4120R USER MANUAL

8 November 2004

-Installation Notes
-Hardware Overview
- 4120R Features

-MSAssist SW Guide
included under separate cover

1. INSTALLATION NOTES

In accordance with FCC regulations the following information is provided to all users:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

All installations of the IDmicro 4120 must be accomplished by professional installers who are knowledgeable of the FCC rules and regulations. When designing the transmit antenna placement, particular emphasis on location and stand offs must be accorded to ensure people can not be exposed to levels above the permissible limits pr within the 20 cm. distance to the antenna. The IDmicro 4120R is installed using only the antennas provided by IDmicro that have been approved for use by the FCC. No other antennas may be used without written approval.

IDmicro warrants that with the approved antennas, the output power of the 4120 will not exceed the FCC permissible levels. Use of additional amplifiers or higher gain antennas is not permitted. Deviation from or usage of non-IDmicro supplied parts may void the users authority to use the equipment.

Using the 20 cm. distance for persons, professional installers have the option to mount the antennas above the reach of persons or supply a physical barrier to ensure that persons are not closer to the front of the antenna than the distance defined. IDmicro highly recommends placing the antennas above or out of the reach of persons, typically on poles or overhead structures. When installed in an area that maintenance persons may have access to, the installers must provide for physical barriers or affix a warning label.

The standard IDmicro antenna is the 8.5dB gain linear patch antenna from Arc Wireless. In addition, IDmicro can provide lower gain antennas for special situations. For the patch antennas, the rule is that the appropriate isolation from persons and max power to the antenna must be accounted for in the design and installation activities.

As of November 2004, all fixed installations will be set up in accordance with the power output rules for mobile applications.

2. 4120R HARDWARE OVERVIEW

This section is a brief overview of the physical communications layer. An understanding of these concepts is necessary for optimum system implementation.

Forward and Return Link Communications

The interrogator-to-tag physical communications protocol is called the “forward link” protocol. The forward link on MicroStamp products is direct sequence spread spectrum (DSSS). The tag-to-interrogator physical communications protocol is referred to as the “return link” protocol. The return link uses frequency hopped spread spectrum (FHSS).

Forward Link Physical Description

Forward link data uses direct sequence spread spectrum (DSSS) and consists of a calling code, preamble, barker code, data, and check sum. Spread spectrum helps reduce electromagnetic noise in the surrounding environment by using a transmission bandwidth that is wider than the bandwidth required for communicating the data, thus reducing the peak power spectral density. The operation of the MicroStamp backscatter system is illustrated in Figure 1.

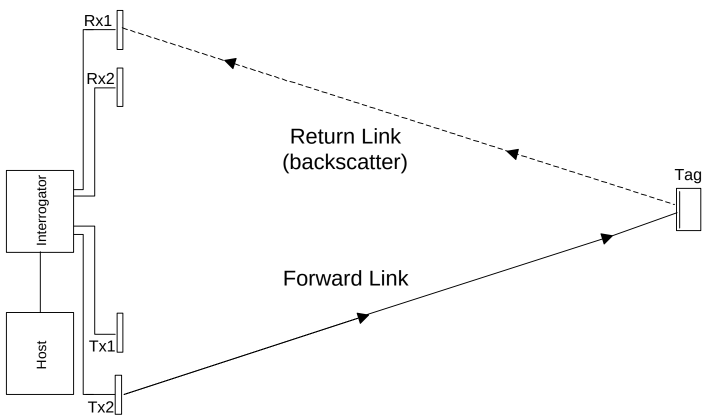


Figure 1 – Backscatter

The forward link signal is detected by the tag, and the data is demodulated and processed by the tag’s internal logic and microprocessor. During a return link message, the interrogator sends a continuous unmodulated radio frequency signal.

A data 0 corresponds to a 180º phase shift in the subcarrier, relative to the previous bit, while a data 1 corresponds to no phase change. The phase-modulated subcarrier modulates a tag’s antenna impedance. For a simple dipole, a switch between the two halves of the dipole antenna is opened and closed. When the switch is closed, the antenna becomes the electrical equivalent of a single half-wavelength antenna that reflects a portion of the power being transmitted by the interrogator. When the switch is open, the antenna becomes the electrical equivalent of two quarter-wavelength antennas that reflect little of the power transmitted by the interrogator.

Return Link Physical Description

Return link data uses differentially phase shift keyed (DPSK) modulated onto a square wave subcarrier. Frequency hopped spread spectrum (FHSS), another spread spectrum technique, reduces potential interference from other systems and is used on the return link portion of the RIC system. FHSS is accomplished by hopping through a list of pseudo-randomly selected frequencies. If an interfering signal occurs at one frequency in the band, it only affects communications on that frequency; other frequencies remain unaffected. After each forward link transmission, the interrogator hops to another frequency.

For operation in the United States, the forward link is always at 2.442 gigahertz (GHz). The return link may be in any of three bands centered around 2.418, 2.442, and 2.465 GHz. Each return link band has 75frequencies, spaced 400 kilohertz (kHz) apart resulting in about 30 megahertz (MHz) of bandwidth. For operation in Japan, the forward link is always at 2.484 GHz. The receive band is centered at 2.484 GHz with 47 frequencies spaced 400 kHz apart.

Backscatter Characteristics

Modulated backscatter systems are particularly suited for some applications. Since the power received at the interrogator during the return link is reflected from a tag's antenna, this type of system is effective for short ranges. The range depends on the RF carrier frequency, interrogator output power, data rate, and tag antenna design.

For a RIC Key Ring Tag operating at 2.44 GHz, +27 dBm (10 * LOG(P), in milliwatts) output power, with a 6 dB antenna, at an effective high rate of 307.6 kilobits/second, a maximum range in a realistic environment is 90 feet. Range can be reduced by decreasing output power. The 4120R series interrogators output power is programmable from +5 dBm to +28 dBm.

Interrogator RF Communications Operation

The interrogator RF communications uses the external transmit and receive antennas. The interrogator generates a synthesized RF signal divided into two paths. One path is fed to a Mixer acting as an AM modulator. The AM modulated signal is amplified to the final output power and routed to a transmit antenna via switches. The second signal from the power divider is used as the local oscillator to down convert the received signal. A receive antenna is also selected by a switch. Only a single transmit and a single receive antenna can be activated simultaneously. The receive signal is down converted to baseband through a quadrature downconverter. I and Q outputs are fed to a DPSK demodulator that recovers the return link data and regenerates a bit rate clock. The data and clock are then sent to the digital controller board for processing.

Antenna Operation

Antennas are a critical part of an RF communication link, and they perform two primary functions. Transmit antennas convert electrical energy into radiated electromagnetic energy. Receive antennas convert electromagnetic energy into electrical energy. The distance over which communications are maintained is determined by the power output of the transmitter, receiver sensitivity, RF energy propagation media, and design and alignment of the transmit and receive antennas.

Antenna Types

Several types of antennas are used for the RIC system. The tag uses a loop and dipole antennas for receive and backscatter communications (respectively). The interrogator uses patch antennas supplied by IDmicro. Different antennas are not allowed without prior approval from IDmicro.

In accordance with FCC regulations, there are minimum stand off distances for the different antennas supplied by IDmicro . The distances are set to ensure persons are not exposed to more than 1 mw/cm^2.

Antenna Setup

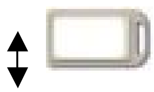
The transmit and receive antennas should be mounted or positioned at least 24 inches apart to minimize cross-talk between the Tx and Rx ports as shown in Figure 3.

Ensure that the polarization arrows on the back of the antennas are the same for all antennas (usually horizontal). The antennas should all face the same direction.

NOTE: Various antennas are available for use with the 4120R series interrogator, which have differing parameters, such as polarization, gain, and frequency. Orientation does not matter with circularly polarized antennas.

The antennas provided with the IDmicro development system are linearly polarized. The polarization (indicated by the direction of the arrow on the back of the antenna) should match the tag. See Figure 2.

If the arrow is vertical, the tag should be read horizontally.



If the arrow is horizontal, the tag should be read vertically.

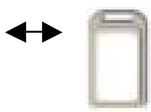


Figure 2 – Tag / Antenna Orientation

Antenna Selection

A backscatter system requires a pair of antennas for transmit and receive. The 4120R series interrogators provide the option for up to six ports for receive antennas and six ports for transmit antennas allowing up to 36 combinations of transmit and receive pairs. This feature allows one interrogator to cover multiple operational areas of RFID operation or allows for a spatial diversity scheme to be implemented.

Antenna Placement

Determining proper antenna placement is important for optimizing system performance. For a given position of antennas, fades will be induced due to multiple signal paths. Optimal antenna placement can be found through experimentation. One procedure is to set the antennas in place, map the coverage by moving a tag through the desired coverage area to find a location that provides favorable results. If diversity is being used, the same procedure needs to be performed (with diversity disabled) for each combination of transmit and receive antennas.

Proximity of the Antenna to Conducting Surfaces

When placed near conducting surfaces, antenna performance may be altered by reflections or ground plane proximity. Conducting surface reflections can modify the incoming (or outgoing) RF signals. The reflections may enhance or degrade antenna performance. In addition to the effects of multipath, conductive surfaces close to the antenna can change the antenna’s characteristics. Tag range may be impacted if an interrogator transmit antenna is placed in the proximity of a conducting surface. When possible, it is best to keep the interrogator antennas at least several wavelengths from conducting surfaces to reduce this effect.

Antenna Line-of-Sight Communications

Normally, frequencies above 500 MHz are used for line-of-sight communications. Large (several wavelengths in size) obstacles that block the view of the transmit antenna to the receive antenna may also block the communications link. For optimum system performance, interrogator antennas must have a clear communications path with a tag. The composition and density of obstacles will determine the amount of signal loss. Using diversity, the antennas can be placed so that the likelihood of obtaining a clear line of sight is increased. Ground bounce is also a factor and must be determined through testing.

Site Suitability

For permanent installations, a site survey should be conducted to determine the suitability of the location. Because the 2.4000-2.4835 GHz bands are considered unlicensed by the FCC, the potential for interference from other systems exists. Fortunately, most of these systems operate at low power levels; the potential for interference is limited to systems operating within close proximity to one another.

RF propagation is difficult to predict accurately and is a function of the surrounding environment. Because of this, the levels of other in-band signals should be determined using a spectrum analyzer equipped with an omni-directional antenna. Before an initial system installation, a “max hold” type of measurement should be performed for at least several hours (preferably for 24 hours or longer) to identify other frequencies that may be in use at the site.

Multipath

Multipath is the result of a transmitted signal arriving at the receiver from multiple paths. This is caused by the signal being reflected from conductive and dielectric objects. The signals are received at different times creating a phase difference between the direct path and reflected signals. This phase difference can result in a reduction of signal strength. When the phase difference approaches 180 degrees, the signals will cancel, resulting in little or no power available for detection. The ground can act as a reflector of RF energy and add to the multipath environment. Due to ground reflections (for a given antenna height) there will be nulls in the coverage at particular distances. These nulls can be predicted numerically and confirmed via field testing for a given environment. The primary tool for eliminating the effects of multipath in a system is spatial diversity—the act of orienting antennas in order to increase or reduce the number of paths that RF signals can travel. For spatial diversity to be effective, the antennas need to be separated by a reasonable distance compared to the wavelength of the RF carrier. At the frequencies used by the RIC system, the wavelength is 1/8 of a meter.

Physical Considerations

During the return link, a high power continuous wave (CW) signal is emitted from the transmit antenna. If too much of this power is “seen” at the receive antenna, the receiver will saturate and its sensitivity will be severely reduced. To prevent this from occurring, do not direct the transmit and receive antennas at one another. In addition, separate the transmit and receive antennas by several feet if possible. For permanent installations, measure the received forward link power with a spectrum analyzer and verify that the level is less than -15 dBm. The receive antennas should be adjusted to receive the minimum power level possible. Optimum tag performance can be obtained when forward link power is less than 30 dBm. Repeat this process for each transmit/receive antenna combination. An antenna collects the maximum amount of energy from an incident field when the polarization of the antenna and the polarization of the incident field are matched. When the antenna polarization and the incident field are perpendicular to each other (cross-polarized), the antenna cannot collect energy from the incident field. RIC tags use linearly polarized antennas. Users must verify that the interrogator antennas and tag antennas align correctly.

3. 4120R Series Features

The 4120R series includes the availability of up to six transmit and six receive RF ports with port selection using the Avera4120 embedded code or through the MSL (Micro Stamp Library), programmable transmit and receive attenuation, and programmable antenna queue selection. In addition, two software controlled LEDs, eight external TTL-compatible auxiliary I/O lines, a time-of-day clock with battery backup, and two external user-defined analog inputs are available. Onboard memory includes one megabyte of read/write FLASH, up to 0.5 megabyte of EPROM, and one megabyte of SRAM.

When using the embedded MSL for the 4120R series interrogator, the embedded processor executes all of the control functions for handling interrogator-to-tag communications on the interrogator. This limits the necessary communications between the interrogator and a host computer to application-specific messages. The hardware enhancements for the 4120R series interrogators required modification of some of the interrogator-specific MSL functions.

The 4120R series interrogator provides enhanced anti-jamming capabilities and performance in extreme temperatures. The operational temperature range for the 4120R series interrogator is -40 to +85°C.

Interrogator Microprocessor - Motorola MC68340

The 4120R series interrogator includes a Motorola MC68340 microprocessor. This processor handles tag communication functions and application–specific tasks. Because the controller is embedded, communication traffic over the serial ports with the host computer becomes application-specific.

The addition of a processor and its associated memory for embedded applications provides several advantages. Primarily, the design effectively optimizes the RIC interrogator for multiple-interrogator installations while also modularizing the code that is specific to RFID control. The embedded processor executes all of the control functions for handling interrogator-to-tag communications at the interrogator which allows the communications between the interrogator and a host computer to be limited to application-specific tasks. By incorporating a microprocessor, systems employing a host computer only require one host for communications with multiple interrogators.

Interrogator Communications Configurations

The 4120R series interrogator provides three UARTs (universal asynchronous receiver-transmitter). The UARTs are referred to as *SerialPortA*, *SerialPortB,* and *SerialPortC*. *SerialPortA* and *SerialPortB* are contained in the serial communications module on the MC68340 processor. A Philips SCC2691 UART is used for *SerialPortC*.

The Util4120R utility library supplies basic drivers for standard RS-232 and RS-485 communications. The drivers can be modified by the developer to meet custom application requirements. *SerialPortA* and *SerialPortB* are configurable for any of the available modes: RS-232, RS-422, RS-485, or TTL. Mode selection for *SerialPortA* requires switches on the interrogator to be set appropriately. Software can override the hardware settings for baud rate and parity for *SerialPortA*. *SerialPortB*’s mode, baud rate, parity, start and stop bits, and handshaking are configured with software. *SerialPortC* is configured to operate in RS-485 mode only with software selectable baud rate, bits per char, stop bits, and parity.

Interrogator Configuration Switches

The switches on the back of the 4120R series interrogator enclosure are labeled SW1 through SW10 (left to right). Some of the switches are interpreted by MccMon boot software while other switches select hardware features independent of the boot software. The MccMon boot software interprets switches SW1 through SW3 and initializes the hardware appropriately. Switches SW4 through SW10 control hardware directly and have fixed functionality.

Interrogator Switch Settings

The following section provides guidelines for configuring the serial bus communications interface with a RIC Interrogator, definitions of available serial port configurations, and suggested switch settings. These guidelines do not cover every situation or PC configuration, including RS-422 and RS-485 modes where the host system requires various communication cards and drivers. The switch layout is illustrated in Figure 4. Some of the switches are interpreted by application software, while others determine hardware configurations. The software-interpreted definitions are applicable to MccMon bootstrap software only.

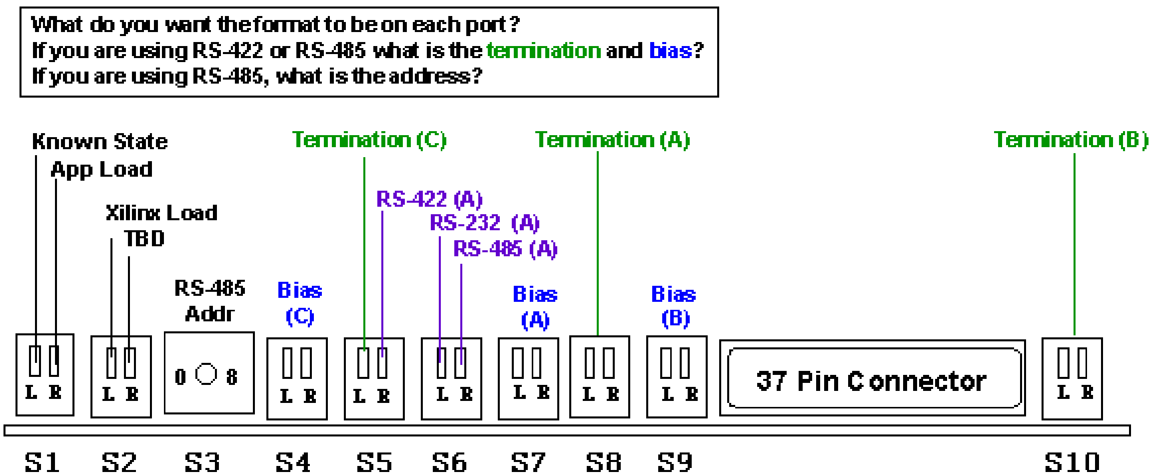


Figure 3 – Front Panel Switch Layout

Hardware Configuration Switch Settings

The hardware configuration switches S4 through S10 allow the interrogator to be externally configured for running embedded code or in monitor mode as well as a a variety of serial communication interfaces. See Table 1 to determine the appropriate switch settings for a specific bus configuration.

	S1		S2		S3	S4		S5		S6		S7		S8		S9		S10	
	L	R	L	R	Dial	L	R	L	R	L	R	L	R	L	R	L	R	L	R
RS-232 (A)	U	X	X	X	0	X	X	X	U	D	U	X	X	X	X	X	X	X	X
RS-422 (A)	U	X	X	X	0	X	X	X	D	U	U	X	X	D	D	X	X	X	X
RS-485 (A)	U	X	X	X	#	X	X	X	U	U	D	D	D	D	X	X	X	X	X
TTL (A)	U	X	X	X	0	X	X	X	D	U	U	X	X	U	U	X	X	X	X
RS-232 (B)	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X
RS-422(B)	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	D	D
RS-485(B)	X	X	X	X	#	X	X	X	X	X	X	X	X	X	X	D	D	D	X
TTL (B)	X	X	X	X	0	X	X	X	X	X	X	X	X	X	X	X	X	U	U
RS-485 (C)	X	X	X	X	#	D	D	D	X	X	X	X	X	X	X	X	X	X	X

D = Switch Down U = Switch Up # = RS-485 Addr X = Don't Care

Table 1 – Interrogator Switch Settings

For typical 232 communications using embedded code, set SW1 L down, SW1 R up, and SW6 L down. For monitor mode SW1 R should be up.

Interrogator Serial Communications

The 4120R series interrogators are equipped with three standard asynchronous serial communication ports. Two of these ports, (SerialPortA and SerialPortB) can be configured for RS-232, RS-422, RS-485, or TTL level RS-232 line drivers. The third serial port (SerialPortC) is a dedicated RS-485 port. Some options for these ports are selected via the switches on the front of the interrogator. These switches are discussed in this and the next sections.

Asynchronous communications is the standard means of serial data communication for many computers and terminals. Serial data communications implies that individual bits of a character are transmitted consecutively to a receiver that re-assembles the bits into a character. Communications characteristics such as data rate, error checking, handshaking, and character framing (start and stop bits) are pre-defined and must correspond at both the transmitting and receiving ends. The serial communications standard usually defines signal levels, maximum bandwidth, connector pin-out, supported handshaking signals, drive capabilities, and electrical characteristics of the serial lines.

RS-232 Serial Ports

One of the most widely used communication standards is RS-232. The most common connector for RS-232 is a standard 25-pin D-subminiature connector, although the accepted PC standard defines the RS-232 port on a 9-pin D-subminiature connector. Both implementations are in widespread use.

RS-232 is capable of operating at data rates up to 20 Kbaud at 50 feet. The absolute maximum data rate may vary due to line conditions and cable lengths. RS-232 often operates at 38.4 kilobaud (Kbaud) at very short distances. The voltage levels defined by RS-232 range from –12 to +12 volts. RS-232 is a single-ended interface, which means that a single electrical signal is compared to a common signal (ground) to determine binary logic states. A voltage of +12 volts (normally +8 to +10 volts) represents a binary 0, and -12 volts (normally -8 to -10 volts) denotes a binary 1. (See Figure 12 on page .)

For the 4120R series interrogator, serial I/O levels are generated using Maxim 5 volt buffers that generate +/- 7 to 10 volt rails for the output drivers. Request to send (RTS) and clear to send (CTS) lines are available at the same drive levels to provide the hardware handshake, if necessary. Software configuration determines whether the RTS and CTS lines are used.

RS-422 Serial Ports

RS-422 uses a differential interface to define voltage levels and driver/receiver electrical specifications. On a differential interface, logic levels are defined by the difference in voltage between a pair of outputs or inputs. In contrast, a single-ended interface (for example RS-232), defines the logic levels as the difference in voltage between a single signal and a common ground connection. Differential interfaces are typically more immune to noise or voltage spikes that may occur on the communication lines. Differential interfaces also have greater drive capabilities that allow for longer cable lengths. RS-422 is rated up to 10 megabits per second and can have cabling 4,000 feet long. RS-422 differential signal levels range from 0 and +5 volts. The RS-422 standard does not define a physical connector. (See Figure 13 on page .)

The output levels for the 4120R series interrogator using RS-422 mode are driven with signal levels between 0 and +5. There is a dedicated pair of wires for each direction of transmission. To operate at 4,000 feet, cables of twisted pairs with individual shields, having a 120 ohm impedance and properly terminated into 120 ohms are required. At shorter distances, some compromise may be tolerated depending on the application. Software examples in the Utility 4120R do not support the CTS and RTS lines.

RS-485 Serial Ports

The RS-485 interface is similar to RS-422 in several ways. RS-485 is a differential interface that allows cable lengths up to 4000 feet and data rates up to 10 megabits per second. The signal levels for RS-485 are the same as those defined by RS-422. RS-485 has electrical characteristics that allow for (up to) 32 drivers and receivers to be connected on one bus. This interface is ideal for multi-drop or network environments.

RS-485 tri-state driver (not dual-state) allows the electrical presence of the driver to be removed from the line. The driver is in a tri-state or high impedance condition when this occurs. Only one driver should be active at a time, and the other driver(s) must be tri-stated. In the 4120R series interrogator, the output modem control signal, RTS, controls the state of the driver. RS-485 does not define a connector pin-out, a physical connector, or a set of modem control signals.

Similar to the RS-422 mode, the signals are 0 to +5 volts differential with one pair of wires in one cable. Transmission and reception are made on the pair in a time-multiplexed mode. To operate at 4000 feet, twisted pair cable with a shield and a 120 ohm impedance, properly terminated into 120 ohms, is required. The host (or interrogator) only drives the cable when transmitting. While the cable is not being driven, it must maintain a defined state. This state is accomplished by biasing the lines with resistors to a defined state. The biasing should only be added on one host or interrogator.

TTL Level RS-232 Serial Ports

A TTL level RS-232 serial mode is also available with the 4120R series interrogator. This mode is a modification of the RS-422 mode. The high side of the RS-422 transmit and receive signals must be used. Electromagnetic interference (EMI) and electrostatic discharge (ESD) protection as well as hysteresis, inherent in this receiver, are available by using the RS-422 driver and receiver. The non-inverting output is used as a TTL level signal for output. On the receive side, the inverting input is biased at 1.7 volts (a reasonable TTL level threshold) and the non-inverting input is used to receive data. To maintain this bias, the inverting input pin must be left floating (unconnected) while in TTL mode. RTS and CTS lines are not available in this mode. (See Figure 15 on page .)

Multifunction Connector Description

The 4120R series interrogator uses a multifunction 37-pin connector for all wired external connections. This section illustrates cabling examples between the 4120R series interrogator and common equipment such as PCs. This section also illustrates the interrogator power, auxiliary port, and analog input connections.

PIN	SIGNAL	DEFINITION
1	-----	NOT USED
2	TX232_1	Port A RS-232 Transmit
3	RX232_1	Port A RS-232 Receive
4	RTS_1	Port A Ready-To-Send
5	CTS_1	Port A Clear-To-Send
6	AUX2	Auxiliary I/O port 2
7	GND2	Port B Signal Ground (100 ohm series resistance to ground)
8	P422_1	Port a RS-422 Receive HI / TTL Receive
9	GND	Ground
10	P485_1	Port A RS-485 / RS-422 Transmit HI / TTL Transmit
11	M485_1	Port A RS-485 / RS-422 Transmit LO
12	M485_2	Port B RS-485 / RS-422 Transmit LO
13	M485_3	Port C RS-485 LO
14	AUX4	Auxiliary I/O Port 4
15	AUX6	Auxiliary I/O Port 6
16	CTS_2	Port B Clear-To-Send
17	TX232_2	Port B RS-232 Transmit

18	EXTAN0	External Analog Input 0 (0 to +5 Volts)
19	DCDCVDC	DC-to-DC Converter Input
20	-----	NOT USED
21	AUX0	Auxiliary I/O port 0
22	M422_2	Port B RS-422 Receive LO
23	M422_1	Port A RS-422 Receive LO
24	AUX1	Auxiliary I/O Port 1
25	AUX3	Auxiliary I/O Port 3
26	P422_2	Port B RS-422 Receive HI
27	POSVDC	Positive Power Input (+8VDC to +9 VDC)
28	NEGVDC	Negative Power Input (-8VDC to -9VDC)
29	P485_2	Port B RS-485 / RS-422 Transmit HI / TTL Transmit
30	GND1	Port A Signal Ground (100 ohm resistance to ground)
31	P485_3	Port C RS-485 HI
32	GND	Ground
33	AUX5	Auxiliary I/O Port 5
34	AUX7	Auxiliary I/O Port 7
35	RX232_2	Port B RS-232 Receive
36	RTS_2	Port B Ready-To-Send
37	EXTAN1	External Analog Input 1 (0 to +5 Volts)

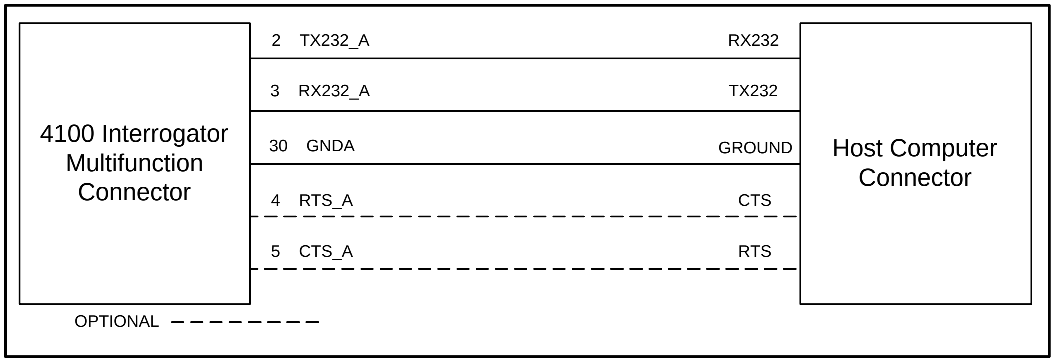
Table 2 – 37 Pin Connector Description

Multifunction Connector Cabling

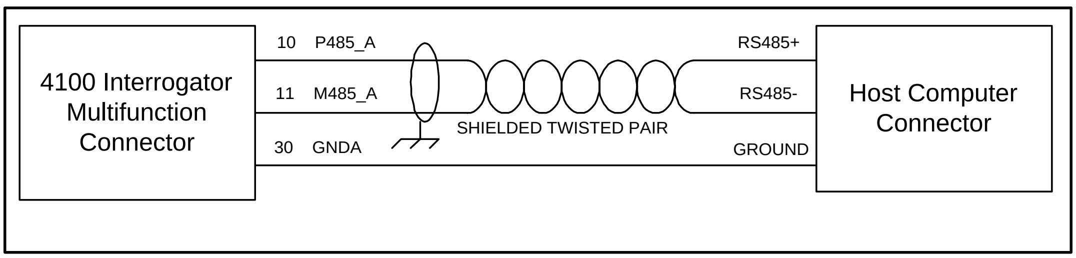
The cabling configuration depends on the handshake options and the communication standard being utilized (i.e., RS-232, RS-422, RS-485). The following diagrams illustrate typical wiring configurations for common standards. If modem control signals are not used, they should be tied to a fixed logic level. When using a differential interface such as RS-422 or RS-485, each cable connection shown in figures 12-22 requires two connections. For example, when cabling data terminal equipment (DTE) to DTE, TD+ is normally connected to RD+ and TD- is connected to RD-.

The quality and electrical specifications of the cables can greatly affect the performance of the communication interface. Always use high-quality cables and follow guidelines for twisting, shielding, and biasing, and for bus termination.

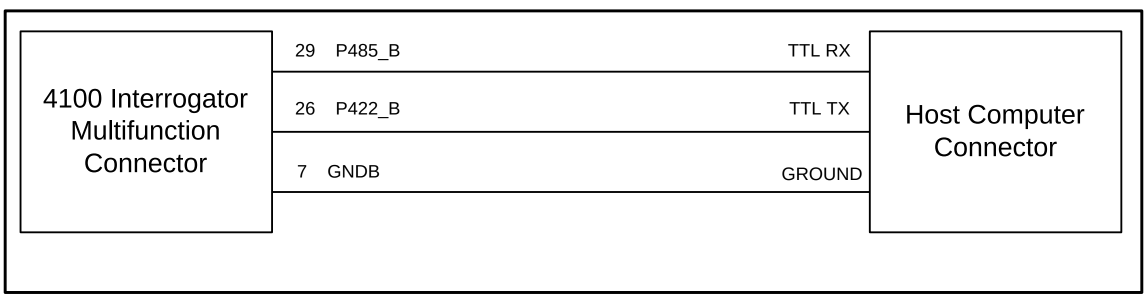
IMPORTANT NOTE:
In some applications, the cabling examples may not apply. To ensure proper cabling requirements are maintained, refer to the documentation provided with the external device to which the interrogator is connected. The following diagrams illustrate some pin-outs for the *SerialPortA* RS-232, RS-422, RS-485, and TTL level RS-232 interfaces. To use the TTL serial mode, configure the port for RS-422 mode



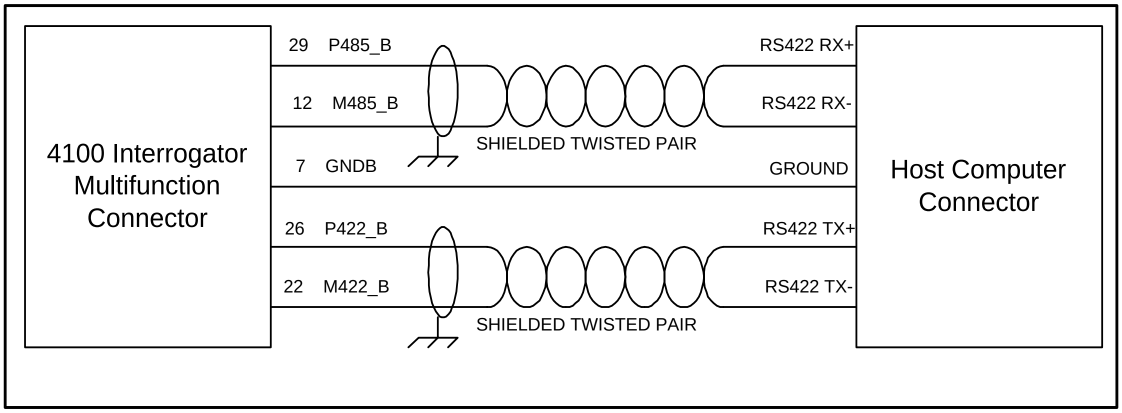
Port A RS-232 Interface



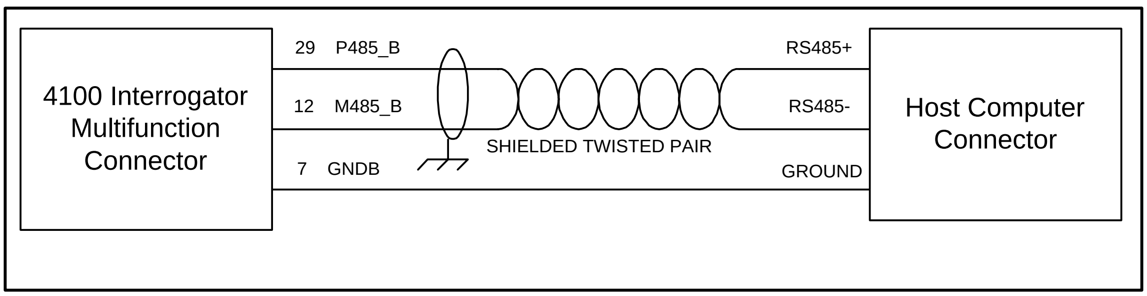
Port A RS-485 Interface



Port B TTL Interface



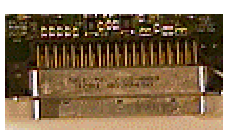
Port B RS-422 Interface



Port B RS-485 Interface

Interrogator Auxiliary Port Cabling

The interrogator has eight auxiliary I/O signals that can be independently controlled as inputs or outputs.



Pin	Function
21	Aux Port 0
24	Aux Port 1
6	Aux Port 2
25	Aux Port 3
14	Aux Port 4
33	Aux Port 5
15	Aux Port 6
34	Aux Port 7
9	Ground
32	Ground