Rio*Express*™ User's Guide

Industrial Wireless I/O - Model G308

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Introduction

This guide covers the operation, installation and configuration options of the Rio*Express*, Industrial Wireless I/O - Model G308. Refer to the Quick Start Guide for basic plug-and-play operation with a pair of Rio*Express* units.

The Rio*Express* 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 a pair of Rio*Express* modules to replicate (mirror) I/O signals for cable replacement. Also use the Rio*Express* as a Modbus Slave Wireless I/O in point-to-point or point-to-multipoint applications. The unit can be polled from most any Modbus Master using a compatible spread spectrum radio modem (i.e. Model G306C Wireless Modem).

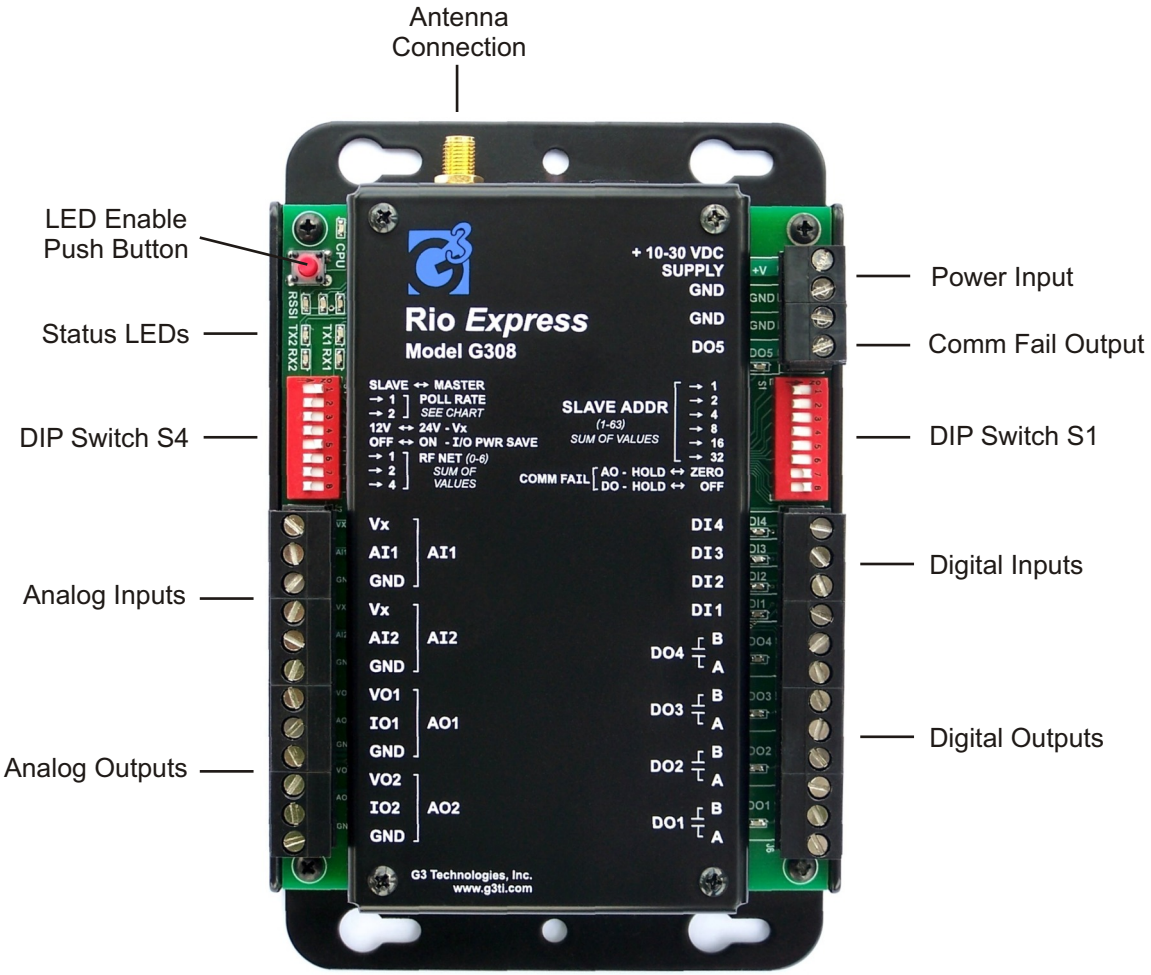


Figure 1

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
Receiver Sensitivity	900MHz, -110dBm; 2.4GHz, -107dBm

Data Communications:

Modbus Protocol	Modbus RTU
Data Rate (Throughput)	9600 baud (bps)
RF Net codes	7 RF Net codes (Channels)
Addresses	63 Device Addresses (per Radio Channel)
Poll Rate	4 choices: 1) Continuous (approximately 4 per second) 2) Every Second 3) Every 10 Seconds 4) Every 60 Seconds
Comm Fail Action	DIP switch selection for DO Hold/Off, AO Hold/Zero.
Comm Fail Output	DO5 open-collector sinking output (200mA, 30Vdc max load)

Digital I/O:

Digital Inputs (DI)	4 ea. (DI1-4) Non-latching or selectable min. hold of 2, 20 or 120 sec. Active low (shorted to power common), 200mS minimum. 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 totalizer/rate or event-capture (not accessable with cable-replacement pair)
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	DIP switch selectable DO1-4 (Hold current state, or Off)
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), Individually DIP switch selectable 12 bit resolution Overall accuracy 0.25% FS Typical accuracy 0.1% FS @ 25 degrees C Over-voltage tolerance +/-30Vdc
Internal Analog Input	(AI3) internally monitors power supply voltage; 0-32V range (not accessable with cable-replacement pair)
Sensor Excitation Voltage (Vx)	DIP switch 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. Overall accuracy 0.45% FS (1-5V or 4-20mA) Typical 0.2% FS @ 25 degrees C (1-5V or 4-20mA)
Comm Fail Action	DIP switch selectable AO1-2 (Hold current value, or Zero)

Specifications Continued

Power Input:

Input Voltage	10-30 Vdc (rated at 500mA max)
Current, Power-Save (I_{PS})	I_{PS} = 7mA @ 12Vdc
Current, Receive/Standby (I_{RX})	I_{RX} = 38mA @ 12Vdc
Current, Transmit (I_{TX})	I_{TX} = 70mA @ 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.
Data Comm Port 2	4 pin latching header, used for factory testing only.
Surge protection	All power, serial 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 C/US Class I, Div 2, Groups A,B,C,D Temp. Code: T4

Physical:

Operating Temperature	-40 to 85 degrees C
Humidity	5-95% non-condensing
Field Wiring Connections	All wire connections are pluggable screw terminals, 0.2” spacing Recommended 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” #8 pan-head screws recommended Optional mounting clip available for DIN Rail mounting
Antenna Connection	RP-SMA, 50 ohm, unbalanced

Input Power

The Rio*Express* 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. To protect the power supply wiring, a 2A Slow-Blow fuse should be installed in the secondary circuit powering the unit. The supply voltage range is 10-30Vdc.

With the I/O PWR SAVE selection turned on 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 Rio*Express*, lower cost battery or solar charge regulators that do not provide the Low Voltage Disconnect circuit can be used. With the I/O PWR SAVE selection turned off the unit will power down if the supply voltage is less then 9.9Vdc for more then 10 seconds, and power up once the supply voltage is above 10Vdc for more then 10 seconds.

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:

RioExpress, 10sec. Poll Rate, I/O PWR SAVE “On”, 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.)(7mA) + (2/10sec.)(83mA) + (6mA Solar Reg.)

$I_{Load\ Avg}$ = 28mA = 0.028A

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 = (0.028A)(24hrs)(12Vdc) / (3.33 Sun hrs/day)

Solar Array Size = 2.42 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:

$I_{Load\ Avg}$ = 28mA = 0.028A

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 = (0.028A)(24hrs)(8 days)(1.5 Temp. Factor) / (0.8 Discharge)

Minimum Battery Size = 10.1 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 digital inputs are internally powered with a wetting voltage of 10-14Vdc and a wetting current of 4mA. In Power-Save mode the digital inputs can optionally be powered down (see DIP Switch and Communication Settings for more detail). A digital input must be active for 200ms to insure acceptance as valid.

A valid DI whose duration may be shorter that the poll rate can be “held” or “stretched” in order to insure reliable detection. It is done by setting the Poll Rate DIP Switches to a setting other than zero (see DIP Switch Settings section) with a hold time of twice the poll rate value (i.e. 2, 20 or 120 sec). Note: On a slave unit the poll rate selection does nothing except set the DI hold time. On a RioExpress being used as a master (in cable replacement pair), the poll rate setting determines the rate of polling as well as the DI hold time.

DI1 and DI2 are also internally connected to pulse totalizers that are edge-triggered with approx 250uS filtering. They provide both pulse total and pulse rate in pulses-per-second (PPS) and pulses-per-minute (PPM). In addition to a typical metering function, these registers can be used to capture very short duration DI events by watching for an increment in the Totalizer or by watching for a non-zero value in one of the Rate register. The PPM register will “hold” a single-pulse event for one minute. Note, however, that the pulse input registers are only accessible when using Modbus mode.

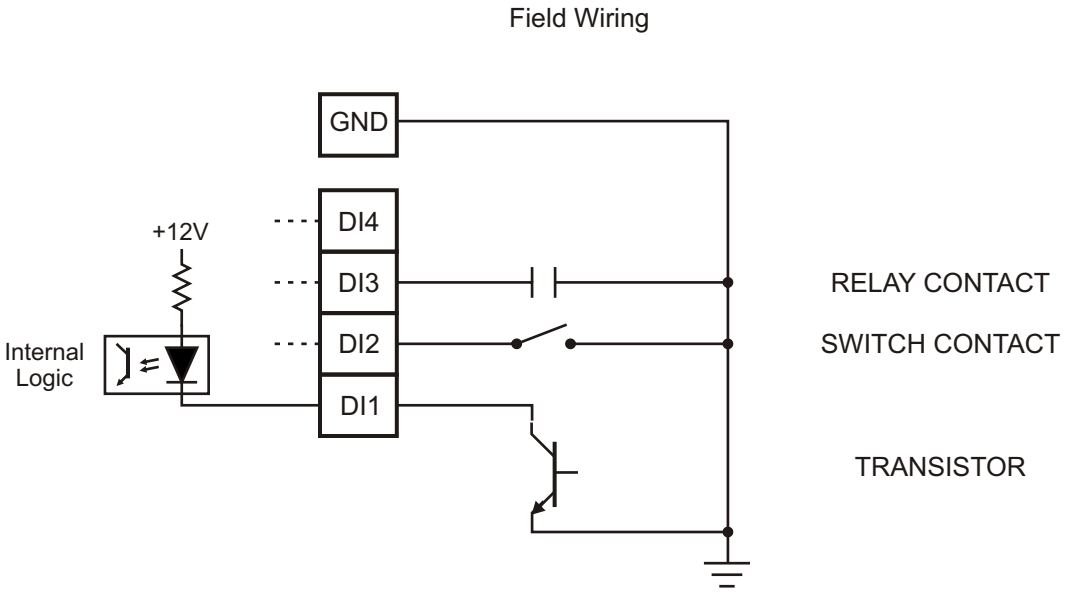


Figure 2

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 rated at 200mS 30Vdc max. 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.

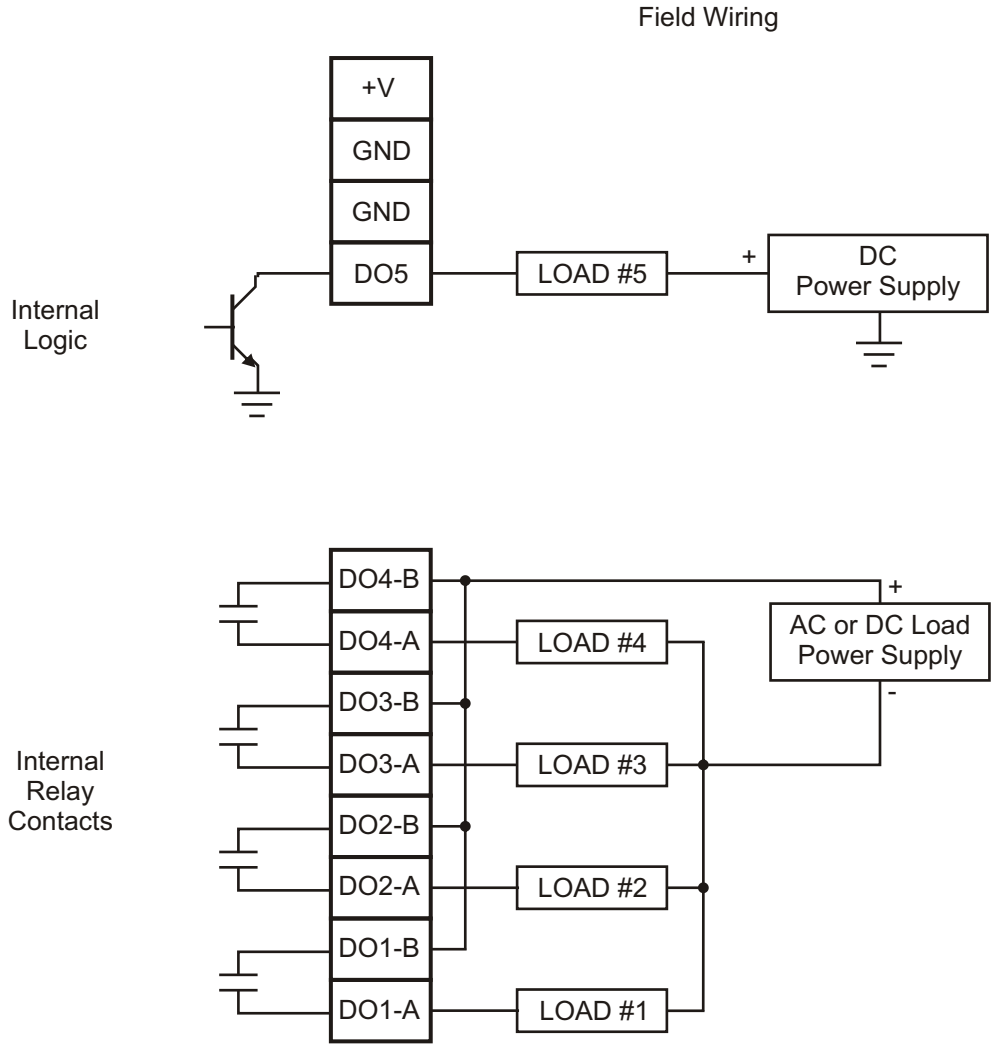


Figure 3

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 the cover vertically. The default factory analog input setting is 0-20mA (4-20mA). We suggest that unused / unterminated analog inputs should be set to 0-20mA (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 DIP Switch and Communication 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.

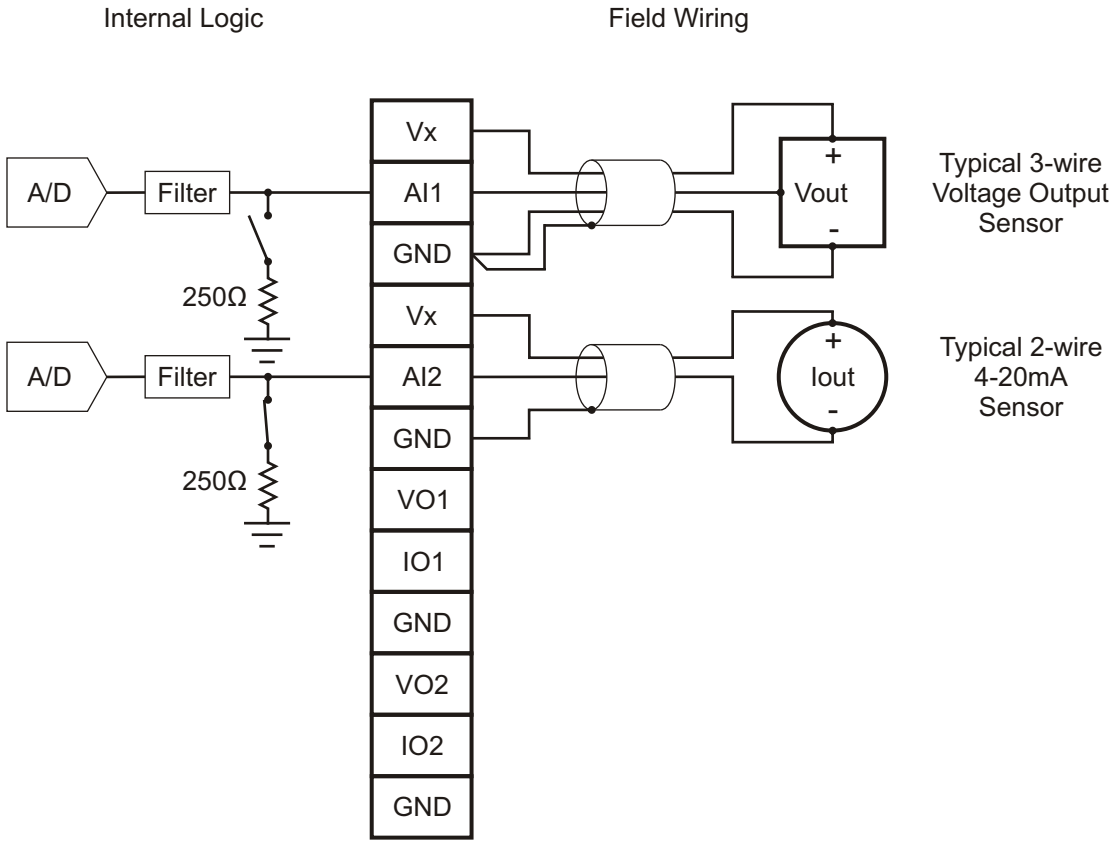


Figure 4

Analog Output Wiring Diagram

Each analog output channel provides a 0-5V (1-5V) and 0-20mA (4-20) 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 loop resistance is 450 ohms. With Vx = 24V the maximum loop resistance is 1000 ohms.

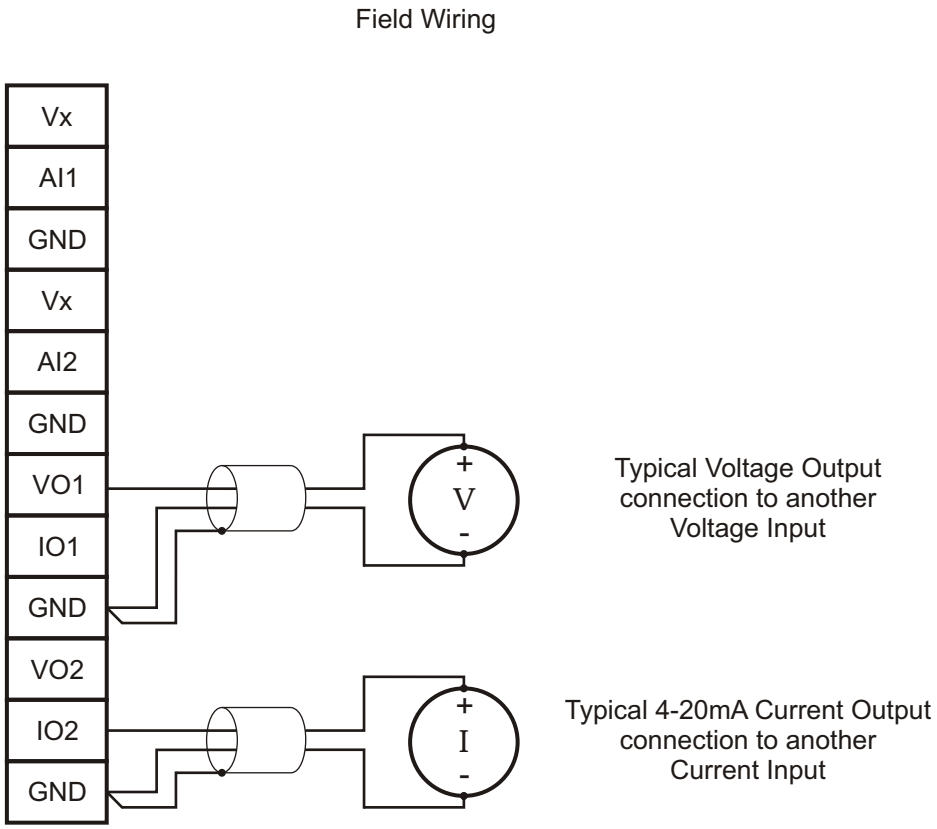


Figure 5

DIP Switch and Communications Settings

Figure 6 Master Unit Settings

Figure 7 Slave Unit Settings (factory default)

MASTER / SLAVE, DIP switch S4 position 1
When using a pair of Rio*Express* units for cable replacement, one unit must be set as a MASTER and the other unit set as a SLAVE. The master unit initiates each radio message and determines the polling rate along with several other related parameters (see Table 1 below). Otherwise the function of the Master and Slave are the same.

Each time the master polls the slave, the master sends a message to the slave updating the slave's digital and analog outputs with the values of the master's digital and analog inputs. The slave then responds with a message updating the master's digital and analog outputs with the slave's digital and analog input values.

NOTE: When the Rio*Express* is set as a SLAVE it functions as a basic Modbus Slave and can be polled by most any Modbus Master using a compatible Radio Modem (i.e. Model G306C Wireless Modem).

POLL RATE, DIP switch S4 position 2 & 3, Bit 1 and Bit 2
On a unit set as a master, the Poll Rate setting determines how frequently it polls the slave, along with setting several other related parameters. When set for continuous polling, the master polls the slave about four times per second. Note that on a slave, the Poll Rate settings control DI hold time only.

Table 1 below lists the POLL RATE settings and associated parameters.

Bit 1	Bit 2	Poll Rate	Re-Tries	Comm. Fail Time	Power Down Time	Digital Input Min Hold Time
OFF	OFF	Continuous	0	20 sec.	0 sec.	0
ON	OFF	every 1 sec.	0	60 sec.	0 sec.	2 sec.
OFF	ON	every 10 sec.	1	60 sec.	8 sec.	20 sec.
ON	ON	every 60 sec.	2	6 min.	58 sec.	120 sec.

Table 1

RE-TRIES
If the master does not receive a valid response from the slave after a short time-out period (500ms), then the master will re-send the message up to the number shown in Table 1 above.

COMM FAIL TIME
With every poll cycle a RioExpress master sets a Comm. Fail Time value in both the master and in the slave. If the next valid message is not received by the end of the COMM FAIL TIME then both units will go into Comm Fail Mode. In Comm Fail Mode, DO5 will be turned on, and the analog and

digital outputs will be set as determined by the COMM FAIL AO & DO settings. When the master is in Comm Fail mode it sends a zero value to the Comm Fail Time register in the slave forcing it into Comm Fail in the event that the failure is in the slave-to-master leg. This insures that both slave and master enter and exit comm fail mode together. Note that power-on default sets Comm Fail disabled.

When in Comm Fail Mode, the master will continue to poll the slave at the set poll rate trying to re-establish communications. Once a valid message is received from the slave, the master will write a non-zero comm fail time in both units causing master and slave to exit Comm Fail Mode.

POWER DOWN TIME
For the 10 sec. and 60 sec. poll rate settings, after a valid message is received, the master and slave will power down the radio for the POWER DOWN TIME. If the I/O PWR SAVE selection is on, then the discrete input wetting voltage and the sensor excitation voltage (Vx) will also be turned off for this time period. In each case the unit will exit Power Save Mode, powering everything back on, two seconds before the next polling time.

DIGITAL INPUT HOLD TIME
In addition to the other parameters, the Poll Rate setting on the master unit determines the hold time for its digital inputs. Likewise on a slave, the Poll Rate setting determines the DI hold time. However, this is all it does on a slave, and its setting is independent of the master setting (i.e. The master could be set to poll continuously while the slave is set for 2 second DI hold time).

Vx 12V/24V, DIP switch S4 position 4
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.

I/O PWR SAVE, DIP switch S4 position 5
With I/O PWR SAVE turned on, the digital input wetting voltage and the sensor excitation voltage (Vx) are turned off during Power Save Mode along with the radio. This disables the analog inputs and digital inputs including pulse inputs to the totalizers. This setting can be useful to decrease power consumption for solar powered units, but I/O requirements must be considered. With I/O PWR SAVE turned off, Vx and the digital input wetting voltage remain powered during Power Save Mode, and the analog and digital inputs are fully active.

The **Low Voltage Disconnect** and Low Voltage Restore voltage levels are also determined with the I/O PWR SAVE selection. With the I/O PWR SAVE selection turned on 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 Rio*Express*, lower cost battery or solar charge regulators that do not provide the Low Voltage Disconnect circuit can be used. With the I/O PWR SAVE selection turned off the unit will power down if the supply voltage is less then 9.9Vdc for more then 10 seconds, and power up once the supply voltage is above 10Vdc for more then 10 seconds. This setting is suitable for non-battery powered applications.

RF NET CODE, DIP switch S4 position 6-8
The RF NET CODE sets the pseudo-random hopping sequence of the FHSS radio. Only those units that are on the same RF NET CODE (channel) will communicate with each other. On a master/slave pair set both to the same RF NET CODE. When multiple independent wireless networks are operated in close proximity, use a different RF NET CODE for each network. This will eliminate interference with each other. For example if you have two cable replacement pairs in close proximity, set one Master/Slave pair on RF NET CODE = 0 and the other pair on RF NET CODE = 1. The only valid values for the RF NET CODE are 0 thru 6. If the value of 7 is selected the firmware will interpret this setting as RF NET CODE = 6. The value of the RF NET CODE is the sum of the selected binary values. For example selecting values 1 and 4 will set RF NET CODE = 5.

Bit	Value
1	1
2	2
3	4

SLAVE ADDR, DIP switch S1 position 1-6
On a RioExpress functioning as a master, the Slave Addr setting defines the address of the Slave unit it is polling. The slave that is being polled, then, must have the same Slave Addr setting. A slave unit only responds to a message with its address. The valid slave addresses are 1-63. A third-party Modbus Master can poll up to 63 RioExpress slaves on a single radio channel by setting each slave unit with a different Slave Addr. The value of the SLAVE ADDR setting is the sum of the selected binary values. For example selecting values 1, 2 and 16 will select SLAVE ADDR = 19.

Bit	Value
1	1
2	2
3	4
4	8
5	16
6	32

COMM FAIL AO, DIP switch S1 position 7
The COMM FAIL AO setting determines the analog output (AO) value that will be set if communications is interrupted and the unit goes into Comm Fail Mode. The single setting determines the COMM FAIL AO setting for both AO1 and AO2. The analog outputs can be set to either hold the last communicated value, or the analog outputs can be set to output a zero value (VO1 & VO2 = 0V, IO1 & IO2= 0mA).

COMM FAIL DO, DIP switch S1 position 8
The COMM FAIL DO setting determines the state of the digital outputs (DO1-4) if communications is interrupted and the unit goes into Comm Fail Mode. The single COMM FAIL DO setting determines the setting for DO1-4, which is to either hold the last communicated value on each DO, or turn them off.

ANALOG INPUT TYPE, DIP switch S2 position 1-2
Each of the two analog inputs is selectable to accept 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 the cover vertically. The default factory analog input setting is 0-20mA (4-20mA). We suggest that unused / unterminated analog inputs should be set to 0-20mA (4-20mA). This will bias the unterminated analog input at zero.

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 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. Pressing the LED enable push button toggles the LEDs between enabled and disabled. 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 determine the quality of the radio communications. The relative strength of the received RF signal is indicated 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 time out after 10 seconds and turn off until the next valid message is received.

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 2

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 the input is not active and a bit value of one indicates the input is active. Unimplemented inputs always read as zero. By using Poll Rate DIP Switch settings, a short-duration active state on the digital inputs can be “stretched” or “held” for 2, 20 or 120 seconds (see Poll Rate DIP Switch Settings section earlier in this document).

Register #3002-3004 Analog Inputs
The analog-to-digital converter for all of the analog inputs is 12 bits, 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 32 bit long words stored in two 16 bit 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 32 bit long words stored in two 16 bit 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, and it will be held in the register for a full 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 12 bit, 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
The value written to this register determines the time period in seconds that the unit will be in Power Save Mode following its reply when polled. However, if the LEDs are enabled or if this register contains a value of zero the Power Save Mode is disabled. The register 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.

In Power Save Mode the radio is powered down but everything else remains active. However, if the I/O PWR SAVE selection is turned on, then the sensor excitation voltage (Vx) and the discrete input wetting voltage will also be turned off, disabling the analog & digital inputs. The value written to this register should be two or more seconds less then the polling period. This will allow the radio to initialize and the input signals to stabilize before the next message addressed to the slave is to be received. For example, when the Rio*Express* master is set for 10 or 60 sec polling, it writes a value of 8 sec. (0x0008) or 58 sec. (0x003A) respectively to the Power Down Time registers in both the master and slave.

Register #3020 Comm Fail Time
On a unit set as slave, this register is initialized on power-up to a full-scale value of 65,535 (0xFFFF) which holds Comm Fail disabled. On a unit set as master, the value is determined by the Poll Rate selection, and the same value is written to a slave that it is polling. 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 itself into Comm Fail Mode. A non-zero value must again be written to this register in order to exit Comm Fail mode. A master unit 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 when 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 (with variation of +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.

Modbus Communications

The Rio*Express* 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

Since Function Code 03 (Read Holding Registers) is used for reading register values in the RioExpress, common Modbus definition would define the RioExpress registers in the 40000 range (i.e. to read register 3001 Digital Input bits from a RioExpress slave, some Modbus Masters would define it as register 43001, though only the 3001 value is transmitted to the slave).

Modbus Message Examples (data values shown in HEX):

Read Multiple Register Regs #3001 (0x0BB8) - #3024 (0x0BCF). 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 Rio*Express* 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 VHF and 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 a repeater can be used to extend the range. However, for a system using the RioExpress, a repeater is limited to the use of two back-to-back RioLink wireless modems with one RF leg set on a different frequency or RF Net Code (channel) than the other. For a repeater network where any unit can act as a repeater node, refer to the RioLogic (model G309) wireless I/O. It is like the RioExpress but is software configured for more flexible features including RF repeating.

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 supressor be used. Also as the length of the coaxial cable connecting the Rio*Express* to the antenna increases, it becomes more important to use low loss coaxial cable.

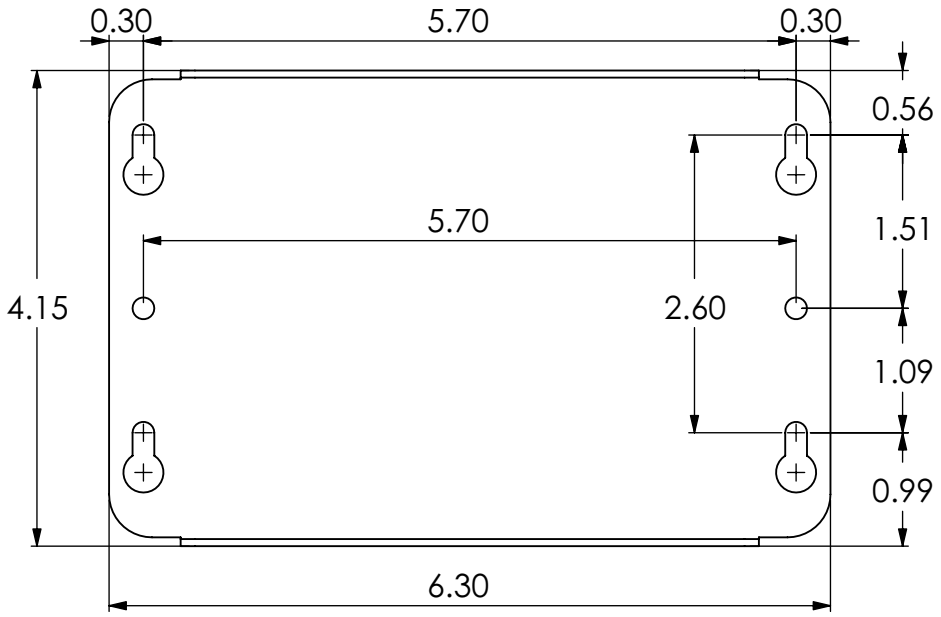
The Received Signal Strength Indicator (RSSI) is a quick and simple tool to determine the quality of the radio communications. The RSSI provides a relative indication of the strength of the received RF signal. All three green RSSI LEDs turn on when a strong RF signal is received with a valid message;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

COM2

The COM2 four pin latching header connection next to the antenna connector is only used for factory testing. (On the RioLogic COM2 is used for device configuration and as a Modbus Slave port.)

Mounting Dimensions

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



Ordering Information

Part Number:	G308-04	RioExpress 900MHz
	G308-04E1	Starter Kit, (1) RioExpress 900MHz, (1) G306C-04 RF Modem & Accessories
	G308-04E2	Starter Kit, (2) RioExpress 900MHz & Accessories
	G308-08	RioExpress 2.4GHz
	G308-08E1	Starter Kit, (1) RioExpress 2.4GHz, (1) G306C-08 RF Modem & Accessories
	G308-08E2	Starter Kit, (2) RioExpress 2.4GHz & Accessories

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.

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Revision History

2007-07-02	Based on Firmware Version 1.5 and 1.6 Original Document
2008-09-10	Based on Firmware Version 1.7 and 1.8 Add receiver sensitivity specifications, default analog input type setting, digital input stretching, and Comm Fail Clearing
2009-08-03	No Firmware change. Expanded description of Poll Rate related parameters including Digital Input hold time on a master and on a slave, and clarified a few other descriptions.
2009-11-18	No Firmware change. Clarified & expanded several descriptions in the document.