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FCC Notification

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) This device may not cause harmful interference and 2) this device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by Thermo Electron Corporation (Thermo). Any changes or modifications made to the device without express written approval from Thermo may void the user's authority to operate the device.

Caution The radio has a maximum transmitted output power of 1 W. It is recommended that the transmit antenna be kept at least 9.06 inches (23 cm) away from nearby persons to satisfy FCC RF exposure requirements. ▲

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult Thermo or an experienced radio/TV technician for help.

Note Whenever any Thermo module is placed inside an enclosure, a label must be placed on the outside of that enclosure which includes the module's FCC ID. ▲

This product is licensed by the United States. Diversion contrary to U.S. law is prohibited.

Shipment or re-export of this product outside the U.S. may require authorization by the U.S. Bureau of Export Administration. Please contact Thermo for assistance and further information.

Contents

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Chapter 1
Product Overview

Introduction

Thermo Electron Corporation's AutoRADIO Wireless Modem is a synchronized wireless networking system. Each radio in the network is a half-duplex radio with frequency hopping spread spectrum features. In transmit mode, the base band receives data from an upper level data source and packetizes it into data packets. After adding the 16-bit CRC check, the radio is set to TX mode, and the PA is ramped up to the power level controlled by the ARM processor. The data train is then Gaussian filtered to reduce bandwidth occupation. The filtered pulse train modulates the frequency (FSK) generated by VCO and then converts to the desired frequency. The RF signal is then amplified to approximately 5 dBm. Frequency control is accomplished by the on-chip synthesizer, and the RF signal is then filtered to remove harmonics via a band pass filter. The radio hops frequency at a rate of 25 ms per hop.

In the receiving mode, the radio signal coming from the antenna is filtered by the band pass filter and amplified by a low-noise amplifier (LNA). After one conversion, the data is demodulated by an on-chip FM demodulator. The on-chip clock recovery circuits recover the clock from the received signal. The recovered data is then fed to the ARM processor.

A Baker code controls the frequency hopping pattern. Within the ISM band, there are 51 hops in each cycle.

The radio also comes with RSSI, automatic gain control, and data retransmission features.

Following is an overview of the instrument:

- Wireless, license-free FHSS modem
- Operates on the 902–928 MHz frequency band
- 16-bit CRC check for data integrity
- Nested private network
- Built-in diagnostic information
- Same footprint as Thermo's AutoWAVE®
- Low power
- Software performance optimization, no tweaking or manual adjustment

- Friendly hardware and software user interface
- Maintenance free

Modes of Operation

1. Normal mode: Radios are defaulted to work as point-to-multipoint. A network consists of a master radio broadcasting to multiple slaves and/or repeaters.

   Any two radios in this network may also be set up as private network or point-to-point using AT command set to dial the other radio ID. Once this link is established, these two radios will reject all data from the master or from the repeater radio.

   The radios will return to point-to-multipoint mode as soon as disconnect AT command is issued.

2. Boot Loader mode: With proper shorting on block JP3, the radio goes into the boot loader mode, allowing for the radio firmware upgrade function.

Components

Refer to Figure 1–1 for locations of the following components. Also reference the specifications section for additional detail.

- J182, antenna connector: SMA jack.
- JP3 (4-pin double row header): Radio operation mode select: normal or boot loader (firmware updates).
  - Place short-block or test jumper on pin 1 and pin 3 for boot loader mode; none for normal operating mode.
- JP2 (5-pin double row header): Radio configuration and diagnostics port. Must be connected in order to configure the radio via your PC or to perform diagnostics on the network. Works with configure-diagnostic PC cable (Thermo P/N 3-0420-024).

- LEDs: Indicate activity – Carrier Detect (CD), Transmit (TX), Receive (RX).
  - Master/repeater/slave ready, idle state:
    - CD = solid green
    - TX = off
    - RX = off
  - Slave and repeater not ready:
    - CD = flashing green (every second)
    - TX = flashing red (every second)
    - RX = flashing red (every second)
  - Slave ready, sleep state:
    - CD = flashing green (two times per second)
    - TX = off
    - RX = off
- JP1 (6-pin double row header): SPI connector. For future development.
- J320 (10-pin single row friction lock header): Firmware download. Data interface port and power connector. Must be connected for communications to be established. Voltage input may be 6 or 12 V.

Pin 1: Bat	Pin 6: GND
Pin 2: N/C	Pin 7: TX/RX+
Pin 3: N/C	Pin 8: DCD/TX+
Pin 4: GND	Pin 9: RTS/RX-
Pin 5: RX/TX-	Pin 10: N/C


J182 (SMA antenna connector)
Thermo Electron Corporation
AutoRADIO
Part Number : 3-0420-003
Model Number: FHSS1W12V
Serial Number: ENG-2
FCC ID: MCO-AR900
Canada: 2246A-AR900
Sugar Land TX 77478-2890. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: 1)This device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.
JP3
JP1
JP2
J320
LEDs

Figure 1–1.

Specifications

Table 1–1.

Radio Specifications	
Frequency range	902–928 MHz
Modulation	GFSK, frequency hopping spread spectrum
Channel spacing	500 KHz
Error detection	16-bit CRC
Output power	10 mW–1 W, programmable
Receive sensitivity	-110 dBm at 10^{-6} RAW BER
Input voltages	9–17 V and 4.5–10 V, version dependent
Current consumption	Model FHSS1W12V: TX 70 mA; RX 20 mA; Sleep 12 mA Model FHSS1W6V: TX 116 mA; RX 32 mA; Sleep 20 mA
Range	40 miles LOS (Line of Sight)

Approved Antennas

Table 1–2.

Omni-directional antenna specifications (Bluewave™ Marathon™ BMO902J)	
Application	Rugged antenna suitable for use at Master stations
Frequency band (MHz VSWR ≤ 1.5)	902–928 MHz
Nominal gain	11.15 dBi

Table 1–3.

Yagi antenna specifications (Bluewave™ Marathon™ BMY890K)	
Application	Rugged directional antenna suited for use at Remote stations
Frequency band (MHz VSWR ≤ 1.5)	890–960 MHz
Nominal gain (dBd, dBi > 1 GHz)	12.15 dBi

Consult Thermo for additional antenna options.

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Chapter 2
Installation

Transceiver

Installation requires special training and must be done by a professional installer only.

Transceiver location typically has a significant impact on the instrument's performance. In general, higher placement of the antenna ensures a better communication link. Additionally, the transceiver should be placed away from computers, telephones, answering machines, and other similar equipment.

Placement of the external antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference. It is also possible that slight adjustments in antenna placement will solve noise problems. Approved antennas include the Bluewave Marathon BMY890K Yagi antenna and the Bluewave Marathon BMO902J omni-directional antenna.

Note Power output of the radio system, including cable loss, the antenna gain, and insertion loss, should not exceed 36 dB EIRP. ▲

Cable Loss

The choice of feedline used with the antenna must be carefully considered. Thermo recommends using a low-loss cable type suited for 900 MHz, such as the Bluewave BW400 or LMR400. The following table lists the signal losses that result when using various lengths of this cable at 900 MHz.

Table 2–1. Cable length versus loss at 900 MHz

Cable type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)
BW400/LMR400	0.39 dB	1.95 dB	3.9 dB

Antenna System Gain

The following steps will enable to you determine the maximum allowable power setting of the radio:

1. Determine the antenna system gain. To do so, subtract the cable loss from the antenna gain. For instance, if the antenna gain is 10 dBi and the cable loss is 3.9 dB, the antenna system gain is 6.1 dB. Note that if the antenna system gain is 6 dB or less, no power adjustment is required.

2. Subtract the antenna system gain from 36 dBm, maximum allowable EIRP. The result is the maximum transmitted power allowed. Based on the example in step 1, this value is 29.9 dBm.

3. The radio transmit power parameter should be configured to equal or less than the output power value found in step 2. Set the power output using the Radio Transmit Power field in the Advanced Configuration screen (Chapter 3).

The following table provides several antenna system gains and the corresponding maximum allowable power setting of the radio.

Table 2–2. Antenna system gain versus power output setting

Antenna System Gain[1]	Maximum Power Setting (dB)	EIRP (dB)
6 dB or less	30 dB	36 dB
16 dB	20 dB	36 dB

[1] Antenna system gain calculated by subtracting cable loss in dB from antenna gain in dBi. If antenna gain is rated in dBd, convert to dBi by adding 2.15 dB.

Software

To install the software, the operating system must be running Microsoft® Windows® 98/NT/2000/XP (English versions). Insert the CD into the appropriate drive. The CD should automatically start. Follow the directions as they appear on the screen.

Chapter 3
Set Up

Hardware Configuration

1. Install the antenna to the radio board.
2. Apply power to the radio via the 2-position .200” connector on the serial PC cable. Observe polarity.
3. Connect the diagnostic cable from the PC to JP2 (see Figure 1–1).

Software Startup

Using the AutoRADIO startup software, you can fine tune certain parameters in order to optimize performance. When you open the software, the startup screen appears.

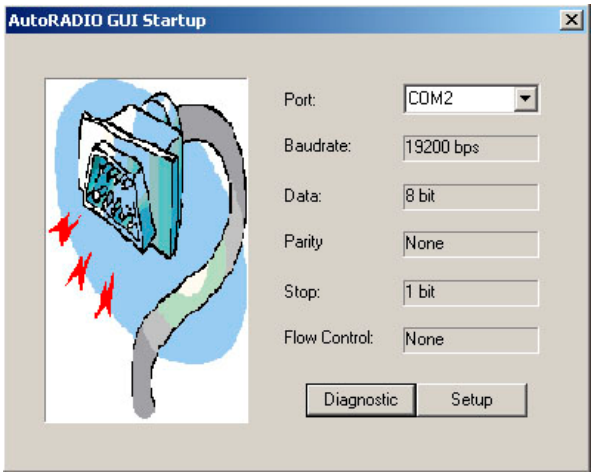

Figure 3–1.

Select the correct communications port from this screen. The remaining fields are read-only.

Click the Setup button to continue. On the following screen, click the Search Connected Radio tab, and the screen displays information pertaining to the connected instrument.

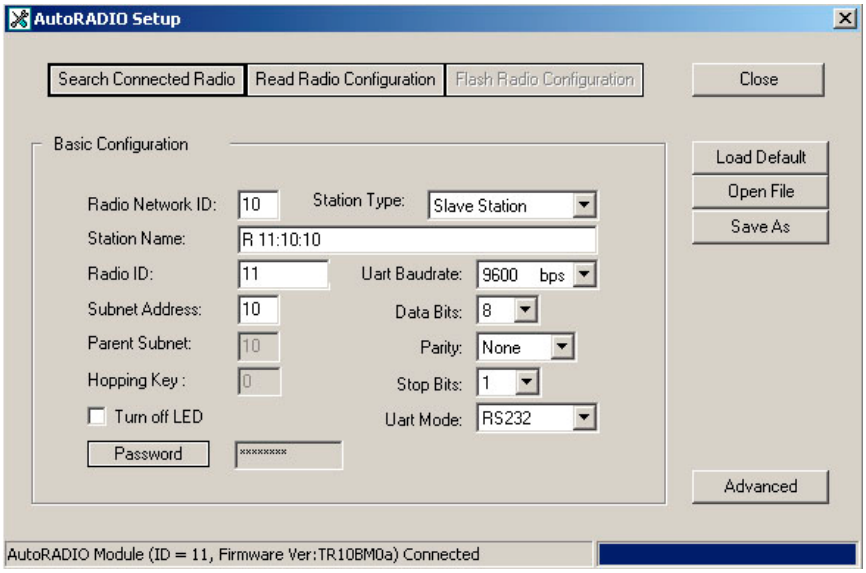

Figure 3–2.

Basic Configuration

From the screen shown in Figure 3–2, you can load the default configuration or a previously saved configuration. You can also edit the following parameters:

1. Radio Network ID: Enter a number from 1–255 for the radio network. The network ID enables slaves to identify and communicate only with masters or repeaters within the same network.

2. Station Type

   a. Master Station: Designate this instrument as the master that maintains network timing synchronization and broadcasts data to all radios in its subnet or cell.

   b. Slave Station: Designate the instrument as a slave within the network that responds to a network master or a repeater radio.

   c. Repeater Station: Designate the instrument as a repeater within the network. A repeater radio acts as a repeater by relaying data from the master radio or from another repeater radio; it also acts as a slave in a network. The repeater is used to increase coverage or distance to route radio signals around natural or manmade obstructions.

3. Station Name: Enter a name that enables you to easily identify the installed location. You can enter a maximum of 23 characters.

4. Radio ID: Enter a number from 1–65535 which identifies the radio. The assigned ID should be unique for every radio within a radio network. The maximum number of radios in the network is 65535.

5. Subnet Address: For master and slave stations, this is the number assigned to all radios within a particular cell. For repeater stations, it is the number of the cell to which the radio is relaying data.

6. Parent Subnet: This field is only selectable if you have set the radio as a repeater. A repeater radio relays data from a master or a repeater radio that has a matching subnet number with its parent subnet.

7. Hopping Key: This field is only selectable if you have set the radio as a repeater. Enter a number from 1–50. The default setting is 1. It is very important that the hopping key is different for every repeater located in the same cell with the master. The different hopping key will ensure that only repeater transmits in any instance.

   Use these guidelines to help you set a hopping key:

   a. Within the master radio cell, select a unique hopping key (1–25) for each of the repeaters.

   b. Select a hopping key (1–50) for any repeaters in a subsequent cell.

   c. Repeaters in subsequent cells may have the same hopping key.

8. Turn off LED: Enable this power-saving feature by clicking the check box. The 3 status indicator LEDs will turn off if checked.

9. Password: Click this button to enter or change a password. The default password field is none. A password is not required to configure the radio; however, if one is used, store it in a safe place where it can be retrieved if forgotten.

   Contact Thermo's engineering department if you need to reset the password. The radio configuration profile (filename.cfg) is needed for this task.

10. Uart Baud Rate: Select the baud rate of the data interface port, 115.2 Kbps maximum.

11. Data Bits: This selection applies to the data interface port.

12. Parity: This selection applies to the data interface port.

13. Stop Bits: This selection applies to the data interface port.

14. Uart mode: Select between serial RS232 or 4-wire RS485.

15. You can now save this configuration by clicking the Save As button or you can click the Advanced button to access additional parameters.

Advanced Configuration

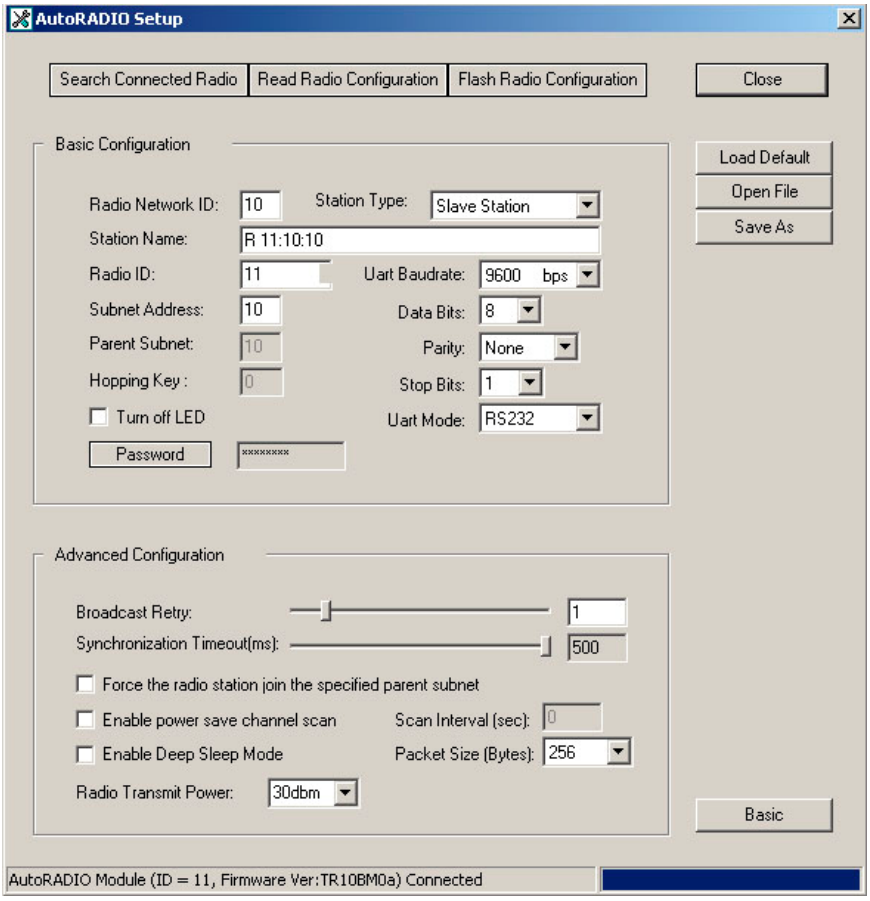

Figure 3–3.

1. Broadcast Retry: You can set the radio to attempt up to 8 retries.

2. Synchronization Timeout: You can set this field from 250–500 ms with 50 ms increments. This setting applies to the repeater and slave radios only. The repeater or slave radio will start the synchronization procedure and scan for the master once it is out of sync with the master for this amount of time.

3. Force a join with the specified parent subnet: This field is only available if the radio is set as a slave station. If not selected, the slave radio will try to talk to any repeater or master in a network.

4. Enable power save channel scan: This field is available if the radio is set as a slave or repeater station. If the radio loses sync with the master, it begins to continuously scan for the master signal. Enabling this feature allows you to set the radio to scan only at specified intervals (0–60 s).

5. Enable Deep Sleep Mode: This field is available only if the radio is set as a slave station. This feature causes the radio to power down once it has completed its transmission. Insert an RS232 space signal on RTS pin to bring the radio out of sleep mode.

6. Packet Size: Designate the size of the data packets used by the radio in its transmission. In noisy environments, it is often beneficial to use smaller data packet sizes to increase the chance that data is received at the other end.

7. Radio Transmit Power: Reducing the transmit power ensures that the radios do not overwhelm each other when used in close proximity. Follow these guidelines when setting radio transmit power:

Table 3–3. Radio transmit power settings

Setting	Power Level	Used
10 dBm	Low	Pair or pairs of radios operating within the same or adjoining rooms
20 dBm	Medium	More than one pair operating within the same facility
30 dBm	Full	Normal operation extending beyond a facility

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Chapter 4
Diagnostics

Clicking Diagnostic from the start-up screen enables you to view the diagnostics data from a network simultaneously with the application data. The diagnostics window is divided into two panes. The left pane displays all the network components, and the right pane displays the components of the selected item only.

Build a Network

The first step is to build a network.

1. Right-click in the left pane, and select New Network.

2. Enter the network ID in the dialog box that appears and click OK.

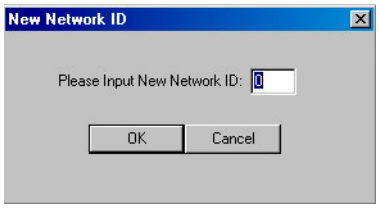

Figure 4–1.

3. Right-click on the network label that is now displayed in the left pane, and select New Station.

4. This first station should be the master.
   a. Enter a name that enables you to easily identify the station.
   b. Enter the subnet of the station.
   c. Enter the ID.
   d. You can also enter a brief description of the station.
   e. Click OK.

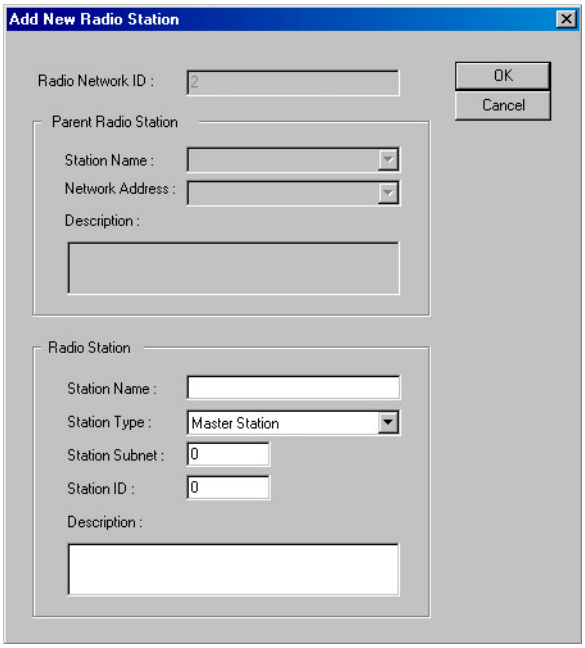

Figure 4–2.

5. The left pane now displays the master station you just set up. Right-click on it, and select New Station.

6. The dialog that opens contains the master station information. Set up this station as a slave or repeater station. Be sure to enter the same station ID for this unit that you entered during configuration. Click OK.

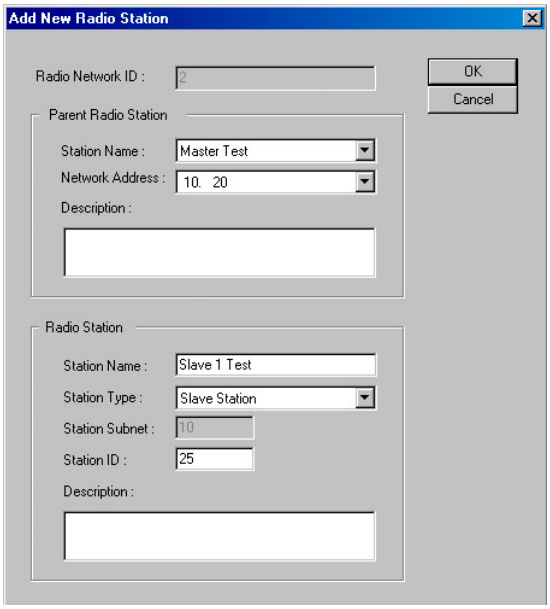

Figure 4–3.

7. The station is now displayed in the right pane. Repeat this process for each repeater or slave you want to add to this network.

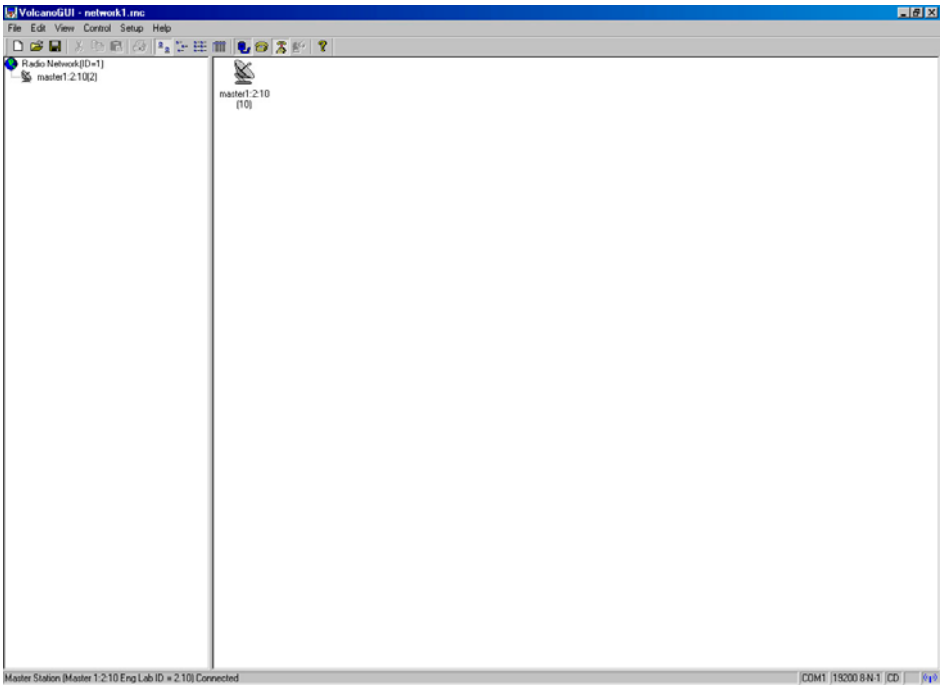

Figure 4–4. Example network with one slave station

8. You can save this network setup by clicking File, Save from the main window.

9. Repeat these steps to build additional networks as necessary.

Station Properties

View the configuration parameters of individual stations by right clicking on the station and selecting Station Property.

Tests

Right-click a station in the right pane to access the tests you can perform.

Dial

This option allows point-to-point link between two radios by dialing other radio ID. This link is most robust because transmit and received data are acknowledged.

Note that when in this operating mode, radios will ignore messages from other radios in the network, including master and repeater radios.

Loop Back Test

This test enables you to observe the transmit and receive performance of the selected unit. The unit sends data to the targeted radio, and the targeted radio returns the received data to the unit. Enter the size of the packet to be sent and the total number of packets to send. Click Start.

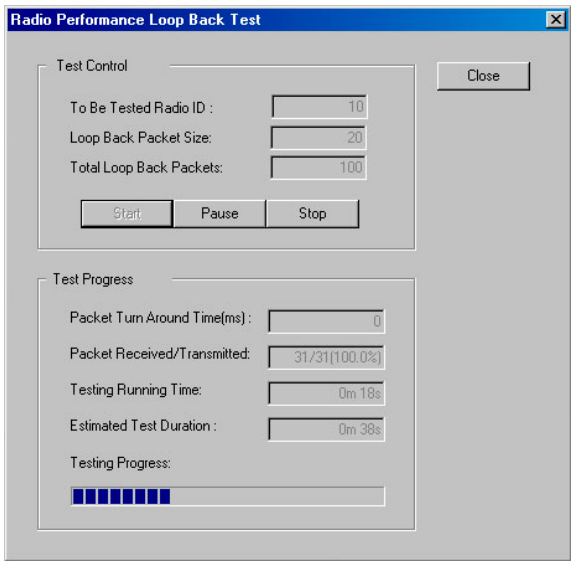

Figure 4–5.

RF Performance

This test provides status of channel performance on the synchronization data or beacon data and channel signal strength in a graph and text form. Click the Enable Auto Refresh button to receive updated data every 5 seconds.

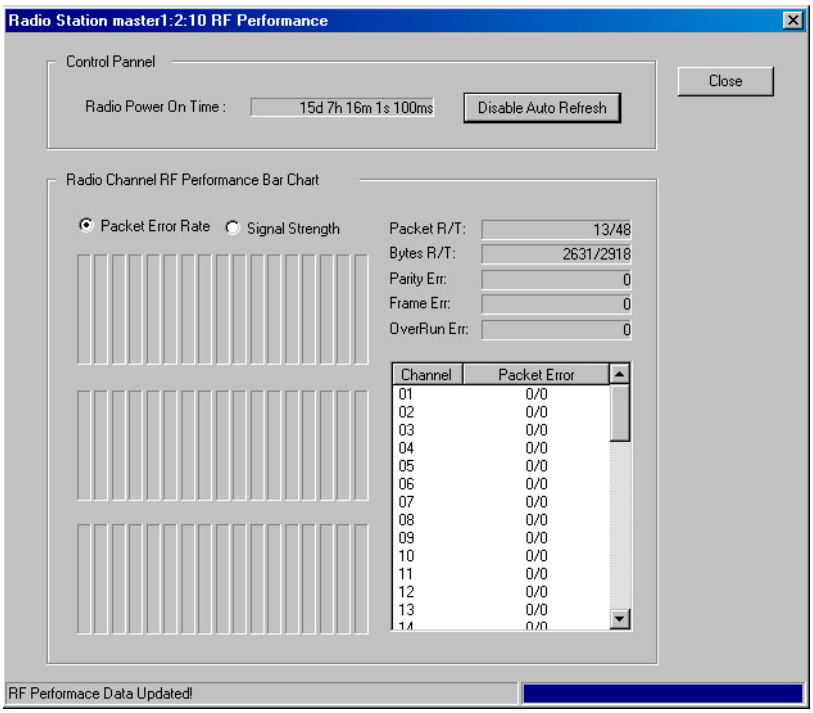
Radio Station master1:2:10 RF Performance
Control Pannel
Radio Power On Time :
15d 7h 16m 1s 100ms
Disable Auto Refresh
Close
Radio Channel RF Performance Bar Chart
Packet Error Rate
Signal Strength
Packet R/T:
13/48
Bytes R/T:
2631/2918
Parity Err:
0
Frame Err:
0
OverRun Err:
0
Channel
Packet Error
01 0/0
02 0/0
03 0/0
04 0/0
05 0/0
06 0/0
07 0/0
08 0/0
09 0/0
10 0/0
11 0/0
12 0/0
13 0/0
RF Performace Data Updated!

Figure 4–6.

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Chapter 5
Maintenance & Troubleshooting

Firmware Upgrade

Firmware in the instrument is stored in flash memory. This allows you to update software via a serial communications link. Use the Configuration/Diagnostic Software RS10MB0A to read the current firmware of the radio. Refer to the following for the firmware upgrade procedure for a 1-W radio.

1. Install the antenna to the radio board.

2. Install a short-block (jumper) at JP3 pins 1 and 3.

3. Apply power to the radio via the 2-position .200” connector on the serial PC cable. Observe polarity.

4. Run the OKI ISFP Flash Write Utility and configure parameters as follows (Figure 5–1):
   a. Port: Select the serial port to which the device is connected
   b. Baud Rate: 38400
   c. Frequency: 16 MHz
   d. Device ID: ML674002
   e. Filename: Point to the location of the firmware

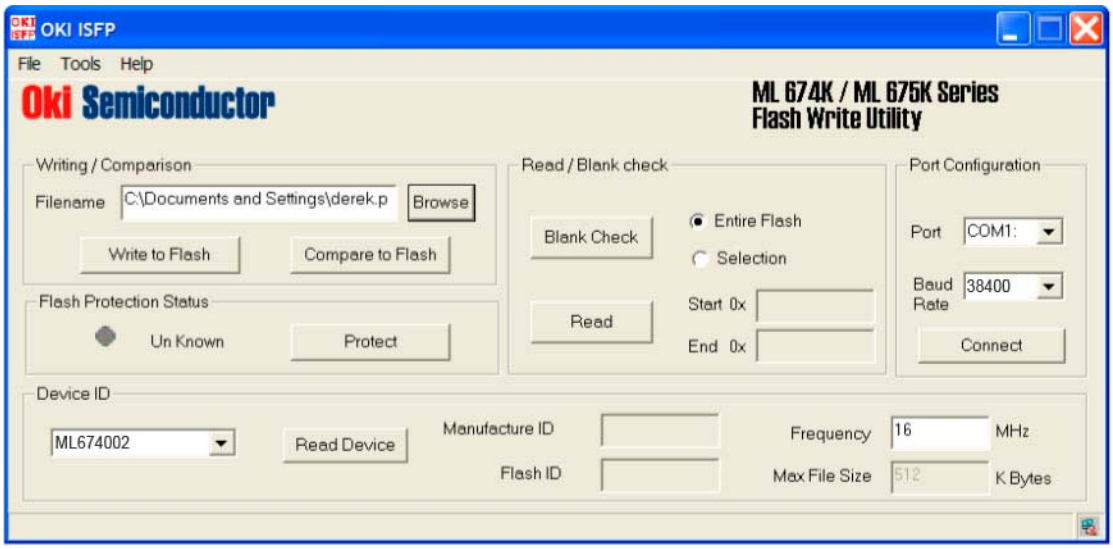

Figure 5–1.

5. Click the Connect button in the Port Configuration section of the screen and follow the on-screen instruction.

6. Click the Protect/Un-Protect button to put the device in the unprotected mode.

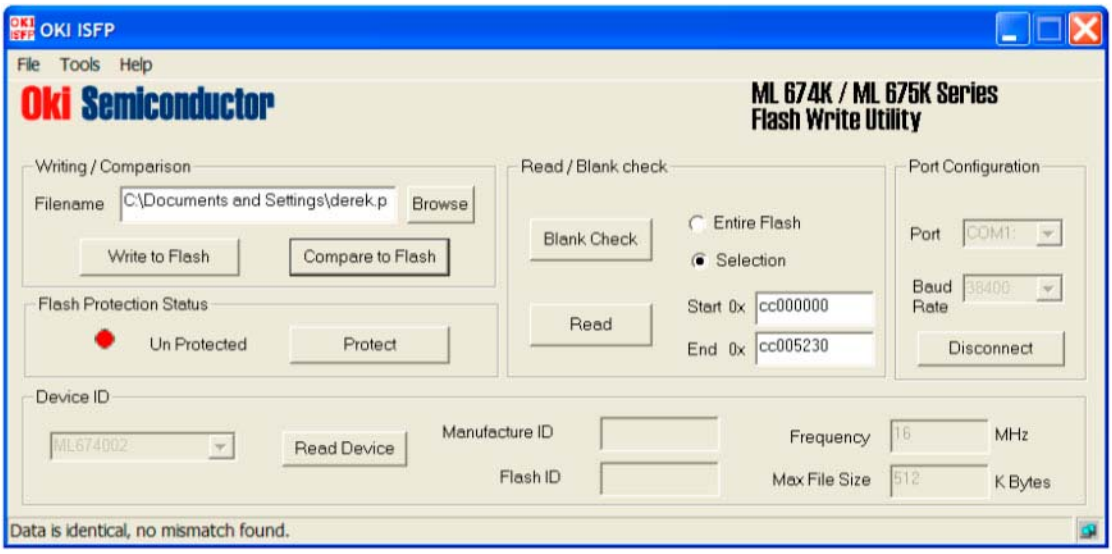

Figure 5–2.

7. Click the Write to Flash button and follow the on-screen instructions.

8. When the firmware download is complete, return the device to the protected mode.

9. Click the Disconnect button to disconnect the PC serial port.

10. Remove the short-block (jumper) at JP3 pins 1 and 3.

11. Recycle power into the radio board.

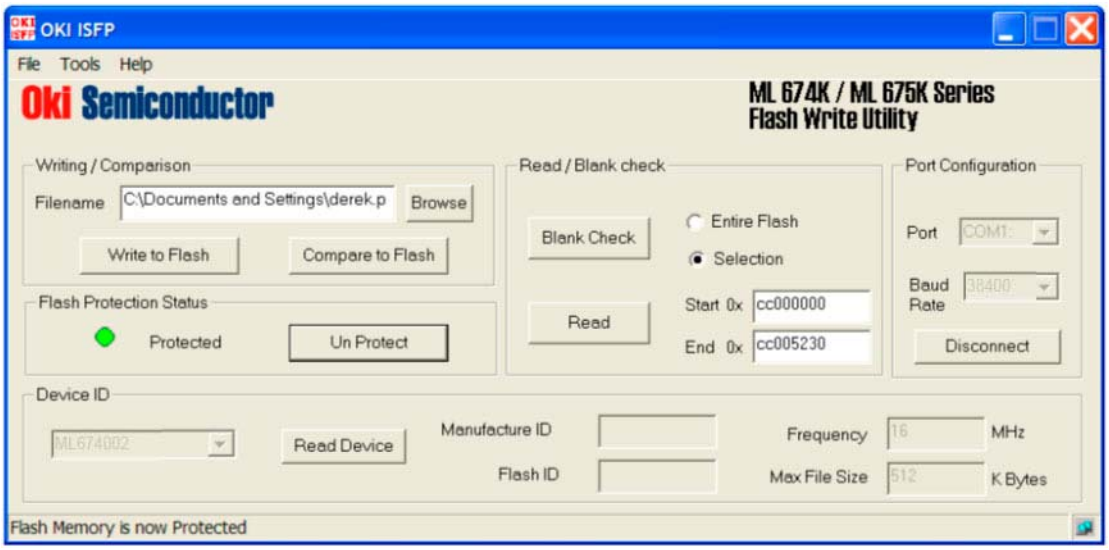

Figure 5–3.

This completes the firmware download procedure.

Service & Returns

Before returning an instrument, you must contact Thermo for a Return Material Authorization number. You can contact Thermo at:

Thermo Electron Corporation

Process Instruments Division

1410 Gillingham Lane

Sugar Land, TX 77478 USA

Phone: 713-272-0404

Fax: 713-272-2272

Web: www.thermo.com

Warranty

Thermo Electron Corporation (Thermo) products are warranted to be free from defects in material and workmanship at the time of shipment and for one year thereafter. Any claimed defects in Thermo products must be reported within the warranty period. Thermo shall have the right to inspect such products at Buyer's plan or to require Buyer to return such products to Thermo plant.

In the event Thermo requests return of its products, Buyer shall ship with transportation charges paid by the Buyer to Thermo plant. Shipment of repaired or replaced goods from Thermo plants shall be F.O.B. Thermo plant. A shop charge may apply for alignment and calibration services. Thermo shall be liable only to replace or repair, at its option, free of charge, products which are found by Thermo to be defective in material or workmanship, and which are reported to Thermo within the warranty period as provided above. This right to replacement shall be Buyer's exclusive remedy against Thermo.

Thermo shall not be liable for labor charges or other losses or damages of any kind or description, including, but not limited to, incidental, special, or consequential damages caused by defective products. This warranty shall be void if recommendations provided by Thermo or its sales representatives are not followed concerning methods of operation, usage, and storage or exposure to corrosive conditions.

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