit timeout fault is to turn off the transmitter (see section 5.2). The 'Enable transmit timeout' option must be set for this to occur. By default, this option is disabled.

PTT SYSTEM OVERRIDE

Transmitter PTT can be completely disabled using the PTT system override setting. By default it is set to Enable Transmit.

4.3.4 External Reference

The transmitter supports an external reference for channel frequency generation. To use the external reference, a 10 MHz sine or square wave -10 dBm to 0 dBm signal must be applied to the “External Frequency” input BNC connector on the back panel. The paging transmitter will attempt to use an external reference by default.

AUTOMATIC REFERENCE SWITCHOVER

If the external reference is selected as the default reference, the transmitter will failover to the internal reference in the event of the external reference failing.

The external reference is considered to have failed when there is no signal transition on the external reference for at least two consecutive falling edges of the internal reference.

NOTE: If the paging transmitter is transmitting when reference switchover occurs, there may be data loss.

4.3.5 Absolute Delay Adjustment

The paging transmitter can insert a small artificial delay on data presented on the LIU interface before it is passed to the digital synthesiser. The delay adjustment can be set from 0 to 40 ms in 5 μ s steps. The additional net delay is accurate to $\pm 3 \mu$ s.

4.3.6 Carrier Offset

A carrier offset from the channel frequency can be specified from -5000 to +5000 Hz in increments of 1 Hz.

4.3.7 RF Diagnostics

The paging transmitter provides an RF diagnostics port output on the back panel. The RF diagnostics port can be configured for two modes:

- **Transmission:** The sniffer port will output a signal identical to that of RF out, attenuated by approximately 105 dB. This is the normal mode of operation.
- **Listening:** Attenuation from the antenna port to the sniffer port is reduced to less than 15 dB. This is a special mode of operation used for network testing. **NOTE:** While the sniffer port is configured for listening, transmission is disabled.

4.4 Data

The RFI-148 250 supports the following modulation formats:

- **POCSAG:** Baud rates of 512, 1200 and 2400 bps (2-level FSK) are supported.
- **FLEX:** Baud rates of 1600 (2-level FSK), 3200 (2-level or 4-level FSK) and 6400 bps (4-level FSK) are supported.

2-level FSK protocol data may optionally be clocked into the paging transmitter using the external data clock or may run asynchronously. 4-level FSK protocols must use the external data clock.

Once the desired paging protocol, deviation and carrier offset settings have been selected, the `Save Protocols` routine must be executed to apply the selected settings.

4.5 Fan Control

The transmitter has two fans for cooling; the front fan is an intake and the rear fan is the exhaust.

4.5.1 Current Fan Speed

The current fan speed displays the target fan speed by the fan controller as a percentage of total possible fan speed. This value is set by the paging transmitter and depends on the fan control type, current temperature, whether fan override is enabled or a fan test is in progress.

4.5.2 Control Types

The fans have two control types:

- **On/off:** The fans will turn on and off at a specified temperature. The fans turn on at the speed specified by the fan speed setting parameter.
- **Linear scaling:** The fans will increase in speed as the transmitter heats up. The fan turn on and fan turn off temperatures determine the how quickly the fans respond to increases in temperature. Once the temperature exceeds the fan turn on temperature, the fans will then be set to full speed.

The fan control types act from a configurable temperature sensor. By default the fan controller will use the highest temperature of all the temperature sensors.

4.5.3 Fan Override

There is a fan override feature available to force the fans to turn on at full speed. When fan override is enabled the fans will ramp up to full speed and ignore the configured control type. Otherwise, the fans turn off and on as specified by the control type.

4.5.4 Self-Test

The fan controller has a self-test feature which causes the fans to run at full speed for a minute so fan operation can be verified. The self-test feature runs once every 24 hours by default.

5. Diagnostics

5.1 Status Monitoring

The paging transmitter has a number of sensors which are continuously monitored. The sensors are used to monitor:

- Internal voltage and current levels.
- Ambient and transmitter temperature.
- Fan operation.
- Transmitted and reflected power.

Each sensor has configurable upper and lower cut-offs that will cause a fault when exceeded. For example, if the driver temperature upper cut-off is exceeded, the high driver temperature fault will be set active.

For a full list of sensors monitored by the transmitter and their tracked units and value range see Appendix E.

5.1.1 Conditional Cut-off Checking

Some sensors are only compared against their upper and lower cut-offs under certain conditions, such as when the transmitter is on. The following sensors have conditional cut-off checking:

During transmission:

- Exciter current.
- PA current.
- Driver current.
- Reverse power.
- Transmit power.
- Driver power.
- Exciter power.
- Isolator VSWR.

While the fans are turned on to full speed:

- Fan 1 and 2 current.
- Fan 1 and 2 RPM.

A sensor that falls outside its cut-offs while its checking condition is met will cause the respective fault to become active. The fault will only be cleared once it has returned to within its cut-offs while its checking condition is met.

5.1.2 Minimum and Maximum Sensor History

When a sensor exceeds a previous minimum or maximum value for that sensor, the new minimum or maximum value is saved to non-volatile storage. The minimum and maximum sensor values also use the conditional cut-off checking. For example, minimum and maximum transmit power values are only recorded during transmission.

5.2 Faults

Undesirable operating conditions are reported using the faults feature of the paging transmitter. In most circumstances the paging transmitter should not have any active faults. Active faults indicate incorrect setup, a hardware issue or misconfiguration of the paging transmitter.

Faults can be in one of four states:

- **Inactive:** The fault is inactive.
- **Fleeting:** The source of the fault is currently active; however it has not been active longer than the minimum fault duration setting.
- **Active:** The source of the fault is currently active.
- **Latched:**
 - For Faults: The fault was previously active but the source of the fault is no longer present.
 - For Fault Actions: The fault action has been carried out.

A list of possible faults can be found in Appendix E.

5.2.1 Fault Actions

Each fault can be configured to perform an action when the fault transitions from the inactive (or fleeting) to the active or latched state. The actions that are taken due to a fault are called *Fault Actions*. There are five fault actions:

- **Reference switchover:** The paging transmitter switches to the internal reference.
- **Disable transmission:** Any current transmission is interrupted, the transmitter is keyed down and future transmissions are disabled.
- **Scale transmit power:** Transmit power is reduced.
- **Enable PA current fold-back:** The PA current fold-back is engaged.
- **Enable reverse power fold-back:** The reverse power fold-back is engaged.

Each fault action operates as a fault itself; therefore when a fault action is taken, it can be seen as latched in the faults menu and logged in the fault history. Fault actions are latch-only and can only be cleared through user intervention. Any actions performed are reverted once the fault action is cleared.

To protect the paging transmitter hardware fault actions can only be changed by users with the distributor password.

5.2.2 Fleeting Faults

The minimum fault duration parameter determines how long the source of a fault is active until it is reported to the fault interface. A fault that does not reach the minimum fault duration will not be logged, activate a hardware alarm or trigger a fault action.

5.2.3 Combined Fault

The combined fault is an optional fault that will become active if any fault within a selected set becomes active. Each fault can be configured to be part of the combined fault set. The combined fault will only become inactive when all of the faults in the configured set return to inactive. The combined fault can have a hardware alarm output configured.

5.2.4 Hardware Alarm Outputs

Each fault may have a hardware alarm output associated with its state (see Appendix A.4 for the LIU interface pin-outs). When the fault is in the active or latched state, it will set its respective alarm active. Multiple faults can share the same alarm output. The alarm output will only be set inactive if all of the faults that use that alarm output are inactive or fleeting.

A list of hardware alarms available can be found in section 3.7.

5.3 Remote Firmware Update and Recovery

5.3.1 Update

The remote firmware update feature can be used to upload a firmware update to a paging transmitter for feature additions and bug fixes. Remote firmware update requires a Cruise Control connection to the paging transmitter and a valid RFI-148 250 firmware image in the Motorola S-Record format (*.mot).

Cruise Control sends the firmware image to the paging transmitter and the paging transmitter stores it in non-volatile storage. Once the image has been fully received the paging transmitter verifies the integrity of the image. If the image is valid the paging transmitter can then load the new firmware image.

The paging transmitter will not update to a new firmware image downloaded using the remote update feature unless it has a valid recovery image (see section 5.3.2).

5.3.2 Recovery

The paging transmitter can save the current firmware and configuration to non-volatile storage. The recovery image can be reverted to in case of configuration loss, or a new firmware image loaded has undesired behaviour.

After a firmware recovery the paging transmitter will latch a firmware update exception fault.

5.4 Time

5.4.1 Real Time Clock

A real time clock is used to track the passage of time. The clock is used for:

- Keeping a time-stamped history of faults.
- A short history of transmitter events (PTT on, off).

5.4.2 SNTP Client

The transmitter supports time synchronisation using the Simple Network Time Protocol (SNTP) version 4.

MODES OF OPERATION

The SNTP client has three modes of operation:

- **Disabled:** The paging transmitter will not perform any time synchronisation.
- **Unicast:** The paging transmitter will query a time server for time updates.
- **Broadcast:** The paging transmitter will listen for time server updates.

In unicast mode the IP address of the time server must be specified. By default, the paging transmitter will query the time server at start-up and once per hour and wait a maximum of 10 seconds for a response.

TIME ZONE

The time zone can be specified in hours and minutes as an offset from Coordinated Universal Time (UTC).

Appendix A Technical Specifications

A.1 Type Approvals

Australia / New Zealand	AS NZS 4769.1	Australian Supplier ID: N161
FCC	CFR 47 Part 15 and Part 90	FCC ID PSM RFI148
ETSI (Planned)	ETS 300 113	N/A

Table 3: Type approvals

A.2 RFI-148 250 Specifications

RF Operating Bandwidth	138 MHz – 174 MHz
RF Switching Bandwidth	2 MHz
RF Channel Bandwidth	12.5 kHz, 25 kHz
RF Frequency Raster	Selectable: 25 kHz, 12.5 kHz, 6.25 kHz, 5 kHz
RF Output	20 to 250 Watts
Internal Reference	Frequency: 10 MHz Stability: +/- 1 ppm (-30 to +75 degrees C)
Modulation	- POCSAG 512, 1200, 2400 bps (2-level FSK). - FLEX 1600 (2-level FSK), 3200 (2- or 4-level FSK), 6400 bps (4-level FSK).
Ethernet Port	10BASE-T/100BASE-TX, auto-negotiating.
Serial Ports	Dual asynchronous full-duplex RS-232 (DTE) Baud rates: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps Data bits: 7 or 8 Parity: None, odd, or even Stop bits: 1 or 2 Flow control (main port only): None or hardware (RTS/CTS) Control lines (main port only): RTS, CTS, DTR, DCD
Digital Inputs	TTL Schmitt trigger with internal 100 K Ω pull-up. - Frequency Select 1 - Frequency Select 2 - Frequency Select 3 - Frequency Select 4 - Protocol Select - Hardware PTT - Tx Data L-bit - Tx Data H-bit - Transmit Clock
Alarm Outputs	Open-collector Darlington with 500 mA sink current.

	• Power Supply Alarm • Reference Out-of-Lock Alarm • Reference Switchover Alarm • High Output Power Alarm • Low Output Power Alarm • High VSWR Alarm • High Temperature Alarm • Fan Failure Alarm • Exciter Out-of-Lock Alarm • Combined Alarm • Spare Alarm 1 • Spare Alarm 2 • Spare Alarm 3 • Spare Alarm 4
Input Voltage	DC: 20 V to 31.2 V
Typical Current Draw at 24 V DC.	Fans off: • Idle: 0.3 A • 25 W: 7.0 A • 100 W: 12.5 A • 250 W: 20.3 A Fans on: • Idle: 0.6 A • 25 W: 7.4 A • 100 W: 13.1 A • 250 W: 20.9 A
Connectors	Power: Terminal Block Main Serial Port (Rear): DE-9 RS-232 Male (DTE) Auxiliary Serial Port (Front): DE-9 RS-232 Female (DCE) LIU Interface: DC-37 Female Ethernet: RJ45 RF Output: N-type female 50 Ω Sniffer Port Output: BNC female 50 Ω External Reference Input: BNC female

Table 4: RFI-148 250 Specifications

A.3 Serial Connectors

A.3.1 Main Serial Port (Rear)

Pin	Function	Direction
1	DCD	Input
2	RxD	Input

3	TxD	Output
4	DTR	Output
5	GND	
6	N/A	
7	RTS	Output
8	CTS	Input
9	N/A	

Table 5: Back Panel Connector Pin Out

A.3.2 Auxiliary Serial Port (Front)

Pin	Function	Direction
1	N/A	
2	RxD	Output
3	TxD	Input
4	N/A	
5	GND	
6	N/A	
7	N/A	
8	N/A	
9	N/A	

Table 6: Front Connector Pin Out

A.4 LIU Interface

Pin	Function	Direction
1	Protocol Select	Input
2	Reference Switchover Alarm	Output
3	Spare Alarm 1	Output
4	Spare Alarm 2	Output
5	Frequency Select 4	Input
6	Frequency Select 3	Input
7	Frequency Select 2	Input
8	Frequency Select 1	Input
9	GND	
10	GND	
11	Hardware PTT	Input

12	Combined Alarm	Output
13	N/A	
14	Power Supply Alarm	Output
15	Tx Data L-bit	Input
16	Tx Data H-bit	Input
17	LIU Detect	Input
18	Tx Data Clock	Input
19	GND	
20	Reference Out-of-Lock Alarm	Output
21	High Temperature Alarm	Output
22	High Output Power Alarm	Output
23	Spare Alarm 3	Output
24	Spare Alarm 4	Output
25	N/A	
26	Exciter Out-of-Lock Alarm	Output
27	N/A	
28	N/A	
29	Low Output Power Alarm	Output
30	High VSWR Alarm	Output
31	Fan Failure Alarm	Output
32	+5 V	Output
33	+5 V	Output
34	+12 V	Output
35	+12 V	Output
36	+24 V (Note: identical to DC input voltage)	Output
37	+24 V (Note: identical to DC input voltage)	Output

Table 7: LIU Interface Pin Out

Appendix B Controller Configurations

The following section provides example wiring between the transmitter and some common controllers.

B.1 Motorola NIU Controller / FLEX Mode

External NIU(TB3, TB4)	Transmitter (LIU, DB37)
TB3-2: Tx Clock	DB37-18: TX SYNC CLK
TB3-4: Tx key	DB37-11: TX ON EXT
TB3-8: GND	DB37-19: GND
TB4-2: Rx FQ1	DB37-16: TX DATA H-BIT
TB4-3: Rx FQ2	DB37-15: TX DATA L-BIT

Table 8: Motorola NIU controller / FLEX mode connection

B.2 Glenayre C2000 Controller / FLEX Mode

C2000 (J4)	Transmitter (LIU, DB37)
J4-10: GND	DB37-19: GND
J4-26: TXKEY+	DB37-11: TX ON EXT
J4-3: TD0+, MSB	DB37-15: TX DATA L-BIT
J4-34: TD1+, LSB	DB37-16: TX DATA H-BIT
J4-18: Data Clock+	DB37-18: TX SYNC CLK
J4-7: Freq2	DB37-6: FREQ SEL LINE 3
J4-6: Freq1	DB37-7: FREQ SEL LINE 2
J4-36: Freq0	DB37-8: FREQ SEL LINE 1

Table 9: Glenayre C2000 controller / FLEX Mode connection

B.3 Glenayre C2000 Controller / POCSAG Mode

Encoder	Transmitter (LIU, DB37)
Tx Data	DB37-15: TX DATA L-BIT
PTT	DB37-11: TX ON EXT
GND	DB37-19: GND

Table 10: Glenayre C2000 controller / POCSAG mode connection

B.4 Zetron Model 66 Transmitter Controller / POCSAG Mode

Model 66	Transmitter (DB37)
DIG DATA (pin 10)	DB37-15: TX DATA L-BIT
DIG PTT (pin 7)	DB37-11: TX ON EXT
GND (pin 3)	DB37-19: GND

Table 11: Zetron Model 66 controller / POCSAG mode connection

Appendix C Management Reference

C.1 Serial Port Diagnostics

Name	Description	AT
Rx Total	The size of the input buffer.	I20 [p, 0]
Rx Used	The number of bytes currently stored in the input buffer.	I20 [p, 1]
Rx Bytes	The total number of bytes received.	I20 [p, 2]
Rx Errors	The total number of receive errors that have occurred. Sum of Rx Overflows, Rx Overruns, Rx Framing, and Rx Parity errors.	I20 [p, 3]
Rx Overflows	The number of receive overflow errors that have occurred. An overflow occurs when data is received, but the buffer is full.	I20 [p, 4]
Rx Overruns	The number of overrun errors that have occurred. An overrun occurs when the device is overloaded and cannot handle the incoming data.	I20 [p, 5]
Rx Framing	The number of framing errors that have occurred. Framing errors usually occur due to mismatched serial port baud rates.	I20 [p, 6]
Rx Parity	The number of serial parity errors that have been detected.	I20 [p, 7]
Tx Total	The size of the output buffer.	I20 [p, 8]
Tx Used	The number of bytes currently stored in the output buffer.	I20 [p, 9]
Tx Bytes	The total number of bytes that have been transmitted.	I20 [p, 10]
Tx Errors	The total number of errors that have occurred while transmitting. This is equal to the Tx Overflows count.	I20 [p, 11]
Tx Overflows	The number of transmit overflow errors that have occurred. This occurs when there is data to transmit, but the buffer is full.	I20 [p, 12]

Table 12: Serial Port Statistics

C.2 SNMP Diagnostic Parameters

SNMP Textual Name	Description
Radio parameters	
rfiChnChnCtrlChnnlsTable rfiChnChnCtrlChnnlsEntry rfiChnChnCtrlChnnlsIndex	Table of frequencies for all radio channels.
rfiChnChnCtrlChnnlNmbr	Radio channel number.
rfiChnChnCtrlTxFrq	Radio channel transmit frequency.
Faults	

rfiCrFltsFltIdxTable rfiCrFltsFltIdxEntry rfiCrFltsFltIdxIndex	Table containing configuration and status of all fault conditions.
rfiCrFltsFltNm	Name of the fault in this row of the table.
rfiCrFltsFltStts	Indicates whether or not this fault condition is currently active.
rfiCrFltsActvDrtn	Duration for which this fault has been active, or 0 if the fault is not active.
rfiCrFltsFltActn	Configured action to be taken when this fault occurs.
rfiCrFltsCntr	The number of times this fault has occurred since the statistics were reset.
Sensors	
rfiCrSnsMnSttsPrmTable rfiCrSnsMnSttsPrmEntry rfiCrSnsMnSttsPrmIndex	Table of parameters associated with sensors.
rfiCrSnsMnCrrVl	Current measured sensor value.
rfiCrSnsMnMxVl	Maximum possible sensor value.
rfiCrSnsMnMnVl	Minimum possible sensor value.
rfiCrSnsMnCrrStt	Current fault status associated with this sensor.
rfiCrSnsMnUppCtff	Upper cutoff value for this sensor. Measurements which exceed this cutoff cause a fault.
rfiCrSnsMnLwCtff	Lower cutoff value for this sensor. Measurements lower than this cutoff cause a fault.
Identity	
rfiCrIdntGtSrlNmbr	Factory assigned serial number for this device.
rfiCrIdntGtMnfctrDt	Date on which this device was manufactured.
rfiCrIdntApprvlCd	International type approval code which applies to this device.
rfiCrIdntUptmHrs	An approximation of the total number of hours that this device has been powered up.
rfiCrIdntGtFrmwrVrStr	Version information for the firmware loaded in this device.

Table 13: SNMP Diagnostic Parameters

Appendix D Hayes References

D.1 General Commands

Command	Name	Notes
ATI100	Read All Sensors	Returns a list of the current value of all sensors, separated by commas and ended by a period, carriage return and line feed. See Appendix E for the sensor reference.
ATI101	Read Active Faults	Returns either: a variable list of active fault indexes separated by commas; or "None", followed by a period, line feed and carriage return. See Appendix E for the fault reference.
ATI102	Read Upper Sensor Limits	Returns a list of the current upper sensor cut-offs for all sensors, separated by commas and ended by a period, carriage return and line feed. See Appendix E for the sensor reference.
ATI103	Read Lower Sensor Limits	Returns a list of the current lower sensor cut-offs for all sensors, separated by commas and ended by a period, carriage return and line feed. See Appendix E for the sensor reference.
AT&F1	Factory Reset	Resets all settings to factory defaults.
AT&T9	Reset	Causes the device to reboot.
AT?	Enable Menu	Starts the terminal menu this port.
AT%30	Enable Cruise Control	Enables Cruise Control on this port. Waits for 10 seconds after executing with no further data input to return to normal Hayes mode.

Table 14: Hayes General Commands

D.2 I-Registers

Command	Name	Notes
ATI0	Product String	Returns the product string.
ATI4	Version String	Returns the version string.
ATI5	Manufacture Date	Returns the manufacture date.
ATI6	Serial Number	Returns the device serial number.
ATI20[p, s]	Serial Port Statistics	Returns a serial port statistic where <i>p</i> selects port (0: main, 1: auxiliary) and <i>s</i> selects statistic (0 to 12, in the order listed in Table 12).

ATI90 [<i>p</i>]	Current status parameter	Returns the current value of a status parameter where <i>p</i> selects a parameter. See Appendix E for the sensor reference.*
ATI91 [<i>p</i>]	Maximum status parameter	Returns the maximum recorded value of a status parameter. See Appendix E for the sensor reference.*
ATI92 [<i>p</i>]	Minimum status parameter	Returns the minimum recorded value of a status parameter. See Appendix E for the sensor reference.*
ATI93 [<i>p</i>]	Status parameter upper cut-off	Returns the upper cut-off value of a status parameter where <i>p</i> selects a parameter. See Appendix E for the sensor reference.*
ATI96 [<i>p</i>]	Status parameter lower cut-off	Returns the lower cut-off value of a status parameter where <i>p</i> selects a parameter. See Appendix E for the sensor reference.*
ATI151	Clear All Latched Faults	Clears all faults in the latched state.

Table 15: Hayes I-Register Commands

* The parameter *p* is an integer index, as shown in the Index column of Table 17

Command	Name	Notes
ATS45	Transmit Power	Get or set transmit power in Watts.
ATS54	Current Channel	Get or set the current channel.
ATS100 [<i>p</i>]	Baud	Get or set the baud rate for serial port <i>p</i> . 1: 300 2: 600 3: 1200 4: 2400 5: 4800 6: 9600 8: 19200 9: 38400 10: 57600 11: 115200
ATS101 [<i>p</i>]	Parity	Get or set the parity for serial port <i>p</i> . 0: None 1: Even 2: Odd
ATS102 [<i>p</i>]	Data Bits	Get or set the data bits for serial port <i>p</i> . 0: 7 1: 8
ATS103 [<i>p</i>]	Stop Bits	Get or set the stop bits for serial port <i>p</i> .

Command	Name	Notes
		0: 1 1: 2
ATS104	Main Port Flow Control	Note that this command cannot have a [p] port specifier. 0: None 2: Hardware (RTS / CTS)
ATS180	Enable Hardware Frequency Select	0: Disabled 1: Enabled

Table 16: Hayes S-Register Commands

Appendix E Sensor and Fault List Reference

Index	Sensor	Unit	Range	Default Upper Cut-off	Default Lower Cut-off
0	PA Temp	°C	-128 to 126	80	-20
1	Driver Temp	°C	-128 to 126	80	-20
2	PA Ambient Temp	°C	-128 to 126	80	-20
3	Isolator Temp	°C	-128 to 126	80	-20
4	Baseband Temp 1	°C	-128 to 126	60	-20
5	Baseband Temp 2	°C	-42 to 152	60	-20
6	24V Voltage	mV	0 to 32767	30000	18000
7	12V Voltage	mV	0 to 14833	15000	10000
8	5V Voltage	mV	0 to 6649	6000	4000
9	3.3V Voltage	mV	0 to 4347	4000	2500
10	24V Current	mA	0 to 3296	1500	200
11	12V Current	mA	0 to 3296	2500	300
12	5V Current	mA	0 to 2197	1200	350
13	3.3V Current	mA	0 to 3296	900	400
14	Exciter Current	mA	0 to 999	700	200
15	PA Current	mA	0 to 24951	20000	14000
16	Driver Current	mA	0 to 2495	800	300
17	Supply Current	mA	0 to 30742	21000	200
18	Fan 1 Current	mA	0 to 1636	450	100
19	Fan 2 Current	mA	0 to 1636	450	100
20	Fan 1 Speed	RPM	0 to 32767	2700	1900
21	Fan 2 Speed	RPM	0 to 32767	2700	1900
22	Reverse Power	W	0 to 86	16	0
23	Transmit Power	W	0 to 650 (typical)	275	225
24	Driver Power	W	0 to 1714	18	8
25	Exciter Power	mW	0 to 21977	700	200
26	Isolator VSWR	10 ⁻³ :1	0 to 32767	2000	0

Table 17: Sensor Reference

Index	Fault	Latching	Default Fault Action	Default Alarm
0	High PA Temperature	Configurable	Disable Transmission	High Temperature
1	High Driver Temperature	Configurable	Disable Transmission	High Temperature
2	High PA Ambient Temperature	Configurable	Disable Transmission	High Temperature
3	High Isolator Temperature	Configurable	Disable Transmission	High Temperature
4	High Baseband 1 Temperature	Configurable	None	High Temperature
5	High Baseband 2 Temperature	Configurable	None	High Temperature
6	High 24V Voltage	Configurable	None	Power Supply
7	High 12V Voltage	Configurable	None	Power Supply
8	High 5V Voltage	Configurable	None	Power Supply
9	High 3.3V Voltage	Configurable	None	Power Supply
10	High 24V Current	Configurable	None	Power Supply
11	High 12V Current	Configurable	None	Power Supply
12	High 5V Current	Configurable	None	Power Supply
13	High 3.3V Current	Configurable	None	Power Supply
14	High Exciter Current	Configurable	None	Power Supply
15	High PA Current	Configurable	Enable Current Foldback	Power Supply
16	High Driver Current	Configurable	None	Power Supply
17	High Supply Current	Configurable	None	Power Supply
18	High Fan 1 Current	Configurable	None	Fan Failure
19	High Fan 2 Current	Configurable	None	Fan Failure
20	High Fan 1 RPM	Configurable	None	Fan Failure
21	High Fan 2 RPM	Configurable	None	Fan Failure
22	High Reverse Power	Configurable	Enable Reverse Power Foldback	None
23	High Transmit Power	Configurable	Scale Transmit Power	High Power
24	High Driver Power	Configurable	None	None
25	High Exciter Power	Configurable	None	High Power
26	High Isolator VSWR	Configurable	None	High VSWR
27	Low PA Temperature	Configurable	None	None
28	Low Driver Temperature	Configurable	None	None
29	Low PA Ambient Temperature	Configurable	None	None

30	Low Isolator Temperature	Configurable	None	None
31	Low Baseband Temperature 1	Configurable	None	None
32	Low Baseband Temperature 2	Configurable	None	None
33	Low 24V Voltage	Configurable	None	Power Supply
34	Low 12V Voltage	Configurable	None	Power Supply
35	Low 5V Voltage	Configurable	None	Power Supply
36	Low 3.3V Voltage	Configurable	None	Power Supply
37	Low 24V Current	Configurable	None	Power Supply
38	Low 12V Current	Configurable	None	Power Supply
39	Low 5V Current	Configurable	None	Power Supply
40	Low 3.3V Current	Configurable	None	Power Supply
41	Low Exciter Current	Configurable	None	Power Supply
42	Low PA Current	Configurable	None	Power Supply
43	Low Driver Current	Configurable	None	Power Supply
44	Low Supply Current	Configurable	None	Power Supply
45	Low Fan 1 Current	Configurable	None	Fan Failure
46	Low Fan 2 Current	Configurable	None	Fan Failure
47	Low Fan 1 RPM	Configurable	None	Fan Failure
48	Low Fan 2 RPM	Configurable	None	Fan Failure
49	Low Reverse Power	Configurable	None	None
50	Low Transmit Power	Configurable	None	Low Power
51	Low Driver Power	Configurable	None	None
52	Low Exciter Power	Configurable	None	None
53	Low Isolator VSWR	Configurable	None	None
54	External Reference Fail	Configurable	Reference Switchover	Reference Out-of-Lock
55	Internal Reference Fail	Configurable	None	None
56	Exciter Out-of-Lock	Configurable	Disable Transmission	Exciter Out-of-Lock
57	Transmit Timeout	Latch-only	Disable Transmission	None
58	PA Current Foldback	Configurable	None	None
59	Reverse Power Foldback	Configurable	None	None
60	Invalid Calibration	Latch-only	Disable Transmission	None

61	Watch Dog Reset	Latch-only	None	None
62	Assertion Reset	Latch-only	None	None
63	Firmware Update Exception	Latch-only	None	None
64	Reference Switchover	Latch-only	None	Reference Switchover
65	Disable Transmission	Latch-only	None	None
66	Scale Transmit Power	Latch-only	None	None
67	Enable PA Current Foldback	Latch-only	None	None
68	Enable Reverse Power Foldback	Latch-only	None	None

Table 18: Fault Reference

Appendix F Factory Defaults

If a setting is not specified in the factory defaults table then it is not changed during a factory reset.

Group	Parameter	Default Value
Transmitter Settings	Enable Transmit Timeout	True
	Transmit Timeout	600 s
	Default Reference	External
	Delay Correction	0 ms
	Auto PTT	Disabled
	Auto PTT Timeout	5 s
	PTT System Override	Enable Transmit
	PTT Turn Off Delay	0 s
	Isolator Mode	Set for Transmitting
	Fault Scaling Factor	50 %
	Raster	12.5 kHz
Paging Protocols	Protocol 2 Protocol	POCSAG 1200
	Protocol 2 Deviation	4500.0 Hz
	Protocol 2 Carrier Offset	0 Hz
Faults	Alarm and Fault Actions	See Table 18.
Fan Control	Fan Turn On Temperature	55 °C
	Fan Turn Off Temperature	40 °C
	Sensor To Use	Hottest Sensor
	Fan Speed Setting	100 %
	Control Method	On/off
Sensor Configuration	Upper and Lower Cut-off	See Table 17
Encoder Interface	Encoder Protocol Control	Disabled
	Encoder Frequency Control	Disabled
	Encoder Hardware PTT	Enabled
	Active Protocol	Protocol 1
	Clock Invert	Normal
	Data Invert	Normal
IP Networking	IP Address	192.168.1.80
	Subnet Mask	255.255.255.0
	Gateway	192.168.1.1
Serial Port	Main Flow Control	None
	Main DTR Mode	Always High

	Main RTS Mode	Always High
	Main Port Baud Rate	19200
	Main Port Data Bits	8
	Main Port Parity	None
	Main Port Stop Bits	1
	Auxiliary Port Baud Rate	19200
	Auxiliary Port Data Bits	8
	Auxiliary Port Parity	None
	Auxiliary Port Stop Bits	1
Diagnostics	SNTP Server	0.0.0.0 (Disabled)
	SNTP Query Interval	60 min
	Time Zone	+ 8:00

Table 19: Factory Defaults

Appendix G Glossary

BNC	British Naval Connector
CTS	Clear To Send
DCD	Data Carrier Detect
DCE	Data Communications Equipment (radio modem)
DTE	Data Terminal Equipment (computer device)
DTR	Data Terminal Ready
EIRP	Effective Isotropic Radiated Power
GUI	Graphical User Interface
PA	Power Amplifier
PTT	Push-To-Talk
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTS	Request To Send
Rx	Received
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
Tx	Transmitted
UTC	Coordinated Universal Time
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio

Table 20: Glossary

Index

Appendix

Controller Configurations		
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