

**Synthesized TSLM
Hi-Spec Integrated
Wireless Modem**

Synthesized TSLM Hi Spec Wireless Modem Installation Manual

December 2005 001-2200-101 Revision 0 © 2005 by Dataradio COR Ltd.

About Dataradio

Dataradio is the leading designer and manufacturer of trusted wireless products and systems for critical infrastructure applications. Our products have been found at the heart of mobile and SCADA data networks around the world for over 20 years. Dataradio products include mobile data products and systems, telemetry devices, integrated wireless modems for fixed point-to-point and point to multi-point applications and OEM solutions. Our product line is one of the broadest and most trusted in the industry.

Product Warranty

The manufacturer's warranty statement for this product is available in our manuals or by contacting COR Ltd. 299 Johnson Avenue, P.O. Box 1733, Waseca, MN 56093-0833. Phone (507) 833-8819.

www.dataradio.com

Dataradio provides product brochures, case studies software downloads and product information on our website.

Every effort is taken to provide accurate, timely product information in this technical manual. Product updates may result in differences between the information provided herein and the product shipped. The information in this document is subject to change without notice.

Dataradio is a registered trademark of Dataradio, Inc.

SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 GENERAL

This installation manual provides information for selecting, installing, operating, and maintaining the Dataradio TSLM wireless modem.

1.2 FEATURES

The TSLM is a transparent real-time wireless modem designed primarily for SCADA (Supervisory Control and Data Acquisition) and telemetry use. Features of the TSLM include:

- Data speeds of 4800 to 9600 b/s maximum in half-channels using a standard RS-232 interface
- Built-in 8 channel synthesized radio transceiver for VHF and UHF Power output of 0.10 W to 5 W (software controlled)
- Half duplex or simplex operation
- Transmit control via RTS
- Online diagnostics monitoring
- Offline local and remote diagnostics
- Compatible with Dataradio T-Base for base station or repeater use
- Compatible with any Dataradio Interoperability Standard (DI-OS) equipment including the T-96S for data rates of 4800 and 9600 b/s.

1.3 TSLM PART NUMBER BREAKDOWN

The following table shows the breakdown of the TSLM part number.

Table 1-1 TSLM Part Number Breakdown

| 242-22W0-XYZ | | | |
|---------------------|---------------|------------|----------|
| W | X | Y | Z |
| 1 VHF | 6 150-174 MHz | 1 12.5 kHz | 0 |
| | 7 137-162 MHz | 1 12.5 kHz | 0 |
| 4 UHF | 2 403-422 MHz | 1 12.5 kHz | 0 |
| | 2 414-430 MHz | 1 12.5 kHz | 1 |
| | 5 450-470 MHz | 1 12.5 kHz | 0 |

1.4 ACCESSORIES

Table 1-2 TSLM Accessories

| Accessory | DRL Part Number |
|------------------------------------|--|
| Unterminated Power Cable | 023-3276-007 |
| DE-15 to DB-9 Power and Data Cable | 697-0000-001 |
| Field Programming Kit | 250-2200-001 |
| Factory Mutual NI Kit | 023-1000-100 |
| Installation Manual for TSLM | 001-2200-102 (CD ROM version) 001-2200-101 (Hard Copy version) |
| DIN Rail Mount | 250-4800-406 |
| Switching Power Converter | 250-0300-075 (7.5 VDC VOut, 3 Amp) 250-0300-133 (12.5 VDC V Out, 3 Amp) |

For information about sales and accessories, contact your sales representative. In the U.S. phone 1-800-992-7774 or 1-507-833-8819.

1.5 TRANSCEIVER IDENTIFICATION

The transceiver identification number is printed on a label that is affixed to the PC board. The following information is contained in that number:

| Model | Revision Letter | Manufacturer Date | Plant | Warranty Number |
|-------|--------------------------|-------------------|-------|-----------------|
| 22W0 | 2 A Ninth Digit of PN | 455 Month Year | A | 12345 |

Figure 1-3 Transceiver Identification Nomenclature

1.6 PRODUCT WARRANTY

Dataradio warranties are available in Appendix B and are included in .pdf format on CD versions of Dataradio manuals.

1.7 FACTORY TECHNICAL SERVICE

The Technical Service Department of Dataradio COR Ltd. (DRL) provides customer assistance on technical problems and serves as an interface with factory repair facilities. They can be reached by mail, phone, and email at:

Dataradio COR Ltd. Technical Service Department 299 Johnson Avenue, P.O. Box 1733 Waseca,
MN 56093-0833

1-800-992-7774 or 1-507-833-8819 Fax: 507-833-6748

Email address: support@dataradio-cor.com

Technical Service hours: Monday through Friday 7:30 A.M. to 4:30 P.M. Central Time

1.8 REPLACEMENT PARTS

This product is not field serviceable, except by the replacement of complete units. Specialized equipment and training is required to repair logic boards and radio modules.

1.9 IF A PROBLEM ARISES...

Component level repair is not recommended on the TSLM. DRL's factory is best equipped to diagnose problems and make component level repairs. Contact Technical Service before returning equipment. A service technician may suggest a solution eliminating the need to return equipment.

1.9.1 FACTORY REPAIR

Dataradio products are designed for long life and failure-free operation. If a problem arises, factory service is available. Contact the Technical Service Department before returning equipment.

A Return Material Authorization (RMA) is required when returning equipment to Dataradio for repair. Contact the Technical Service Department at 1-800-992-7774 or 1-507-833-8819 (extension 6707) to request an RMA number. RMA's are available through our website at

www.dataradio.com/products_tech_adv.html. Be prepared to give the equipment model and serial number, your account number (if known), and billing and shipping addresses.

Include the RMA number, a complete description of the problem, and the name and phone number of a contact person with the returned units. This information is important. The technician may have questions that need to be answered to identify the problem and repair the equipment. The RMA number helps locate your equipment in the repair lab if there is a need to contact Dataradio concerning the equipment.

Units sent in for repair will be returned to the customer re-tuned to the current Dataradio Test and Tune Procedure and will conform to all specifications noted in this section

Customers are responsible for shipping charges (to Dataradio) for returned units in warranty. Units in warranty are repaired free of charge unless there is evidence of abuse or damage beyond the terms of the warranty. Dataradio covers return shipping costs for equipment repaired while under warranty.

Units out of warranty are subject to repair service charges. Customers are responsible for shipping charges (to and from Dataradio) on units out of warranty. Return shipping instructions are the responsibility of the customer.

1.10 EQUIPMENT DESCRIPTION

1.10.1 PHYSICAL DESCRIPTION

The TSLM consists of a logic printed circuit board (PCB) (which includes the modem circuitry) and a separate radio module. The two boards plug directly together, attach to a front panel and slide into a sheet metal case. The front panel includes a DE-15 data connector, a BNC antenna connector and two LED indicators. Power connections are made through the DE-15 data connector. The unit is not hermetically sealed and should be mounted in a suitable enclosure where dust and/or a corrosive atmosphere are anticipated. There are no external switches or adjustments. Operating parameters are set using software.

TSLM General Specifications

The following general specifications are subject to change without notice.

GENERAL

| | VHF | UHF |
|------------------------|---|--|
| Frequency | 137 - 174 MHz | 406.2 - 470 MHz |
| Channel bandwidth | 12.5 kHz | 12.5 kHz |
| Operating temperature | -30°C to +60°C | |
| Supply voltage | 6.00 – 15.0 VDC (applied through the interface connector) | |
| RX Current at 12.5 VDC | 180 mA | 180 mA |
| TX Current at 12.5 VDC | 2.0 A | 2.0 A |
| RX/TX bandwidth | 25 MHz (137 - 162) 24 MHz (150 - 174) | 24 MHz (406 - 430) 20 MHz (450 - 470) |
| Nominal Dimensions | 1.02" (H) x 2.45" (W) x 3.63" (L) | |
| Shipping Weight | 0.50 lbs (0.23 Kg) | |
| RF connector | BNC-F | |
| Interface connector | DE-15F high density D-subminiature | |

RECEIVER*

| | VHF | UHF |
|------------------------|-------------------|-----|
| Selectivity (12.5 kHz) | 60 dB minimum | |
| Intermodulation | 70 dB minimum | |
| Spurious rejection | 70 dB minimum | |
| Conducted spurious | < -57 dBm maximum | |

TRANSMITTER

| | VHF | UHF |
|------------------------|---|----------------------|
| Power output | 0.10 - 5 watts | 0.10 - 5 watts |
| Spurious and harmonics | -57dBc (-20 dBm) max | -57dBc (-20 dBm) max |
| Frequency stability | 1.0 ppm | 1.0 ppm |
| Duty cycle | 50% at full power, 30 seconds maximum transmit time | |

* per TIA 603 with psophometrically weighted filter

MODEM OPERATION

| | |
|---|--|
| Interface | EIA RS-232C |
| Operation | Simplex/half duplex |
| Data rates | 12.5 KHz Channels 4800, 9600 bps |
| Modulation type | DRCMSK |
| RTS/CTS delay (Online diagnostics OFF) | 30 ms |
| Bit error rate | better than 1×10^{-5} at 1.0 μ V at 9600 b/s half channel |
| Protocol | Transparent to the user |

PROGRAMMABLE FEATURES

30 second timeout timer enable, bit rate, word length, parity, compatibility modes, frequency, channel, diagnostics on/off.

FCC / IC CERTIFICATIONS

| | FCC | IC (DOC) |
|-----|-----------------------|------------------------------------|
| VHF | 2422210-001 (9K30F1D) | 2984195430A (9K30F1D) (11K0F1D) |
| UHF | 2422240-001 (9K30F1D) | 2984195432A (9K30F1D) (11K0F1D) |

SECTION 2 OPERATION AND CONNECTION

2.1 INTRODUCTION

2.1.1 GENERAL

This section outlines the operation and connections of the TSLM.

2.2 FRONT PANEL

2.2.1 INTRODUCTION

The front panel includes one BNC female antenna connector, two LED indicators and one DE-15F interface (includes power connections).

2.3 DTE PORT INTERFACE

2.3.1 RS-232 INTERFACE SIGNAL LEVELS

Table 2-2 RS-232 Signal Levels

| Term | Alternates | Signal level |
|------|-------------------|--------------|
| ON | asserted, spacing | +3 to +15 V |
| OFF | dropped, marking | -3 to -15 V |

Table 2-3 Modem DE15F Interface Connector Pin Outs

| Pin | Name | Pin | Name | Pin | Name |
|------------|-------------|------------|-------------|------------|-------------|
| 1 | Ground | 6 | Ground | 11 | CS 0 |
| 2 | Rx Data | 7 | CTS | 12 | CS 1 |
| 3 | Tx Data | 8 | RTS | 13 | CS 2 |
| 4 | Test Audio | 9 | DCD | 14 | RSSI |
| 5 | B+ Power | 10 | B+ Power | 15 | DTR_PGM |

Note: Table 2-3 is for use with the 023-3276-007 (one end unterminated) if channel selection control is desired. If not, use 697-0000-001 cable.

2.3.3 INTERFACE SIGNAL DESCRIPTION

Table 2-4 Signal Description

| | |
|-------------------------|--|
| B+ Power (input) | 6.00 – 15.0 VDC (12.5V nominal) maximum 2.0A |
| Rx Data | Received Data from TSLM to DTE |
| Tx Data | Transmit Data from DTE to TSLM |
| CTS | Clear to Send. Asserted when the TSLM is ready to accept Tx data |
| RTS | Request to Send. Causes the TSLM to transmit when asserted by the DTE. |
| DCD | Data Carrier Detect. Asserted by the TSLM when a data signal is being received |
| DTR | Data Terminal Ready. Asserted by the Field Programming Software to select setup mode. Do not connect to this pin for user applications. |
| Test Audio | Output signal used during adjustment and testing |
| RSSI | Output signal used during testing |

In the table, “gnd” indicates that the pin should be connected to ground (Pins 1 or 6)

2.4 CHANNEL SELECTION

Channel frequencies for 8 channels are programmed using the TSLM Field Programming Software (FPS). Once programmed, the current operating channel may be selected either by:

- 1.Utilizing hardware jumpers By strapping connections on the Data Port Connector. There is a 10k ohm pull up resistor on each line (CS0 to CS2) (refer to Table 2-5) or making changes with the TSLM Field Programming Software:
- 2.By selecting the channel from the TSLM FPS Offline Diagnostics feature.

Table 2-5 Channel Selection

| Channel | CS2 | CS1 | CS0 |
|---------|------|------|------|
| 1 | gnd | gnd | gnd |
| 2 | gnd | gnd | open |
| 3 | gnd | open | gnd |
| 4 | gnd | open | open |
| 5 | open | gnd | gnd |
| 6 | open | gnd | open |
| 7 | open | open | gnd |
| 8 | open | open | open |

2.5 TSLM FIELD PROGRAMMING SOFTWARE

The TSLM Field Programming Software provides programming and diagnostics for the Dataradio TSLM wireless modem. The Field Programming Software allows the user to edit and program user programmable settings, interactively tune modem and RF parameters, and monitor diagnostic data from the TSLM.

The PTT Watchdog allows the user to set the maximum transmit time. This is used to protect against a 'stuck' transmitter. The time is selected by a slider bar. The range is 0 to 120 seconds with a default of 30 seconds.

2.6 FCC MPE Compliance Reports - VHF and UHF

RF Exposure Compliance Requirements TSLM VHF Wireless Modem

FCC Rule: 1.1307, 1.1310, 2.1091 (b) (d), 2.1093

Description of Compliance:

The TSLM will be professionally installed in the SCADA (Supervisory Control And Data Acquisition) market and will be mounted with a fixed RTU (Remote Terminal Unit). A typical installation would use a maximum gain antenna of 10 dBi mounted on a tower. A minimum separation distance of more than 141 cm must be maintained between the radiating structure and any person to classify as a mobile under FCC MPE regulations.

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The calculation for the more stringent specification, a General Population/Uncontrolled Mobile device according to section 2.1091(b) and section 1.1310 Note 2 is shown below:

Limits for General Population/Uncontrolled Exposure:

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm ²) | Averaging Time (mins) |
|-----------------------|-------------------------------|-------------------------------|-------------------------------------|-----------------------|
| 0.3-1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34-30 | 824/f | 2.19/f | *(180/f ²) | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | --- | --- | f (MHz)/1500 (MHz) | 30 |
| 1500-100000 | --- | --- | 1.0 | 30 |

Environmental Specification: 0.2 mW/cm²

$$S = (PG)/(4\pi R^2) \quad (\text{OET Bulletin 65})$$

Where:

S = Power Density (mW/cm²)

P = Power input to the antenna (mW)

G = Power Gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna (cm)

Distance Calculation:

$$R = \sqrt{(PG)/(4\pi S)}$$

Typical Antenna Gain: 10.0 dBi $10^{(10.0 \text{ dBi}/10)} = 10.0$

Power input to the Antenna: 37dBm = $10^{(37\text{dBm}/10)} = 5000 \text{ mW}$

$$R = \sqrt{((5000\text{mW} * 10.0)/(4\pi * 0.2 \text{ mW/cm}^2))} = 141 \text{ cm (Minimum Distance)}$$

RF Exposure Compliance Requirements TSLM UHF Wireless Modem

FCC Rule: 1.1307, 1.1310, 2.1091 (b) (d), 2.1093

Description of Compliance:

The TSLM will be professionally installed in the SCADA (Supervisory Control And Data Acquisition) market and will be mounted with a fixed RTU (Remote Terminal Unit). A typical installation would use a maximum gain antenna of 10 dBi mounted on a tower. A minimum separation distance of more than 121 cm must be maintained between the radiating structure and any person to classify as a mobile under FCC MPE regulations.

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The calculation for the more stringent specification, a General Population/Uncontrolled Mobile device according to section 2.1091(b) and section 1.1310 Note 2 is shown below:

Limits for General Population/Uncontrolled Exposure:

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density (mW/cm ²) | Averaging Time (mins) |
|-----------------------|-------------------------------|-------------------------------|-------------------------------------|-----------------------|
| 0.3-1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34-30 | 824/f | 2.19/f | *(180/f ²) | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | --- | --- | f (MHz)/1500 (MHz) | 30 |
| 1500-100000 | --- | --- | 1.0 | 30 |

Environmental Specification: $f(\text{MHz})/(1500 \text{ mW/cm}^2)$
 $406 \text{ MHz}/(1500 \text{ MHz mW/cm}^2) = 0.27 \text{ mW/cm}^2$ (worst case)

$$S = (PG)/(4\pi R^2) \quad (\text{OET Bulletin 65})$$

Where:

S = Power Density (mW/cm²)

P = Power input to the antenna (mW)

G = Power Gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna (cm)

Distance Calculation:

$$R = \sqrt{((PG)/(4\pi S))}$$

Typical Antenna Gain: 10.0 dBi $10^{(10.0 \text{ dBi}/10)} = 10.0$

Power input to the Antenna: 37dBm = $10^{(37\text{dBm}/10)} = 5000 \text{ mW}$

$$R = \sqrt{((5000\text{mW}*10.0)/(4\pi*0.27 \text{ mW/cm}^2))} = 121 \text{ cm (Minimum Distance)}$$

2.6 IC MPE Compliance Reports - VHF and UHF

RF Exposure Compliance Requirements TSLM VHF Wireless Modem

IC Rule: RSS-119 Section 9, RSS-102 Section 4.2

Description of Compliance:

The TSLM will be professionally installed in the SCADA (Supervisory Control And Data Acquisition) market and will be mounted with a fixed RTU (Remote Terminal Unit). A typical installation would use a maximum gain antenna of 10 dBi mounted on a tower. A minimum separation distance of more than 1.41 meters must be maintained between the radiating structure and any person to classify as a mobile under IC MPE regulations.

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The calculation for the more stringent specification, a General Population/Uncontrolled Mobile device according to RSS 102 Section 4.2 is shown below:

RF Limits for Devices used by the General Public

| Frequency Range (MHz) | Electric Field (V/M rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | Time Average (min) |
|-----------------------|--------------------------|--|-----------------------------------|----------------------------|
| 0.003-1 | 280 | 2.19 | - | 6 |
| 1-10 | 280 / f | 2.19 / f | - | 6 |
| 10-30 | 28 | 2.19 / f | - | 6 |
| 30-300 | 28 | 0.073 | 2* | 6 |
| 300-1 500 | 1.585 f ^{0.5} | 0.0042 f ^{0.5} | f / 150 | 6 |
| 1 500-15 000 | 61.4 | 0.163 | 10 | 6 |
| 15 000-150 000 | 61.4 | 0.163 | 10 | 616 000 / f ^{1.2} |
| 150 000-300 000 | 0.158 f ^{0.5} | 4.21 x 10 ⁻⁴ f ^{0.5} | 6.67 x 10 ⁻⁵ f | 616 000 / f ^{1.2} |

Environmental Specification: 2.00 W/m²

$$S = (PG)/(4\pi R^2)$$

Where:

S = Power Density (W/m²)

P = Power input to the antenna (W)

G = Power Gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna (m)

Distance Calculation:

$$R = \sqrt{(PG)/(4\pi S)}$$

Typical Antenna Gain: 10.0 dBi $10^{(10.0 \text{ dBi}/10)} = 10.0$

Power input to the Antenna: 37dBm = $10^{(37\text{dBm}/10)} = 5.00 \text{ W}$

$$R = \sqrt{((5.00 \text{ W} * 10.0)/(4\pi * 2.00 \text{ W/m}^2))} = 1.41 \text{ meters (Minimum Distance)}$$

RF Exposure Compliance Requirements TSLM UHF Wireless Modem

IC Rule: RSS 119 Section 9, RSS-102 Section 4.2

Description of Compliance:

The TSLM will be professionally installed in the SCADA (Supervisory Control And Data Acquisition) market and will be mounted with a fixed RTU (Remote Terminal Unit). A typical installation would use a maximum gain antenna of 10 dBi mounted on a tower. A minimum separation distance of more than 1.21 meters must be maintained between the radiating structure and any person to classify as a mobile under IC MPE regulations.

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The calculation for the more stringent specification, a General Population/Uncontrolled Mobile device according to RSS 102 Section 4.2 is shown below:

RF Limits for Devices used by the General Public

| Frequency Range (MHz) | Electric Field (V/M rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | Time Average (min) |
|-----------------------|-------------------------------|---|-----------------------------------|-----------------------------------|
| 0.003-1 | 280 | 2.19 | - | 6 |
| 1-10 | 280 / <i>f</i> | 2.19 / <i>f</i> | - | 6 |
| 10-30 | 28 | 2.19 / <i>f</i> | - | 6 |
| 30-300 | 28 | 0.073 | 2* | 6 |
| 300-1 500 | 1.585 <i>f</i> ^{0.5} | 0.0042 <i>f</i> ^{0.5} | <i>f</i> / 150 | 6 |
| 1 500-15 000 | 61.4 | 0.163 | 10 | 6 |
| 15 000-150 000 | 61.4 | 0.163 | 10 | 616 000 / <i>f</i> ^{1.2} |
| 150 000-300 000 | 0.158 <i>f</i> ^{0.5} | 4.21 x 10 ⁻⁴ <i>f</i> ^{0.5} | 6.67 x 10 ⁻⁵ <i>f</i> | 616 000 / <i>f</i> ^{1.2} |

Environmental Specification: $f(\text{MHz})/(150 \text{ W/cm}^2)$
 $406 \text{ MHz}/(150 \text{ MHz mW/cm}^2) = 2.71 \text{ W/m}^2$ (worst case)

$$S = (PG)/(4\pi R^2)$$

Where:

S = Power Density (W/m²)

P = Power input to the antenna (W)

G = Power Gain of the antenna in the direction of interest relative to an isotropic radiator

R = Distance to the center of radiation of the antenna (meters)

Distance Calculation:

$$R = \sqrt{(PG)/(4\pi S)}$$

Typical Antenna Gain: 10.0 dBi $10^{(10.0 \text{ dBi}/10)} = 10.0$

Power input to the Antenna: 37dBm = $10^{(37\text{dBm}/10)} = 5.00 \text{ W}$

$$R = \sqrt{((5.00 \text{ W} * 10.0)/(4\pi * 2.71 \text{ W/m}^2))} = 1.21 \text{ meters (Minimum Distance)}$$