Gridstream Modular SCADA/DA
Series 4 Single Board Radio
Quick Start Guide

Publication: 98-1138 Rev AD

Limitation on Warranties and Liability

Information in this document is subject to change without notice. This manual or any part of it thereof may not be reproduced in any form unless permitted by contract or by written permission of Landis+Gyr.

In no event will Landis+Gyr be liable for any incidental, indirect, special, or consequential damages (including lost profits) arising out of or relating to this publication or the information contained in it, even if Landis+Gyr has been advised, knew, or should have known of the possibility of such damages.

All brands and product names are the trademarks or registered trademarks of their respective holders.

Gridstream Modular SCADA/DA Series 4 Single Board Radio Quick Start Guide			
Publication: 98-1138			
Revision History			
Modification Date	**Revision**	**Description**	**Author**
1/29/2013	***AD***	***draft***	***Randy Roten***
12/26/2012	AC	Released	Randy Roten
9/24/2012	AB	Released	Randy Roten
9/6/2012	AA	Released	Randy Roten
Landis+Gyr 30000 Mill Creek Avenue Alpharetta, GA 30022 Website: www.landisgyr.com E-mail: solutionsupport.na@landisgyr.com Technical Support: 1-888-390-5733			

Table of Contents

1 Product Overview

Introduction

The Gridstream SCADA Series 4 Single Board Radio (Gridstream S4SBR) is for use by OEM vendors wanting to incorporate Gridstream capability into their SCADA/DA and similar products.

The design of the board allows integration with an OEM enclosure and communication with the customer's equipment via a 14-pin connector. Table 1 - 4, "I/O Connector Pin Functions and Acceptable Voltage Levels," provides details for the interface. The Gridstream S4SBR is available in four unique versions, listed/numbered below and in the following illustration:

1. External Antenna (MCX connector), without Super Cap, Part number 40-1681
2. External Antenna (MCX connector), with Super Cap, Part number 40-1682
3. Internal Antenna, without Super Cap, Part number 40-1683
4. Internal Antenna, with Super Cap, Part number 40-1684

The Gridstream S4SBR is a self-contained 600 mW Integrated WanGate Radio (IWR) which includes voltage regulation, micro-processor, and radio. Output power can be set to 100, 450, or 600 mW.

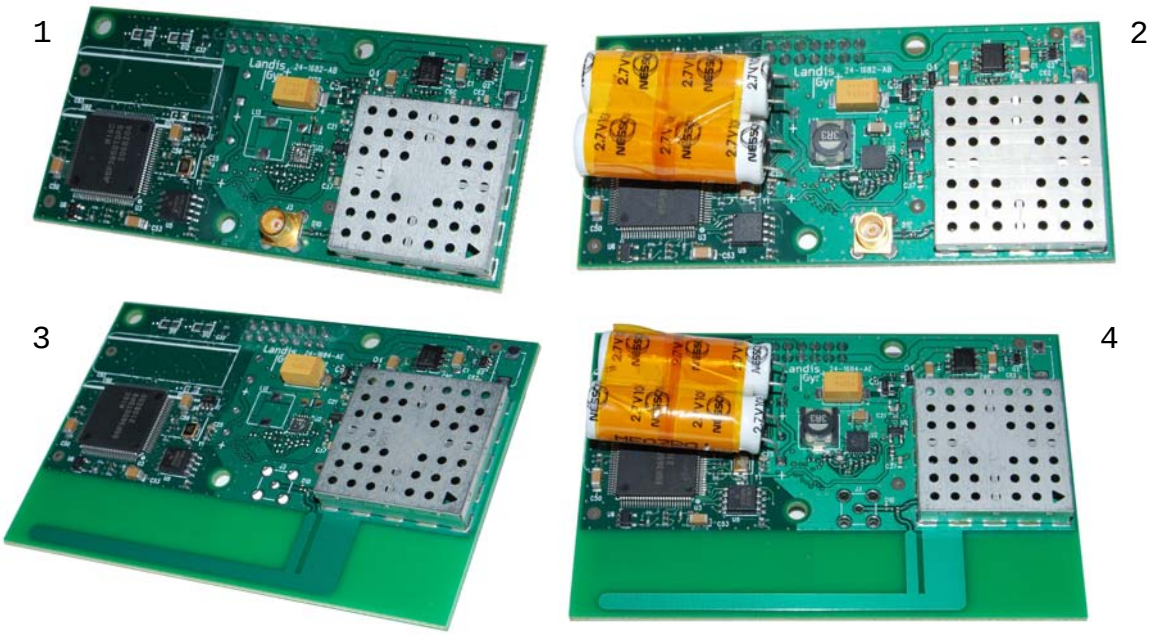


Figure 1 - 1. Gridstream S4SBR Internal and External Antenna Versions

This Gridstream S4SBR is based upon existing Gridstream architecture and will operate as a node within a Gridstream network. It is similar in construction to a Gridstream metering endpoint, but with an optional onboard antenna and I/O ports. It has received Modular FCC approval when used with the approved cable and antenna.

The Gridstream S4SBR provides two digital I/O ports and two analog input ports, which can also be configured as two general purpose I/O ports. One of the digital ports can also be configured as a counter by sensing either the rising end of the pulse, trailing edge of the pulse, or both. These interfaces are accessible via the Device Control Word (DCW) programming language.

NOTE: All Gridstream S4SBR models have identical base electrical architecture with minor physical variations based on antenna/connector type and whether or not the super cap circuitry is included.

The on-board antenna version is designed for customers seeking the lowest-cost solution. The onboard F-antenna exhibits nominal performance. The external antenna version is designed for customers who require enhanced performance (greater range).

The Gridstream S4SBR shares similarities with other Gridstream IWR devices, but also has differences.

Similarities	Differences
RF Mesh Routing	**Connection Type: TTL**
RF Speed	**Digital & Analog Commands**
Programmability	**Physical Antenna Configuration (External/Internal)**
DCW / Applet Storage	**Super Capacitor**

Performance Specifications

NOTE: Specifications are the same for all S4SBR models unless otherwise stipulated.

Table 1 - 1. Series 4 Gridstream S4SBR General Electrical Specifications

Parameter	Value			Units	Comments
	Min	Typ	Max		
Input Voltage	4.0	5.0	7.0	VDC	
Current Consumption Rx mode w/o super-capacitor Rx mode w/ super-capacitor charging Tx mode (low power)† Tx mode (medium power)† Tx mode (high power)†		 41 120 250 440 520	 140 288 480 600	mA	†Super-capacitor charging is disabled during transmit mode
Current Consumption Shut Down mode*		 85	 100	µA	V_{in} = 5V *PWR_DN = 0V
RF Frequency Range	902		928	MHz	
RF Baud Rate	9.6		115.2	kbps	Variable - 9.6, 19.2, 38.4, 115.2 kbps
Frequency Stability	-3		+3	ppm	Over temperature range
Processor Processor Type Clock Speed SRAM (internal) Flash (internal)	 M16C/65 14.7456 47 512			 MHz KB KB	
Additional Memory SRAM Flash	 768 1024			 KB	

Table 1 - 2. Series 4 Gridstream S4SBR Transmitter Electrical Specifications

Parameter	Value			Units	Comments
	Min	Typ	Max		
Modulation Type	FSK/GFSK				Depends on baud rate
Baud Rates		9.6 19.2 38.4 115.2		kbps	± 4.95 kHz ± 9.9 kHz ± 19.8 kHz ± 57.6 kHz
Output Power High Setting (600 mW)‡ Medium Setting (450 mW) Low Setting (100 mW)	 26.8 25 19	 27.8 26.5 20	 28.8 27 21	dBm	Over temperature range, <2:1 VSWR load ‡Default Factory Setting
Ruggedness	+30dBm, 40% duty cycle, open circuit on antenna port				No Damage

Table 1 - 2. Series 4 Gridstream S4SBR Transmitter Electrical Specifications

Parameter	Value			Units	Comments
	Min	Typ	Max		
Conducted Spurious Second harmonic All other harmonics			 -40 -70	dBc	At +30dBm output power, <2:1 VSWR load Meets FCC requirements

Table 1 - 3. Series 4 Gridstream S4SBR Receiver Electrical Specifications

Parameter	Value			Units	Comments
	Min	Typ	Max		
Cascaded Noise Figure		5.0		dB	
Input IP3		-10		dBm	Two-tone test (1 MHz tone spacing); desired signal 3dB above sensitivity; 9.6 kbps operation
Sensitivity (@ 25° C) 9.6 kbps 19.2 kbps 38.4 kbps 115.2 kbps		 -112 -110 -107 -101		dBm	
Image Rejection (worst-case)		30		dB	Desired signal 3dB above sensitivity, CW jammer (at image freq) increased until PER = 10%; 9.6kbps baud rate
Selectivity (In-band blocking) f_0 ± 100 kHz f_0 ± 200 kHz f_0 ± 10 MHz		 30 35 80		dB	Desired signal 3dB above sensitivity, CW jammer (at image freq) increased until PER = 10%; 9.6kbps baud rate
Blocking (Out-of-band) *No Pager-Reject Filter* f < 880 MHz 880 < f < 895 MHz 960 < f < 3000 MHz	 0 -10 -10			dBm	Desired signal 3dB above sensitivity, CW jammer (at image freq) increased until PER = 10%; 9.6kbps baud rate
Maximum input RF power ISM Band 902 MHz < f < 928 MHz			+19	dBm	Permanent damage can occur to receiver if exposed to RF level above this specification
Minimum spacing between S4 SBR antenna and any other device transmitting in the ISM band 902 MHz < f < 928 MHz	8			inches	Applies to both internal and external antenna versions of S4 SBR

Electrical Interface

The electrical interface for power and control circuitry is provided via a 14-pin keyed connector located on the bottom (non-component) side of the board and shown in Figure 1 - 2.

The Gridstream S4SBR requires a nominal 5.0 VDC supply, with a total input range of 4.0 to 7.0 VDC.

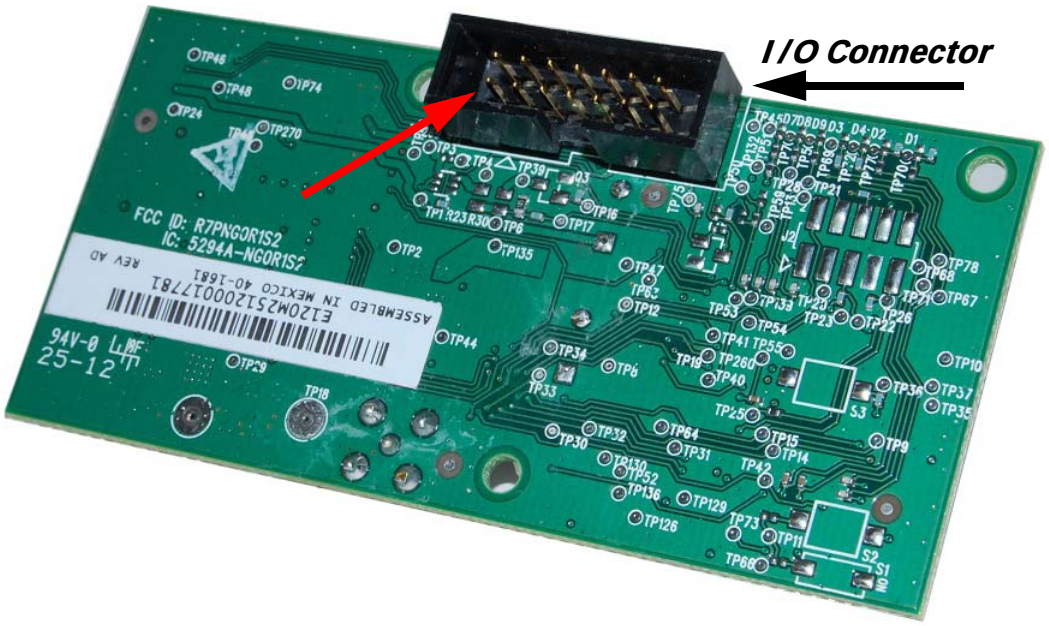


Figure 1 - 2. Gridstream Series 4 Single Board Radio Rear View, I/O Connector, Pin 1 (Red Arrow)

The I/O connector provides seven interface connections listed below:

- Input power connections
- LAN Packet Port (LPP)
- Transparent Port (TPP)
- Digital I/O signals
- Analog I/O signals
- Radio Enable/Disable control
- RF output power control

Pin Functions

Pin Outs for the connector as described below are designed to interface with developer OEM architecture. When pins are connected to non developer boards or when standard interfaces are required without use of the USB cable (P/N 19-2325, as shown in Figure 1 - 6), appropriate design constraints (power and logic level) must be adhered to (See “Gridstream SBR Logic” on page 30).

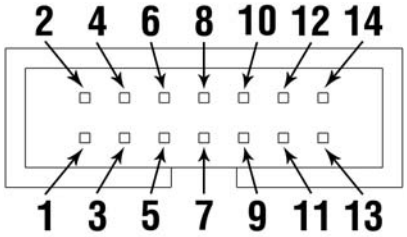


Figure 1 - 3. Pinout Diagram (Rear View) For All Board Versions)

Table 1 - 4. I/O Connector Pin Functions and Acceptable Voltage Levels

Pin Number	Name	Function	Logic Level Low (VDC)	Logic Level High (VDC)
1	VIN	Main supply for the board.	0	4.0 ~ 7.0 Nominal = 5.0
2	LPP TX	This pin is an output from the device for connecting to RadioShop via the LAN Packet Port (LPP) interface.	0 ~ 0.5	2.8 ~ 3.4
3	LPP RX	This pin is an input to the device for connecting to RadioShop via the LAN Packet Port (LPP) interface.	0 ~ 0.6	2.6 ~ 3.4
4	DIGITAL_IO1	A general purpose Digital Input / Output Pin. The application-specific DCW can use this pin as desired.	0 ~ 0.6	2.6 ~ 3.4
5	ANALOG_IN1	An input to the device’s A/D converter. The application-specific DCW can read the voltage on this pin. Note: This pin may be configured as a Digital I/O, if desired.	0 ~ 2.5	
6 and 7	GND	Common ground for both power and communications. These two pins are tied together on the device.	0	0
8	LOW_RF_POWER	Digital input used to select Low-Power Mode, an RF output power reduction to 100 mW [20 dBm].	ground	3.3V ***max***
9	PWR_DN	Digital input used to completely shut down the device.	ground	2.8 ~ 5V ***max***
10	ANALOG_IN2	An input to the device’s A/D converter. The application-specific DCW can read the voltage on this pin. Note: This pin may be configured as a Digital I/O, if desired.	0 ~ 2.5	
11	DIGITAL_IO2	A general purpose Digital Input / Output Pin. The application-specific DCW can use this pin as desired.	0 ~ 0.6	2.6 ~ 3.4
12	TPP RX	This pin is an input to the Transparent Port (TPP) device.	0 ~ 0.6	2.6 ~ 3.4
13	TPP TX	This pin is an output from the Transparent Port (TPP) device.	0 ~ 0.5	2.8 ~ 3.4
14	3.3V_Logic_supply	3.3V Supply for logic level shifting. Pin is current limited to 300µA	≈3.3	

Pin 1 (VIN)

This pin must be supplied with DC voltage between 4.0 and 7.0 VDC with 5.0 VDC considered nominal.

The input voltage is linearly regulated on the board. While the linear regulation can remove some noise, Power Supply Rejection Ratio (PSRR) varies with frequency. If the power source is particularly noisy, filtering may be required. Landis+Gyr engineering can assist in defining radio tests to determine if power supply noise is affecting radio performance.

The input voltage must be maintained between 4.0 VDC and 7.0 VDC during operation. The on-board electronics include fast-acting reset circuitry. If the voltage drops below 4.0 VDC, even transiently, the system will reboot once the voltage returns to normal range. If the voltage rises above 7.0 VDC, even transiently, the voltage-sensitive components could be damaged.

Upon power up, the on-board processor and voltage regulator requires the supply voltage to have a minimum of 0.05 V/msec slew rate - which implies rising from a logic 0 to a logic 1 in no less than 66 msec. Power consumption during normal receive mode is typically 41 mA. Current consumption during 100 mW transmit mode is 250 mA, 440 mA during 450 mW transmit mode, and 520 mA during 600 mW transmit mode.

During the first 30 minutes after initial power-on or after an extended outage, the on-board super-capacitor will be charging. During this time, the total input current to the device will increase by 80 mA. SeeTable 1 - 1, "Series 4 Gridstream S4SBR General Electrical Specifications," for additional details.

The Gridstream S4SBR uses a frequency-hopping sequence transmission and, while typically rare, transmissions can be as long as 400 mS in duration, and can theoretically sustain at a 45% duty cycle on a single channel.

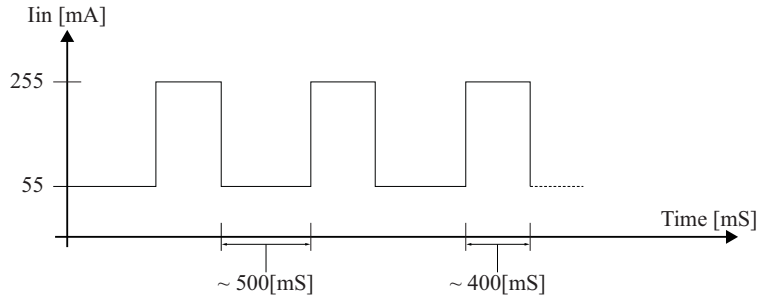


Figure 1 - 4. Single-channel Worst-Case Current Consumption Profile

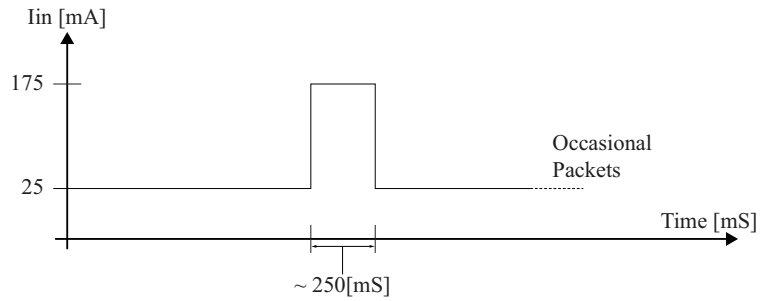


Figure 1 - 5. Typical Current Consumption Profile

Pin 2 (LPP TX) and Pin 3 (LPP RX)

These pins are used to interface with the device's LAN Packet Port. These pins are driven at TTL level supply, 2.5 VDC.

Baud rates on this port default to 9,600 bps but, using RadioShop, are configurable from 1,200 bps to 115,200 bps.

To reduce chances of electrical damage, a 10Kohm series resistor is placed in-series with the pin which limits the drive current capability of this pin.

Stray physical capacitance on this circuit should be kept below 250[pF].

NOTE: These pins should NOT be directly connected to an RS-232 interface on a computer. Where such a connection is necessary, the developer must connect to the unit through an externally-powered TTL to RS-232 VDC converter, NOT via the pins or the RS-232 connection on the computer.

Pin 4 (DIGITAL_IO1) and Pin 11 (DIGITAL_IO2)

These pins are general purpose digital I/O lines and are driven at TTL supply levels.

If not used, they should not be left unconnected and should be held low by connecting the pin to a common ground.

If used, these pins must be driven to a valid logic high or low and not left at intermediate voltages as this will result in indeterminate logic values and may damage the device.

Pin 5 (ANALOG_IN1) and Pin 10 (ANALOG_IN2)

These pins are analog inputs to the device. Voltages must be scaled to the 0 to 2.5 VDC range. The Gridstream S4SBR returns the DC voltage as HEX values in the memory locations as described in “Analog Input Functionality” on page 31.

To obtain the HEX values, a DCW must be developed to read and send the HEX values to the host computer. Once the host has the HEX values, the corresponding voltage can be derived using the following formula:

- Voltage = (Decimal value/1023) * 2.5

The DCW that reads the memory location returns a HEX value, within range of 0x0 - 0x03FF. The user can convert to decimal using the formula obtaining the value in VDC. The table below shows examples of various voltages and the equivalent HEX values.

Table 1 - 5. Example Hex Values and Equivalent Voltages

Example HEX Read	Corresponding Actual Voltage
0000	0.00
0006	0.01
006B	0.25
0119	0.68
0253	1.44
0382	2.19
039F	2.26
03C7	2.36
03F1	2.46
03FD	2.49

NOTE: If desired, the Analog I/O pins may be configured as Digital I/O pins or, alternatively, as General Purpose I/O pins.

Pins 6 and 7 (GND)

These pins are the ground connection for both power and communications. These two pins are tied together on the device.

Pin 8 (LOW_RF_POWER)

The purpose for this pin is to reduce the RF output power level to assure operation during development and OEM manufacturing process. A logic high on this pin leaves the device in its normal mode of operation, functioning with full rated RF transmitter power. This pin may also be left unconnected and would therefore result in normal mode operation due to onboard pull-up.

A logic low (pin connected to ground) reduces the RF output power level to approximately 100 mW for use in environments where high RF output power is not required or only low input power is available to the device. When the USB cable is used to power the board, the pin is automatically brought low. This pin is a digital input, driven internally at TTL supply level.

This pin must be left not connected or pulled low to ground as intermediate voltages will result in indeterminate conditions and may damage the device.

Pin 9 (PWR_DN)

This pin is used to enable or disable the Gridstream S4SBR. It is a digital input and must be driven to a valid logic high (5.0 VDC) or low (GND), since intermediate voltages will result in indeterminate logic values and may damage the device.

NOTE: When the Pin 9 power-off command is asserted on super-capacitor units, the unit will remain operational for a few minutes as the super-capacitor voltage bleeds off. Once Pin 9 power-off command is asserted on units without the super-capacitor, the units will turn off immediately.

- A logic high (5VDC) provides power to the device.
- A logic low (GND) turns off the device.

Prior to turning off the device, all interface signals must be driven low and logic voltage removed. This includes all TTL logic lines, digital and analog I/O lines.

When the device is turned off with this pin, total current consumption will be less than 100µA.

NOTE: When the board is not in use, voltage should not be applied to any interface. Applied voltage may damage the device as destructive latch-up may occur.

Pin 12 (TPP RX) and Pin 13 (TPP TX)

These pins are used to interface with the device's Transparent Port. These pins are driven at TTL supply level.

Baud rates on this port default to 9,600 bps but, using RadioShop, are configurable from 300 bps to 115,200 bps.

To reduce chances of electrical damage, a 1Kohm series resistor is placed in-series with the pin which limits the drive current capability of this pin.

Stray physical capacitance on this circuit should be kept below 250[pF].

NOTE: These pins should NOT be directly connected to an RS-232 interface on a computer. Where such a connection is necessary, the developer must purchase a TTL to RS-232 VDC converter which is powered external and NOT via the pins or the RS-232 connection on the computer.

Pin 14 (3.3V_Logic_supply)

This pin is used as an output to provide 3.3V for the purpose of logic interfacing. To reduce chances of electrical damage, this pin is current limited to 300uA and caution should be taken when connecting to external circuit to ensure it doesn't exceed the 300µA limit.

For additional information about the purpose of this pin contact Landis+Gyr.

CAUTION: Pin 14 should NOT be used whenever Pin 9 (PWR_DN) is held in logic low level.

USB Programming Cable

A USB Serial Interface programming cable (P/N 19-2325, shown in Figure 1 - 6) is available for developers to access the device via the LPP Port using RadioShop or their own application.

The cable provides power (5.0 VDC) from the USB port and a single emulated COM Port connection. The USB cable allows the OEM vendor to configure, load DCWs, and program the Gridstream S4SBR via the LPP port.

Figure 1 - 6. USB Serial Interface programming cable

The cable converts TTL level signals for connecting to Serial interfaces (COM Ports) via the USB interface. The cable is designed to allow for a fast, simple way to connect the board via the USB interface to the virtual RS-232 COM Port on the PC, allowing the developer to access the board using RadioShop.

The entire USB protocol is handled by the USB Serial Interface cable when connected to the PC, thus no USB specific firmware programming is required.

WARNING: The 19-2325 USB Cable requires a USB 2.0 port for proper operation. PC damage may occur if the 19-2325 USB Cable is connected to a USB 1.0 port.

NOTE: Previous model (19-1220) USB cables will not function correctly with this unit.

In order to be compatible with most computer USB ports the USB 19-2325 cable maintains a current limit of less than 500mA by setting the Gridstream S4SBR to low RF output power mode by grounding pin 8 of the I/O connector.This mode sets the output power level to approximately 100

mW. The USB is 2.0 Full Speed compatible, thus providing for COM Port data rates between 9,600 to 115,200 BPS as required by the Gridstream S4SBR LPP port.

Table 1 - 6. USB Cable I/O Operating Parameters

Parameter	Description	Min	Typ	Max	Unit	Conditions
VCC	Output Voltage	4.25	5.0	5.25	VDC	Dependent on the USB port that the TTL-232R-3V3 is connected to
I/O	Output Current			500	mA	
Operating Temp	Operating Temperature Range	0		+40	°C	

USB Cable Installation

NOTE: Before using the USB cable the first time, confirm that the PC's Internet connection is active.

Connect the device to a spare USB port on your PC. The Microsoft composite device driver is automatically loaded in the background. Once the composite driver has been installed, the Windows Found New Hardware Wizard dialog will launch.

The installation process may continue by installing the USB Serial Converter driver for a second port of the USB Cable. The procedure for installing the second port is identical to that for installing the first port from the first screen of the Found New Hardware Wizard.

Antennas

As with any RF device, antenna-related decisions are critical and must be made early. The RF range of the final product will depend greatly on the choice of antenna and where it is placed. The S4SBR is available in four versions, selected at the time of order. The on-board antenna versions are built and tuned to utilize an on-board F-antenna. The external antenna versions include an on-board 50-ohm MCX connector for RF co-ax connection to an external antenna.

External Antenna

An external antenna is connected to the board via an MCX Female coaxial RF connector.

The external antenna used to qualify the board is an omnidirectional 5 dBi whip (shown in the next figure), made by Manufacturers Marketing Group (MMG). The MMG part number for this antenna is 16-1000-0. MMG contact information is on page 35. This antenna can be used, or any other omnidirectional whip antenna with 5 dBi gain or less.

Figure 1 - 7. Whip Antenna with N-type Male Reverse-Polarity Connector

NOTE: See "External Antenna Specifications" on page 35 for antenna technical specifications.

On-board Antenna

The on-board antenna design is an F-antenna (-0 dB). This design was chosen because its performance is more broad-band relative to a slot antenna, and its pattern is somewhat omni-directional. This version of the product does not allow an external antenna in conjunction with the on-board antenna.

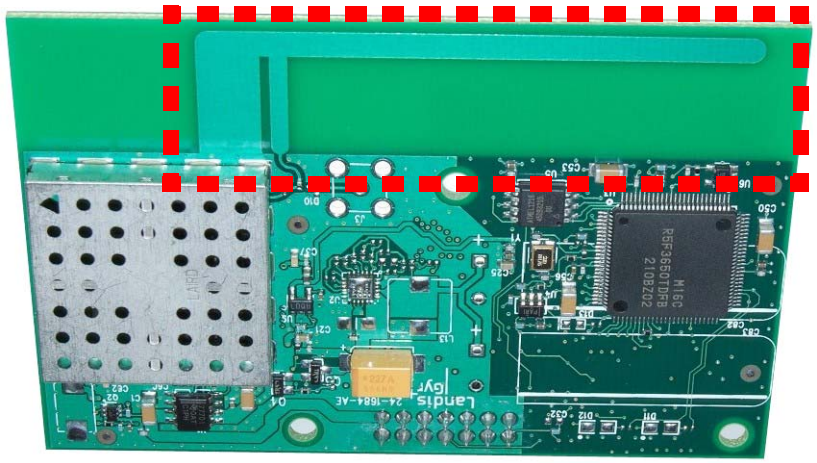


Figure 1 - 8. S4SBR On-board Antenna

NOTE: See “On-Board Antenna Specifications” on page 39 for antenna technical specifications.

Additional Specifications

Table 1 - 7. Additional Specifications

Category	Specification	Value(s) or Range(s)
Networking	Number of Channels	240 (narrow channel mode), 86 (wide channel mode)
	Channel Spacing	100 KHz (narrow channel mode), 300 KHz (wide channel mode)
	Modulation Type	2-FSK
	RF Baud Rate	9.6, 19.2, 38.4, 115.2 kbps
	FCC Operation Certification	Part 15.247
	Spreading Technique	Frequency Hopping
	Hopping Technique	Pseudo Random Asynchronous
	Hopping Patterns	65,536 (Unique per network)
	Network Address	Latitude / Longitude Coordinates
	Turn-Around Time	100[uS] max
Programming	Programming Language	Device Control Word (DCW)
	Radio Firmware	Version 5.72 later
Data	LAN Packet Port (LPP)	Serial Interface, DCW adjustable per specs below
		Data Rate - 9.6, 19.2, 38.4, 115.2 kbps
	Transparent Port (TPP)	Serial Interface, DCW adjustable per specs below
		Data Rate - 9.6, 19.2, 38.4, 115.2 kbps
	Serial Interface	TTL
	Parity	Odd, Even, or None
	Data bits	7 or 8
	Stop bits	1 or 2
	Duplex	Full
	Protocol	Any asynchronous byte-oriented protocol
Environmental	Operating Temperature	-40°C to +85°C
	Storage Temperature	-40°C to +85°C
	Humidity	85C, 95% RH
Mechanical	Size	On-board Antenna 3.43”L x 2.275”W x 0.65”H (0.96”H w- Super Cap)
		External Antenna 3.43”L x 1.65”W x 0.65”H (0.96”H w- Super Cap)

Dimensions: Gridstream S4SBR 25-1681 / 25-1682

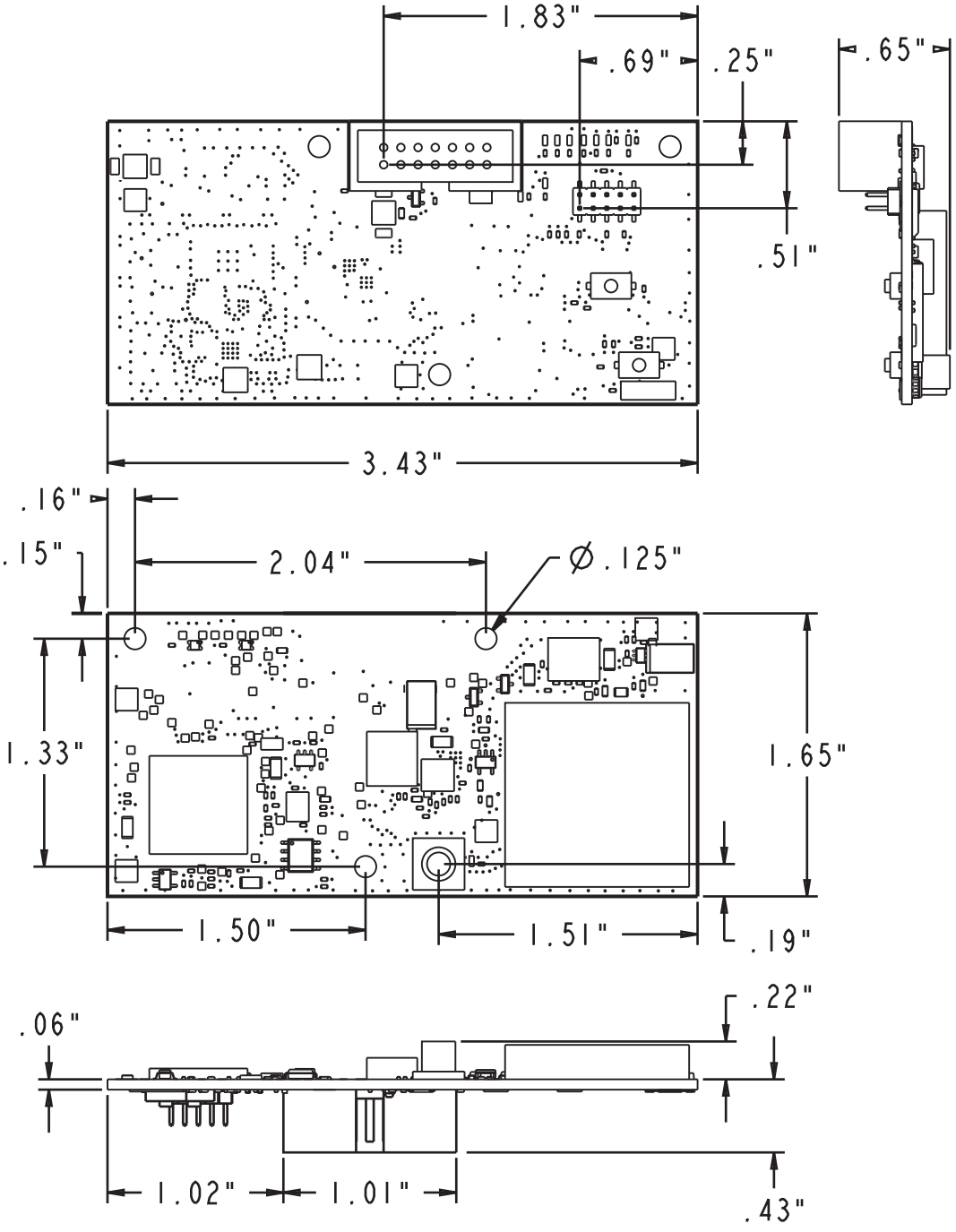


Figure 1 - 9. Gridstream S4SBR 25-1681 Dimensions

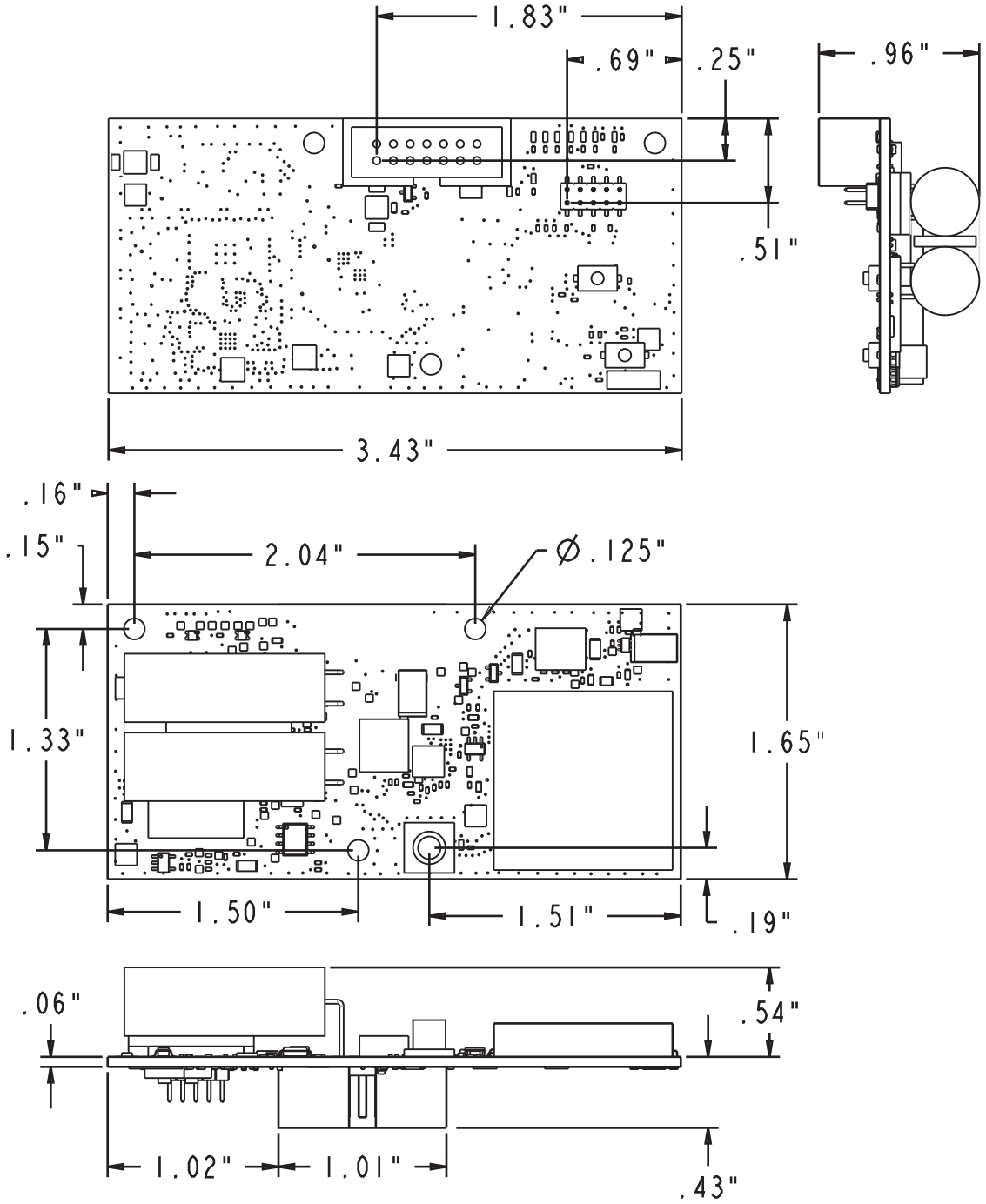


Figure 1 - 10. Gridstream S4SBR 25-1682 Dimensions

Dimensions: Gridstream S4SBR 25-1683 / 25-1684

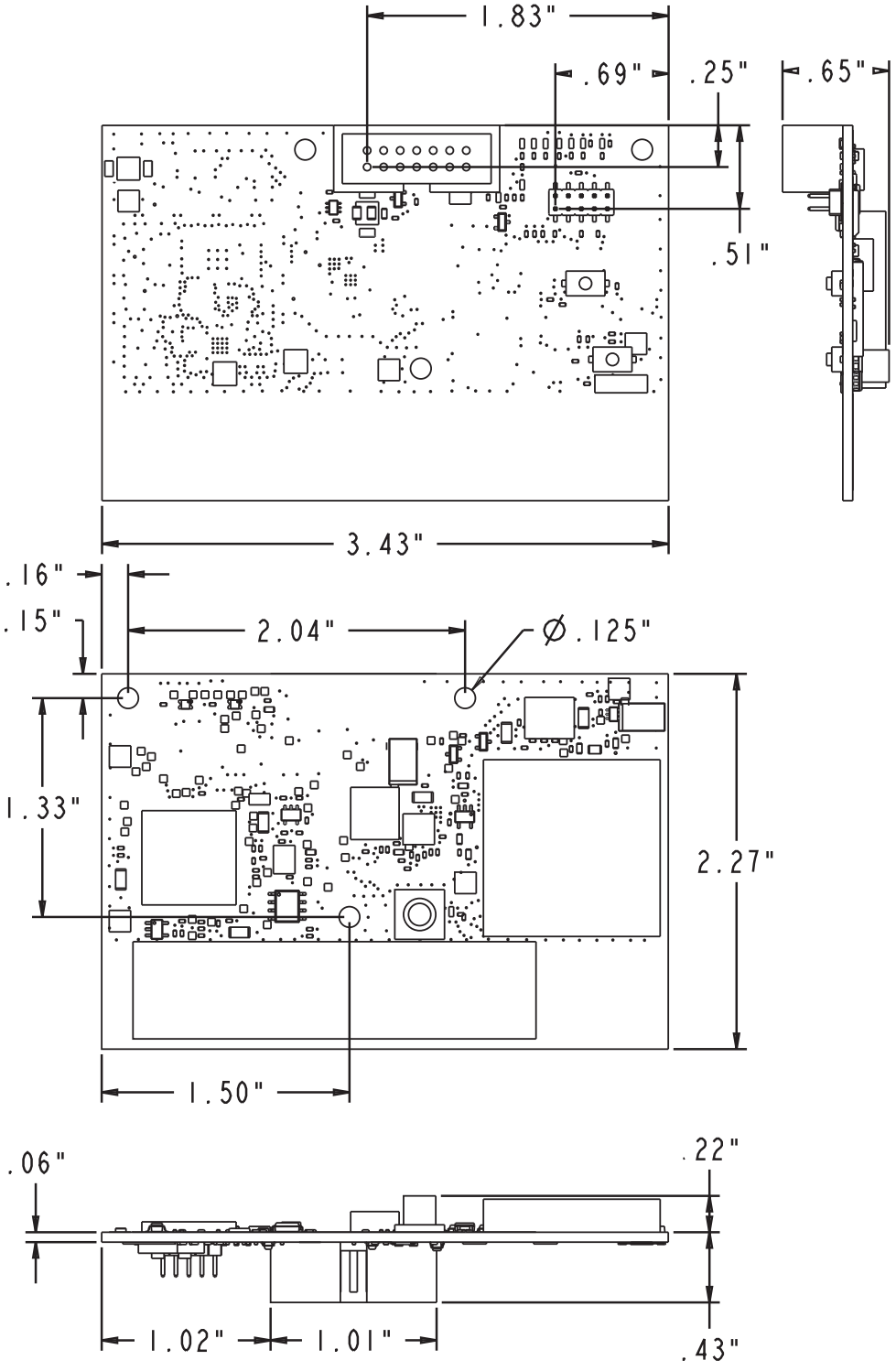


Figure 1 - 11. Gridstream S4SBR 25-1683 Dimensions

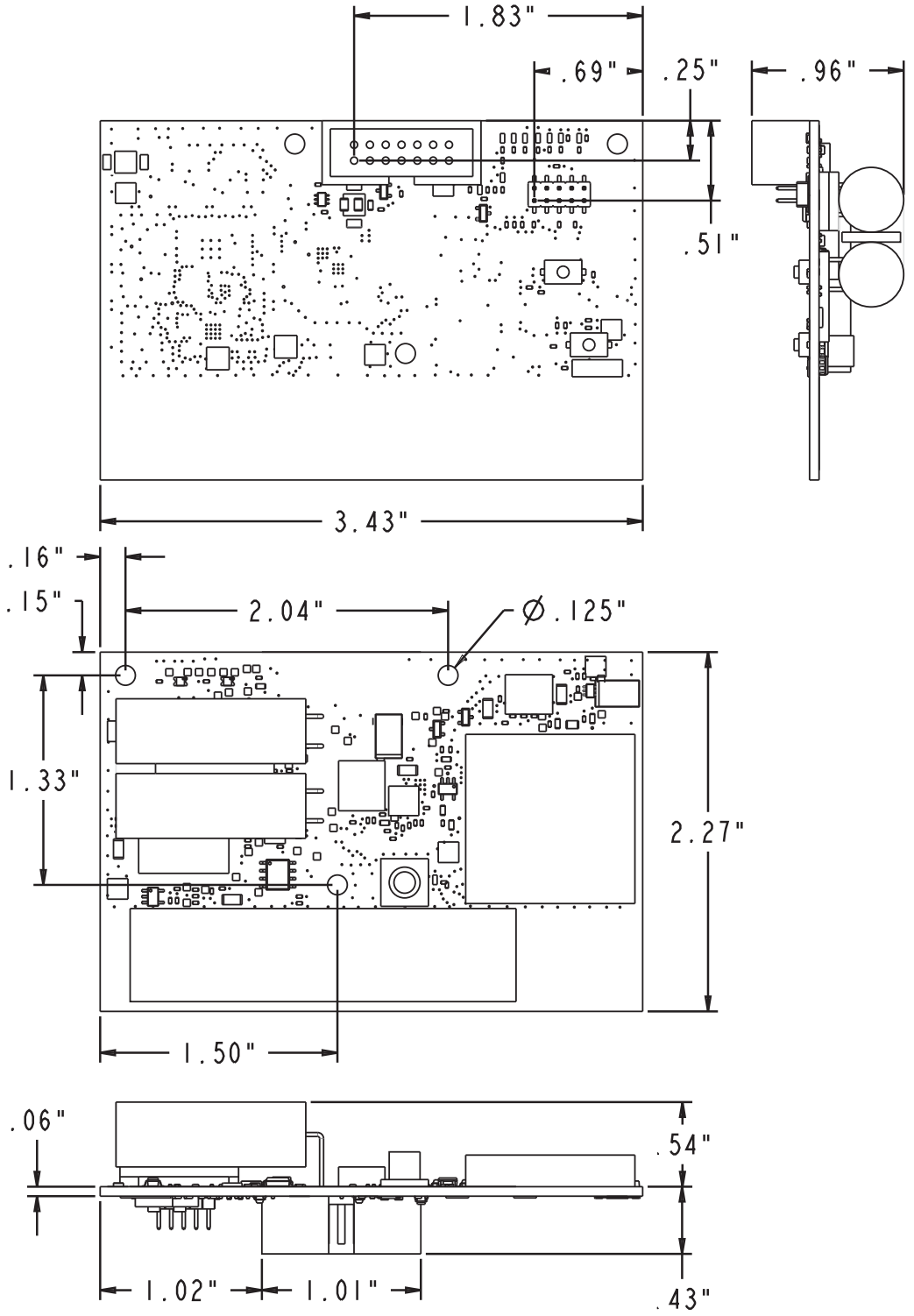


Figure 1 - 12. Gridstream S4SBR 25-1684 Dimensions

2 Configuration & Testing

Overview

In this overview, the Gridstream SCADA Series 4 Single Board Radio (Gridstream S4SBR) is configured using the RadioShop program. Setup is similar to setting up and configuring any Gridstream Radio.

Refer to the RadioShop Getting Started Guide, Landis+Gyr publication 98-1008, for further details about using RadioShop.

NOTE: RadioShop's version number changes as new features and functionality are added to the application.

Connecting to a Gridstream S4SBR using RadioShop

Connect the LAN Packet Protocol port of your Gridstream S4SBR to your computer's serial port using the USB cable. Once the Gridstream S4SBR is powered up, you can launch RadioShop on your computer. RadioShop will now connect to your local Gridstream S4SBR card.

1. On the RadioShop home screen, click **Discover | Force Scan and Discover Entry Ports**.

NOTE: When the Select COM Ports for Discovery window opens, select the COM port on your computer that is connected to the Gridstream S4SBR, and then click OK.

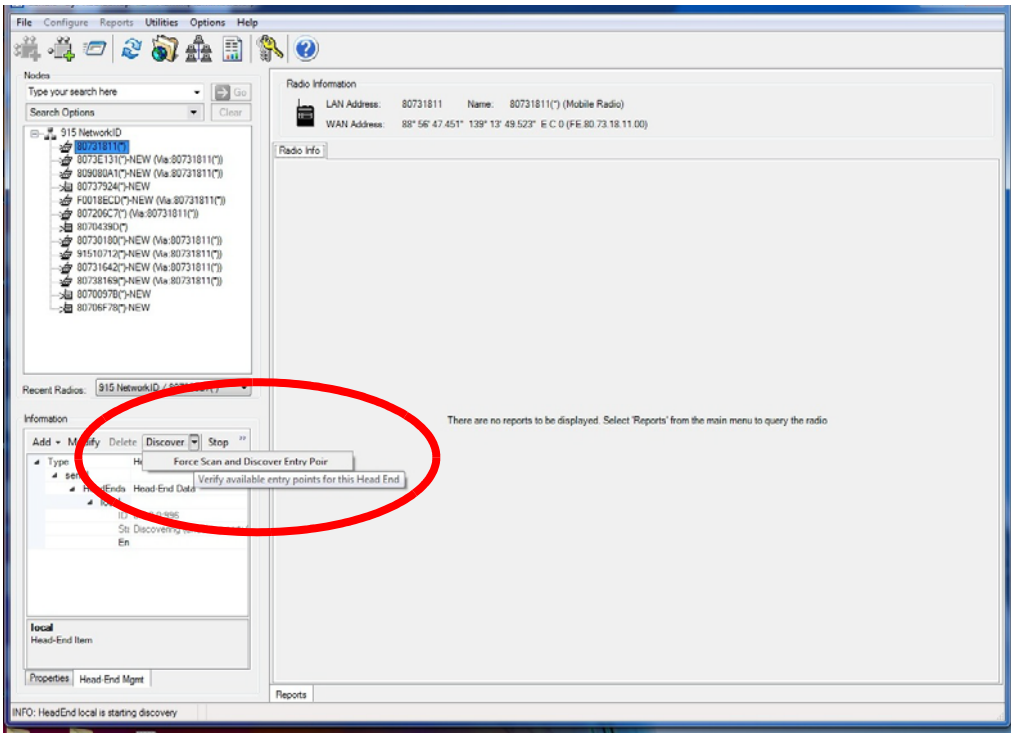


Figure 2 - 1. Connecting to a Head-end Radio

Once connected, the local radio's LAN address will appear on the list at the top left-hand side of the screen, and the radio configuration will be displayed in the main window (Figure 2 - 1). This radio can now be used to communicate with the Gridstream S4SBR and configure it as needed.

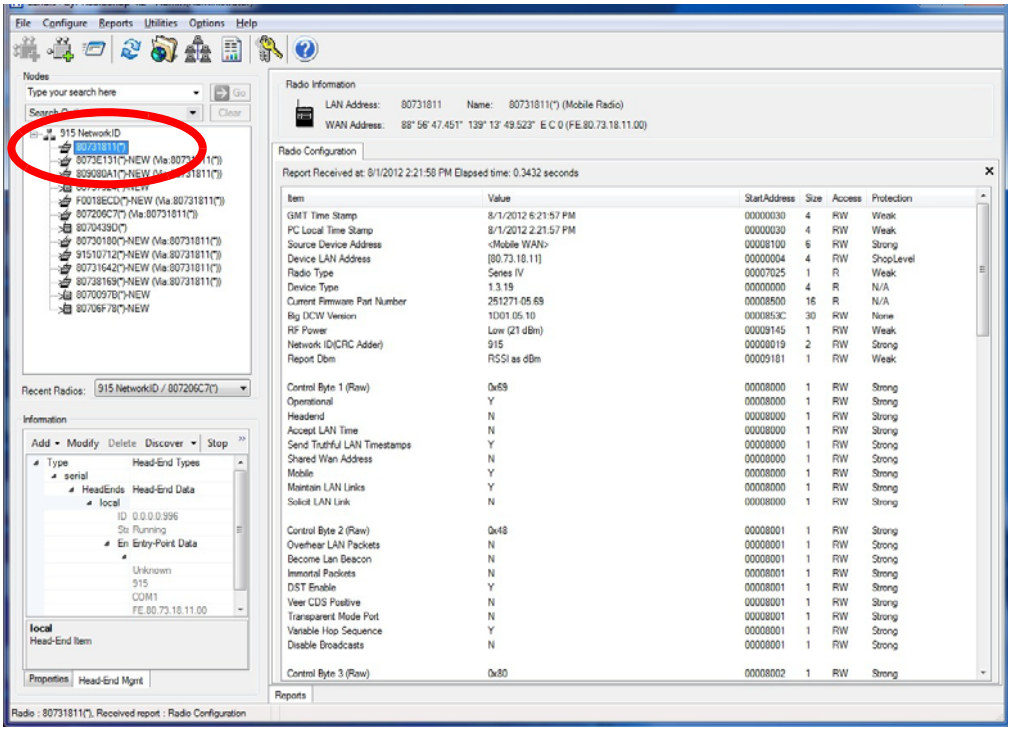


Figure 2 - 2. Radio Configuration for Head-end Radio

NOTE: All RF Mesh radios ship with a default Network ID, or CRC, of 670. In order to communicate with the Gridstream S4SBR, your local radio will have to be re-configured to match the Network ID (default 670) of the Gridstream S4SBR.

After re-configuring the Gridstream S4SBR to match the customer's unique Network ID, the local radio will need to be reset to its original network ID. See below or see "Assigning a New Network ID to a Gridstream S4SBR" on page 22 for viewing the steps to re-configure the local radio.

Assign the Network ID (CRC) of the Gridstream S4SBR

All Gridstream SBRs ship with a default network ID, or CRC, of 670. In order to communicate with other radios in a customer's network, the Gridstream S4SBR will have to be re-configured to match the customer's unique network ID.

NOTE: Prior to operation, a Network ID / CRC must be assigned. Network ID / CRC parameters are unique and are assigned for each customer. Please call Landis+Gyr Customer Service if you require a Network ID / CRC.

1. From the RadioShop home screen, select **Configure | Change Network Id (CRC)**. The Network ID Wizard dialog will open,
2. Select **Use an Existing Network** and click **Next** to continue.

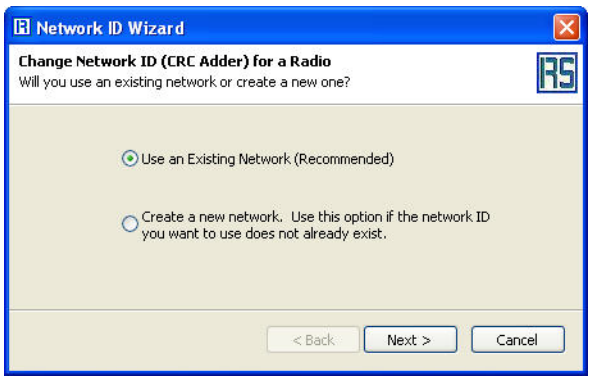


Figure 2 - 3. Network ID Wizard

The Choose an Existing Network dialog is displayed.

Figure 2 - 4. Choose an Existing Network

3. Choose a Network ID from the Available Networks drop-down list.

4. Click **Next** to continue.

   The Final Confirmation dialog is displayed.

5. Click **Next** to change the Network ID for the Gridstream S4SBR.

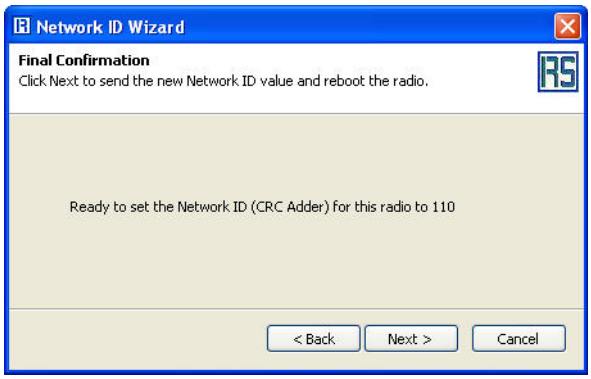


Figure 2 - 5. Final Confirmation Dialog

A confirmation message verifies that the Network ID has been changed.

NOTE: The Gridstream S4SBR will reboot to complete the Network ID / CRC Change action.

Assigning a New Network ID to a Gridstream S4SBR

WARNING: Assign a new Network ID only if the ID you want to use does not exist already.

WARNING: Valid values range from 1 to 65535. If 0 is displayed at startup, call Landis+Gyr Customer Service.

To assign a new Network ID to a Gridstream S4SBR, perform the following steps.

1. Select **Configure** > **Network Id (CRC)**. The first dialog of the Network ID Wizard is displayed.
2. Select **Create a New Network**.
3. Click **Next**.

   The Specify New Network dialog is displayed.

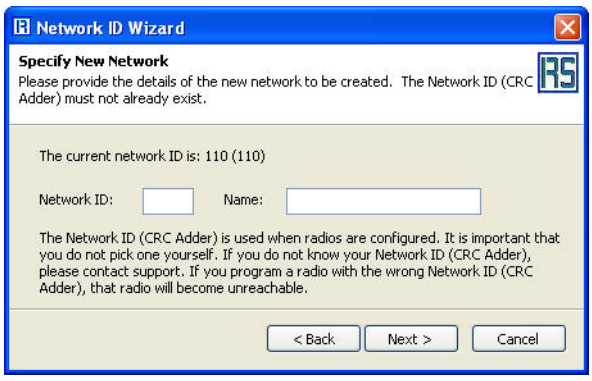


Figure 2 - 6. Specify New Network

4. Specify the Network ID and Name of the new network you want to assign.
5. Click **Next** to continue.

NOTE: Do not use spaces in the **Name** field.

The Final Confirmation dialog is displayed.

6. Click **Next** to create the Network ID for the Gridstream S4SBR.

A confirmation message verifies that the new Network ID has been assigned to the Gridstream S4SBR.

Adding New Radios to RadioShop

You can now add the Gridstream S4SBR to the RadioShop database.

1. Confirm that your local radio is highlighted on the **Nodes** Pane.
2. Click the **Generate WAN Nodes Report** icon.
3. From the RadioShop home screen, click **Utilities | Radio | Discover Neighbors**, as shown in the figure below.

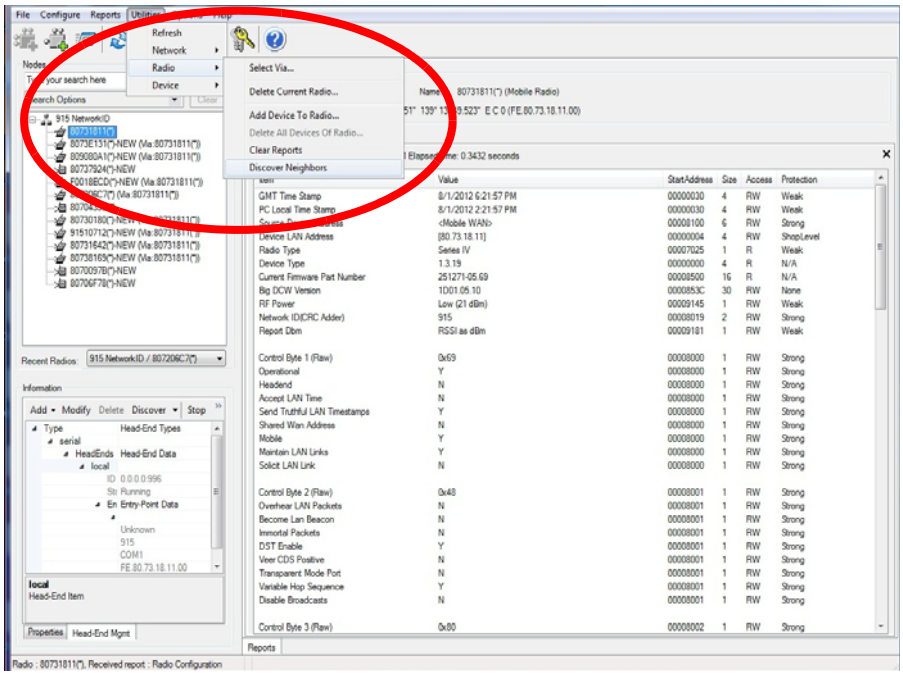


Figure 2 - 7. Discovering Neighbors

4. Once discovered, the Gridstream S4SBR's LAN Address will appear in the Nodes pane, as shown in Figure 2 - 8.

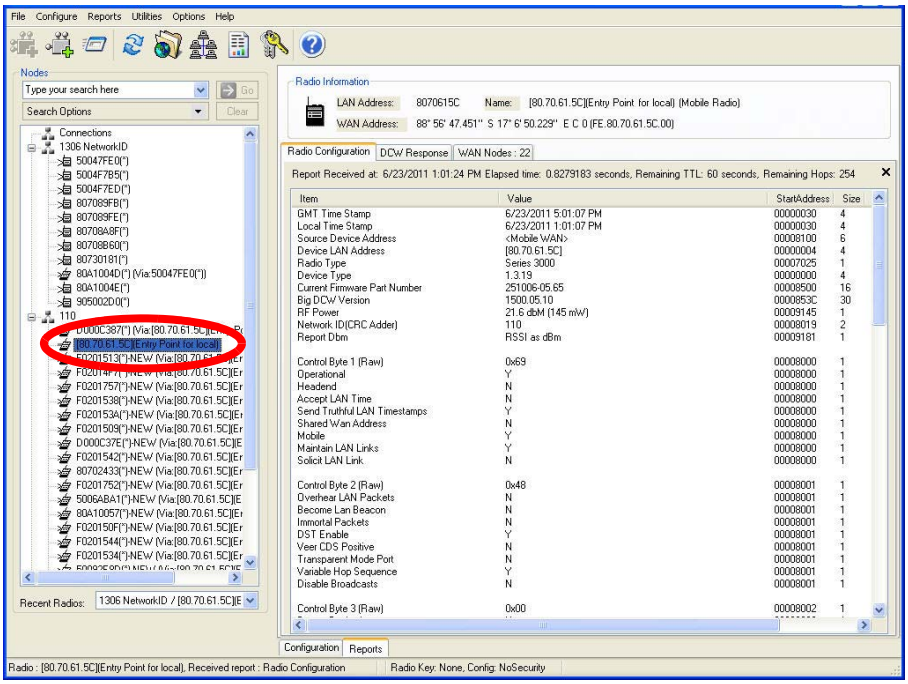


Figure 2 - 8. Gridstream S4SBR's LAN Address Appears in the Nodes Pane

5. Highlight the new Gridstream S4SBR as shown in Figure 2 - 8, and click **Reports | Configuration | Radio** to verify that you can communicate with the Gridstream S4SBR.
6. Review the report to verify the radio's firmware version and network ID.

Setting the Latitude & Longitude

1. From the RadioShop home screen, click **Configure | WAN Address**.
2. In the Configure WAN Address window, specify the new coordinates, and click **OK**.

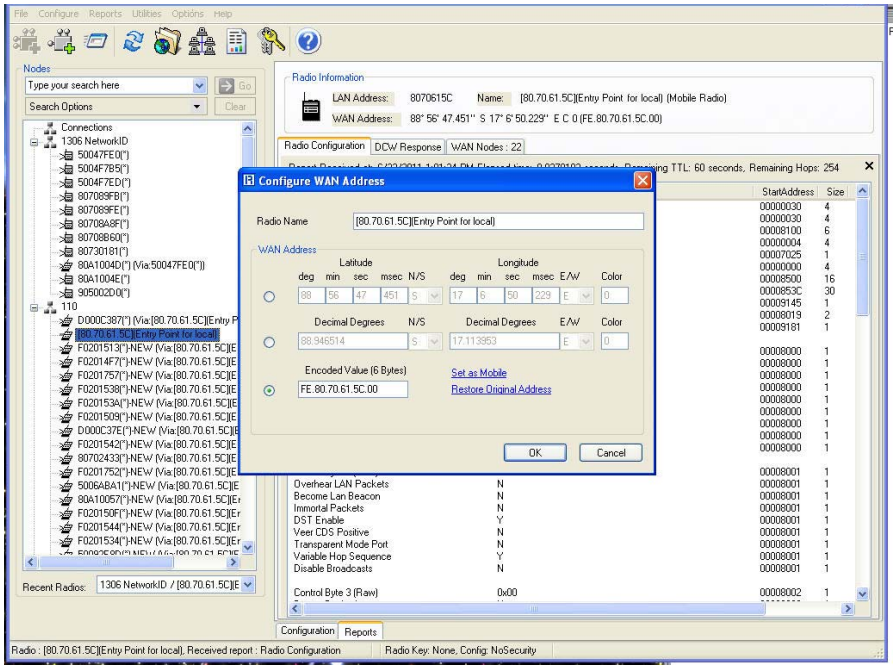


Figure 2 - 9. Configuring the WAN Address

A message will appear indicating that the radio was successfully programmed.

Troubleshooting

The Gridstream S4SBR has been designed as a Field Replaceable Unit (FRU). As such, there are no serviceable parts in the unit.

If you suspect parts within the Gridstream S4SBR have failed:

1. Inspect the module to determine if there is any visual indication of damage to the unit.
2. Verify that power is being supplied to the unit. If the power is within operating parameters, proceed to Step 3.
3. Try to connect with a locally connected Series-4 IWR configured the same as the Gridstream S4SBR. If, after five minutes, the locally connected Series-4 IWR does not acquire the Gridstream S4SBR in its neighbors list, the Gridstream S4SBR should be replaced.

For additional assistance for this product, contact Landis+Gyr Technical Support at 1-888-390-5733 or solutionsupport.na@landisgyr.com.

3 Development Environment

Gridstream SCADA/DA Series 4 Single Board Radio Interface Board

This section provides instruction for the using the Gridstream S4SBR interface. A simple prototype board block diagram is provided to demonstrate how to connect a Gridstream S4SBR to a PC-compatible computer either for programming or to integrate the Gridstream S4SBR into OEM devices.

NOTE: The drawings provided in this section are for design reference purposes only. No interface board is available for purchase from Landis+Gyr.

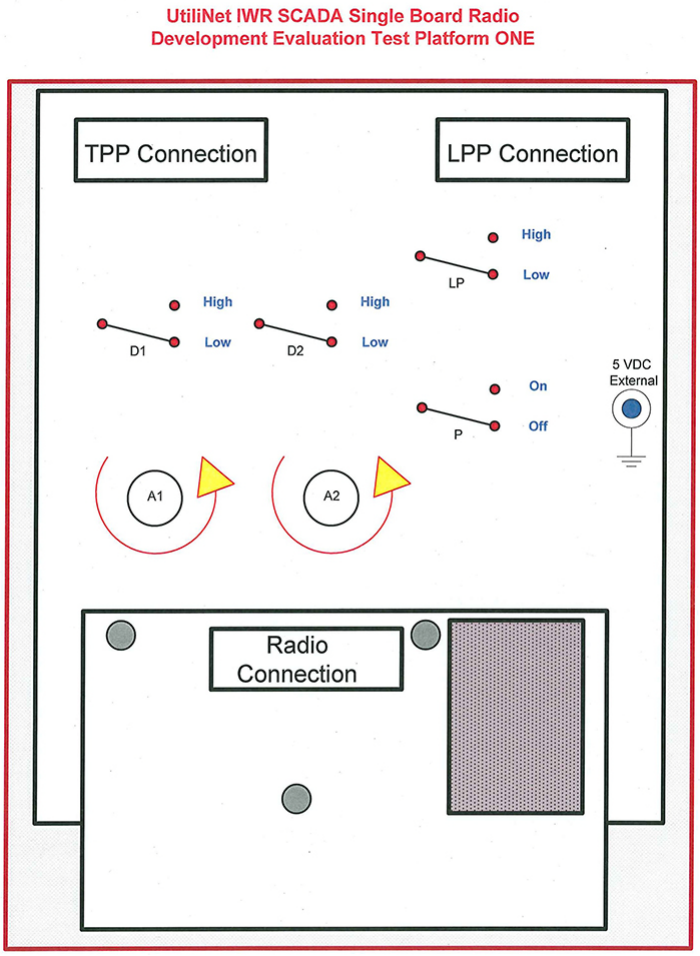


Figure 3 - 1. Board Component Layout with On-board Antenna

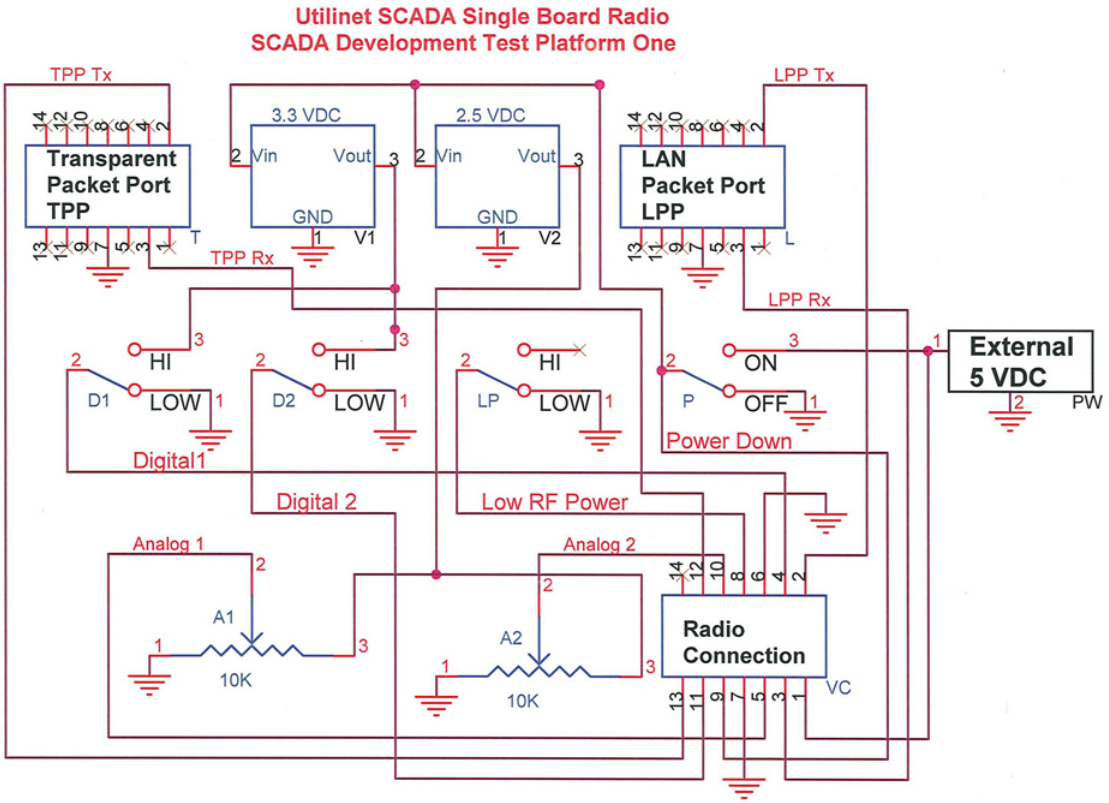


Figure 3 - 2. Board Components Schematic

NOTE: With the digital input switch tying the digital I/O pin on the Gridstream S4SBR to either a logic 0 or a logic 1 voltage level, this Development Test Platform One does not have functions to test the digital output of the Gridstream S4SBR. It is recommended to NOT configure the digital I/O pin as output when the Gridstream S4SBR is connected to the test interface board.

Transparent Port (TPP) Connection

This connector is used to establish connection to the Gridstream S4SBR through the transparent port. When communication through the transparent port is desired, connect the USB cable to this connector.

LAN Packet Port (LPP) Connection

This connector is used to establish connection to the Gridstream S4SBR through the LAN packet port. When communication through the LAN packet port (using RadioShop) is desired, connect the USB cable to this connector.

Onboard Regulator

The Gridstream S4SBR interface board is equipped with an onboard VDC regulator. This regulator accepts a 4.0 ~ 7.0 VDC input from a main power source and regulates it to power device electronics.

NOTE: The S4SBR onboard VDC regulator is not capable of supplying power to additional devices beyond the S4SBR.

Digital Input

Digital input to Gridstream S4SBR can be tested by toggling the two switches on the test board that correspond to D1 for DIGITAL_IO1 and D2 for DIGITAL_IO2. The switch will toggle between 0V and supply VDC.

Analog Input

Analog input to the Gridstream S4SBR can be tested by tuning the two potentiometers on the test board that correspond to A1 for ANALOG_IN1 and A2 for ANALOG_IN2. The input voltage should lie between 0 VDC and 2.5 VDC.

NOTE: With an on-board reference of 2.5 VDC, the highest analog input the Gridstream S4SBR may sense is limited to 2.5 VDC. Although the processor on the Gridstream S4SBR may withstand supply VDC analog input, users are advised not to exceed 2.5 VDC.

General Usage Instruction

Depending on the desired method used to establish communication, connect a USB cable to either the Transparent Packet Port (TPP), the LAN Packet Port (LPP) connection, or both.

NOTE: To provide power to the Gridstream S4SBR test Platform, the power input must be supplied externally (as shown) because the USB cable, when connected to the TPP or LPP connector, does not provide power for the test board.

Set the USB power input to an appropriate level by toggling the switch (P) controlling the *PWR_DN signal (pin 9) to OFF position.

Connect the Gridstream S4SBR to the test board through the board-to-board I/O connector (located under the SRB).

Toggle the switch (P) controlling the signal (pin 9) *PWR_DN to the ON position to turn the Gridstream S4SBR ON.

The switch (LP) controlling *LOW_RF_POWER may be toggled to set (pin 8) the transmit level of the Gridstream S4SBR under test. This switch will control whether to transmit with limited or full power.

Gridstream S4SBR Logic

Developers planning to use the Gridstream SCADA/DA Series 4 Single Board Radio (Gridstream S4SBR) in their SCADA equipment as a monitoring device should be aware of the logic of the setting when writing a DCW program. The following describes the logic for reading and writing

Gridstream S4SBR Control Registers 1 and 2 located at memory locations 7700h and 7700h in the radio using a DCW.

Control Register 1

D1-Input

Pin D1 at 7700h (Bits 0-3), if 7700h (Bit 0 = “0”) Input then read Control at 7700h (Bits 2-3)

- If Control = “00” - General Purpose => Read state at 7700h (Bit 1) and report
- If Control = “01” - Rising Edge => Read count at 7706h (four bytes) and report
- If Control = “10” - Falling Edge => Read count at 7706h (four bytes) and report
- If Control = “11” - Either Edge => Read count at 7706h (four bytes) and report

D1-Output

Pin D1 at 7700h (Bits 0-3), if 7700h (Bit 4 = “0”) Output then verify Control = “00”

- If NOT “00” => Report Error in configuration
- If “00” General Purpose => Set state at 7700 (Bit 1) and report

Pin D2 at 7700h (Bits 4-5), if 7700h (Bit 4 = “0”) Input then read state at 7700 (Bit 5) and report

D2-Input

Pin D2 at 7700h (Bits 4-5), if 7700h (Bit 4 = "0") Input then read state at 7700 (Bit 5) and report

D2-Output

Pin D2 at 7700h (Bits 4-5), if 7700h (Bit 4 = “1”) Output then set state at 7700 (Bit 5) and report

Control Register 2

A1-Input

Pin A1 at 7701h (Bits 0-2), if 7701 (Bit 0 = “0”) Input then read Control at 7701h (Bit 2)

- If Control = “0” - General Purpose => Read state at 7701h (Bit 1) and report
- If Control = “1” - Analog to Digital Channel => Read channel at 7702h (2 bytes) and report

A1-Output

Pin A1 at 7701h (Bits 0-2), if 7701 (Bit 0 = “1”) Output then read Control at 7701h (Bit 2)

- If Control = “0” - General Purpose => Set state at 7701h (Bit 1) and report
- If Control = “1” - Analog to Digital Channel => Report Error in configuration

A2-Input

Pin A2 at 7701h (Bits 4-6), if 7701 (Bit 4 = “0”) Input then read Control at 7701h (Bit 6)

- If Control = “0” - General Purpose => Read state at 7701h (Bit 5) and report

- If Control = “1” - Analog to Digital Channel => Read channel at 7704h (2 bytes) and report

A2-Output

Pin A2 at 7701h (Bits 4-6), if 7701 (Bit 0 = “1”) Output then read Control at 7701h (Bit 6)

- If Control = “0” - General Purpose => Set state at 7701h (Bit 5) and report
- If Control = “1” - Analog to Digital Channel => Report Error in configuration

Digital I/O Functionality

NOTE: This device provides two general purpose digital I/O lines. These are controllable through the DCW programming language. It is outside the scope of this document to describe that language but, in brief, there are mechanisms by which each line can be independently configured as input or output.

The state of inputs can be read, and the state of outputs can be set. DCW code execution operates as a virtual environment and, as such, does not support rapid transitions. Users should understand the speed limitations associated with the use of these digital I/O pins.

The register below can be used to control either of the two general purpose I/O pins (D1 & D2) located at memory location 7700 (hex).

Table 3 - 1. Control Register 1

Bit	Feature	Description	Dflt.
0	Pin D1 Direction	0: Input 1: Output	0
1	Pin D1 State	When D1, bit 0 is "0" and bit 2-3 is "00", then bit 1 returns current state as "0" or "1". When D1, bit 0 is "0" and bit 2-3 is not "00", then read location 7706-7709 which returns the count of the as defined in bit 2-3. When D1, bit 0 is "1" then the value can be read or set.	0
2-3	Pin D1 Control	00: General Purpose I/O 01: Count interrupts on rising edge 10: Count interrupts on falling edge 11: Count interrupts on either edge	0
4	Pin D2 Direction	0: Input 1: Output	0
5	Pin D2 State	When D2, bit 4 is "0" then bit 5 returns current state as "0" or "1". When D2, bit 4 is "1" then the value can be read or set.	0
6-7	Reserved	N/A	0

Analog Input Functionality

This device provides two general purpose analog inputs. These are filtered and connected to a 10-bit A/D converter.

NOTE: The voltage reference for this A/D converter is 2.5 VDC +/- 60[mVDC] across the operating temperature range.

This A/D converter has the following specifications:

Table 3 - 2. A/D Converter Specifications

A/D characteristic	Specification
Resolution	10 bit
INL	+/-5 LSB
Absolute Accuracy	+/-5 LSB
DNL	+/-1 LSB
Offset Error	+/-3 LSB
Gain Error	+/-3 LSB

NOTE: The actual sampling time is 0.25 µS and the conversion time is 2.75 µS, but the rate at which signals on these inputs can be sampled in-practice is limited by the DCW execution. It is recommended that these channels be used only for DC voltage measurement, and that the sampling rate can not exceed 100 mS.

The register below can be used to control either of the two general purpose Analog pins (A1 & A2) located at memory location 7701 (hex).

Table 3 - 3. Control Register 2

Bit	Feature	Description	Dflt.
0	Pin A1 Direction	0: Input 1: Output	0
1	Pin A1 State	When A1, bit 0 is "0" and bit 2 is "0", then bit 1 returns current state as "0" or "1". When A1, bit 0 is "0" and bit 2 is "1", then read location 7702-7703 which returns the Hex value of the sampled voltage between 0-2.5 VDC. When A1, bit 0 is "1", then the value of bit 1 can be set.	0
2	Pin A1 Control	0: General Purpose I/O 1: Analog to Digital Channel (Bit 0 = "0" only)	0
3	Reserved	Not Used	0
4	Pin A2 Direction	0: Input 1: Output	0

Table 3 - 3. Control Register 2

Bit	Feature	Description	Dflt.
5	Pin A2 State	When A2, bit 4 is "0" and bit 6 is "0", then bit 5 returns current state as "0" or "1". When A2, bit 4 is "0" and bit 6 is "1", then read location 7704-7705 which returns the Hex value of the sampled voltage between 0-2.5 VDC. When A2, bit 4 is "1", then the value of bit 5 can be set.	0
6	Pin A2 Control	0: General Purpose I/O 1: Analog to Digital Channel (Bit 0 = "0" only)	0
7	Reserved	Not Used	0

Memory Location

INTRODUCTION INFORMATION

[7702-7703h] Analog to Digital Channel A1.

When A1 is set to "Analog to Digital" (Bit 2) this location will contain a 10-bit reading. The scale on this board is from 0 to 2.5 volts. Voltages greater than 2.5 VDC will be reported as 2.5 VDC.

[7704-7705h] Analog to Digital Channel A2.

When A2 is set to “Analog to Digital” (Bit 6) this location will contain a 10-bit reading. The scale on this board is from 0 to 2.5 volts. Voltages greater than 2.5 VDC will be reported as 2.5 VDC.

[7706-7709h] D1 Interrupt Counter.

If D1 is configured as an interrupt (Bit 2-3) then this location will count the number of interrupts that have been detected.

NOTE: The interrupt counter is cleared each time interrupts are enabled.

A External Antenna

Manufacturer Contact Information

Manufacturers Marketing Group, Inc.
922-C Merchants Walk
Huntsville, AL 35801
Phone: 256-519-2455
Fax: 256-519-9299
Website: www.mmg-inc.com

External Antenna Specifications

The external antenna used to qualify the board is an omnidirectional 5 dBi whip (shown in the next figure), made by MMG. The MMG antenna part number is 16-1000-0. See page 48 for product data sheet.

Figure A - 1. Whip Antenna with N-type Male Reverse-Polarity Connector

NOTE: This antenna's maximum gain is 5 dBi and its efficiency is 80%.

NOTE: Any antenna may be used as long as it is an omnidirectional whip with a gain of 5 dBi or less.

Ground Plane Specifications

NOTE: Please note this antenna requires a ground plane (MMG P/N 17-1000-A). The ground plane should be at least six inches in diameter. See Figure A - 2

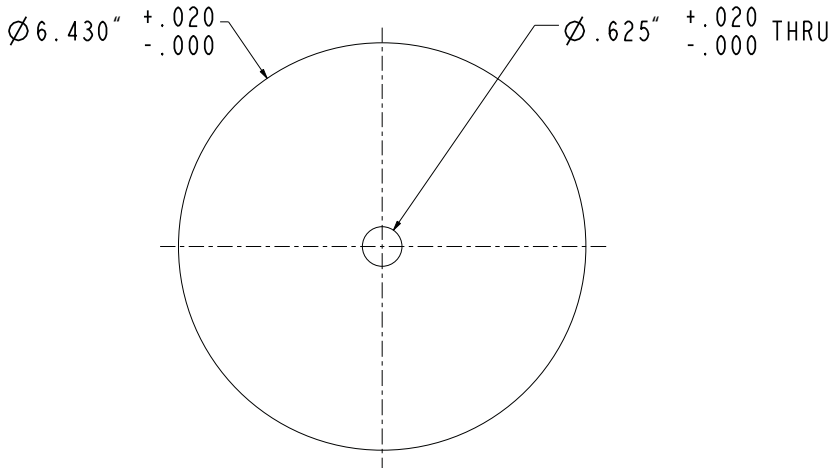


Figure A - 2. Ground Plane Specification

If the enclosure for the board is metal and at least 6" across, and the antenna is connected directly to the enclosure, no ground plane is required, as the enclosure is the ground plane. The radiation pattern of the recommended antenna is of a traditional dipole (RF pattern as a donut). The orientation of the antenna should be in the vertical position (straight up or straight down), such that the RF pattern is omni-directional in the horizontal plane.

RF External Antenna Cable Specifications

An external antenna is connected to the board via an RF coaxial cable of the type as shown in Figure A - 3. See page 49 for the product data sheet.

Figure A - 3. RF Coaxial Cable

The cable has a Reverse-Polarity N-Type Female/Jack connector on one end and an MCX Male connector on the other. This cable is available from MMG in lengths of 6", 12", and 18".

The MMG part numbers and typical insertion loss for these cables are shown in Table 1:

Table 1. Part Numbers and Typical Insertion Loss

Length (inches)	Part number	Insertion Loss
6	21-1000-0	0.23 dB
12	21-1001-0	0.40 dB
18	21-1002-0	0.54 dB

External Antenna Radiation Pattern

The antenna's radiation pattern is shown in Figure A - 4 and Figure A - 5.

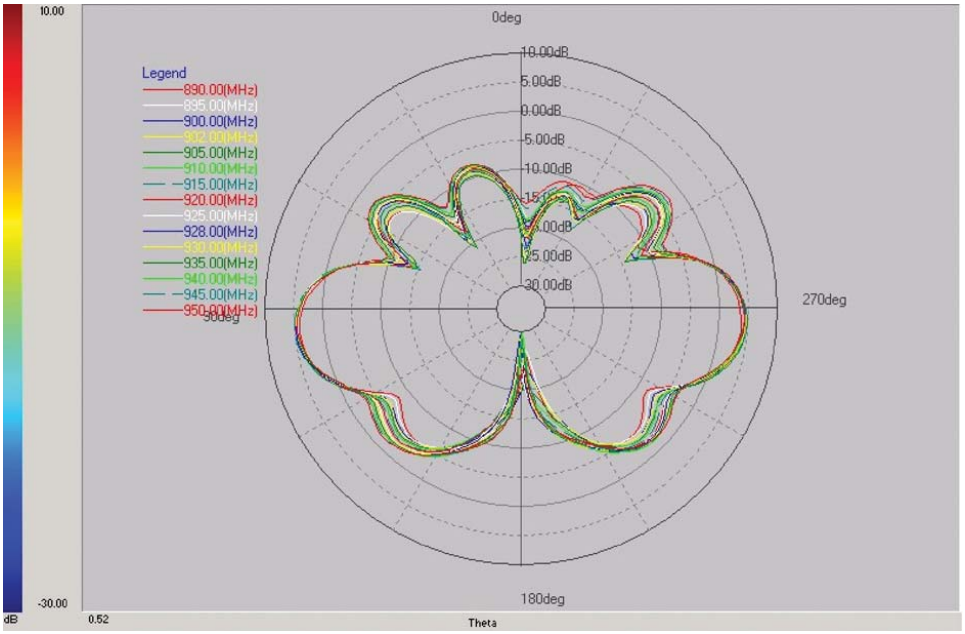


Figure A - 4. External Antenna Radiation Pattern, Side View

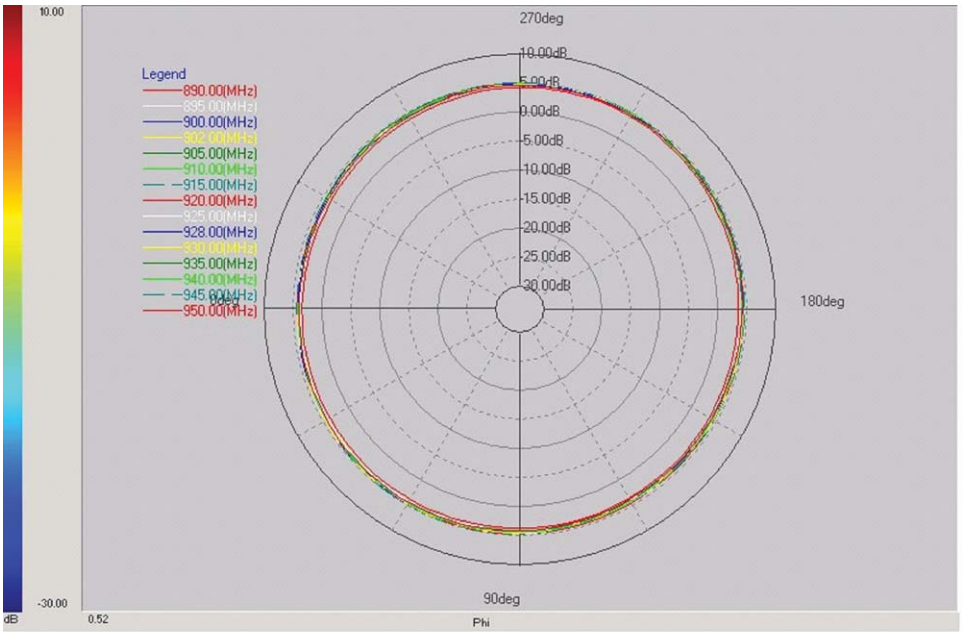


Figure A - 5. External Antenna Radiation Pattern, Top View

Identifying a Reverse-Polarity Connector

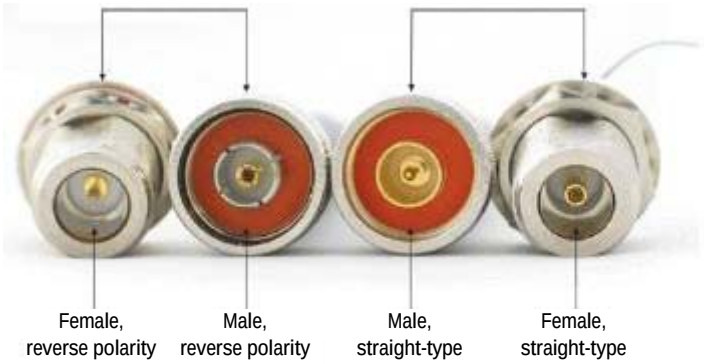


Figure A - 6. Reverse Polarity and Straight Connectors

A reverse-polarity polarized coaxial connector alters the standard connector interface by using a male pin center conductor in a female threaded coupling mechanism with a female basket center conductor in a male threaded coupling nut mechanism.

This prevents mating with a standard non-polarized connector. This type of connector is required by FCC part 15.203 rules for modular approval. See Appendix C on page 43.

B On-board Antenna

Specifications

The on-board antenna design is an F-antenna. This design was chosen because its performance is more broad-band relative to a slot antenna, and its pattern is somewhat omni-directional. This antenna's maximum gain is 0 dB and its efficiency is 45%. This product does not allow an external antenna in conjunction to the on-board antenna.

Using the on-board antenna, the recommended placement of the Gridstream S4SBR is at the edge of the OEM board, with the antenna-side edge of the board extending beyond the edge of the board, hanging out into free space and facing up as shown in Figure B - 1. If the antenna on the board does not extend out into free space, then the customer's board will load the antenna and affect the radiation pattern.

Also, an RF-transparent enclosure must be used (plastic or similar). Do not enclose the board within a metal box. If a metal box is required to house the assembly, then the external antenna version of the product must be used.

The on-board F-antenna's radiation pattern in free space is nearly Omni-directional, but has nulls in the direction of the 14-pin I/O connector. The best way to visualize the antenna's radiation pattern is a semi-sphere about the antenna-side edge of the board.

The main radiating element is the long trace running the length of the board. The length of this trace sets the resonant frequency of the antenna. The thicker F element, parallel to the feed element, is the return path to ground. The length of the feed element and size of the gap between the feed and ground elements dictate the match of the antenna.

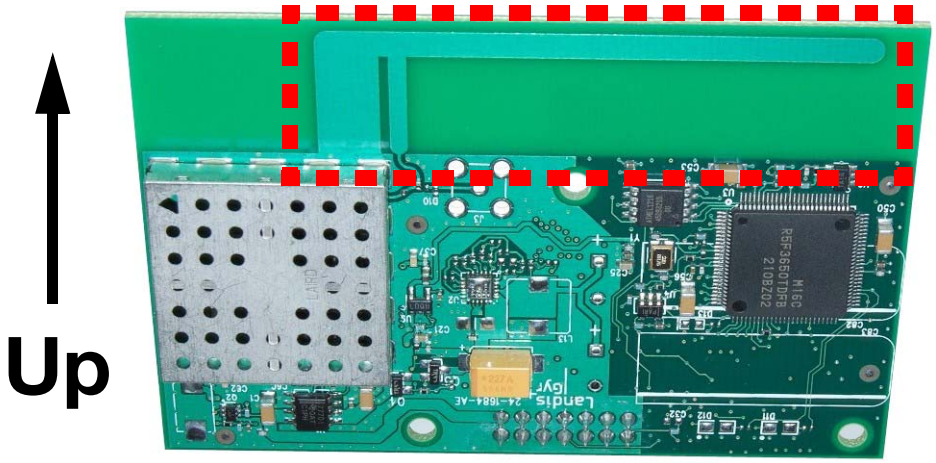


Figure B - 1. Recommended Board Orientation for Optimal Antenna Performance

On-board Antenna Radiation Pattern

Using the orientation of the antenna as described above, the antenna's radiation pattern is shown in the following figures.

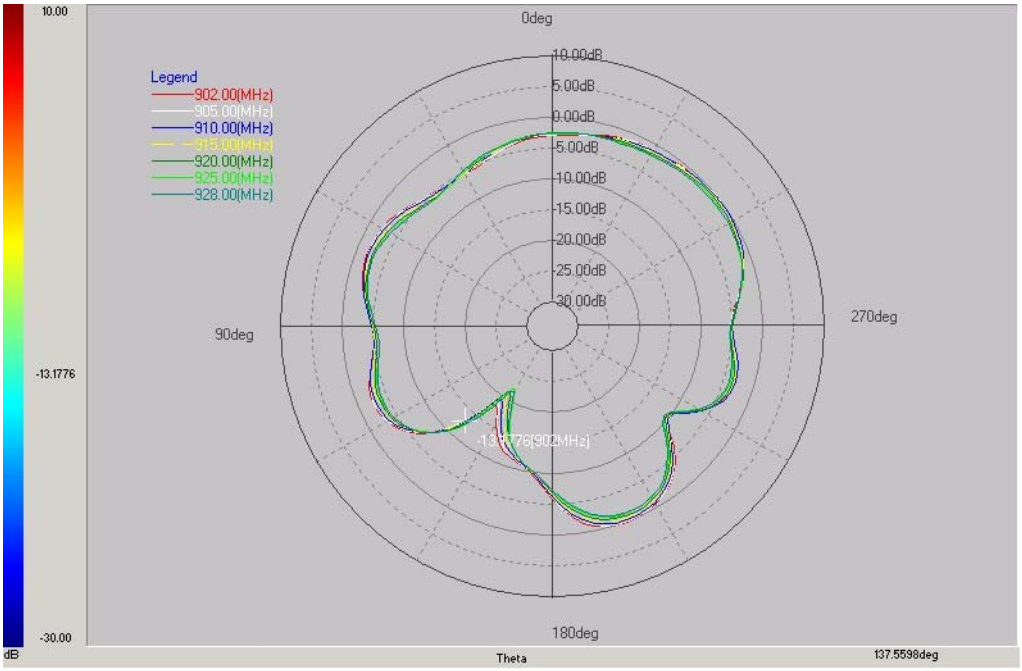


Figure B - 2. On-board Antenna Radiation Pattern, Side View, Looking at the Components

Rotating the board 90° on the Z-axis, relative to the above plot (so the antenna is still up), the antenna's radiation pattern is shown in Figure B - 3.

The Top View of the antenna's radiation pattern is shown in Figure B - 3.

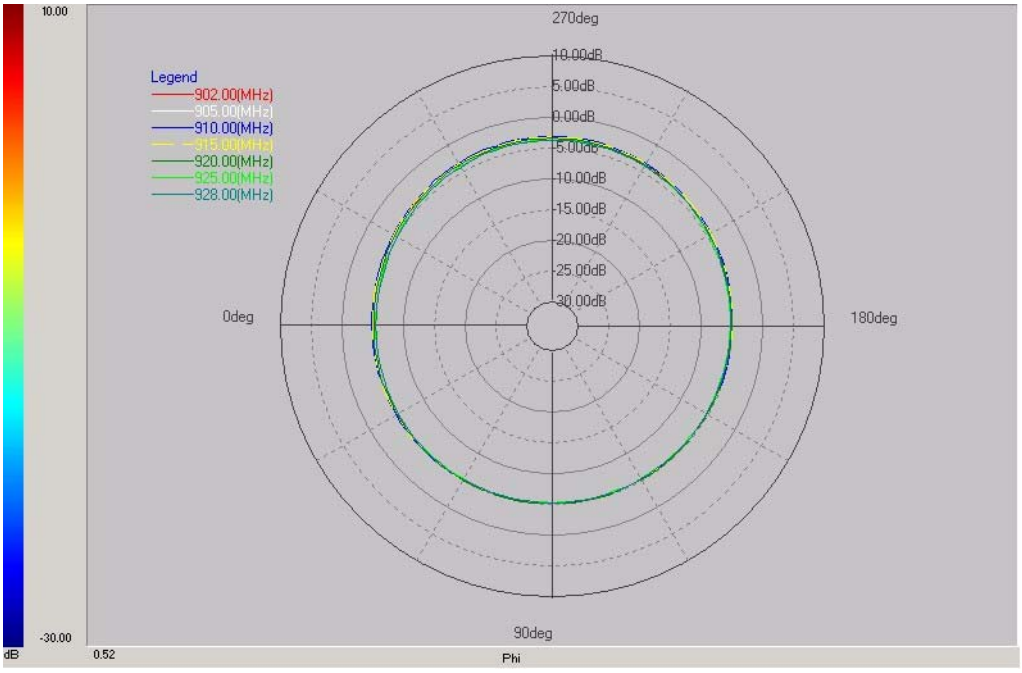


Figure B - 3. On-board Antenna Radiation Pattern, Top View

C FCC and Industry Canada Compliance

FCC Class B

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 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.
- Consult Landis+Gyr or an experienced radio technician for help.

WARNING: Changes or modifications to this device not expressly approved by Landis+Gyr could void the user's authority to operate the equipment.

RF Exposure

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 centimeters between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Industry Canada

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device. Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter (DEVICE IC 5294A-NG0R1S1) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Approved Antenna: Omni-directional antenna, 5 dBi gain, 902-928 MHz, antenna impedance is 50 ohms.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement. Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (DEVICE IC 5294A-NG0R1S1) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Host FCC Label Requirement

In the final installation, the following information must be visible:

- Contains FCC ID: R7PNG0R1S1
- Contains IC: 5294A-NG0R1S1
- Module Model: Gridstream S4 Modular SCADA/DA

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.
2. This device must accept any interference received, including interference that may cause undesired operation.

D

MMG Data Sheets

Data Sheets

NOTE: These drawings are for information purposes only. For additional information, including pricing, contact MMG.

Whip Antenna P/N 16-1000-0

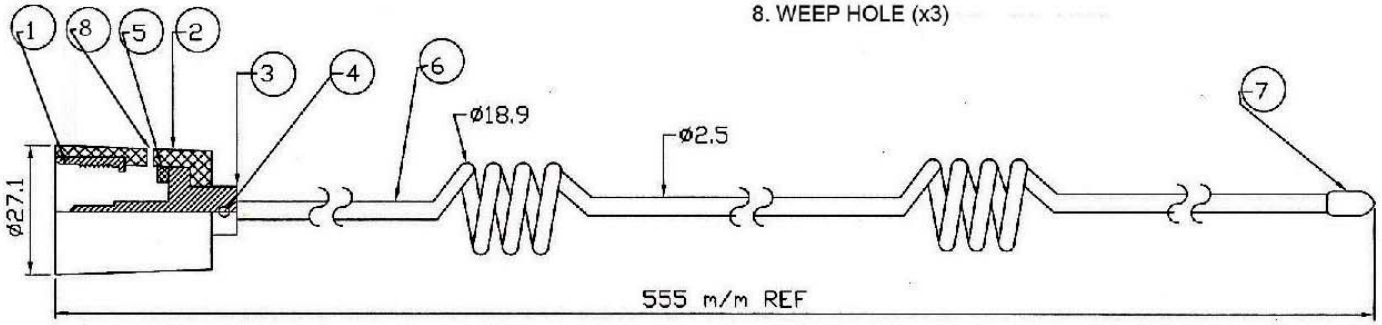
MANUFACTURERS MARKETING GROUP, INC.

www.MMG-Inc.com
Ph 256.519.2455
Fx 256.519.9299
Contact: Sales@MMG-Inc.com

MMG Part # 16-1000-0

MATERIAL/ FINISH

1. GROUND BODY:	BRASS / NICKEL
2. OUTER SHELL:	UV POLYCARBONATE / BLACK
3. CONTACT:	BRASS / NICKEL
4. SCREW:	STAINLESS/ NATURE
5. O-RING:	RUBBER/ BLACK
6. WHIP:	STAINLESS/ BLACK CHROME
7. TOP:	PVC/ BLACK
8. WEEP HOLE (x3)	



Antenna Base
(Reverse-Polarity N-type Male/Plug)

ELECTRICAL SPECIFICATIONS

Frequency	920 MHz
Frequency Range	920 +/- 50 MHz
Gain (nominal)	5 dB
Return Loss	<-18 dB
V.S.W.R.	<1.5
Impedance	50 Ω
Connector	Reverse-Polarity N-type Male/Plug

This drawing is for information purposes only.

RF External Antenna Cable P/N 21-1000-0

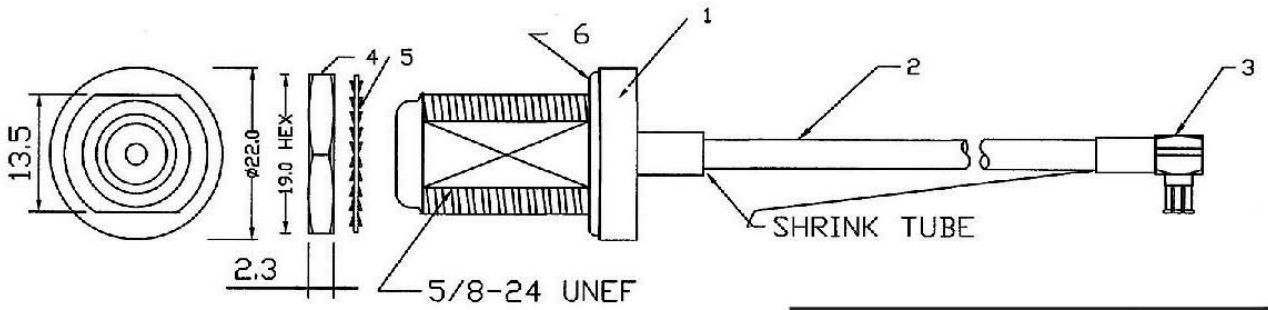
MANUFACTURERS MARKETING GROUP, INC.

www.MMG-Inc.com
Ph 256.519.2455
Fx 256.519.9299
Contact: Sales@MMG-Inc.com

MATERIAL/ FINISH

1. N CONNECTOR:	
BODY:	BRASS / NICKEL
CONTACT:	BRASS / GOLD PLATED
INSULATION:	TEFLON / NATURE
2. CABLE:	RG-316U
3. MCX CONNECTOR:	
BODY:	BRASS / NICKEL
CONTACT:	BRASS / GOLD PLATED
INSULATION:	TEFLON / NATURE
4. NUT:	BRASS / NICKEL
5. SPRING WASHER:	IRON / NICKEL
6. O-RING:	SILICON RUBBER / RED

MMG Part # 21-1000-0 (6 inch coax)
MMG Part # 21-1001-0 (12 inch coax)
MMG Part # 21-1002-0 (18 inch coax)



ELECTRICAL SPECIFICATIONS

	6 inch	12 inch	18 inch
Frequency	900 MHz	900 MHz	900 MHz
Insertion Loss (typical)	-.23 db	-.40 db	-.54 db
V.S.W.R. (typical)	1.12	1.06	1.13
Impedance	50 Ω	50 Ω	50 Ω
Connectors	R/A MCX Male, Reverse-Polarity N-type Female/Jack		

This drawing is for information purposes only.