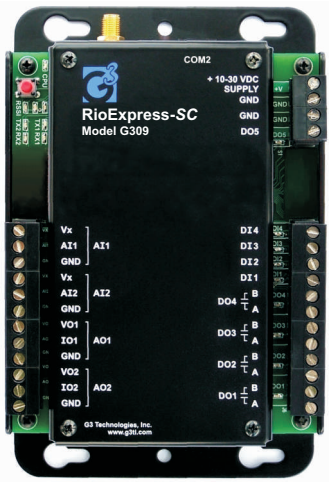

RioExpress-*SC*™ User's Guide

Industrial Wireless I/O

Model G309

2011-05-12
G3 Technologies, Inc.

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Introduction

The G309 RioExpress-SC is sister to the G308 RioExpress. In addition to providing more configuration flexibility for the same functions, the G309 also supports radio repeating and point-to-multipoint cable replacement. In many cases, however, the G308 and G309 can be used together in the same system.

This guide covers the operation, installation and configuration options of the RioExpress-SC, Industrial Wireless I/O - Model G309. It is an easy-to-use Wireless I/O module with an integrated high performance Spread Spectrum Radio. It provides reliable access to remote or hard-to-reach Digital & Analog process signals for both monitoring and control. Use the RioExpress-SC modules to replicate (mirror) I/O signals for point-to-point or point-to-multipoint cable replacement, or use it as a Modbus Slave polled from most any Modbus Master RTU/PLC using a G306C RioLink Wireless Modem on the master's serial port.

The RioExpress-SC is easy to configure with the PC-based G3 AXS Configuration Utility and a serial cable. All of the configuration is made with selection boxes, drop down lists and value entry, and the default settings are appropriate for many applications.

Unlike the RioExpress, the RioExpress-SC supports Radio Repeater function. One or more repeaters can be set up to easily extend the communications range.

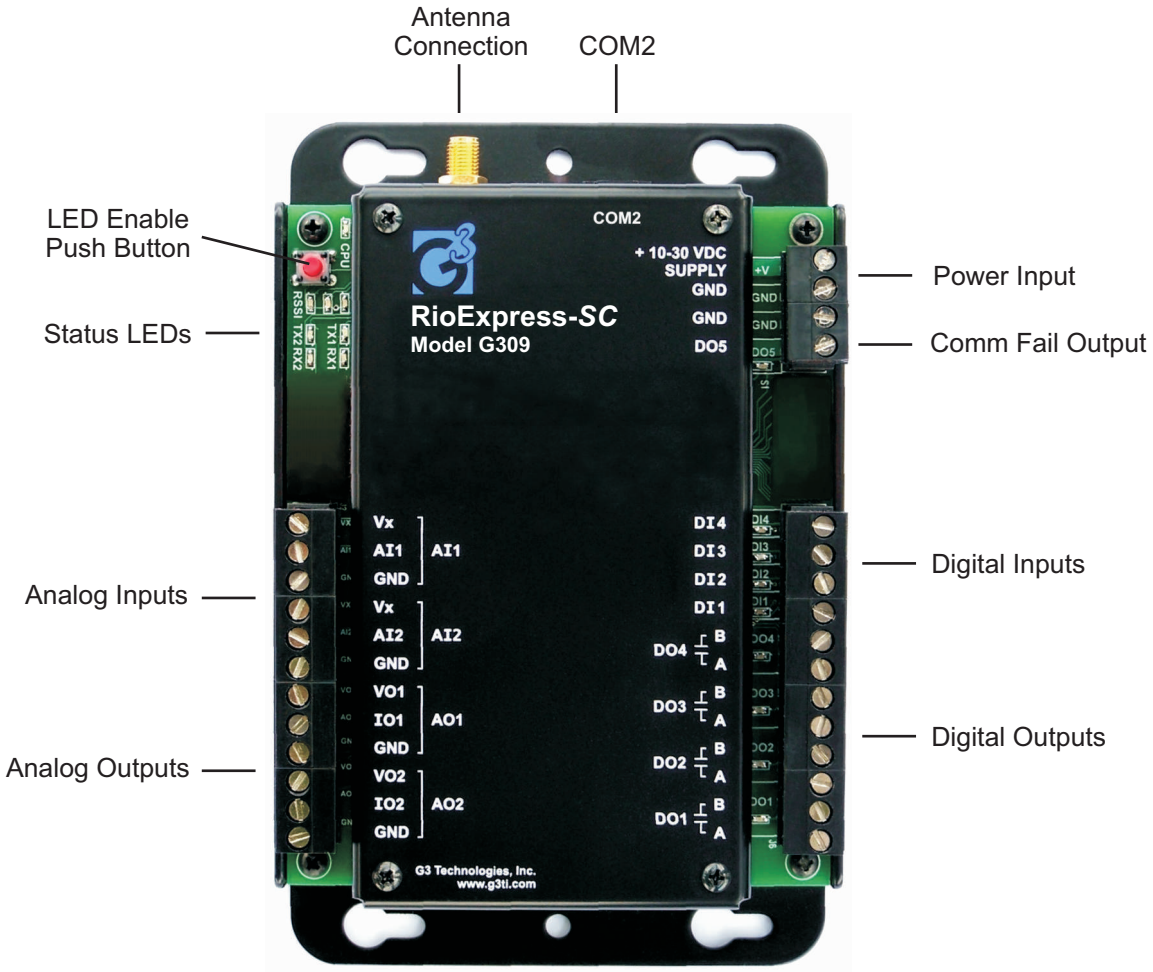


Figure 1

Specifications

Radio Performance:

Indoor/Urban Range (w/ 2.1 dB dipole antenna)	900MHz, up to 1500' (450m); 2.4GHz, up to 600' (180m)
Outdoor RF line-of-sight Range (w/ 2.1 dB dipole antenna)	900MHz, up to 7 miles (11km); 2.4GHz, up to 3 miles (5km)
Outdoor RF line-of-sight Range (w/ high gain antenna)	900MHz, up to 20 miles (32km); 2.4GHz, up to 10 miles (16km)
Transmit Power Output	900MHz, 100mW; 2.4GHz, 50mW

Radio Communications:

Modbus Protocol	Modbus RTU
Data Rate (Throughput)	9600 baud (bps)
RF Net codes	7 RF Net codes (Channels)
Addresses	255 Device Address (per Channel)
Poll Rate	0-65535 seconds between polls 0 = Continuous (Approximately 4 times per second)
COM2	4 pin latching header RS-232 signals: (1) TXD, (2) RXD, (3) +VIN, (4) GND 9600 baud, N81

Digital I/O:

Digital Inputs (DI)	4 ea. (DI1-4) Non-latching, active low (power common/ground) Optical coupled for surge and noise tolerance 12V wetting voltage, 4mA wetting current Optional DI power down in Power Save Mode
Pulse Inputs	DI1-2 are also transition-sensing for pulse rate, totalizing or event-capture
Digital Outputs (DO)	4 ea. (DO1-4) Form A, normally-open relay contacts
Contact Rating	2 Amps 250VAC/30VDC General Purpose, Pilot Duty D150
Comm Fail Action	Individually configurable, DO1-4, hold current state or Comm. Fail Value
Comm Fail Output	DO5 open-collector sink output (200mA, 30Vdc max load)

Analog I/O:

Analog Inputs (AI)	2 ea. (AI1-2) 0-5V (1-5V) or 0-20mA (4-20mA), DIP switch selectable 12 bit resolution Typical accuracy 0.1% FS @ 25°C Overall accuracy 0.25% FS Over-voltage tolerance +/-30Vdc
Internal Analog Input	(AI3) internally monitors power supply voltage; 0-32V range
Sensor Excitation Voltage (Vx)	Selected 12V or 24V 12/24Vdc, 20mA load per terminal Vx optionally powered down in Power Save Mode
Analog Outputs (AO)	2 ea. (AO1-2), single ended Both 0-5VDC (1-5VDC) and 0-20mA (4-20mA) provided Voltage outputs are recommended for low-power applications. Typical 0.2% FS @ 25°C (1-5V or 4-20mA range) Overall accuracy 0.45% FS (1-5V or 4-20mA range) Maximum current loop resistance 450 ohms (Vx=12V) Maximum current loop resistance 1000 ohms (Vx=24V)
Comm Fail Action	Individually configurable AO1-2, hold current value or Comm. Fail Value

Specifications Continued

Power Input:

Input Voltage, Power	10-30 Vdc, 5 Watts max.
Current, Power-Save (I_{PS})	I_{PS} = 9mA @ 12Vdc
Current, Receive/Standby (I_{RX})	I_{RX} = 40mA @ 12Vdc
Current, Transmit (I_{TX})	I_{TX} = 72mA @ 12Vdc
Actual Installed Current Draw	Actual average current draw varies with Poll Rate and Power-Save settings. Also, Sensor and I/O Current loads add to the overall Supply Current requirements.

Miscellaneous:

Diagnostics	LEDs: CPU status, RSSI, TX, RX, DIs, DOs and Comm Fail LED Enable is toggled with Pushbutton, and has a 30 min. timeout.
Surge protection	All power, Comm Port and I/O connections meet or exceed minimum standards for ESD, EFT, and Surge withstand per the international IEC 1000-4 standards
Certifications	FCC Part 15 Class A CSA certification for Class I, Div 2, Groups A,B,C,D. Temp code T4

Physical:

Operating Temperature	-40 to 85°C
Humidity	5-95% non-condensing
Field Wiring Connections	All wire connections are pluggable screw terminals, 0.2” spacing Screw Torque 4.5 lb-in,12-28 AWG
Dimensions	6.3” long x 4.15” wide x 1.55” high overall
Weight	11 oz. (300g)
Mounting	Panel mounting, 5.7” x 2.6” rectangular pattern “key-hole” #6 or #8 pan-head screws recommended Optional mounting clip available for DIN Rail mounting
Antenna Connection	RPSMA Female

Input Power

The G309 should be powered from an isolated source. Solar and battery power sources are inherently isolated. For line voltage connected AC/DC power supplies, verify that they have the proper secondary isolation. The supply voltage range is 10-30Vdc.

With the default Low Voltage Detect setting the unit will power down if the supply voltage is less then 11.4Vdc for longer then 10 seconds and power up after the supply voltage is above 12.6Vdc for more then 10 seconds. This feature performs the same function as a Low Voltage Disconnect circuit on a solar charge regulator. By integrating this function into the unit, lower cost battery or solar charge regulators that do not provide the Low Voltage Disconnect circuit can be used. If a lower input voltage range is desired the Disconnect voltage can be set as low as 9.90V and the Restore Voltage can be set as low as 10.00V.

The following solar site calculations provide an example of the factors that effect the solar module and battery sizing. Because of the many factors that affect the sizing requirements for a solar installation, please contact G3 Technologies for specifics. We are happy to assist in determining the best configuration for your application.

Solar Site Example:

G309, 10sec. Poll Rate, DI and Vx Power Down 8 sec, Vx = 24V

(2) Digital Inputs assumed active

(1) 4-20mA Sensor assumed at full scale, 20mA

Solar Array Size = $(I_{Load\ Avg})(24hrs)(12Vdc) / (Average\ Sun\ hrs/day)$

Where:

$I_{Load\ Avg}$ = Average Current Load = (8/10sec.)(9mA) + (2/10sec.)(85mA) + (6mA Solar Reg.)

$I_{Load\ Avg}$ = 30.2mA = 0.0302A

Average Sun hrs/day depends on the geographic location and time of year. For this example we will use the Winter Average Sun hrs/day for Boise, ID (3.33 hrs/day).

Solar Array Size = (0.0302A)(24hrs)(12Vdc) / (3.33 Sun hrs/day)

Solar Array Size = 2.61 Watts (A standard 5W Solar Module could be a good choice.)

Minimum Battery Size = $(I_{Load\ Avg})(24hrs)(Days\ of\ Autonomy)(Temp.\ Factor) / (\%\ of\ Discharge)$

Where:

$I_{Load\ Avg}$ = 30.2mA = 0.0302A

Days of Autonomy = The number of days without sun that the load current is supplied solely by the battery. Six to Eight days autonomy is common for 99.9% system availability.

Temp. Factor = Batteries are effected by temp. A colder battery will store and supply less energy. For this example we will use the Boise, ID average January, temp. of 25 deg. F (1.5 Temp. Factor).

% of Discharge = The deeper the discharge the shorter the battery life. The % of Discharge should not be more then 80%.

Minimum Battery Size = (0.0302A)(24hrs)(8 days)(1.5 Temp. Factor) / (0.8 Discharge)

Minimum Battery Size = 10.9 Ahr (A 12-18Ahr battery could be a good choice.)

Grounding

An important item to verify is the proper grounding of the equipment installation. Properly grounded electrical equipment will be safer, operate with less electrical noise and minimize the potential damage from power line surges or lightning strikes. We recommend a common point or star grounding configuration, where all of the equipment in a panel are directly connected to the common grounding point. The common grounding point is then connected to an 8' ground rod or other grounding system using #14 AWG or larger copper wire. Check with local regulations for specific grounding requirements.

Digital Input Wiring Diagram

The four digital inputs (DI1-4) are active low. The most common types of dry contacts used to switch the inputs to GND are relay contacts, switch contacts or open collector transistors. The discrete inputs are internally powered with a wetting voltage of 10-14Vdc and a wetting current of 4mA. In Power-Save mode the discrete inputs can optionally be powered down (see Configuration Settings for more detail). The minimum hold time for a valid DI is 200ms.

DI1 and DI2 are also internally connected to pulse input circuitry. The pulse input registers provide both the pulse total and pulse rate in pulses per second (PPS) and pulses per minute (PPM). Short duration events (0.25ms minimum) can also be detected by monitoring the PPM register for a value greater than zero. The PPM register will "hold" each pulse for one minute. The pulse input registers are available to be read by a polling master, but when used as a master/slave pair for cable replacement the totalizer and rate registers are not accessible.

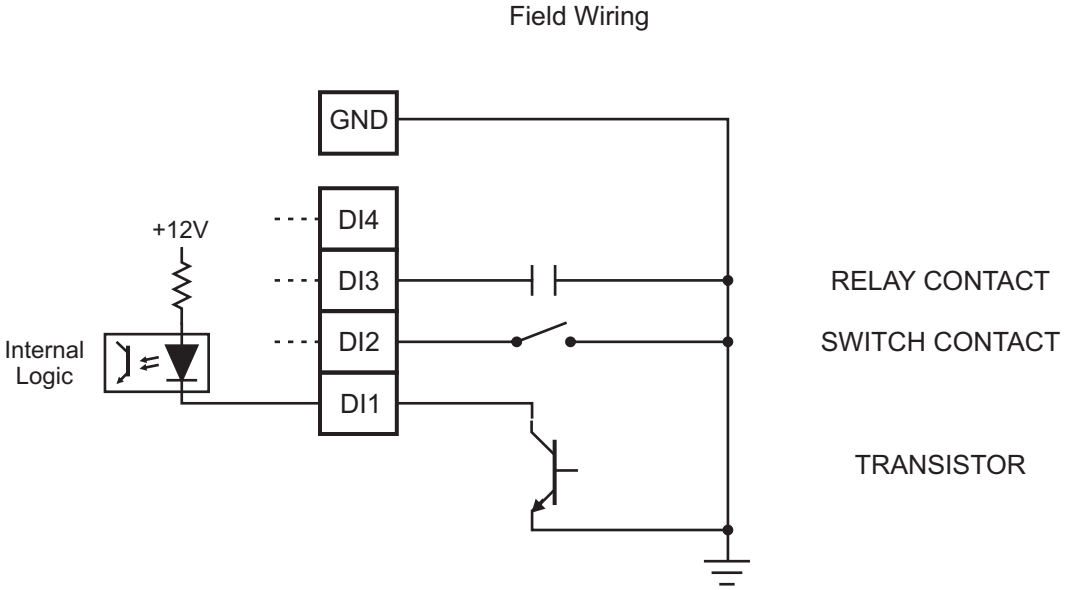


Figure 2

Digital Output Wiring Diagram

The four digital outputs (DO1-4) are Form A, normally-open relay contacts. Digital output #5 (DO5) is an open drain, sinking output. The output driver is internally current limited, thermally limited and surge protected. DO5 is turned on only when the unit is in Comm Fail Mode.

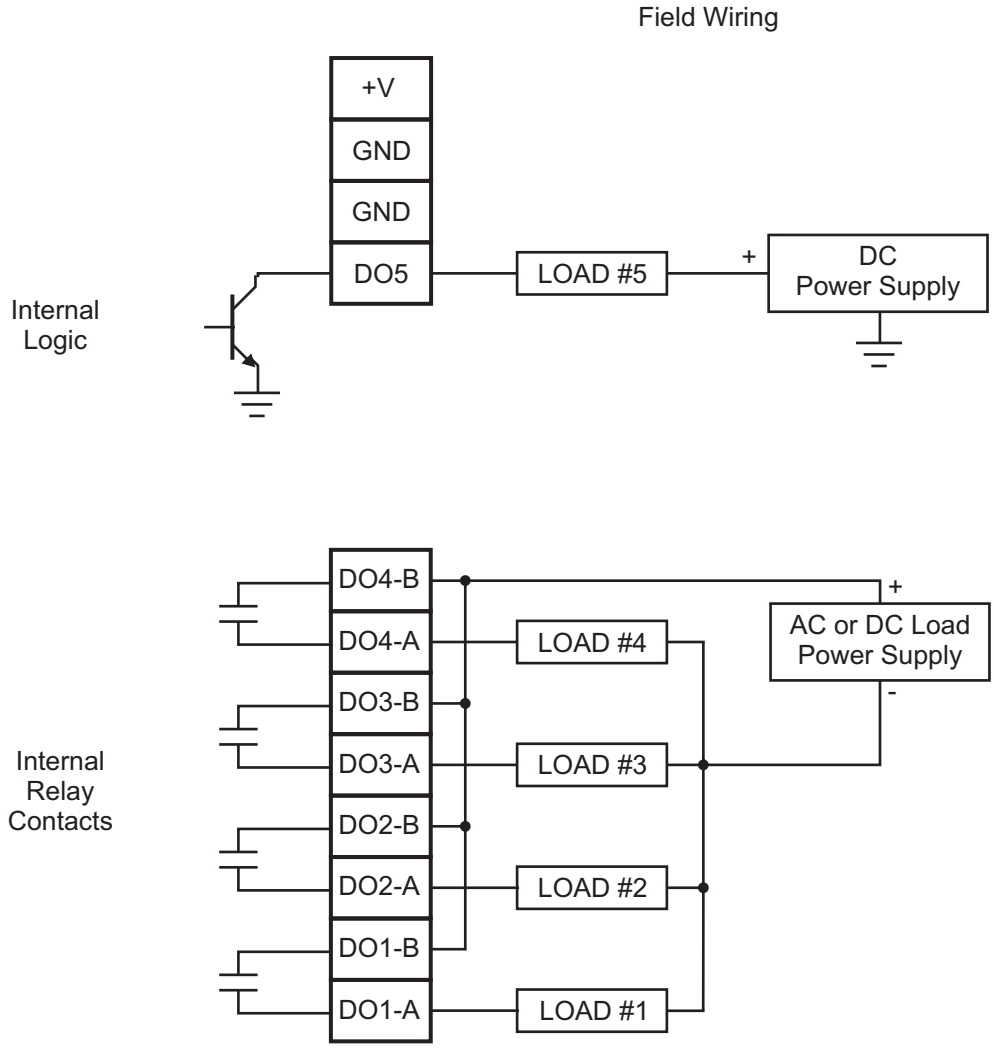


Figure 3

Analog Input Wiring Diagram

Each of the two analog inputs is selectable as either a 0-5V (1-5V) or 0-20mA (4-20mA) signal. The analog input type selection DIP switches are located under the cover in order to meet Class I, Div. 2 hazardous location requirements, and these selections should not be changed unless the area is known to be non-hazardous. To access the analog input type selection DIP switches remove the four screws on the cover and lift vertically. The default factory analog input setting is 0-20mA (4-20mA). We suggest that unused / unterminated analog inputs should be set to 0-20 mA (4-20mA). This will bias the unterminated analog input at zero.

The sensor excitation voltage (Vx) can be set to either 12Vdc nominal or 24Vdc. In the 12V setting Vx will vary with the input voltage (+V) in the range of 10-14.4Vdc. With input voltages (+V) above 14.4Vdc, Vx will be maintained at 14.4Vdc. In the 24V setting the internal DC/DC regulator will maintain Vx = 24Vdc over the full 10-30Vdc input voltage range. The load on each Vx terminal should not exceed 20mA.

In solar powered applications where power conservation is a key concern, there are some features and practices that can help lower the power requirements. Using 1-5V rather then 4-20mA sensors is generally recommended. If the 24V sensor excitation is not required, then select Vx = 12V. With the ability to switch off the sensor excitation voltage during Power Save Mode, 4-20mA sensors can efficiently be used in low power applications (see Configuration Settings for more detail).

The internal Analog Input #3 (AI3) monitors the power input supply voltage, 0-32V voltage range. The analog to digital converter for all of the analog inputs is 12 bits, providing a 0-4095 decimal count for zero to full scale inputs.

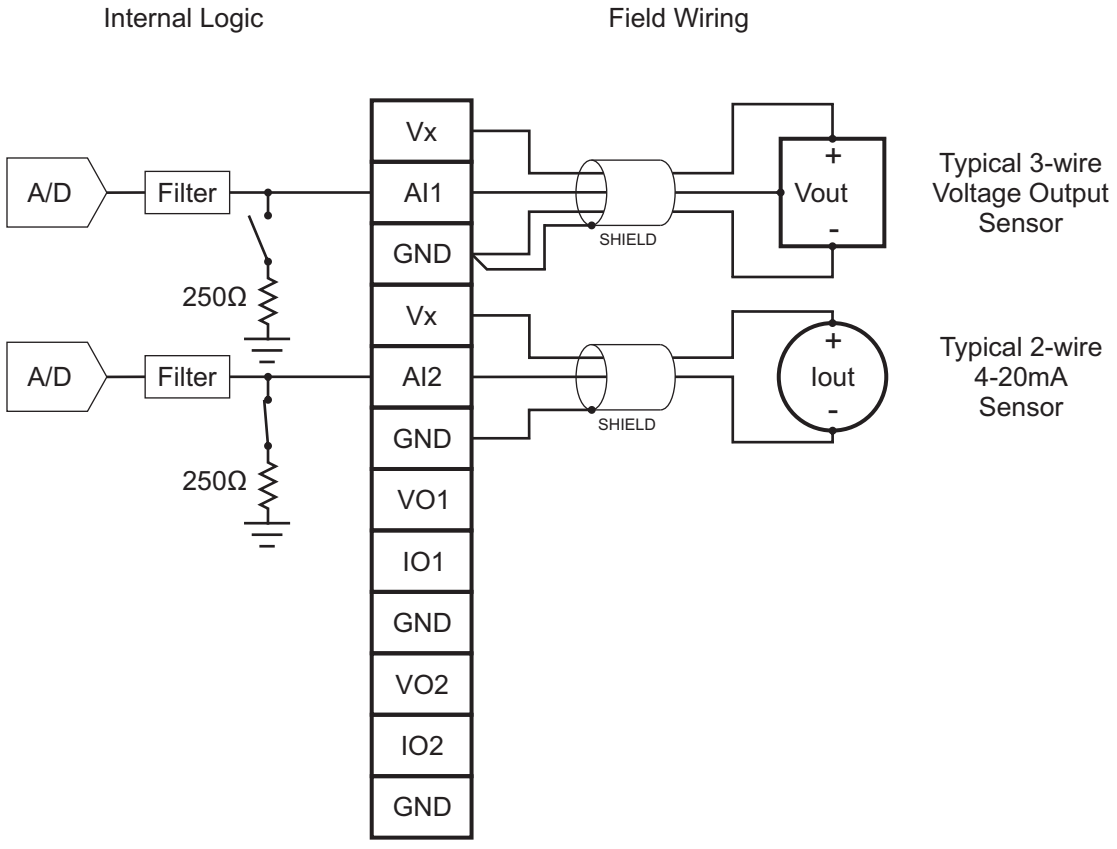


Figure 4

Analog Output Wiring Diagram

Each analog output channel provides a 0-5V (1-5V) and 0-20mA (4-20mA) signal simultaneously. The digital to analog converter is 12 bit, 0-4095 decimal count for zero to full scale outputs. The Vx voltage selection also determines the 0-20mA output drive voltage. With Vx = 12V the maximum current loop resistance is 450 ohms. With Vx = 24V the maximum current loop resistance is 1000 ohms.

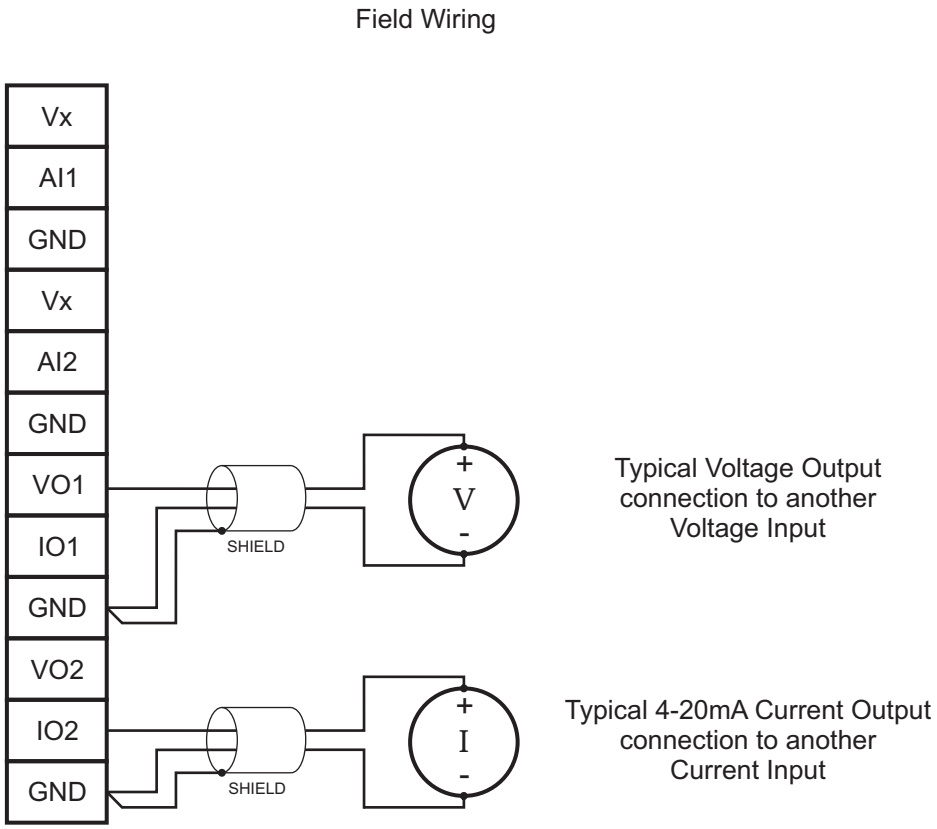


Figure 5

Configuration Settings

The G309 RioExpress-SC is configured using the PC-based G3 AXS software and a serial adaptor cable (DB9F to 4pin latching connector). Install G3 AXS on your PC by inserting the CD and following the installation instructions. With the G3 AXS software installed and the G309 connected and powered you are ready to begin configuring.

MASTER / SLAVE
When using the G309 for cable replacement, one unit must be configured as the MASTER and one or more units configured as SLAVE(s). The MASTER initiates each radio message and determines the polling rate. When using the G309 as a Modbus Slave Wireless I/O the unit is configured as a SLAVE and it can be polled by any Modbus Master device using a compatible SS Radio Modem (i.e. Model G306C RioLink Wireless Modem).

Figure 6

Home Window

The Home Window shown in Figure 6 is the starting place for configuring the G309 unit. Select the serial port that will be used to configure the device and select the type of device to be configured using the corresponding pull down menus.

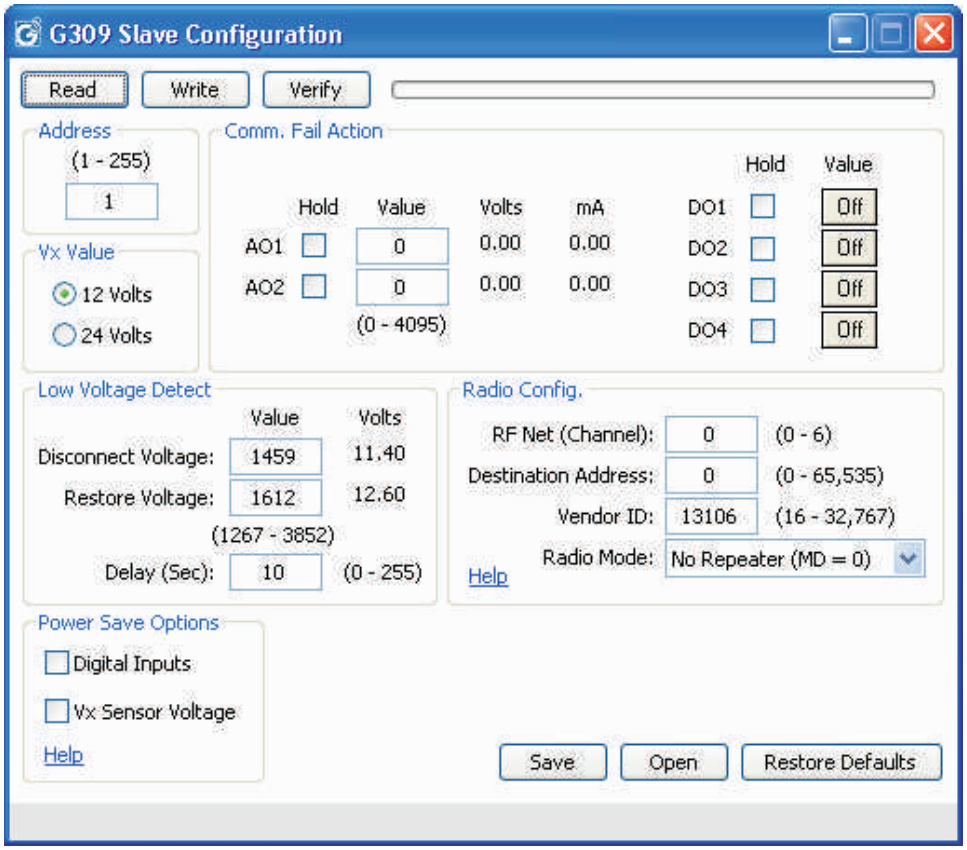


Figure 7 (default values shown)

SLAVE CONFIGURATION
The G309 Slave Configuration window is shown in Figure 7. This window is opened by selecting "G309 Slave" for the Device Type, and clicking the "Configure" button in the Home Window. The status bar to the right of the Read, Write, and Verify Configuration buttons, and the message line at the bottom of the window provide feedback to the user.

Read Configuration, clicking on the “Read” button will read the configuration stored on the G309 and display the information on the screen.

Write Configuration, clicking on the “Write” button will write the configuration on the screen to the G309. The configuration is also verified after writing.

Verify Configuration, clicking on the “Verify” button will compare the configuration on the screen to the configuration stored in the G309. The message line at the bottom of the configuration window will state whether the configuration matches.

Save Configuration, clicking on the “Save” Configuration button will open a standard Windows dialog box to save the configuration to a file. Choose the folder and name for the AXS Configuration File and click Save. The AXS Configuration Files are saved with the .axc file extension.

Open Configuration, clicking on the “Open” Configuration button will open a standard Windows dialog box to open a .axc configuration from a file.

Restore Defaults, clicking on the “Restore Defaults” button will set all of the configuration settings on the screen to the default values. To write the default settings to the G309, click the “Write” button.

Address (Slave)
On a given network each slave unit must be configured with a unique address. The slave address range is from 1 to 255. This value is the Modbus device address.

Radio Configuration

RF Net (Channel) (Slave)
The RF Net code selects one of seven pre-defined pseudo-random hopping sequences of the radio. Only those units that are on the same RF Net code or "Channel" will communicate with each other. If you have multiple Wireless I/O networks in the same proximity, then using a different RF Net code for each network will eliminate interaction.

Destination Address (Slave)
In a non-repeater system the Destination Address of all of the units must be the same. By default the Destination Address = 0. In a repeater system the Destination Address must be set to 65,535. This setting is used for the radio layer protocol and is separate from the Modbus Address.

Vendor ID (Slave)
Only those units with the same Vendor ID will communicate. This adds one more layer of security to the communications.

Radio Mode (Slave)
In a system that has no repeater, all of the units should be configured as "No Repeater (MD=0)". When a system uses one or more repeaters, then the repeater(s) must be set as "Repeater (MD=3)", and all other units must be set as "Repeater End Node (MD=4)". Also, remember that the Destination Address must be set to 65,535 on all units in a system with one or more repeaters.

There are two radio configuration settings that are automatically set depending on the Radio Mode selection. In a No Repeater system the Source Address is set to (MY=FFFF) and Delay Slots (RN=0). For both the Repeater and Repeater End Node the Source Address is set to the Modbus Address (MY=Address) and Delay Slots (RN=1).

Vx Voltage (Slave)
The sensor excitation voltage (Vx) can be set to either 12Vdc nominal or 24Vdc. In the 12V setting Vx will vary with the input voltage (+V) in the range of 10-14.4Vdc. With input voltages (+V) above 14.4Vdc, Vx will be maintained at 14.4Vdc. In the 24V setting the internal DC/DC regulator will maintain Vx = 24Vdc over the full 10-30Vdc input voltage operating range.

Power Save Options (Slave)
"Power Save" mode is enabled in and controlled by the polling Master. In configuring the Slave, however, selecting the Digital Inputs Power Save Option will turn off the digital input wetting voltage during the power down period, and selecting the Vx Sensor Voltage Power Save Option will turn off the Vx Sensor excitation voltage during the power down period. For those applications that can work with the Digital Inputs and/or Vx Sensor Voltage turned off during the Power Down period the average current requirement for the unit can be significantly reduced. The longer the Power Down period the lower the average current. Power Save Enable and timing are controlled by the Master. Refer to the Master Configuration Timing settings for more details.

Low Voltage Detect (Slave)
This feature performs the same function as a Low Voltage Disconnect circuit on a solar charge regulator. By integrating this function into the G309, lower cost solar charge regulators that do not provide the Low Voltage Disconnect circuit can be used. With the default Low Voltage Detect setting the unit will power down if the supply voltage is less than the Disconnect Voltage (11.4Vdc) for longer than the Delay (10 seconds) and power up after the supply voltage is above the Restore Voltage (12.6Vdc) for more than the Delay (10 seconds). If a lower input voltage range is desired, the Disconnect voltage can be set as low as 9.90V and the Restore Voltage can be set as low as 10.00V.

Comm. Fail Action (Slave)
The Communications Fail Action settings determine the state of the analog and digital outputs if communications is interrupted and the unit goes into Comm. Fail Mode. Each AO and DO can be set to Hold the last communicated value or they can be set to a specific Comm. Fail Value. Refer to the Master Configuration Timing settings for more details.

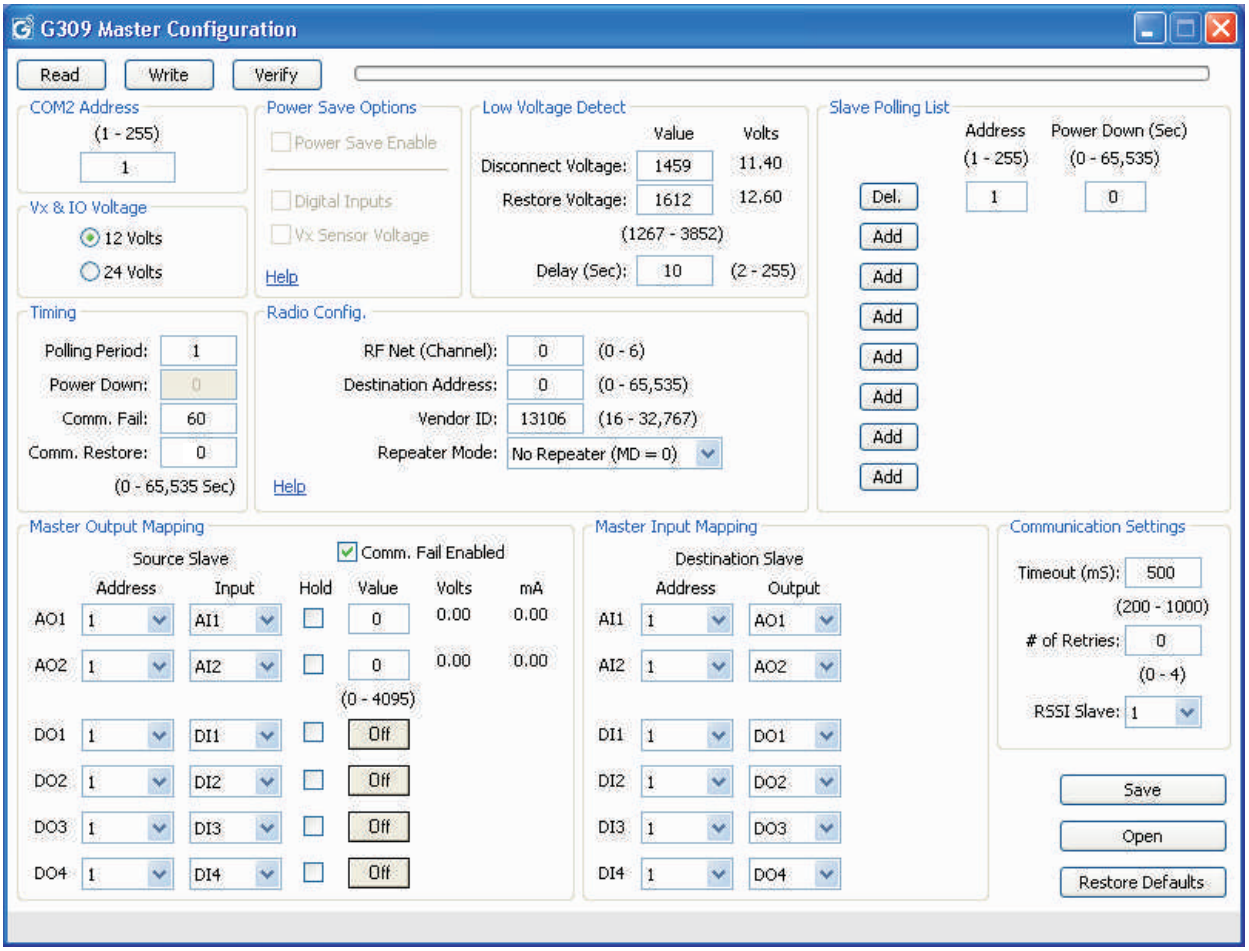


Figure 8 (default values shown)

Master Configuration

The G309 Master Configuration screen is shown in Figure 8. This screen is entered by selecting "G309 Master" as the Device Type, and clicking the "Configure" button in the Home Window. The status bar to the right of the Read, Write, Verify Configuration buttons and the message line at the bottom of the window provide feedback to the user. The Master unit configuration determines the communications timing and the I/O mapping of the system.

Read Configuration, clicking on the “Read” button will read the configuration stored on the G309 and display the information on the screen.

Write Configuration, clicking on the “Write” button will write the configuration on the screen to the G309. The configuration is also verified after writing**.**

Verify Configuration, clicking on the “Verify” button will compare the configuration on the screen to the configuration stored in the G309. The message line at the bottom of the configuration window will state whether the configuration matches.

Save Configuration, clicking on the “Save” Configuration button will open a standard Windows dialog box to save the configuration to a file. Choose the folder and name for the AXS Configuration File and click Save. The AXS Configuration Files are saved with the .axc file extension.

Open Configuration, clicking on the “Open” Configuration button will open a standard Windows dialog box to open a .axc configuration from a file.

Restore Defaults, clicking on the “Restore Defaults” button will set all of the configuration settings on the screen to the default values. To write the default settings to the G309 click on the “Write” button.

COM2 Address (Master)
The COM2 serial port on the G309 performs two main functions, as a configuration port and as a Modbus Slave data server. For example, the G309 Master can be used as a data concentrator, polling a number of Slave units, and the information is then read from the G309 by another Modbus Master device via COM2. The G3 AXS software uses specialized global Modbus commands and will communicate with the G309 regardless of the COM2 Address.

Vx Voltage (Master)
The sensor excitation voltage (Vx) can be set to either 12Vdc nominal or 24Vdc. In the 12V setting Vx will vary with the input voltage (+V) in the range of 10-14.4Vdc. With input voltages (+V) above 14.4Vdc, Vx will be maintained at 14.4Vdc. In the 24V setting the internal DC/DC regulator will maintain Vx = 24Vdc over the full 10-30Vdc input voltage operating range.

Power Save Options (Master)
The Power Save Enable selection enables the power save options for both Master & supported Slaves. The Power Save Enable is only available if the Polling Period is greater the one second. Once the Power Save Enable is selected a Power Down period for the Master can be entered in the "Timing" group, and for each Slave in the "Slave Polling List" group. The Power Save time must be less than the Poll Period.

Selecting the Digital Input's Power Save Option will turn off the local digital input wetting voltage during the Power Down period. Selecting the Vx Sensor Voltage will turn off the local Vx Sensor excitation voltage during the Power Down period. For those applications that can work with the Digital Inputs and/or Vx Sensor Voltage turned off during the Power Down period the average current requirement for the unit can be significantly reduced. The longer the Power Down period the lower the average current.

Low Voltage Detect (Master)
This feature performs the same function as a Low Voltage Disconnect circuit on a solar charge regulator. By integrating this function into the G309, lower cost solar charge regulators that do not provide the Low Voltage Disconnect circuit can be used. With the default Low Voltage Detect setting the unit will power down if the supply voltage is less than the Disconnect Voltage (11.4Vdc) for longer then the Delay (10 seconds) and power up after the supply voltage is above the Restore Voltage (12.6Vdc) for more than Delay (10 seconds). If a lower input voltage range is desire the Disconnect voltage can be set as low as 9.90V and the Restore Voltage can be set as low as 10.00V.

Radio Configuration

RF Net (Channel) (Master)
The RF Net code selects one of seven pre-defined pseudo-random hopping sequences of the radio. Only those units that are on the same RF Net code or Channel will communicate with each other. If you have groups of wireless units that are in the same geographic area but do not need to communicate between the groups, then using one RF Net code for one group and another RF Net code for the other group will prevent interaction.

Destination Address (Master)
In a non-repeater system the Destination Address of all of the units must be the same. By default the Destination Address = 0. In a repeater system the Destination Address must be set to 65,535. This setting is used for the radio layer protocol and is separate from the Modbus Address.

Vendor ID (Master)
Only those units with the same Vendor ID will communicate. This adds one more layer of security to the communications.

Radio Mode (Master)
In a system that has no repeater, all of the units should be configured as "No Repeater (MD=0)". When a system uses one or more repeaters, then the repeater(s) must be set as "Repeater (MD=3)", and all other units must be set as "Repeater End Node (MD=4)". Also, remember that the Destination Address must be set to 65,535 for a repeater system.

There are two radio configuration settings that are automatically set depending on the Radio Mode selection. In a No Repeater system the Source Address is set to (MY=FFFF) and Delay Slots (RN=0). For both the Repeater and Repeater End Node the Source Address is set to the Modbus Address (MY=Address) and Delay Slots (RN=1).

Timing

Polling Period (Master)
The G309 Master will pole each Slave in the Polling List after power-up and then begin another polling cycle based on the Polling Period setting. For example, if the Polling Period is set to 10sec. and it takes 1sec. to poll all of the Slaves. Then the Master will be polling for 1sec. then wait 9sec. before starting another polling cycle.

Power Down Time (Master)
The Master will power down the radio and, if selected, also the Digital Inputs and Vx Sensor Voltage, for the Power Down Time. The Power Down Time must be less then the Polling Period. The Slave Power Down Time is set separately for each Slave in the Slave Polling List.

Comm Fail Time (Master)
The Master Comm Fail Time applies to both the Master and supported Slaves, and maintains a separate Comm Fail timer for each Slave. It is Enabled by checking the “Comm Fail Enabled” box in the Master Output Mapping group. Master & Slave Comm Fail timers are re-written with each valid communication with that Slave. If a valid message is not received from a given Slave by the Comm Fail Time then that Slave goes into Comm Fail mode and the G309 Master goes into Comm Fail Mode pertaining to the failed Slave. In Comm Fail Mode DO5 will be turned on, a zero is written to the Comm Fail Time register in the failed Slave, and any analog and digital outputs that are mapped from the failed Slave will be set as determined by the Comm Fail settings in the Master Output Mapping group. If a Slave fails, communication with the other Slaves is unaffected.

Comm Restore Time (Master)
Once in Comm Fail Mode, the master will continue to poll the slave at the set Polling Period in order to re-establish communications. Depending on the Polling Period and the Comm Restore Time the Master and Slave may not exit Comm Fail Mode on the first valid message, but rather wait for consecutive valid messages for the Comm Restore Time before exiting Comm Fail Mode. This can be used to assure that a proper radio communications link has been re-established before exiting Comm Fail Mode.

Slave Polling List (Master)
The Slave Polling List sets the list of Slaves, with their Addresses and Power Down times, that the Master will poll. To add a Slave to the polling list click on an available “ADD” button and enter the appropriate Address and Power Down time. Up to eight Slave units can be polled by one G309 Master. To remove a Slave from the Polling List click the appropriate “Del.” delete button.

Each Slave must be assigned a unique Address. Default will assign sequential addresses starting at “1”.

The Power Down time for each Slave unit is individually set, and is only applicable if the “Power Save Enable” box is checked in the Power Save Options group. The Power Down time must be less than the selected Polling Period time. After a valid message is received the slave will power down the radio along with the selected options for the Power Down time. Individually set Slave Power Down times allows different settings for Slave sites with differing needs (i.e. a sensor that requires longer “settling time”).

Communications Settings

Reply Timeout (Master)
After the Master transmits a message it will wait the Reply Timeout period for a reply. If the Reply Timeout timer expires then the message has failed. Because of the time delay that repeaters introduce to the message reply time, it is required to increase the Reply Timeout period on systems using repeaters. It is recommended to increasing the Reply Timeout period to 1000ms.

# of Retries (Master)
If the Master does not receive a valid response from the Slave before the Reply Timeout period, then the Master will re-send the message 0-4 times depending on the # of Retries set.

RSSI Slave Address (Master)
The RSSI LEDs will indicate the relative signal strength of the RF signals associated with the Slave Address selected.

Master Output Mapping (Master)
Each digital or analog output on the Master can be set to replicate the signal from a specific digital or analog input on a Source Slave. The Source Slave Address must first be in the Slave Polling List. Then for each digital or analog output simply select the Slave Address and Input that is desired.

The Master and Slave Comm Fail Timer is reset every time a valid message is received. If a valid message is not received by the Comm Fail Time then both units will go into Comm Fail Mode. In Comm Fail Mode, DO5 will be turned on, and any analog and digital outputs mapped from the failed Slave will be set as determined by the Comm Fail settings. The Master has a Comm Fail Timer for each Slave in the Slave Polling List, so Comm Fail is sensed independently for each Slave. The Comm. Fail settings for each output are set to either hold the last communicated value or set to a specific Comm. Fail value. The Comm Fail feature can be disabled by de-selecting the Comm. Fail Enable.

Master Input Mapping (Master)
Each digital or analog input on the Master can be mapped to the output of a specific Slave. The Destination Slave Address must first be in the Slave Polling List. Then select the Destination Slave Address and output desired.

LED Indicators & LED Enable Push Button

The CPU Status LED will normally blink once a second. In Power Down Mode the CPU Status LED will blink once every two seconds. If the unit has an invalid configuration, the CPU Status LED will flash rapidly. If an internal error is detected the CPU Status LED will remain on continuously. The CPU Status LED is the only LED that is continuously enabled. The rest of the LEDs (DI1-4, DO1-5, RSSI, TX/RX1-2) are enabled on power-up and also enabled by pressing the LED enable push button. Once enabled the LEDs remain on for 30 minutes, then turn off. Repeatedly pressing the LED enable push button will toggle the LEDs on and off. While the LEDs are enabled the unit will not go into Power Save Mode.

The Received Signal Strength Indicator (RSSI) is a quick and simple tool to be able to view the relative strength of the radio signal, and thereby have a reasonable indication of expected quality of the wireless data communications. The relative strength of the received RF signal is displayed by the number of RSSI LEDs turned on. All three green RSSI LEDs turn on when a strong RF signal is received with a valid message; two LEDs for a mid-level signal, and one LED for a weak signal. The RSSI LEDs timeout after 10 seconds and turn off until the next valid message is received. On the Master unit the selected Slave RSSI signal is indicated. The Slave RSSI indication is the received signal strength from the Master.

Slave Modbus Register Map

Register #	Description	Read/Write
3001	Digital Input bits	Read Only
3002	Analog Input #1	Read Only
3003	Analog Input #2	Read Only
3004	Power Supply Voltage (AI #3)	Read Only
3005	DI #1 Totalizer (high word)	Read Only
3006	DI #1 Totalizer (low word)	Read Only
3007	DI #1 Rate, PPS	Read Only
3008	DI #1 Rate, PPM (high word)	Read Only
3009	DI #1 Rate, PPM (low word)	Read Only
3010	DI #2 Totalizer (high word)	Read Only
3011	DI #2 Totalizer (low word)	Read Only
3012	DI #2 Rate, PPS	Read Only
3013	DI #2 Rate, PPM (high word)	Read Only
3014	DI #2 Rate, PPM (low word)	Read Only
3015	Code Version #	Read Only
3016	Digital Output bits, latched	Read/Write
3017	Analog Output #1	Read/Write
3018	Analog Output #2	Read/Write
3019	Power Down Time	Read/Write
3020	Comm Fail Time	Read/Write
3021	Timed Digital Output #1	Read/Write
3022	Timed Digital Output #2	Read/Write
3023	Timed Digital Output #3	Read/Write
3024	Timed Digital Output #4	Read/Write

Table 1

Note: All hex values are indicated by the prefix 0x. For example 0x0FFF hex is the equivalent decimal value 4095.

The register address is zero based and the register number starts at one. This creates an offset of one between the register number and the register address. For example the register numbered 3001 (0x0BB9) is addressed as 3000 (0x0BB8). Each register is a 16 bit word. Unimplemented bits are zero-filled. Data is transmitted using “big-Endian” representation, where the high byte is transmitted then the low byte. The CRC value is the only value transmitted using “little-Endian” representation, where the low byte is transmitted then the high byte.

Register #3001 Digital Input bits

Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Digital Input	-	-	-	-	-	-	-	-	-	-	-	-	4	3	2	1

A bit value of zero indicates that the input is not active and a bit value of one indicates that the input is active. Unimplemented inputs always read as zero.

Register #3002-3004 Analog Inputs

The analog to digital converter for all of the analog inputs is 12bits, providing a 0-4095 decimal count (0x0000-0x0FFF) for zero to full scale inputs. AI1 and AI2 input signal type selection can be for 0-5V or 0-20mA. The range for AI3 is 0-32V. For example with AI1 selected as a 0-5V input type, and a 2.5V signal applied, then the register #3002 value will be 2047 (0x07FF). Also for example with Power Supply Voltage (+V) equal to 12.0Vdc, then the register #3004 value will be 1536 (0x0600).

Register #3005-3006 & #3010-3011 Digital Input Totalizer

The pulse totals for DI1 and DI2 are 32bit long words stored in two 16bit word registers. The register values are stored in volatile memory and do not hold their value when power is turned off. On power-up the pulse totalizer registers are reset to a value of zero.

Register #3007 & #3012 Digital Input Pulse Rate, PPS

The pulses per second, pulse rate for DI1 and DI2 are stored in register #3007 and #3012 respectively. The pulse rate value is updated once every second.

Register #3008-3009 & #3013-3014 Digital Input Pulse Rate, PPM

The pulses per minute, pulse rate for DI1 and DI2 are 32bit long words stored in two 16bit registers. For pulse rates lower then 65,535 ppm (0xFFFF) only the lower register word needs to be considered. The lower word register can also be monitored to detect short duration events. A value greater then zero indicates that an off-to-on transition has occurred within the last minute.

Register #3015 Code Version

The version number high byte contains the major version number and the low byte contains the minor version number. For example, if register #3015 contains 0x0105, it can be viewed as version 1.5.

Register #3016 Digital Output bits, latched

Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Digital Output	-	-	-	-	-	-	-	-	-	-	-	x	4	3	2	1

For DO1-4 writing a bit value of “1” turns on the output and writing a bit value of “0” turns off the output. Writing a bit value to bits 5-16 has no effect. DO5 is internally controlled, and is turned on when the unit is in Comm Fail Mode. Reading the register will return the output value for DO1-5; all unimplemented output bits will return a value of zero. The register value is initialized to zero on power-up.

Register #3017-3018 Analog Outputs

Each analog output channel provides a 0-5V (1-5V) and 0-20mA (4-20mA) signal simultaneously. The digital to analog converter is 12bit, 0-4095 decimal (0x0FFF) count for zero to full scale outputs. For example writing a value of 2047 (0x07FF) to register #3017 will set VO1 = 2.5V and IO1 = 10.0mA. Reading the analog output registers will return the output value. The register value is initialized to zero on power-up.

Register #3019 Power Down Time

This register is written to by the Master. When using a G309 as Master, it writes to its own register as well as to the Slaves it supports. When using an RTU/PLC as Modbus Master, it would have to be programmed to support this feature by writing Power Down Time values to the Slaves it supports.

The value of this register determines the time period in seconds that the unit will stay in Power Save Mode following a valid message. However, if the LEDs are enabled or if this register contains a value of zero the Power Save Mode is disabled. It is initialized to zero on power-up. A written value is held until re-written with a new value or the unit is power cycled.

The value written to this register should be two or more seconds less than the polling period, allowing the radio to initialize and input signals to stabilize before the next data communications.

Register #3020 Comm Fail Time

Comm Fail Time is controlled by the Master, and its selected values are written to the Slaves that it supports. On a unit configured as a Slave, this register is initialized on power-up to full-scale value of 65,535 (0xFFFF) which disables Comm Fail. Any non-zero value less than 0xFFFF written to this register sets the Comm Fail Time in seconds. If valid communications does not occur within the Comm Fail Time,

this register is set to zero putting the unit into Comm Fail Mode. A non-zero value must again be written to this register in order to exit Comm Fail mode. A G309 Master will re-write a value into its register & the Slave's register when communications is restored. The value in this register will be held until Comm Failure occurs or until either a new value is written or the unit is power cycled.

Register #3021-3024 Timed Digital Outputs

The Timed Digital Output registers are "count-down" registers decremented every 100ms (0.1 sec.). Any non-zero value written to these registers will energize the corresponding relay, and once the register decrements to zero the corresponding relay will then de-energize. A timed DO can be set from 100mS up to 1.8 hrs (+0 / -100mS). The Timed DO registers are logically "OR'd" with the Latched DO register bits. Therefore, if a bit is set in the Latched DO register, then the DO relay will be energized regardless of the value in the Timed DO register.

Master Modbus Register Map

		Master	Slave 1	Slave 2	Slave 3	Slave 4	Slave 5	Slave 6	Slave 7	Slave 8
Description	R/W	Reg #	Reg #	Reg #	Reg #	Reg #	Reg #	Reg #	Reg #	Reg #
Digital Inputs	R	3001	3051	3101	3151	3201	3251	3301	3351	3401
Analog In #1	R	3002	3052	3102	3152	3202	3252	3302	3352	3402
Analog In #2	R	3003	3053	3103	3153	3203	3253	3303	3353	3403
Supply Voltage	R	3004	3054	3104	3154	3204	3254	3304	3354	3404
DI1 Totalizer H	R	3005	3055	3105	3155	3205	3255	3305	3355	3405
DI1 Totalizer L	R	3006	3056	3106	3156	3206	3256	3306	3356	3406
DI1 PPS	R	3007	3057	3107	3157	3207	3257	3307	3357	3407
DI1 PPM H	R	3008	3058	3108	3158	3208	3258	3308	3358	3408
DI1 PPM L	R	3009	3059	3109	3159	3209	3259	3309	3359	3409
DI2 Totalizer H	R	3010	3060	3110	3160	3210	3260	3310	3360	3410
DI2 Totalizer L	R	3011	3061	3111	3161	3211	3261	3311	3361	3411
DI2 PPS	R	3012	3062	3112	3162	3212	3262	3312	3362	3412
DI2 PPM H	R	3013	3063	3113	3163	3213	3263	3313	3363	3413
DI2 PPM L	R	3014	3064	3114	3164	3214	6264	3314	3364	3414
Code Version	R	3015	3065	3115	3165	3215	3265	3315	3365	3415
Digital Outputs	R/W	3016	3066	3116	3166	3216	3266	3316	3366	3416
Analog Out #1	R/W	3017	3067	3117	3167	3217	3267	3317	3367	3417
Analog Out #2	R/W	3018	3068	3118	3168	3218	3268	3318	3368	3418
Pwr Down Time	R/W	3019	3069	3119	3169	3219	3269	3319	3369	3419
Comm Fail Time	R/W	3020	3070	3120	3170	3220	3270	3320	3370	3420
Timed DO #1	R/W	3021	3071	3121	3171	3221	3271	3321	3371	3421
Timed DO #2	R/W	3022	3072	3122	3172	3222	3272	3322	3372	3422
Timed DO #3	R/W	3023	3073	3123	3173	3223	3273	3323	3373	3423
Timed DO #4	R/W	3024	3074	3124	3174	3224	3274	3324	3374	3424

Table 2

With the G309 configured as a Master it has the same base register map as a Slave, and in addition it stores the register image of each Slave that it polls. Access to the register map is via COM2, which acts as a Modbus Slave Port. Standard Modbus Read, Write and Read/Write commands are supported. If a register value is mapped in the configuration settings, then the mapped value will have precedence. The mapped value will always override a value written to that register via COM2. When polling COM2 on a G309 Master, the Modbus Function 23 (0x17) should not be used.

Modbus Communications

The G309 RioExpress-SC communicates using the Modbus RTU protocol. The following Modbus function codes are supported:

Function Code 03 (0x03)	Read Holding Registers
Function Code 06 (0x06)	Write Single Register
Function Code 16 (0x10)	Write Multiple Registers
Function Code 23 (0x17)	Read/Write Multiple Registers

Modbus Message Examples (data values shown in HEX):

Read Multiple Register Regs #3001 (0x0BB8) - #3024 (0x0BC8). Read all Data

Master Tx: - 01 03 0B B8 00 18 C7 C1

(addr 0x01, funct 0x03, start reg 0x0BB8, # of regs 0x0018, CRC 0xC7C1)

Slave Tx: - 01 03 30 00 00 00 00 00 00 0C 76 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 00 00 00 00 00 00 00 00 00 FF FF 00 00 00 00 00 00 00 00 03 59

(addr 0x01, funct 0x03, byte count 0x30, reg #3001-3024 values, CRC 0x0359)

Read Single Register Reg #3004 (0BBB hex). Read Power Supply Voltage

Master Tx: - 01 03 0B BB 00 01 F6 0B

(addr 0x01, funct 0x03, start reg #3004 (0x0BBB), # of regs 0x0001, CRC 0xF60B)

Slave Tx: - 01 03 02 0C 76 3C A2

(addr 0x01, funct 0x03, byte count 0x02, reg #3004 value 0x0C76, CRC 0x3CA2)

Write Single Register Reg #3016 (0x0BC7). Latch Digital Outputs #s 2 & 4

Master Tx: - 01 06 0B C7 00 0A BA 14

(addr 0x01, funct 0x06, reg #3016 (0x0BC7), write value 0x000A, CRC 0xBA14)

Slave Tx: - 01 06 0B C7 00 0A BA 14

(addr 0x01, funct 0x06, reg #3016 (0x0BC7), stored value 0x000A, CRC 0xBA14)

Write Multiple Register Regs #3021 (0x0BCC) - #3024 (0x0BCF).

This sample message turns on the slaves Timed DO's #1=200ms, #2=400ms, #3=600ms, #4=800ms.

Master Tx: - 01 10 0B CC 00 04 08 00 02 00 04 00 06 00 08 8C 67

(addr 0x01, funct 0x10, start reg #3021 (0x0BCC), # of reg 0x0004, byte count 0x08, DO#1 0x0002, DO#2 0x0004, DO#3 0x0006, DO#4 0x0008, CRC 0x8C67)

Slave Tx: - 01 10 0B CC 00 04 03 D1

(addr 0x01, funct 0x10, start reg #3021 (0x0BCC), # of regs written 0x0004, CRC 0x03D1)

Read/Write Multiple Registers Read Inputs and Write Outputs.

This is an example of the standard Master polling message for paired units.

Master Tx: - 01 17 0B B8 00 03 0B C7 00 05 0A 00 00 00 01 00 00 00 00 00 14 8E A4

(addr 0x01, funct 0x17, start read register #3001 (0x0BB8), # of read reg. 0x0003, start write register #3016 (0x0BC7), # of write registers 0x0005, byte count 0x0A, Register values (Reg #3016-3020), CRC 0x8EA4)

Slave Tx: - 01 17 06 00 00 00 01 00 00 70 4A

(addr 0x01, funct 0x17, byte count 0x06, Register Values (#3001-3003), CRC 0x704A)

Antenna and RF Considerations

The RioExpress-SC operates in the ISM 900MHz or 2.4GHz frequency bands. At these frequencies the RF signal is able to travel a considerable distance line of sight (LOS). At the higher frequencies the RF signal does not “bend” around obstacles like lower frequency RF signals. Obstacles in the line of sight are generally the key consideration when evaluating the radio communications path. For short distance of less then a few miles, obstacles such as trees and buildings can be overcome by raising the antenna or relocating the equipment. For longer distances or for situations where raising the antenna height becomes impractical, then adding a repeater becomes a cost effective solution.

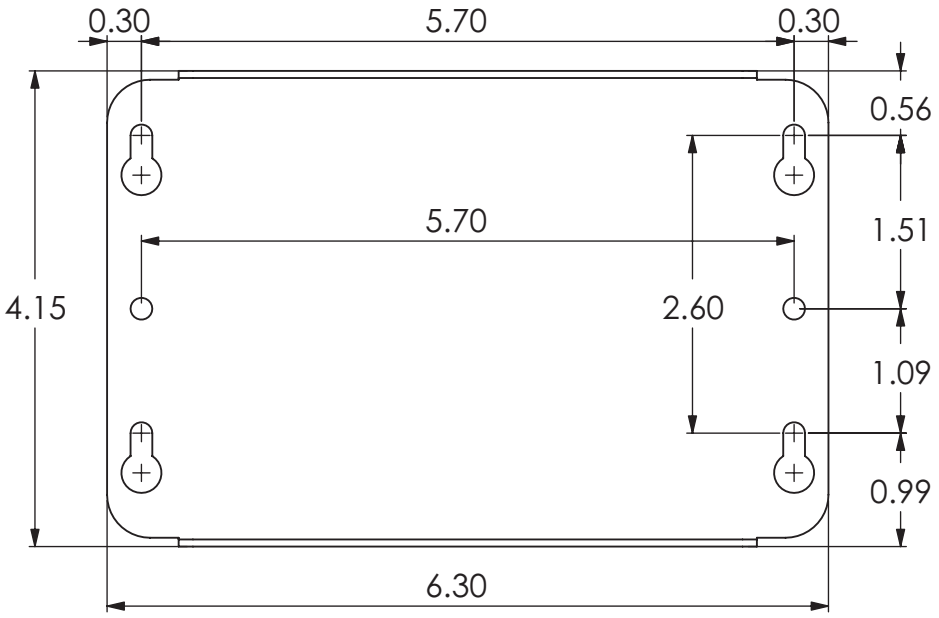
The antenna connection is a reverse-polarity SMA (RPSMA). For very short distances, less then 2000' in an open area or less then 100' within a building or wooded area, a minimum antenna system can be used. A low profile or dipole whip antenna mounted on the enclosure may be suitable. For distances of less then 5 miles LOS a dipole antenna mounted six or more feet above the ground is suitable. For longer distances a higher gain, directional, yagi antenna is recommended. When using a pole mounted antenna it is recommended that a coax lightning arrester is used, also as the length of the coaxial cable connecting the unit to the antenna increases, it becomes more important to use low loss coaxial cable.

The Received Signal Strength Indicator (RSSI) is a quick and simple tool to determine the quality of the radio communications. The RSSI provides a relative indication of the strength of the received RF signal. All three green, RSSI, LEDs turn on when a strong RF signal is received with a valid message; two LEDs for a mid-level signal, and one LED for a weak signal. The RSSI LEDs timeout after 10 seconds and turn off until the next valid message is received.

G3 Technologies can provide you with computer simulated RF Path Studies. This cost effective service can save you time and money and also assist in determining system installation requirements.

Mounting Dimensions

#8 Pan Head screws are recommended for mounting (All dimensions are in inches)



Ordering Information

PN:	G309-04	RioExpress-SC 900MHz
	G309-04E1	Starter Kit, (1) RioExpress-SC 900MHz, (1) G306C-04 RioLink, & Accessories
	G309-04E2	Starter Kit, (2) RioExpress-SC 900MHz, & Accessories
	G309-08	RioExpress-SC 2.4GHz
	G309-08E1	Starter Kit: (1) RioExpress-SC 2.4GHz, (1) G306C-08 RioLink, & Accessories
	G309-08E2	Starter Kit: (2) RioExpress-SC 2.4GHz, & Accessories

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NEMA 4X packages are also available. For pricing and availability contact G3 Technologies.

Warranty

This product is covered by a one year limited warranty against defects in material and workmanship. See the full warranty statement for details. For product support and further information contact G3 Technologies, Inc.

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