Wire Replacement I/O

I/O Masters: FGRIO-M
I2-IOM-U

I/O Slaves: FGRIO-S
I2-IOS-C-U
FGR2-IOS-C-U
FGR2-IOS-CE-U

I/O Expansion Base: FGR2-IO-IOE

User Manual and Reference Guide

Part Number: LUM0008AG
Revision: C
Last Updated: 07/11/2012

Safety Information

The products described in this manual can fail in a variety of modes due to misuse, age, or malfunction. Systems with these products must be designed to prevent personal injury and property damage during product operation and in the event of product failure.

Warning! ***Do not*** remove or insert diagnostics cable while circuit is live unless the area is known to be free of ignition concentrations of flammable gases or vapors.

Warranty

FreeWave Technologies, Inc. warrants your FreeWave® Wireless Data Transceiver against defects in materials and manufacturing for a period of three years (two years for FGR and I2 models) from the date of shipment. In the event of a Product failure due to materials or workmanship, FreeWave will, at its option, repair or replace the Product. The Product must be returned to FreeWave upon receiving a Return Material Authorization (RMA) for evaluation of Warranty Coverage.

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Warranty Policy may **not apply**:

1. If Product repair, adjustments or parts replacements is required due to accident, neglect, unusual physical, electrical or electromagnetic stress.
2. If Product is used outside of FreeWave specifications.
3. If Product has been modified, repaired, or altered by Customer unless FreeWave specifically authorized such alterations in each instance in writing. This includes the addition of conformal coating.

Special Rate Replacement Option

A special rate replacement option is offered to non-warranty returns or upgrades. The option to purchase the replacement unit at this special rate is only valid for that RMA. The special replacement rate option expires if not exercised within 30 days of final disposition of RMA.

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FreeWave's Wireless Data Transceivers are designed and manufactured in the United States of America.

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UL Notifications

Models FGRIO-M, FGRIO-S, FGR2-IOS-C-U, FGR2-IOS-CE-U, FGR2-IO-IOE, I2-IOM-U, and I2-IOS-C-U are suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only. Do not connect or disconnect any connectors while the circuit is live unless the area is known to be non-hazardous.

Warning! EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS1, DIVISION 2.

Warning! DO NOT REMOVE OR INSERT THE DIAGNOSTICS CABLE WHILE THE CIRCUIT IS LIVE UNLESS THE AREA IS KNOWN TO BE FREE OF IGNITION CONCENTRATIONS OR FLAMMABLE GASES AND VAPORS.

Input voltage for the FGR2-IOS-C-U, FGR2-IOS-CE-U, FGR2-IO-IOE, and I2-IOM-U I2-IOS-C-U is +6.0 to +30.0 VDC.

Input voltage for the FGRIO-S is +6.0 to +20.0 VDC.

Input voltage for the FGRIO-M is +7.0 to +30.0 VDC.

Important: Input power shall be derived from a single Class 2 power source.

FCC Notifications

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 FreeWave Technologies, Inc. Any changes or modifications made to the device without the express written approval of FreeWave Technologies, Inc. may void the user's authority to operate the device.

Warning! The FGRIO-S, FGR2-IOS-C-U, FGR2-IOS-CE-U, FGRIO-M, and FGR2-IO-IOE models have a maximum transmitted output power of 1 W. It is recommended that the transmit antenna be kept at least 23 cm away from nearby persons to satisfy FCC RF exposure requirements.

Warning! The FGRIO-S models have a maximum transmitted output power of 100 mw. It is recommended that the transmit antenna be kept at least 20 cm away from nearby persons to satisfy FCC RF exposure requirements.

Warning! The I2-IOS-C-U and I2-IOM-U models have a maximum transmitted output power of 500 mW. It is recommended that the transmit antenna be kept at least 20 cm away from nearby persons to satisfy FCC RF exposure requirements.

Note: Whenever any FCC approved FreeWave Technologies, Inc. module is placed inside an enclosure a label **must** be placed on the outside of that enclosure which includes the module's FCC ID.

IC Notifications

This device complies with Industry Canada licence-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.

Ce dispositif est conforme aux normes permis-exemptes du Canada RSS d'industrie. L'opération est sujette aux deux conditions suivantes : (1) ce dispositif peut ne pas causer l'interférence, et (2) ce dispositif doit accepter n'importe quelle interférence, y compris l'interférence qui peut causer le fonctionnement peu désiré du dispositif.

Document Revision History

Date	Rev Letter	Updates Made
07/11/2012	B	• Updated UL Notifications and FCC Notifications sections to follow the current standard. • Updated voltage range for FGRIO-M models to +7.0 to +30.0 VDC. • Added specifications for all models discussed in the manual. • Updated document's organization and converted to current FreeWave format standards.
02/08/2012	A	Initial Release

Table Of Contents

Preface

This manual covers details applicable specifically to using FreeWave I/O Master, Short-Range I/O Slaves, and I/O Slave radios as Wire Replacement I/O, and covers the following models:

I/O Masters
- FGRIO-M
- I2-IOM-U

I/O Slaves
- FGRIO-S (board level)
- FGR2-IOS-C-U (board level)
- I2-IOS-C-U (board level)
- FGR2-IOS-CE-U (enclosed)

I/O Expansion Radio Base
- FGR2-IO-IOE

This document includes the following regarding the I/O Masters, Short-Range I/O Slaves, and I/O Slaves:

- A basic introduction to the transceivers including port identification.
- Installation including basic wiring diagrams and parameter setup.
- Terminal Block usage information and terminal block diagrams.

Prior to using this manual, you should be familiar with the following concepts:

- How to access the parameter settings on your transceiver.
- How to program a transceiver using either Tool Suite, or a terminal emulator, such as HyperTerminal (or Setup Terminal within Tool Suite).
- How to program the Call Book.

For more information about the FreeWave transceiver communication settings and using the transceiver, see the *User Guide and Reference Manual* for the model you are using (for example, the *FGR2 Wireless Data Transceivers User Manual and Reference Guide* or the *FGR Wireless Data Transceivers User Manual and Reference Guide*).

For information about the firmware releases that apply to the transceivers described in this manual, see Appendix A.

Notational Conventions

This guide uses the following notational conventions:

- **Bold** - Indicates items that you select, parameter settings, and parameter names.
- **Warning!** - Indicates a situation that might cause damage to your radio, data, or network.
- - Provides time saving or informative suggestions about using the product.

Contacting FreeWave Technical Support

For up-to-date troubleshooting information, check the Support page at www.freewave.com.

FreeWave provides technical support Monday through Friday, 7:30 AM to 5:30 PM Mountain Time (GMT -7). Call toll-free at 1.866.923.6168, within Colorado call 303.381.9200, or contact us through email at moreinfo@freewave.com.

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Additional Information

This guide covers settings and configurations that apply to FreeWave transceivers in an I/O wire replacement system. Some transceiver models have specific settings and configurations that apply to only that model, or settings that do not apply to the wire replacement setup. For information about a specific model or additional information about using the radios in your network, see user manuals and application notes listed below:

- *FGR Wireless Data Transceivers User Manual and Reference Guide*
- *FGR2 Wireless Data Transceivers User Manual and Reference Guide*
- *I2 Wireless Data Transceivers User Manual and Reference Guide*
- Application note #5480, *Driving Relays with FGRIO-M Digital Outputs*
- Application note #5482, *FGRIO Signal Replication with 4-20 mA Signals*
- Application note #5493, *Wireless Signal Replication with Plunger Arrival Sensors*

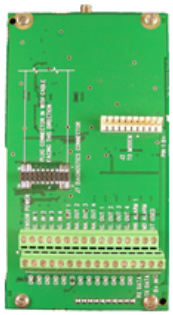
All FreeWave documentation is available on the *User Manual and System Tools* CD and at www.freewave.com.

Chapter 1: Introduction

The FreeWave FGR, FGR2, and I2 Wire Replacement I/O Systems provide outstanding performance and versatility in wireless transmission of process-control signals. FGR, FGR2, and I2 Wire Replacement I/O offers “transparent” acquisition, transport and reconstruction of analog, digital, and power signals, eliminating the need for associated buried wiring. The RTU requires no altered programming.

The following radio models are Class I Div 2 approved, are lower-cost, and provide better signal integrity than potentially vulnerable wiring:

FGRIO-M, I2-IOM-U



FGR2-IOS-CE-U

FGRIO-S, FGR2-IOS-C-U, and I2-IOS-C-U

FGR2-IO-IOE

The FGR, FGR2, and I2 Wire Replacement Systems are based on wireless RF technologies. RF is subject to interference and communication interruptions. Therefore, it should not be expected to provide 100% communication, 100% of the time.

Important: The FGR, FGR2, and I2 Wire Replacement I/O Systems should not be used without proper provisions to ensure safety upon loss of radio communications.

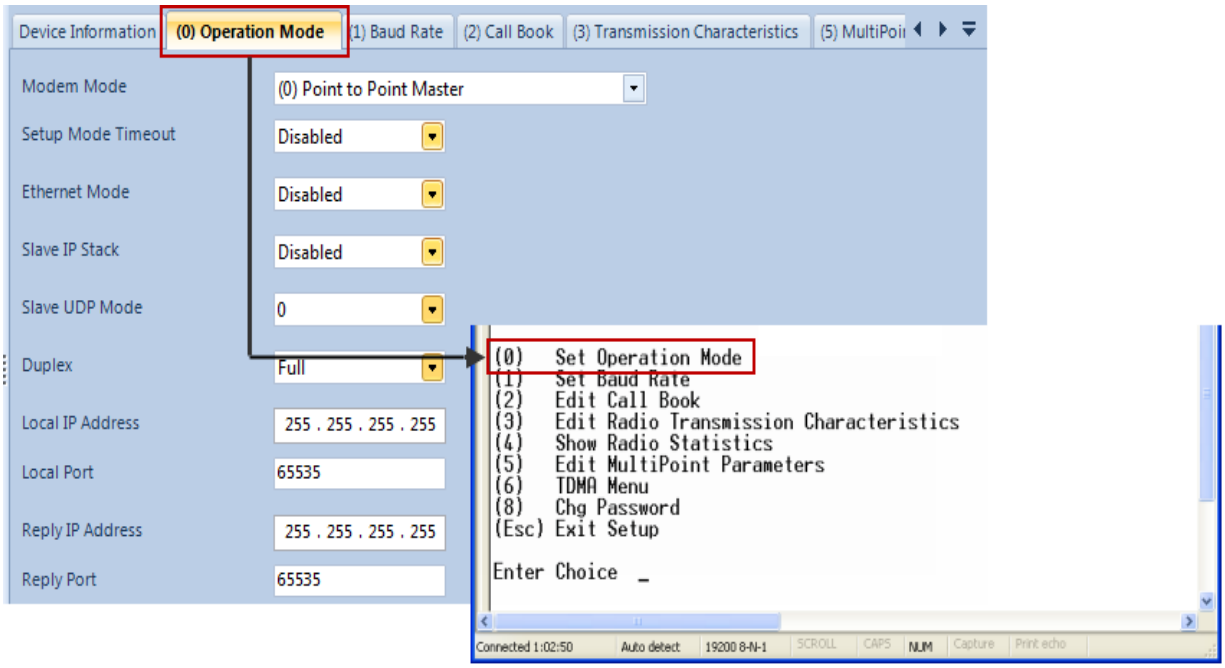
When used in this manual, the term I/O System refers to any network that uses an I/O Master in conjunction with at least one I/O Slave.

LED Indications

	FGRIO Master			FGRIO Slave		
Condition	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)	Carrier Detect (CD)	Transmit (Tx)	Clear to Send (CTS)
I/O Slave linked to I/O Master in a stand alone network	Solid green bright	Solid red dim	Blinking red	Blinking green	Blinking red	Blinking red
I/O Master linked to the network Master and the I/O Slave linked to the I/O Master	Solid green bright	Solid red dim	Flickering red	Blinking green	Blinking red	Blinking red

Tool Suite and HyperTerminal

If you are using HyperTerminal, the tabs for a device in Tool Suite mirror the Setup main menu selections. For example, option **0** from the Setup main menu in HyperTerminal is **Set Operation Mode**. The corresponding configuration tab for the device in Tool Suite is **(0) Operation Mode**.



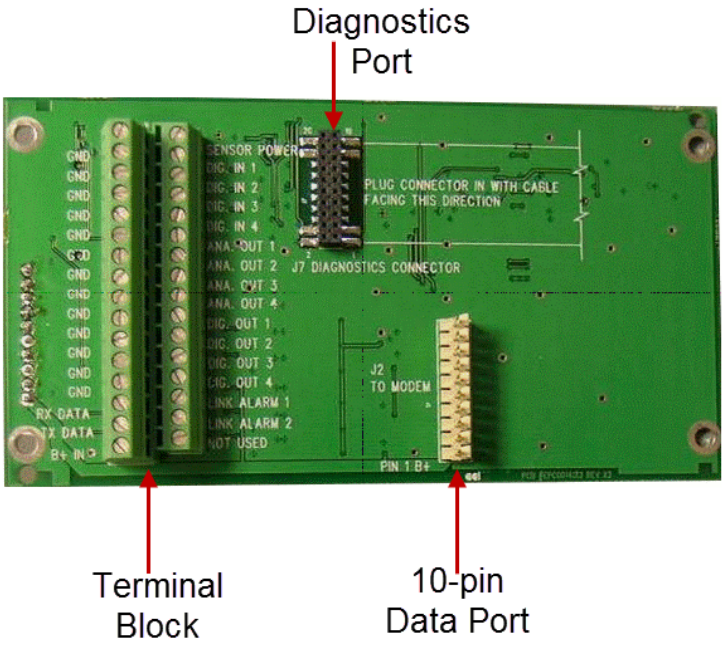
Tip You can also use the Setup Terminal application within Tool Suite to use and view the HyperTerminal menus. It displays the same menus and provides the same programming settings as you see using HyperTerminal.

Throughout this document, if the setup procedure in HyperTerminal is different than the procedure in Tool Suite, the HyperTerminal instructions are also included.

Transceiver Ports

The illustrations in the following sections identify the ports will use when working with an I/O Master, Short-Range I/O Slave, and an I/O Slave. For terminal block channel information, see "Additional Information" on page 29.

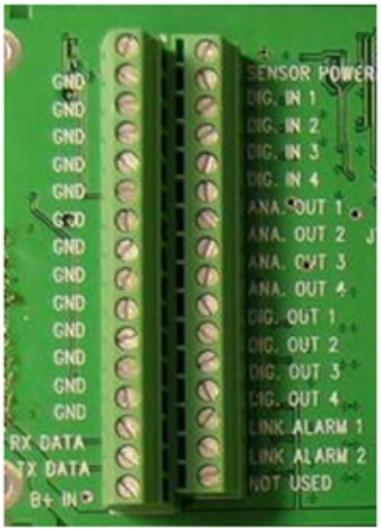
FGRIO-M Ports



FGRIO-M Terminal Block Layout

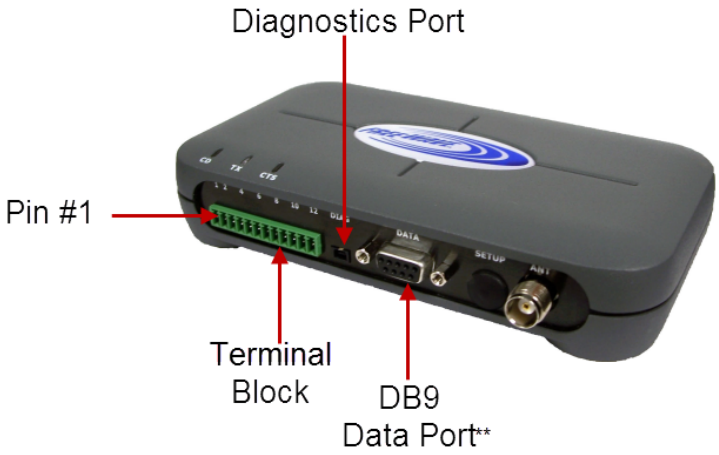
Common Grounds

- RX Data
- TX Data
- B+ In



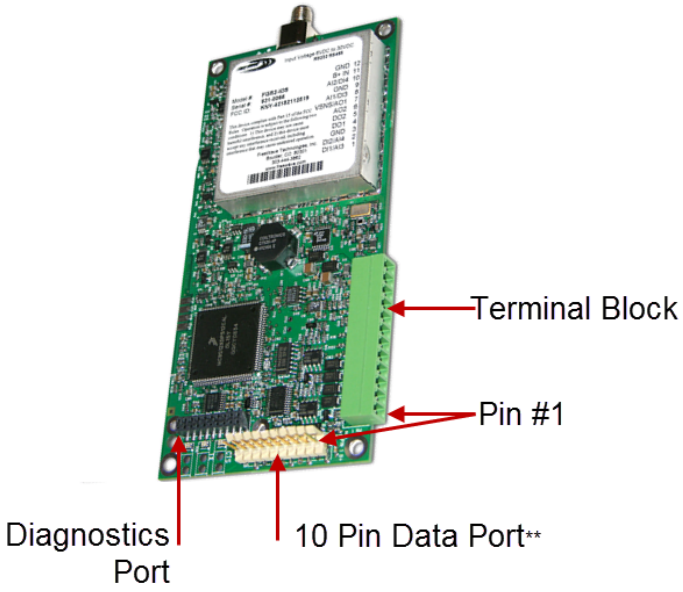
- Sensor Power
- Digital Input 1
- Digital Input 2
- Digital Input 3
- Digital Input 4
- Analog Input 1
- Analog Input 2
- Analog Input 3
- Analog Input 4
- Digital Output 1
- Digital Output 2
- Digital Output 3
- Digital Output 4
- Link Alarm
- CMD Alarm
- Not Used

FGR2-IOS-CE-U Ports



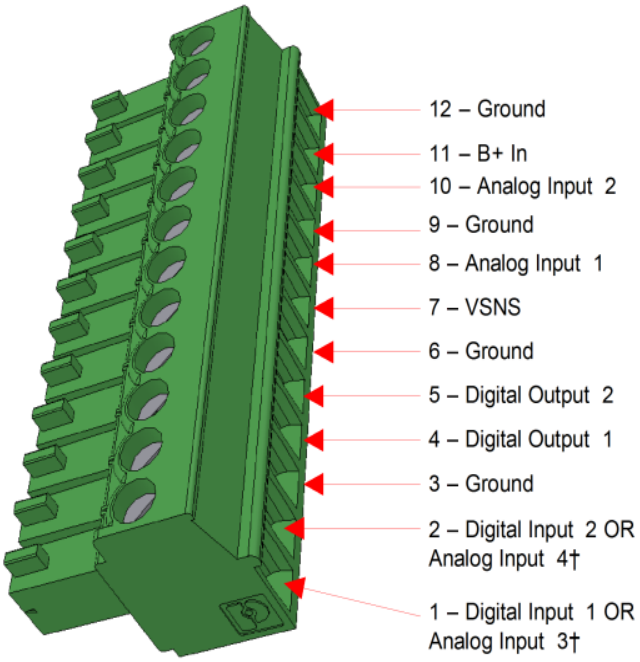
** The data port on Short-Range I/O Slaves and I/O Slaves is not active in a Wire Replacement I/O System

FGRIO-S, FGR2-IOS-C-U, and I2-IOS-C-U Ports



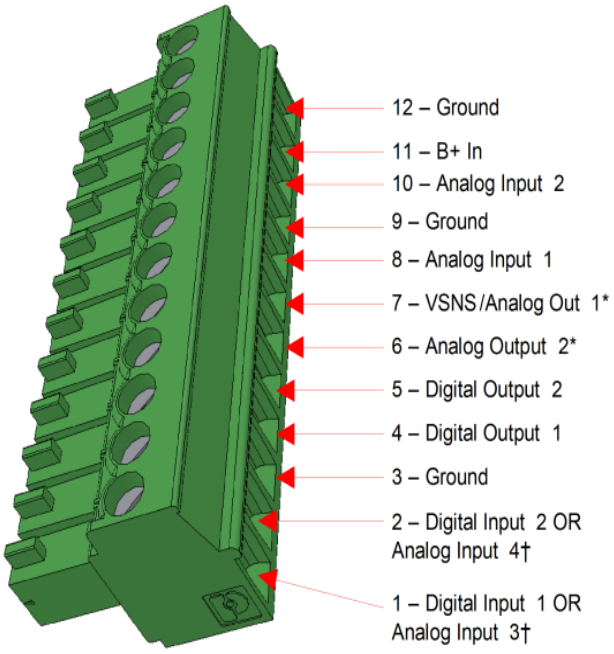
** The data port on Short-Range I/O Slaves or I/O Slaves is not active in a Wire Replacement I/O System.

FGRIO-S Terminal Block Layout



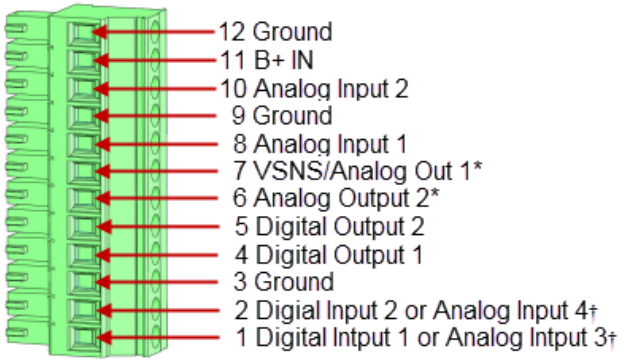
† Analog Inputs 3 and 4 are 0 to 3.3 VDC inputs. See the wiring diagrams in this document for details.

FGR2-IOS-C-U, FGR2-IOS-CE-U, and I2-IOS-C-U Terminal Block Layout



* Analog Outputs 1 and 2 are not available in a Wire Replacement I/O System

FGR2-IO-IOE Terminal Block Layout



† Analog Inputs 3 and 4 are 0 to 3.3 VDC inputs. See wiring diagrams in this document for details.

Chapter 2: I/O Master Installation and Setup

This chapter provides information about the parameter settings and the installation of an I/O Master in a Wire Replacement I/O system.

I/O Master Parameter Settings

The settings for the parameters described in this chapter are specific to an **I/O Master**. There are other parameter settings available on the transceiver. For information about parameters not included here, see the user manual for the radio you are using. For information about the parameters for Short-Range I/O Slaves and I/O Slaves, see the next chapter.

The first parameter you need to set in the I/O Master is the **Operation Mode** in the **Operation Mode** tab in **Tool Suite** or the **Set Operation Mode** menu in HyperTerminal. From there, you can address the parameter settings in any order. Select from the following Operation Modes for the I/O Master:

- **3) Point to MultiPoint Slave** - Select this mode when the I/O Master is being integrated into a Serial Modbus Network as a MultiPoint Slave. The I/O functionality is turned on in the IO Settings tab in Tool Suite and Menu 9 – IO Set Up in HyperTerminal.
- **(E) FGRIO Master** - Select this mode when the I/O Master will not be used as a MultiPoint Slave serial radio and the I/O System is standalone.

In addition, set the following parameters, each described in more detail below, on an I/O Master:

- Call Book
- In the Transmission Characteristics tab/menu:
  - Max Packet Size
  - Min Packet Size
  - RF Data Rate
  - Retry Timeout

- In the MultiPoint Parameters tab/menu:
  - Number Repeaters
  - Network ID
- All I/O Settings in the IO Settings tab/FGRIO menu

Parameter Descriptions

Each parameter description below contains the following information:

parameter name (as you see it in Tool Suite or HyperTerminal)

Tool Suite Tab:	The name of the tab the parameter is grouped under within Tool Suite.
Setup Terminal Menu:	The name of the menu and the submenu the parameter is grouped under within Tool Suite's Setup Terminal and within HyperTerminal.
I/O Master Setting:	A description about how to set the parameter in an I/O Master.

The parameter descriptions are listed in alphabetical order below.

Call Book

Tool Suite Tab:	Call Book
Setup Terminal Menu:	(2) Call Book
I/O Master Setting:	In the Master's Call Book, enter the serial number for each Short-Range I/O Slave and I/O Slave in your network, for a maximum of four transceivers. In addition, set the **Network ID** in the Master to the same ID as the rest of the network. Programming both the Call Book and **Network ID** settings is unique to the Wire Replacement I/O System and must be done for both integrated and stand alone applications.

Default Delay

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > (9) Timeout
I/O Slave Setting:	This setting determines the amount of time to wait before issuing a Link Alarm due to loss of communication between the I/O Master and /IO Slave. The value is set in 0.28 second units. For example, a value of 36 represents 36 x 0.28 = 10.08 seconds. Set between 0 and 255 using the following examples as guidelines: • 1 = 1/6 second • 6 = 1 second • 42 = 7 seconds • 252 = 42 seconds

Digital Output 1 through Analog Output 4

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > Options 1 to 8
I/O Master Setting:	Use these parameters to map the I/O Master outputs to the correct inputs on a Short-Range I/O Slave or an I/O Slave. To create a mapping in Tool Suite, select the appropriate Short-Range I/O Slave or I/O Slave. Slaves are labeled by their serial numbers, as they are entered in the I/O Master's Call Book. To create a mapping using HyperTerminal, see the instructions below.

To map I/O Master outputs to the correct inputs using HyperTerminal:

1. Select which I/O Slave you are mapping to the I/O Master.

   Note the IO Master's Call Book Entry number that lists this I/O Slave's serial number.

2. Determine which analog or digital input from the I/O Slave you want to map to the I/O Master.

   This input could be Analog Input (AI) #1, AI #2, AI #3, AI #4, or Digital Input (DI) #1, or DI #2; depending on which sensor(s) the I/O Slave is connected.

3. Using the table below, find the intersection between the I/O Master's Call Book Entry number found in step 1 and the selected input from the I/O Slave found in step 2. Note the number listed at this intersection.
4. In HyperTerminal, go to Menu **(9) FGRIO Setup**.
5. Select which output from the I/O Master you would like to "connect" to the input from the I/O Slave and enter the number to the left of the selected output.
6. Enter the number found in step 3. This number should display to the right of the selected output.

	AI#1	AI#2	AI#3	AI#4	DI#1	DI#2
I/O Master Call Book Entry #0	1	2	9	10	1	2
I/O Master Call Book Entry #1	3	4	11	12	3	4
I/O Master Call Book Entry #2	5	6	13	14	5	6
I/O Master Call Book Entry #3	7	8	15	16	7	8

Example:

To map **Analog Output 1** of the I/O Master to **Analog Input 2** of the I/O Slave (serial # 930-0004), entry **(5) Analog Out1** in the FGRIO Setup menu will have a value of **2**. This is calculated by first checking the Call Book entry # of IO Slave #930-0004.

```
Enter Choice

                                MODEM CALL BOOK
                                Entry to Call is (ALL)
Entry    Number      Repeater1    Repeater2
(0)      930-0004
(1)      000-0000
(2)      000-0000
(3)      000-0000
(4)      000-0000
(5)      000-0000
(6)      000-0000
(7)      000-0000
(8)      000-0000
(9)      000-0000
(C)      Change Entry to Use (0-9) or A(ALL)
(Esc)    Exit to Main Menu
Enter all zeros (000-0000) as your last number in list
```

The entry # is 0. Next, go to the table above, find call book entry # 0, then go to the column for I/O Slave **Analog Input #2**. The value listed is **2**. Enter a **2** for **Analog Output #1** of the I/O Master.

Enable I/O

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > (0) FGRIO
I/O Master Setting:	Set to **(1) Enabled** to enable the I/O functions in the radio. To use the radio as a standard serial radio, set this to **0**.

Max Packet Size and Min Packet Size

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (1) Max Packet Size and (2) Min Packet Size
I/O Master Setting:	The I/O System requires a minimum combined packet size of 48 Bytes. The table below provides the available packet size for an I/O System.

	Combined Packet Size Definition with RF Data Rate of 3									
	Maximum Setting									
Minimum Setting	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0				56	72	88	104	120	136	152
1				60	76	92	108	124	140	156
2			48	64	80	96	112	128	144	160
3			52	68	84	100	116	132	148	167
4			56	72	88	104	120	136	152	168
5			60	76	92	108	124	140	156	172
6		48	64	80	96	112	128	144	160	176

	Combined Packet Size Definition with RF Data Rate of 3									
	Maximum Setting									
7		52	68	84	100	116	132	148	164	180
8		56	72	88	104	120	136	152	168	184
9		60	76	92	108	124	140	156	172	188

Note: If using Digital Inputs and Outputs for pulse counting, the packet size effects how many pulses the I/O System can register. At a packet size of **Max = 2 Min = 2**, the maximum available count would be 6 Hz. At a packet size of **Max = 9 Min = 9**, the maximum available count would be 3 Hz. The pulse state must last for a 50% duty-cycle (that is, a 3 Hz pulse needs to last at least 166.6 ms and a 6 Hz pulse needs to last at least 83.3 ms)

Network ID

Tool Suite Tab: MultiPoint Parameters

Setup Terminal Menu: (5) MultiPoint Parameters > (6) Network ID

I/O Master Setting: In addition to entering the Short-Range I/O Slave and I/O Slave serial numbers in the Master's Call Book, set the **Network ID** for the network from 1 to 4095. Do not use **255**, as this enables the Call Book only.

Programming both the Call Book and **Network ID** settings is unique to the Wire Replacement I/O System and must be done for both integrated and stand alone applications.

Repeaters

Tool Suite Tab: MultiPoint Parameters

Setup Terminal Menu: (5) MultiPoint Parameters > (0) Number Repeaters

I/O Master Setting: This setting must be set to **(1) Enabled** for all transceivers in the Wire Replacement I/O network, including any serial transceivers in an integrated network.

In addition, if the Wire Replacement I/O System is integrated into an existing network, the serial Master must also have the **Repeaters** setting set to **Enabled**.

Retry Timeout

Tool Suite Tab: Transmission Characteristics

Setup Terminal Menu: (3) Edit Transmission Characteristics > (8) Retry Time Out

I/O Master Setting: By lowering the **Retry Timeout** setting, the inactive link time between the I/O Master and the Short-Range I/O Slave or I/O Slave can be reduced when going from autonomous mode to connecting back to the serial radio network.

If the serial radio network Master goes down, the I/O Master and Short-Range I/O Slave or I/O Slave continues to operate in autonomous mode. When the serial network Master comes back up, the I/O Master breaks the link with the Slave to re-establish a link with the serial network Master.

After the I/O Master is linked to the serial network Master, then the Short-Range I/O Slave and I/O Slave are able to link back to the I/O Master. With a lower **Retry Timeout** setting, the I/O Master is more likely to drop the link to its serial network Master when the incoming signal becomes poor.

RF Data Rate

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (4) RF Data Rate
I/O Master Setting:	The **RF Data Rate** must be set to **(3) Normal** when using a Wire Replacement I/O System, either stand alone or integrated into an existing serial network. All transceivers, including any serial radios in an integrated network, must be set to an **RF Data Rate** of **3**.

Sensor Power

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > (A) Sensor Pwr
I/O Master Setting:	**(0) Always On** - Supplies continuous power to the VSNS port at the Short-Range I/O Slave and I/O Slave, connecting it to the Slave's supply voltage. **(1) Gated** - Controls the VSNS port of all Short-Range I/O Slaves and I/O Slaves communicating with the I/O Master. Applying a voltage of greater than 1.75 VDC to the I/O Master's Sensor Power input port connects the VSNS port of every connected Short-Range I/O Slave and I/O Slave to its supply voltage. Applying less than 1.75 VDC to the I/O Master's Sensor Power input port turns off the VSNS port of all connected Short-Range I/O Slaves and I/O Slaves.

I/O Master Installation Considerations

Review the following additional information when installing and wiring an I/O Master. For an illustration and screw terminal identification of an I/O Master, see "FGRIO-M Terminal Block Layout" on page 4.

Rx, Tx, B+

- Receive (RX Data), Transmit (TX Data), and Power (B+) are available on the screw terminals of the I/O Master terminal block as well as the 10 pin header connector.

Analog Output

Note: Analog Output is 1-5 V at low current, so any 4-20 mA current sensing resistor on the RTU ***must be removed***. If in doubt as to whether RTU-internal resistors are active, test the link with a full scale input.

- Connect the Analog Output wire from the Analog Output 1, 2, 3, or 4 screw terminal on the I/O Master terminal block to the Analog Input of the destination device.
- Common Ground is required. FreeWave recommends running a Ground wire from an I/O Master Ground screw terminal to Ground on the RTU.
- An Analog Output on the I/O Master that is outputting an I/O Slave's analog input remains at the last reported value after communication to the specific radio is lost.

Digital Output

Note: The Digital Output on the I/O Master actively drives Low (0.4 V) and High (4.0 V). Remove any RTU input pull-up resistor, if less than 10 KΩ. Verify that signal levels meet the RTU input requirements after connection to the RTU.

The Master Digital Output sources about 4 mA; therefore, it is not designed to drive relays or solenoids.

- Connect the Digital Output wire from the Digital Output 1, 2 ,3, or 4 screw terminal on the I/O Master terminal block to the Digital Input of the RTU (destination device).
- Common Ground is required. FreeWave recommends running a Ground wire from the I/O Master Ground screw terminal to Ground on the RTU.
- A Digital Output on the I/O Master that is outputting a Short-Range I/O Slave or I/O Slave's digital input remains at the last reported value after communication to the specific radio is lost.

Digital Input

- Connect the RTU Digital Output Wire to Digital Input 1, 2, 3, or 4 screw terminal on the terminal block of the I/O Master. An internal 10 KΩ pullup to +5 V is provided.
- Connect the RTU Ground Wire to any of the Ground screw terminals on the I/O Master's terminal block. Some RTUs use isolated I/O and may require a ground connection for each input and output.

Sensor Power

To minimize power drain of the I/O Solar Power or Battery System, an input terminal called Sensor Power is provided on the I/O Master terminal block. Sensor Power has an internal 10 KΩ pull-down to Ground.

Note: The Sensor Power terminal both activates sensor power at the controlled Short-Range I/O Slaves and IO Slaves, and activates Analog Outputs at the I/O Master interface board, when in **Gated** Sensor Power mode. For more information, see the Sensor Power parameter description on previous page

- If the RTU provides a switched Sensor Power output, connect it to this terminal. Verify that the level at Sensor Power falls to less than 1.0 V when de-asserted to ensure the Short-Range I/O

Slaves and I/O Slaves mirror. If not, connect additional pull-down resistance externally.

- The state of Sensor Power can mirrored at the Short-Range I/O Slave and I/O Slave, powering or disconnecting any connected sensors. To activate this control, it is necessary to change the Sensor Power setting on the I/O Master to **1** or **Gated**. For more information, see the Sensor Power parameter description on page 14

Link Alarms

Note: The terminal block on the I/O Master, Short-Range I/O Slave, and I/O Slave can accept a single wire up to 16 gauge. Smaller wire is required for 2 wires, or wire+resistor into the same screw terminal.

- Link Alarm 1 is an alarm reflecting loss of communication on any path. Connect a wire from the Link Alarm 1 screw terminal to the Link Alarm screw terminal on the RTU.
- Link Alarm 2 (CMD Alarm) indicates that a Digital Output or Sensor Power command was not carried out due to an over-current fault. Connect a wire from the Link Alarm 2 screw terminal to the Link Alarm screw terminal on the RTU.

Chapter 3: Short-Range I/O Slave and I/O Slave Setup

This chapter provides information about the parameter settings and the installation of a Short-Range I/O Slave and an I/O Slave.

Short Range-I/O Slave and I/O Slave Parameter Settings

The settings for the parameters described in this chapter are specific to a **Short-Range I/O Slave** or **I/O Slave**. There are other parameter settings available on the transceiver. For information about parameters not included here, see the user manual for the radio you are using. For information about the parameters required for I/O Masters, see the previous chapter.

The first parameter you need to set in the Short Range I/O Slave and I/O Slave is the **Operation Mode** in the **Operation Mode** tab in **Tool Suite** or the **Set Operation Mode** menu in HyperTerminal. From there, you can address the parameter settings in any order. The only option for Short-Range IO Slaves and I/O Slave radios operating as Wire Replacement I/O is **(E) FGRIO Slave (NOT IO-MODBUS)**.

In addition, set the following parameters, each described in more detail below, on the Slave in your Wire Replacement I/O System:

- Call Book
- In the Transmission Characteristics tab/menu:
  - Max Packet Size
  - Min Packet Size
  - RF Data Rate
  - Retry Timeout
- In the MultiPoint Parameters tab/menu:

  - Number Repeaters
  - Network ID
- All I/O Settings in the FGRIO Setup menu/Wire Replacement tab

Parameter Descriptions

Each parameter description below contains the following information:

parameter name (as you see it in Tool Suite or HyperTerminal)

Tool Suite Tab:	The name of the tab the parameter is grouped under within Tool Suite.
Setup Terminal Menu:	The name of the menu and the submenu the parameter is grouped under within Tool Suite's Setup Terminal and within HyperTerminal.
I/O Master Setting:	A description about how to set the parameter in an I/O Master.

The parameter descriptions are listed in alphabetical order.

AI (DI1) Filter and AI (DI2) Filter

These parameters are available in HyperTerminal, but do not apply in a Wire Replacement I/O System.

Call Book

Tool Suite Tab:	Call Book
Setup Terminal Menu:	(2) Call Book
Setting:	Program the I/O Master's serial number as entry number **0** in the Short-Range I/O Slave and I/O Slave's Call Book. Set the **Entry to Call** option to **0**. In addition, set the **Network ID** to the same ID as the rest of the network. For more information about the Network ID, see "Network ID" on page 13. Programming both the Call Book and **Network ID** settings is unique to the Wire Replacement I/O System and must be done for both integrated and stand alone applications.

Default Delay

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > (9) Default Delay
I/O Slave Setting:	This setting determines the amount of time to wait before setting the Digital Outputs to their Default settings due to loss of communication between the I/O Master and I/O Slave. The value is set in 0.28 second units. For example, a value of 36 represents 36 x 0.28 = 10.08 seconds.

Set between 0 and 255 using the following examples as guidelines:

- 1 = 1/6 second
- 6 = 1 second
- 42 = 7 seconds
- 252 = 42 seconds

DI1 Pullup and DI2 Pullup

Tool Suite Tab:	Wire Replacement
Setup Terminal Menu:	(9) FGRIO Setup > (E) DI1 Pull Up/Down and (F) DI2 Pull Up/Down
I/O Slave Setting:	These parameters control the power-up states of the internal resistor (10 KΩ) connected to the Digital Inputs. • **Up** - The 10 KΩ internal resistor attached to the input is connected to the 3.3 V logic supply to provide a pullup for connecting closed-contact-to-GND sensors. • **Down** - The 10 KΩ internal resistor attached to the input is connected to GND to provide a pullup for connecting closed-contact-to-voltage sensors. • **None** - The internal resistor is not connected, allowing the connected sensor to provide greater than 1.75 VDC for High and less than 1.75 VDC for Low.

Digital Output 1 Default and Digital Output 2 Default

Tool Suite Tab:	Wire Replacement
Setup Terminal Menu:	(9) FGRIO Setup > (3) Digital Def1 and (4) Digital Def2
I/O Slave Setting:	Sets the state the Digital Input returns to when you power up the device, or the device loses its link to the Master in the network. • **0 (Output On)** - Open Drain output ON (Conducting to GND, 2 Amps max) • **1 (Output Off)** - Open Drain output OFF (Non-Conducting) • **2 (No Change)** - Make no change in state If programming a Digital Output to turn on after it loses a link, ensure that the energized device can sustain the state undamaged, in case the loss is lengthy.

Digital Output 1 and Digital Output 2

Tool Suite Tab:	IO Settings
Setup Terminal Menu:	(9) FGRIO Setup > (1) Digital Out1 and (2) Digital Out2
Setting:	Select the I/O Master Digital Input # (1-4) to control the Short-Range I/O Slave or I/O Slave Digital Output.

Both outputs can be driven by the same I/O Master input.

DO Bi-Stable

Tool Suite Tab: Wire Replacement

Setup Terminal Menu: (9) FGRIO Setup

I/O Slave Setting: Controls how the Digital Outputs respond to ON commands.

- **Constant** - The Digital Output remains on for as long as the I/O Master's associated Digital Input is connected to Ground. When the I/O Master's Digital Input is no longer grounded, the Digital Output is OFF.
- **Auto-OFF** - The Digital Output remains on for the duration set in the DO Monostable Time parameter or until the I/O Master's associated Digital Input is no longer grounded, whichever is shorter. The Digital Output does not respond again to the I/O Master's Digital Input being grounded until the Digital Input has been disconnected from Ground.

DO Monostable Time

Tool Suite Tab: Wire Replacement

Setup Terminal Menu: (9) FGRIO Setup

I/O Slave Setting: Sets the length of time the Digital Output remains on when the **DO Bi-Stable** parameter is set to **Auto-OFF**. The amount of time is approximately **0.15 seconds x DO Monostable Time**. This setting can be set from **0** to **255**.

Note: A setting of **0** causes the Digital Output to turn off at an unspecified amount of time. This time is always less than 0.15 seconds, but the actual time may vary.

Fast AI (DI1) and Fast AI (DI2)

Tool Suite Tab: Wire Replacement

Setup Terminal Menu: (9) FGRIO Setup > (I) AI(DI1) Filter and (J) AI(DI2) Filter

I/O Slave Setting: These parameters do not apply to a Wireless I/O Replacement system.

Modbus Mode

Tool Suite Tab: **Note:** This field is only available in HyperTerminal.

Setup Terminal Menu: (9) FGRIO Setup > (5) IO Modbus

I/O Slave Setting: This parameter must be set to **Disabled** when using a Wire Replacement I/O network configuration.

Max Packet Size and Min Packet Size

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (1) Max Packet Size and (2) Min Packet Size
I/O Slave Setting:	The I/O System requires a minimum combined packet size of 48 Bytes. The available packet sizes are the same as they are for the I/O Master. See the table on page on page 12.

Network ID

Tool Suite Tab:	MultiPoint Parameters
Setup Terminal Menu:	(5) MultiPoint Parameters > (6) Network ID
I/O Master Setting:	In addition to entering the I/O Master's serial number in the Master's Call Book, set the **Network ID** for the network from 1 to 4095. Do not use **255**, as this enables the Call Book only. Programming both the Call Book and **Network ID** settings is unique to the Wire Replacement I/O System and must be done for both integrated and stand alone applications.

Retry Timeout

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (8) Retry Time Out
I/O Slave Setting:	By lowering the **Retry Timeout** setting, the inactive link time between the I/O Master and the Short-Range I/O Slave or I/O Slave can be reduced when going from autonomous mode to connecting back to the serial radio network. If the serial radio network Master goes down, the I/O Master and Short-Range I/O Slave or I/O Slave continues to operate in autonomous mode. When the serial network Master comes back up, the I/O Master breaks the link with the Slave to re-establish a link with the serial network Master. After the I/O Master is linked to the serial network Master, then the Short-Range I/O Slave and I/O Slave are able to link back to the I/O Master. With a lower **Retry Timeout** setting, the I/O Master is more likely to drop the link to its serial network Master when the incoming signal becomes poor.

RF Data Rate

Tool Suite Tab:	Transmission Characteristics
Setup Terminal Menu:	(3) Edit Transmission Characteristics > (4) RF Data Rate
I/O Slave Setting:	The **RF Data Rate** must be set to **(3) Normal** when using a Wire Replacement I/O System, either stand alone or integrated into an existing serial network. All transceivers, including any serial radios in an integrated network, must be set to an **RF Data Rate** of **3**.

Short-Range I/O Slave and I/O Slave Terminal Block Usage

For an illustration and screw terminal identification for Short-Range I/O Slaves and I/O Slaves, see the Slave terminal block illustrations beginning on page 4.

Power Supply or Battery

Screw Terminal #11 (B+ In) on the terminal block of the Slave is the raw power for the radio. This terminal is directly connected to Pin # 1 on the 10 pin white header of the transceiver. Either one can be used to power the transceiver.

Connecting 1-5 Volt Sensor to Analog Input 1 or Analog Input 2

For connection to either Analog Input 1 or Analog Input 2, wire the 1-5 volt sensor to the Slave radio with a 3-wire connection.

- Connect the Sensor Ground Wire to Ground screw terminal #3, 9, or 12 on the terminal block of the Slave radio.
- Connect the Sensor Power Wire to the VSNS screw terminal #7 on the terminal block of the radio. Rated total current draw from VSNS is 40 mA or less.

The existing AIs at screw terminal #8 and screw terminal #10 are usable with 0.1 V to 5.625 V input voltages (compatible with most 1-5 V and 4-20 mA transmitters) and load the input with about 100 Kohm to GND. They also offer accuracy of ± 0.1% with 16-bit resolution and are therefore recommended for the most critical variables in a system.

Connecting 1-5 Volt Sensor to Analog Input 3 or Analog Input 4

The Digital Inputs of the Short-Range I/O Slave and IO Slave may be digitized to 10-bit resolution and mapped to Analog Outputs on the I/O Master radio. This mapping allows up to four analog transducers to be connected to a single remote Short-Range IO Slave or IO Slave radio.

Note: In the FGRIO-S radio, this feature requires firmware version of 2.65IO or higher.

The Analog Inputs formed from the Digital Inputs at screw terminal #1 and screw terminal #2 are directly usable with signals only from 0.1 V to 2.812 V in wire replacement mode. Input loading can be selected as 10 KΩ to GND or unloaded (>1 MΩ).

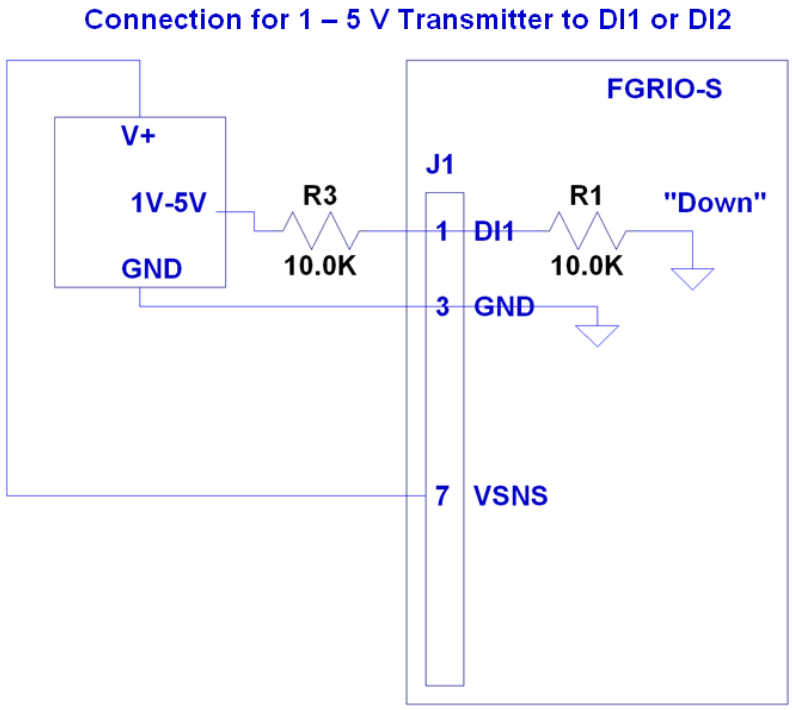
The DI accuracy is within +/-.25% and resolution is 10-bits. The next section describes methods to best apply inputs to them.

1-5 Volt Sensor Signal Coupling for Analog Input 3 and Analog Input 4

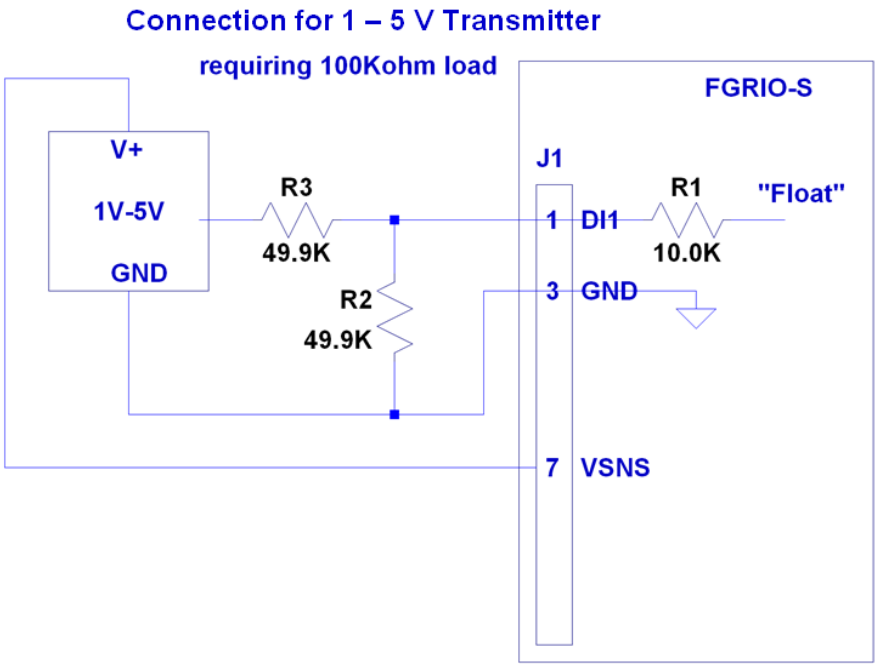
Consider the following for Analog Input 3 and Analog Input 4:

- **Input Resistor** - The Short-Range I/O Slave and I/O Slave Digital Inputs provide an internal 10 KΩ resistor pull-up to the radio's 3.3 V logic supply. The resistor can also be commanded to pull down to GND or "float" unconnected. See "DI1 Pullup and DI2 Pullup" on page 19. As will be shown, these options are useful for Analog Input connections.
- **Signal Level Reduction** - As stated above, Digital Inputs #3 and #4 do not have sufficient voltage range for direct connection to typical transducer outputs, so the input must be restricted. For signal replication, it is assumed the input signal level will be halved, and the measured value sent to the I/O Master doubled, to achieve an overall 1:1 signal reproduction.
- **VSNS Sensor Power** - The switched voltage source at screw terminal #7 is designed to drive only two 4-20 mA transmitters to full scale. Voltage output (1-5 V) transmitters usually consume less current and may allow up to four to be switched.

The following diagram illustrates the connection of a 1-5 V transmitter to Analog Input #3:



The following diagram illustrates the connection of a 1-5 V transmitter requiring 100 KΩ load:



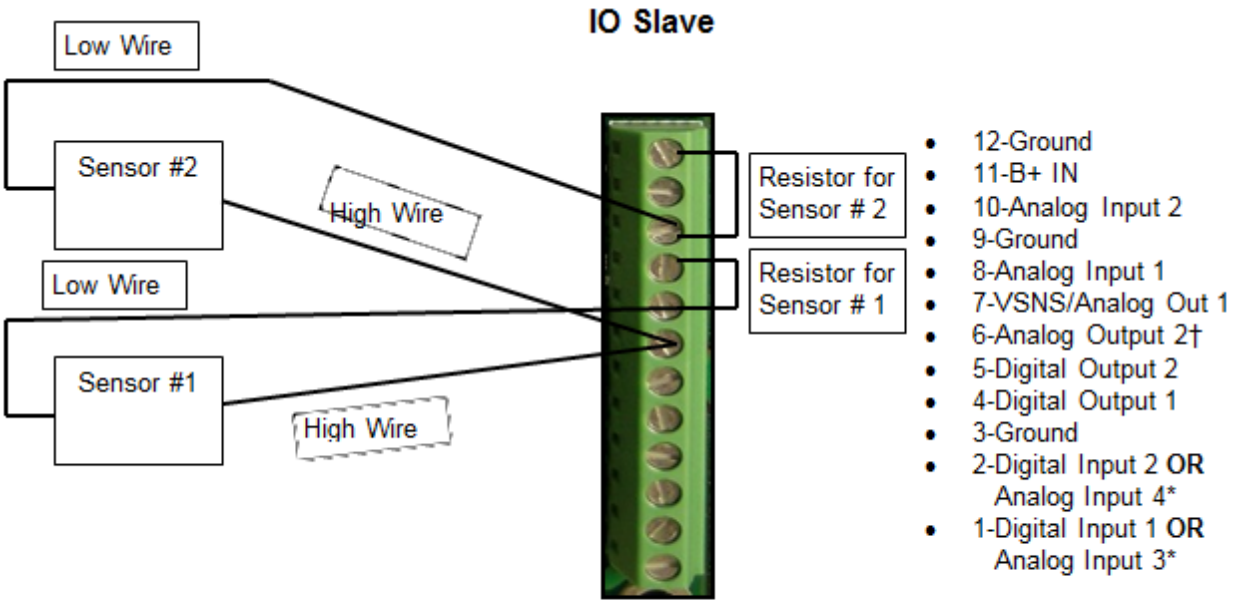
Connecting a 4-20 mA Sensor to Analog Input 1 or Analog Input 2

This connection consists of a 2-wire connection from the Sensor to the radio.

- An external resistor (typically 249 Ω) is required to convert 4-20 milliamps to 1-5 volts. The resistor goes from the desired Analog Input (terminal #8 or #10) to Ground screw terminals (terminal #6, #9 or #12) on the terminal block of the radio.
- The Sensor Power Supply (High) Wire is connected to VSNS screw terminal #7 on the terminal block of the radio.
- The Sensor Output (Low) Wire is connected to the same Analog Input (terminal #8 or #10) as the resistor on the terminal block of the radio.

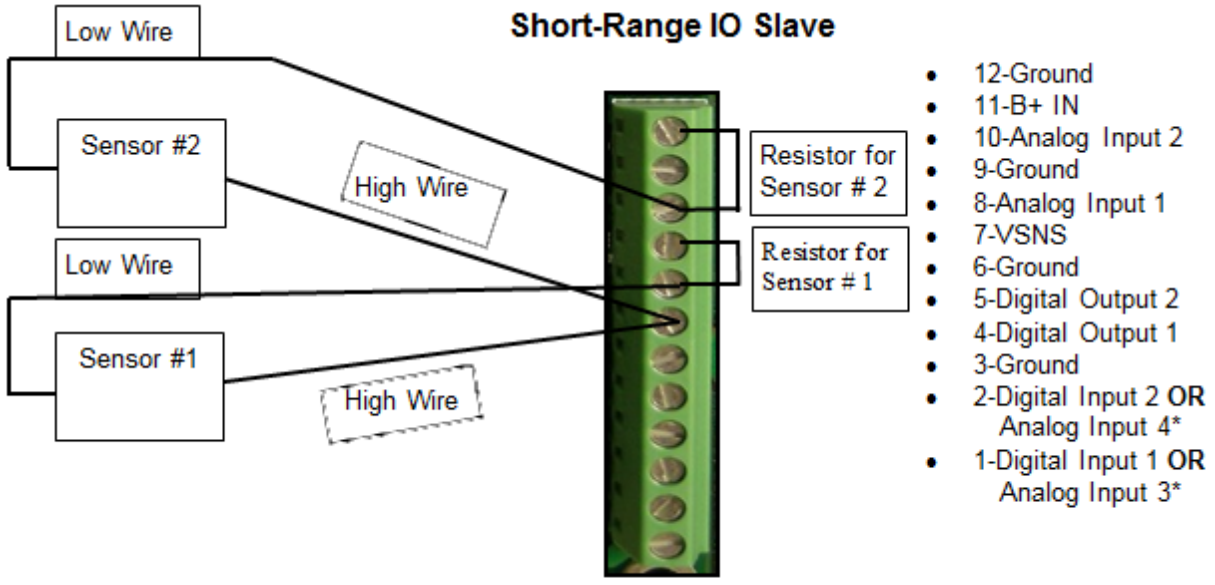
See the following wiring examples.

Example: Connecting one 4 – 20 mA sensor to the terminal block of an I/O Slave:



* Analog Input 3 and Analog Input 4 are 0 – 3.3 VDC inputs
† Analog Output 2 is not available in Wire Replacement I/O Systems

Example: Connecting one 4 - 20 mA sensor to the terminal block of a Short-Range I/O Slave:

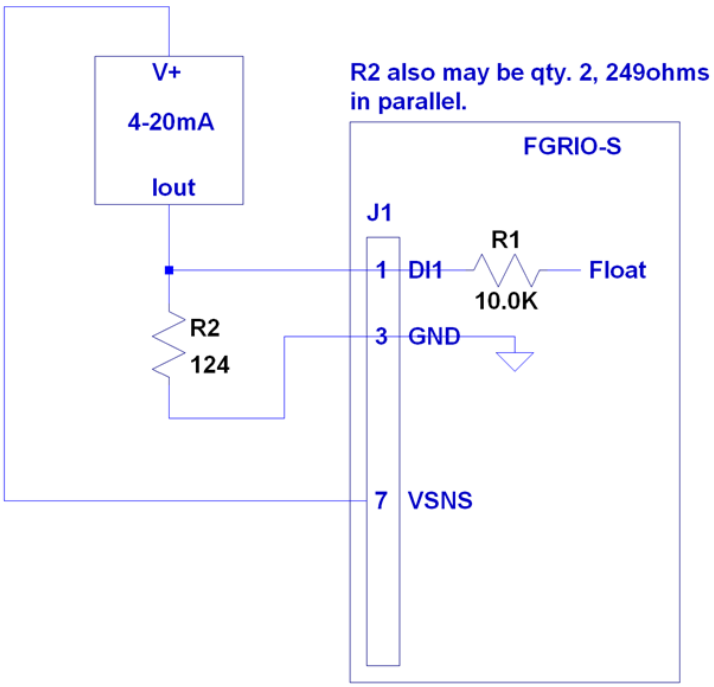


* Analog Input 3 and Analog Input 4 are 0 – 3.3 VDC inputs

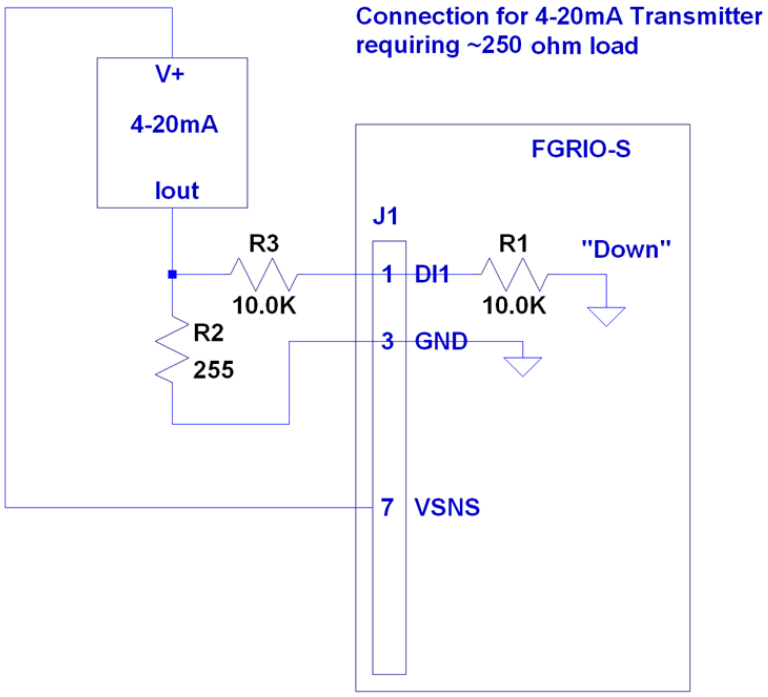
Connecting a 4-20 mA Sensor to Analog Input 3 or Analog Input 4

The same accuracy and signal level reduction considerations stated under 1-5 Volt Sensor, Analog Input 3 or Analog Input 4, apply when using a 4-20 mA sensor. The switched voltage source at screw terminal #7 is designed to drive only two 4-20 mA transmitters to full scale. If a system will use more than two, the additional transmitters must be powered from a separate supply, such as directly from the battery or another DC supply.

The following diagram illustrates the connection of a 4-20 mA sensor to Analog Input 3, with half the typical resistor:



The following diagram illustrates the connection of a 4-20 mA sensor to Analog Input 3 requiring an approximately 250 ohm load:



Short-Range I/O Slave and I/O Slave Installation Considerations

Review the following additional information when installing and wiring a Short-Range I/O Slave or I/O Slave.

Digital Input

- Connect the Switch Output wire to Digital Input 1 screw terminal # 1 or Digital Input 2 screw terminal # 2 on the terminal block of the Short-Range IO Slave/IO Slave.
- Connect the Switch Ground Wire to the Ground screw terminal # 3, 9, or 12 on the terminal block of the Short-Range IO Slave/IO Slave. If the Switch Ground Wire is not returned to the radio, the potential difference between the radio's Ground and the Dry Contact Closure (Switch) Ground should not exceed 1 V.
- In the case of a 3-wire digital transducer, set up similarly to the 1-5 V analog sensor, except connect the signal wire to a Digital Input.

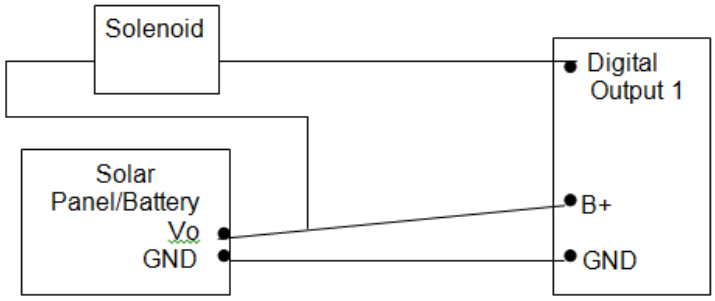
Digital Output

- Both Digital Outputs (screw terminal #4 and 5) are open drain field effect transistors connected to Ground. The outputs connect to Ground when 0 (zero) volts is connected to the controlling I/O Master Digital Input.
- The current rating for a Digital Output is 2 amps or less. The Digital Output self-protects if a current of more than 2 1/2 amps is drawn and automatically retries at 0.16 second intervals.
- If power on the solenoid (end device) is not driven from the same power supply as the Short-Range I/O Slave or I/O Slave, that source must be equal to or less than the radio's power supply voltage.

Within the radio, a 3 amp rated Schottky diode is connected from each Digital Output to the radio power supply terminal for clamping the solenoid fly back current. If the relay supply voltage exceeds the radio supply voltage, then current would flow through that diode back to the radio, preventing coil current from shutting off and potentially causing an over-voltage condition.

- A Digital Output on the Short-Range I/O Slave and I/O Slave that is outputting an I/O Master's Digital Input takes the state set in the **Digital Out 1 Default** and **Digital Out 2 Default** parameters after communication to the I/O Master is lost and the **Default Delay** expires. For more information about the default settings, see "Digital Output 1 Default and Digital Output 2 Default" on page 19.

The following diagram illustrates the typical Digital Output wiring between the solenoid and the Short-Range I/O Slave or I/O Slave:



Chapter 4: Additional Information

This chapter provides the following additional information about I/O Masters, Short-Range I/O Slaves, and I/O Slaves in a Wire Replacement I/O system:

- Answers to frequently asked questions.
- FGRIO wiring diagram.
- Product specifications.

Frequently Asked Questions

Q: Can I/O be used with a 1 watt radio?

A: The FGRIO-M functions as a standard 900 MHz 1 watt serial radio with a 60 mile line-of-sight range.

The FGRIO-S functions as an FGR Short Range radio with a 2 mile line-of-sight range.

The FGR2-IOS-C-U and FGR2-IOS-CE-U function as FGR2 radios with a 60 mile line-of-sight range.

The I2-IOM-U and I2-IOS-C-U function as standard 2.4 GHz 500 mW serial radios with a 20 mile line-of-sight range.

Q: Can the I/O radios be repeated through our other radios to extend the range?

A: From the Short-Range I/O Slave or I/O Slave to the I/O Master, you cannot use a Repeater. When the I/O Master is integrated into a standard serial network, you can use Repeaters between the I/O Master and the Serial Master as they already are in existing FreeWave networks. The I/O Master does not function as a Slave/Repeater.

Q: Can the I/O Master operate as Slave/Repeater in the overall network?

A: The IO Master currently does not have the capability to operate as a Slave/Repeater. It does function as the Master to the Short-Range I/O Slave and IO Slave, and as a Multipoint Slave to the rest of the network.

Q: Can data be sent directly from the Short-Range I/O Slave or I/O Slave to the Master of the Serial Network?

A: No. The Wire Replacement System functions as wire replacement only. The Short-Range I/O Slave and IO Slave's serial ports are inactive and do not have the capability of transmitting data directly to the Master of a Serial Network.

Q: What are the sizes of the I/O Master and Slave?

A: The dimensions of the FGRIO-S, the FGR2-IOS-C-U, and the I2-IOS-C-U are: 127 mm (L) x 62 mm (W) x 6 mm (H).

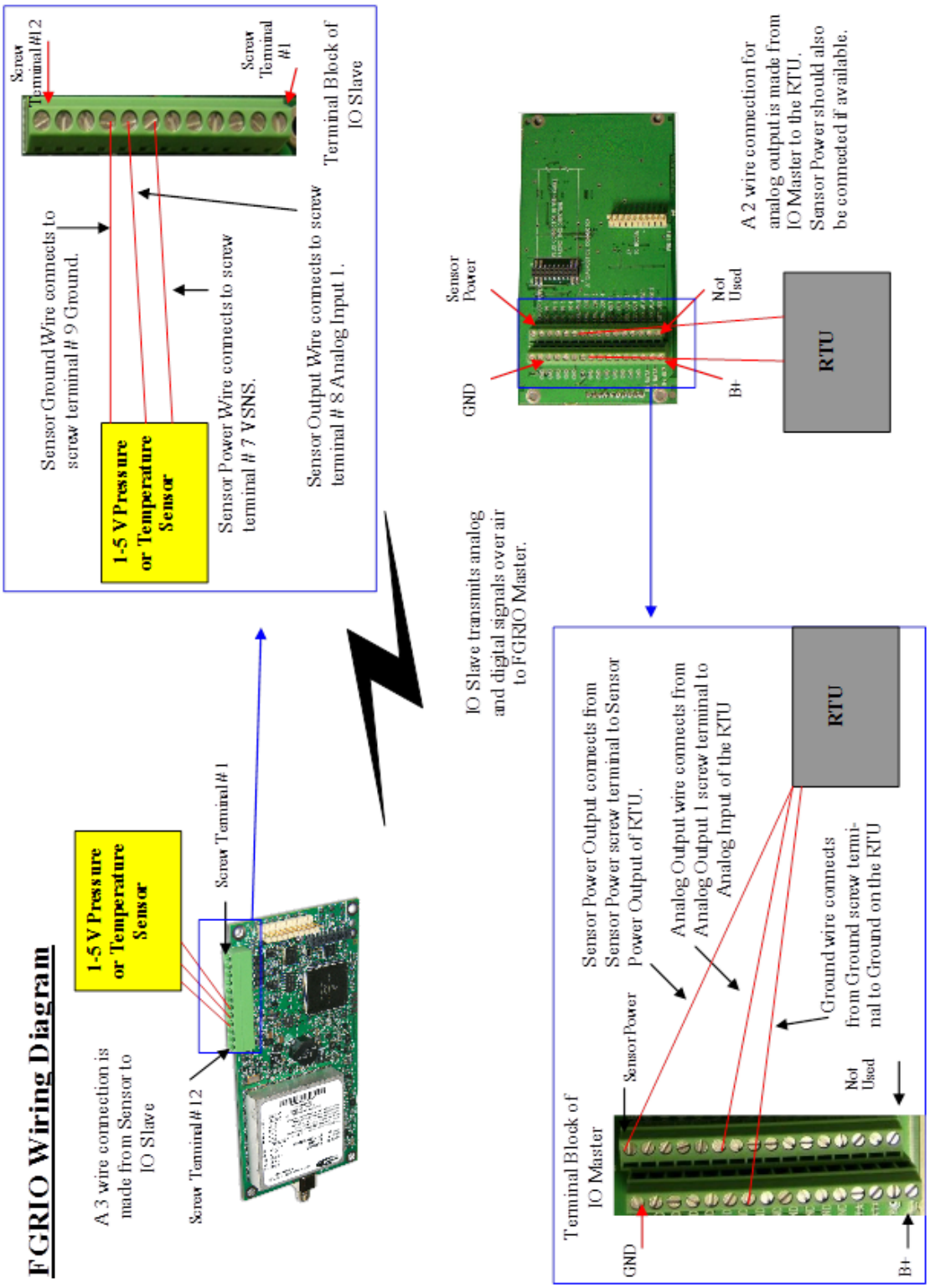
The dimensions of the FGRIO-M and I2-IOM-U are:140 mm (L) x 70 mm (W) x 34 mm (H).

The FGR2-IOS-CE-U is an enclosed radio. Its dimensions are 173.mm (L) x 96 mm (W) x 35 mm (H).

Q: What timing issues does a Wire Replacement System introduce?

A: Although a Wire Replacement System mimics a wired connection, the electronics and communication heartbeat do cause some signal delay. The worst case delay for digital signals in either direction and in the Sensor Power command from I/O Master to Short-Range I/O Slave and IO Slave is 167 ms, assuming a robust link. Worst case delay from I/O Master Sensor Power assertion to I/O Master Analog Output refresh is 700 ms.

FGRIO Wiring Diagram



FGRIO-M Specifications

The following specifications apply to both the FGRIO-M model. Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications			
Transmitter			
Frequency Range	902 - 928 MHz (FHSS)		
Output Power	5 mW to 1 W		
Range - Line of Sight	2 miles with clear LOS to IO Slave, 60 miles to network Master		
Modulation	2 level GFSK		
Occupied Bandwidth	230 kHz		
Hopping Patterns	15 per Band, 105 total user selectable		
Hopping Channels	50 to 112, user selectable		
Hopping Bands	7, user selectable		
RF Connector	Type SMA		
Master Receiver		**Master Analog Output**	
Sensitivity	-108 dBm for BER 10^{-6} -110 dBm for BER 10^{-4}	Number of Outputs	4, can be mapped to up to 4 slaves
Selectivity	20 dB at fc ± 115 kHz, 60 dB at fc ± 145 kHz	Accuracy, Resolution	+/- .1%, 16 bit
System Gain	140 dB	Output Range	.2-5.62V, > 10 Kohm Load Resistance
Master Digital Outputs		**Master Digital Inputs**	
Number of Outputs	4 per Master Link, 1 Command Alarm	Number of Inputs	4
Output Connector	Mini Phoenix (3.55 mm)	Master Input to Slave Output Delay	1 Second Max
Slave Input to master Output Delay	1 Second Max	Voltage Range	0 to 30 V
Signal Voltage Range	0 - 4.6 V		
Data Transmission			
Error Detection	32 bit CRC, Retransmit on Error		
Data Encryption	Dynamic Key Substitution		
Link Throughput	115.2 kbps		

Specifications				
Data Interface	Serial			
Protocol	RS 232 / 485 / 422, 1200 Baud to 115.2 KBaud			
Data Connector	10-pin header with locking ramp, 0.1 inch spacing, power/data connector			
Data Interface				
Connector	Separate 20-pin PCB header			
Power Requirements				
Operating Voltage	+7.0 to +30.0 VDC			
Current	**Mode**	**+7.0 VDC**	**+12.0 VDC**	**+30.0 VDC**
	Transmit	1 A	500 mA	200 mA
	Receive	140 mA	86 mA	43 mA
	Idle	120 mA	70 mA	38 mA
General Information				
Operating Temperature Range	-40° C to +75° C.			
Dimensions	140 L x 70 W x 34 H (mm)			
Weight	137g			
Humidity	0 to 95% non-condensing			

I2IO-M-U Specifications

The following specifications apply to both the I2IO-M-U model. Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications			
Transmitter			
Frequency Range	2.4 - 2.483 GHz (FHSS)		
Output Power	5 mW to 500 mW		
Range - Line of Sight	20 miles with clear LOS		
Modulation	2 level GFSK		
Occupied Bandwidth	230 kHz		
Hopping Patterns	15 per Band, 105 total user selectable		
Hopping Channels	50 to 80 out of 240 user selectable		
Hopping Bands	7, user selectable		
RF Connector	Type SMA		
Master Receiver		**Master Analog Output**	
Sensitivity	-105 dBm for BER 10^{-6} -107 dBm for BER 10^{-4}	Number of Outputs	4, can be mapped to up to 4 slaves
Selectivity	TBD	Accuracy, Resolution	+/- .1%, 16 bit
System Gain	134 dB	Output Range	.2-5.62V, > 10 Kohm Load Resistance
Master Digital Outputs		**Master Digital Inputs**	
Number of Outputs	4 per Master Link, 1 Command Alarm	Number of Inputs	4
Output Connector	Mini Phoenix (3.55 mm)	Master Input to Slave Output Delay	1 Second Max
Slave Input to master Output Delay	1 Second Max	Low Input Voltage Range	0 to 1.75 V
Signal Voltage Range	0 - 4.6 V	High Input Voltage Range	3.25 to 5.0 V
Data Transmission			
Error Detection	32 bit CRC, Retransmit on Error		
Data Encryption	Dynamic Key Substitution		
Link Throughput	115.2 kbps		
Data Interface	Serial		

Specifications				
Protocol	RS 232 / 485 / 422, 1200 Baud to 115.2 KBaud			
Data Connector	10-pin header with locking ramp, 0.1 inch spacing, power/data connector			
Data Interface				
Connector	Separate 20-pin PCB header			
Power Requirements				
Operating Voltage	+6.0 to +30.0 VDC			
Current (mA)	**Mode**	**+6.0 VDC**	**+12.0 VDC**	**+30.0 VDC**
	Transmit	375	295	140
	Receive	120	80	51
	Idle	9	5	3
General Information				
Operating Temperature Range	-40° C to +75° C.			
Dimensions	Board Level: 140 mm L x 62 mm W x 16 mm H			
Weight	Board Level: 137g			
Humidity	0 to 95% non-condensing			

FGRIO-S Specifications

Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications	
Transceiver	
Frequency Range	902 – 928 MHz
Output Power	100 mW
Range, Line-of-sight	2 miles
Modulation	2 level GFSK
Occupied Bandwidth	230 kHz
Hopping Patterns	15, user selectable
Hopping Channels	50 to 112, user selectable
Hopping Bands	7, user selectable
RF Connector	SMA female
Receiver	
Sensitivity	-98 dBm at 10^{-6} BER -100 dBm at 10^{-4} BER
Selectivity	20 dB at fc ± 115 kHz 60 dB at fc ± 145 kHz
System Gain	130 dB
Data Transmission	
Error Detection	32 bit CRC, retransmit on error
Link Throughput	115.2 Kbps
Data Interface	Serial
Protocol	RS-232/422/485, 300 baud – 115.2 Kbaud
Data Connector	10-pin header
Analog Inputs	
Number of Inputs	2
Accuracy, Resolution	± 0.1%, 16 bit
Input Range	0.2 – 5.62 V, 94 KΩ input resistance
Digital Inputs	

Specifications				
Number of Inputs	2			
Input Pull-up	10 KΩ to 3.3 V			
Input Pull-down	10 KΩ to GND			
Input Connector	Mini Phoenix (3.55 mm)			
Slave Input to Master Output Delay	1 sec. maximum			
Signal Input Voltage Maximum	± 20 V			
Maximum Count Size & Rate	32 bits, 1000 Hz			
AI of DI Accuracy, Resolution	± 0.25%, 10 bit			
AI of DI Input Range	0 – 3.5 V			
Digital Output				
Number of Outputs	2			
Current Rating	2 Amps maximum			
Voltage Rating	Lesser of: 20 V or the radio supply voltage			
Diagnostic Interface				
Connector	Separate 20-pin PCB header			
Power Requirements				
Operating Voltage	+6 to +20 V DC			
Average Current Usage (mA)	**Mode**	**6 VDC**	**12 VDC**	**20 VDC**
	Transmit	120	68	48
	Receive	68	38	28
	Linked	12	7	6
General Information				
Operating Temperature Range	-40° C to +75° C			
Dimensions	138 mm L x 76 mm W x 12 mm H			
Weight	58 g			
Humidity	0 to 95% non-condensing			

I2-IOS-C-U Specifications

The following specifications apply to both the I2-IOS-C-U model. Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications	
Transmitter	
Frequency Range	2.4 - 2.483 GHz (FHSS)
Output Power	5 mW to 500 mW
Range, Line of Sight (LOS)	20 miles with clear LOS
Modulation	2 level GFSK, 115.2 Kbps
Occupied Bandwidth	230 kHz
Hopping Patterns	15 per Band, 105 total, user selectable
Hopping Channels	50 to 80, user selectable
Hopping Bands	7, user selectable
RF Connector	Type SMA, TNC (Female connectors)
Receiver	
Sensitivity (board-level only)	-105 dBm at 10^{-6} BER -107 dBm at 10^{-4} BER
Selectivity	TBD
System Gain	134 dB
Data Transmission(1)	
Error Detection	32 bit CRC, retransmit on error
Link Throughput	115.2 Kbps
Data Interface	Serial
Protocol	RS-232/422/485, 300 baud – 115.2 Kbaud
Data Connector	10-pin header with locking ramp 0.1 inch spacing, power/data connector

Input	Modbus	Wire Replacement
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs	x	x
2: DIs with counters (32 bits, 1000 Hz), also act as aux. AI's (10 bits, 0-3.5 V, 0.25% FS Accuracy)	x	(2)
1: DI with pull down resistor (5 Kohm)	x	

Specifications			
1: DI with pulsed 50 mA pull-up for long-lines or high noise		x	
Output			
2: High Current (2 A sink to GND) DO's with current sensing and self-resetting protection		x	x(3)
1: AO - 15 bits, 4-22mA, 0.1% FS Accuracy, also acts as 50mA sensor power or DI		x	
1: AO - 16 bits, 4-22mA, 0.1% FS Accuracy		x	
Internal			
1: Battery/Supply Voltage - 10 bits, 0-30 V, 1% FS Accuracy		x	
1: Radio Temperature - 1° C units, -40° C to +70° C, 4° C accuracy		x	
Diagnostics Interface			
Connector	Separate 20-pin PCB header		
Power Requirements			
Operating Voltage	+6.0 to +30.0 VDC		
Average Current (mA)	**Mode**	**+6.0 VDC**	**+12.0 VDC**	**+30.0 VDC**
	Transmit	375	295	140
	Receive	120	80	51
	Idle	9	5	3
	Modbus Linked Lowpower = 4	10	7	5
	Wire Replacement Linked	30	15	8
General Information			
Operating Temperature Range	-40° C to +75° C. Every radio 100% factory tested over this range.		
Dimensions	Board Level: 127 L x 62 W x 16 H (mm) Enclosure: 173 L x 96 W x 35 H (mm)		
Weight	Board Level: 58 g Enclosure: 1.2 lbs		
Humidity	0 to 95% non-condensing		

FGR2-IOS-C-U/FGR2-IOS-CE-U Specifications

The following specifications apply to both the FGR2-IOS-C-U and FGR2-IOS-CE-U. Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications	
Transmitter	
Frequency Range	902 – 928 MHz
Output Power	1 W
Range, Line of Sight (LOS)	60 miles with clear LOS
Modulation	2 level GFSK, 115.2 Kbps
Occupied Bandwidth	230 kHz
Hopping Patterns	15 per Band, 105 total, user selectable
Hopping Channels	50 to 112, user selectable
Hopping Bands	7, user selectable
RF Connector	Type SMA, TNC (Female connectors)
Receiver	
Sensitivity (board-level only)	-107 dBm at 10^{-6} BER -109 dBm at 10^{-4} BER
Selectivity	20 dB at fc ± 115 kHz 60 dB at fc ± 145 kHz
System Gain	140 dB
Data Transmission(1)	
Error Detection	32 bit CRC, retransmit on error
Link Throughput	115.2 Kbps
Data Interface	Serial
Protocol	RS-232/422/485, 300 baud – 115.2 Kbaud
Data Connector	10-pin header with locking ramp 0.1 inch spacing, power/data connector

Input	Modbus	Wire Replacement
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs	x	x
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs	x	(2)
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs	x	

Specifications			
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs	x	
Output			
2: High Current (2 A sink to GND) DOs with current sensing and self-resetting protection	x	x(3)
1: AO - 15 bits, 4-22mA, 0.1% FS Accuracy, also acts as 50mA sensor power or DI	x	
1: AO - 16 bits, 4-22mA, 0.1% FS Accuracy	x	
Internal			
1: Battery/Supply Voltage - 10 bits, 0-30 V, 1% FS Accuracy	x	
1: Radio Temperature - 1° C units, -40° C to +70° C, 4° C accuracy	x	

Diagnostics Interface	
Connector	Separate 20-pin PCB header

Power Requirements				
Operating Voltage	+6.0 to +30.0 VDC			
Average Current (mA) (currents shown with no AO connections made)	**Mode**	**+6.0 VDC**	**+12.0 VDC**	**+30.0 VDC**
	Transmit	800	380	170
	Receive	90	55	40
	Idle	24	16	8
	Modbus Linked Lowpower = 4	10	7	5
	Wire Replacement Linked	30	15	8

General Information	
Operating Temperature Range	-40° C to +75° C. Every radio 100% factory tested over this range.
Dimensions	Board Level: 127 L x 62 W x 16 H (mm) Enclosure: 173 L x 96 W x 35 H (mm)
Weight	Board Level: 60 g Enclosure: 509 g
Humidity	0 to 95% non-condensing

(1) Data port not operative in wire replacement mode.
(2) DIs operative, but there are no counters in Wire Replacement mode.
(3) No current sensing in wire.

FGR2-IO-IOE Specifications

The following specifications apply to the FGR2-IO-IOE. Specifications may change at any time without notice. For the most up-to-date specifications information, see the product's data sheet available at www.freewave.com.

Specifications			
Transmitter			
Frequency Range	902 – 928 MHz		
Output Power	1 W		
Range, Line of Sight (LOS)	60 miles with clear LOS		
Modulation	2 level GFSK, 115.2 Kbps		
Occupied Bandwidth	230 kHz		
Hopping Patterns	15 per Band, 105 total, user selectable		
Hopping Channels	50 to 112, user selectable		
Hopping Bands	7, user selectable		
RF Connector	Type SMA, TNC (Female connectors)		
Receiver			
Sensitivity (board-level only)	-106 dBm at 10^{-6} BER -108 dBm at 10^{-4} BER		
Selectivity	20 dB at fc ± 115 kHz 60 dB at fc ± 145 kHz		
System Gain	140 dB		
Data Transmission(1)			
Error Detection	32 bit CRC, retransmit on error		
Link Throughput	115.2 Kbps		
Data Interface	Serial		
Protocol	RS-232/422/485, 1200 baud – 115.2 Kbaud		
Data Connector	10-pin header with locking ramp 0.1 inch spacing, power/data connector		
Input		**Modbus**	**Wire Replacement**
2: Precision AIs (20 bits, 0-5.625 V, 0.1% FS Accuracy), also act as exact-threshold DIs		x	x
2: DIs with counters (32 bits, 1000 Hz), also act as aux. AIs (10 bits, 0-3.5 V, 0.25% FS Accuracy)		x	(2)

Specifications				
1: DI with pull down resistor (5 Kohm)		x		
1: DI with pulsed 50 mA pull-up for long-lines or high noise		x		
Output				
2: High Current (2 A sink to GND) DOs with current sensing and self-resetting protection		x		x(3)
1: AO - 15 bits, 4-22mA, 0.1% FS Accuracy, also acts as 50mA sensor power or DI		x		
1: AO - 16 bits, 4-22mA, 0.1% FS Accuracy		x		
Internal				
1: Battery/Supply Voltage - 10 bits, 0-30 V, 1% FS Accuracy		x		
1: Radio Temperature - 1° C units, -40° C to +70° C, 4° C accuracy x		x		
Expandable I/O Stack up to 15 Expansion Modules		x		
Diagnostics Interface				
Connector	Separate 20-pin PCB header			
Power Requirements				
Operating Voltage	+6.0 to +30.0 VDC			
Average Current (mA) (currents shown with no AO connections made)	**Mode**	**+6.0 VDC**	**+12.0 VDC**	**+30.0 VDC**
	Transmit	800	380	170
	Receive	90	55	40
	Idle	24	16	8
	Modbus Linked Lowpower = 4	10	7	5
	Wire Replacement Linked	30	15	8
General Information				
Operating Temperature Range	-40° C to +75° C. Every radio 100% factory tested over this range.			
Dimensions	Enclosure: 181 L x 80 W x 38 H (mm)			
Weight	Enclosure: 163 g			
Humidity	0 to 95% non-condensing			

Appendix A: Firmware Updates

As of this document's release, the following firmware has been released for the model numbers to which this document applies. The latest firmware versions are available on the FreeWave Web site at www.freewave.com. You can also view the latest firmware available for most models in Tool Suite.

FGRIO-M Firmware Updates

The sections below describe the updates and any known limitations in each firmware revision for the FGRIO-M transceivers. The most recent version is listed first.

Version 2.69

Release Date:	09/09/2011
Additions/Updates:	Miscellaneous updates, PPT RF sync fixes, wire replacement bug fix.
Known Limitations:	None

FGRIO-S Firmware Updates

The sections below describe the updates in each firmware revision for the FGRIO-S and FGR-SR series radios. The most recent version is listed first.

Version 2.66

Release Date:	05/21/2009
Additions/Updates:	Fixed FCC compliance issue
Known Limitations:	None

Version 2.53

Release Date:	02/29/2008
Additions/Updates:	Added Modbus address capability.
Known Limitations:	None

FGR2-IOS and FGR2-IO-IOE Firmware Updates

The sections below describe the updates and any known limitations in each firmware revision for the FGR2-IOS and FGR2-IO-IOE transceivers. The most recent version is listed first.

Version 9.76

Release Date:	03/29/2011
Additions/Updates:	Resolves all known bugs from 30VIO firmware.
Known Limitations:	None

Version 9.75

Release Date:	02/22/2011
Additions/Updates:	• Fix for 16 bit Modbus addresses. • Repeater and Slave/Repeater fixes. • Serial Modbus mode. • IO bug fixes.
Known Limitations:	None

Version 9.70

Release Date:	05/08/2009
Additions/Updates:	• ADC resolution fix • Modbus broadcast capable
Known Limitations:	None

Version 9.69

Release Date:	10/16/2008
Additions/Updates:	Acquisition fix.
Known Limitations:	None

Version 9.68

Release Date:	06/26/2008
Additions/Updates:	Repeater fixes.
Known Limitations:	None

Glossary

Symbols

µ

Symbol notation for micro (one millionth). For example, µs is the abbreviation for microseconds.

Ω

Symbol notation for ohm, a measure of electrical resistance.

A

analog circuit

An electronic circuit that operates with currents and voltages that vary continuously with time and have no abrupt transitions between levels. Temperatures, pressures, or flow rates are all represented by analog circuits.

D

digital circuits

An electronic circuit that functions as though currents or voltages exist only at one of a set of discrete levels, all transitions between levels being ignored. The states of a digital circuit are often referred to as on or off, high or low.

I

I/O Master

Refers to FGRIO-M or I2-IOM-U FreeWave wireless radio transceivers that operate as a Master for up to four I/O Slaves and can operate as a serial MultiPoint Slave in a Point-to-MultiPoint network. The I/O Master can receive over the air a total of four analog input signals and four digital input signals from up to four I/O Slaves. It can also transmit up to four digital output signals over air to the I/O Slaves. The I/O Master does not operate as a Slave/Repeater in a serial Point-to-Multipoint radio network.

I/O Slave

Refers to an FGR2-IOS-C-U, FGR2-IOS-CE-U, I2-IOS-C-U, or FGR2-IO-IOE FreeWave wireless radio transceiver that accepts up to a total of four input signals from sensors, then transmits these signals over-the-air to the I/O Master. Two of the available four input signals can only be transmitted as analog signals and are labeled as Analog Input 1 and Analog Input 2 on the Slave's terminal block. The other two input signals may be either analog or digital inputs, depending on your needs. The I/O Slave can also receive over-the-air two digital output signals and a sensor power control signal from the I/O Master. The I/O Slave has a line-of-sight range of 60 miles.

I/O System

When used in this manual, the term I/O System refers to any network that uses an I/O Master in conjunction with an I/O Slave.

M

S

Short-Range I/O Slave

Refers to an FGRIO-S FreeWave wireless radio transceiver that accepts up to a total of four input signals from sensors, then transmits these signals over-the-air to the I/O Master. Two of the four available input signals can only be transmitted as analog signals and are labeled as Analog Input 1 and Analog Input 2 on the Slave's terminal block. The other two input signals may be either analog or digital inputs, depending on your needs. The I/O Slave can also receive over-the-air two digital output signals and a sensor power control signal from the I/O Master.

Refers to any FGRO9CSU, FGR-115RC, FGR2-C-U, FGR2-CE-U, IM-500X007, IM-800X009, IM-900X009, I2-C-U, or I2-CE radio configured as the MultiPoint Master.

V

VSNS

This is screw terminal # 7 on the Short-Range IO Slave and the IO Slave. This is an output used to power sensors/transmitters. This terminal mirrors the radio's supply voltage. The maximum output voltage of this terminal is 20 VDC for the FGRIO-S and 30 VDC for the FGR2-IOS-C-U, FGR2-IOS-CE-U, I2-IOS-C-U, and FGR2-IO-IOE.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