ISO3RS4 Adapter User Manual

Revision

1.03	03/17/10	SJN	Minor fixes
1.02	03/05/10	SJN	Processor pin definitions fixed
1.01	01/22/10	SJN	First cut

1.0 Introduction

The ISO3RS4 Adapter allows a host processor board to be attached to an RS485 network in a robust, isolated manner with Auto Data Direction Control for ease of use. The adapter can be mounted on any board providing 3 volt power and 3 volt RS232 transmit and receive signals. The RS485 portion of the adapter is externally powered and is completely isolated from the 3 volt side by 2500 volt opto-isolators.

The ISO3RS4 is designed to be mount on .1 inch center 5 pin connectors to host processor board. The processor side of the adapter uses a 5 pin header and can be mounted horizontally or verically. The RS485 side of the adapter has 4 pins that can be connected either with screw terminals or a second 5 pin header for the host processor board.

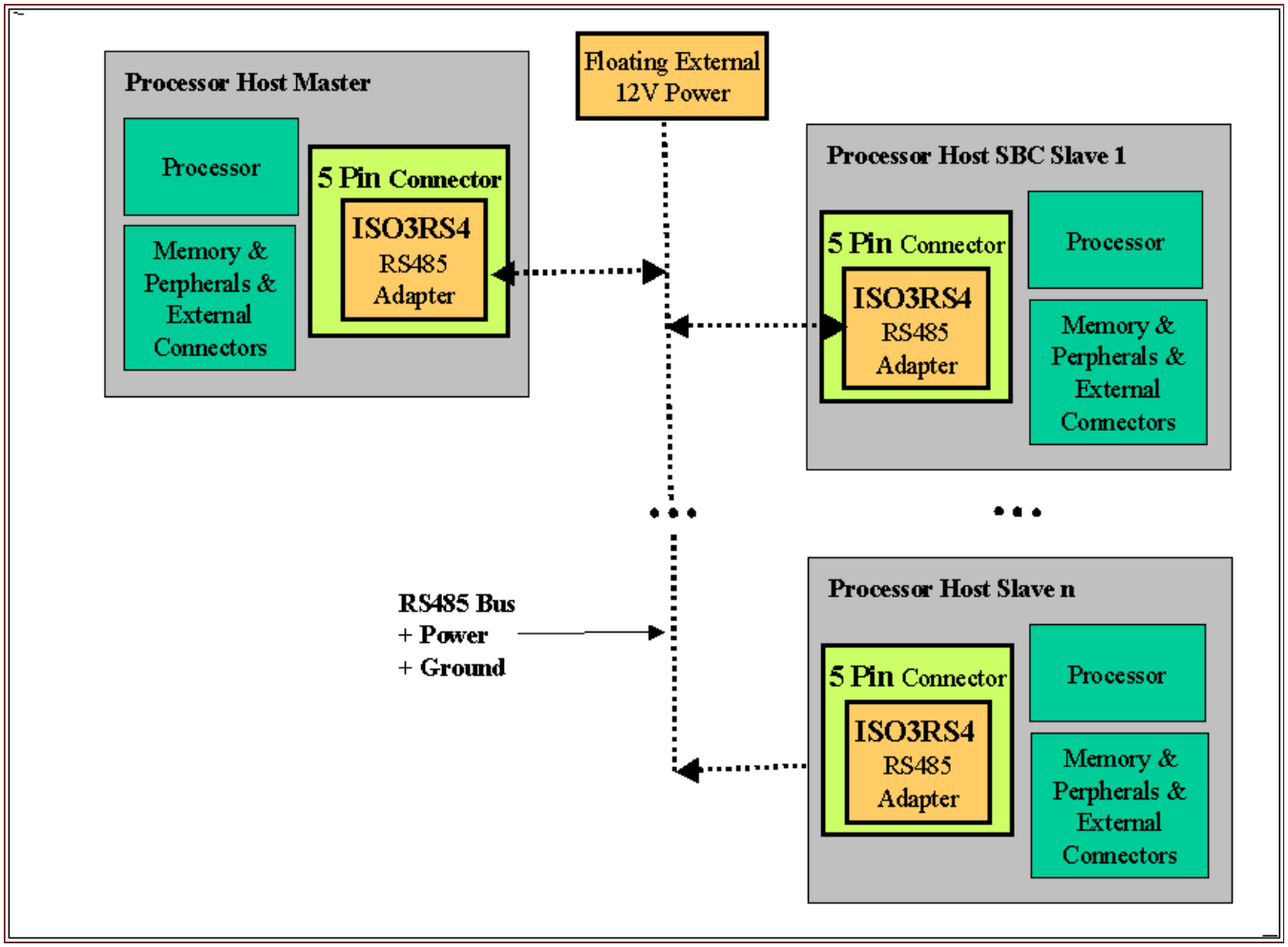
This document describes the ISO3RS4 adapter and how it can be used. It is oriented towards system developers who should be adept at interconnecting systems, using serial communications and using RS485 for controller networking. The user must be able to understand the capabilities of the ISO3RS4 and of the interfaces to the RS485 network.

The user will need to supply the transmission line and a 6 to 28 volt DC converter for the power to the transmission line side of the ISO3RS4. He may also need to provide termination and bias resistors in order to properly drive the transmission line.

2.0 ISO3RS4 Adapter Overview

The following is an overview of how the ISO3RS4 adapter may be used in a system.

ISO3RS4 Adapter System Context



The ISO3RS4 adapter is an RS485 adapter with the a 5 pin interface to a host processor board and a 4 terminal or 5 pin interface to the RS485 network.

In a typical system one host processor board is used as the master and additional processor boards act as slaves. The master usually initiates control and the slaves respond at their appropriate time or when the master asks them to do so.

The transmission line used to connect all units has at least 4 wires: the RS485+ signal, the RS485- signal, the power and the ground. The power and ground are connected to a floating external power supply with a DC voltage of at least 6 volts. This supply can be connected anywhere on the line but if the transmission line is long, it must provide at least 6 volts to all the ISO3RS4 or compatible adapters connected.

The ISO3RS4 adapter has some distinct advantages:

Electrical Isolation to 2500 Volts

The ISO3RS4 adapter uses optical isolators to totally isolate the RS485 line side of the circuits from the host processor controlled side. This allows the adapter to be used in noisy environments such as around inductive loads. Also, the connected components may be thousands of feet apart and may have to overcome ground differential or lightening problems. The ISO3RS4 adapter is robust enough to survive these situations.

Externally powered RS485 chip

The ISO3RS4 adapter uses external power from a transmission line power and ground wire and therefore places a very

small load onto the processor board power source. This may be important when used in battery operated sensors. The ground wire acts as the signal ground and is completely isolated from the host processor ground. An external voltage between 6 and 28 volts is needed at the ISO3RS4 adapter line input. This external voltage can be provided by one power adapter for the entire transmission line or from multiple power adapters if the line is too long for one supply.

5 Volt RS485 signals

The higher the supplied voltage driving the transmission line, the better the drive distance and noise immunity. The ISO3RS4 adapter has been tested for up to 4000 feet at a 57600 baud rate. With good transmission lines and calibrated load and bias resistors, longer distances may be achieved.

Automatic Data Direction Control

In conventional RS485 driver chips, the transmitter must be explicitly enabled when transmitting and disabled otherwise. The RS485 chip being used in the ISO3RS4 has Automatic Data Direction Control (ADDC) logic which automatically puts it into transmit mode when transmit data is being received from the host. There is no need to worry when the transmit enable should be turned on or off. This is a common annoyance issue for most RS485 implementations.

Transmit Echo Enable Control

In conventional RS485 driver chips, a receive enable is used to get received characters from the transmission line. Normally the transmit enable is on for transmitting and receive enable for receiving. In the ISO3RS4, the ADDC logic automatically prevents the transmitted characters from also being echoed back to the receiver. The ISO3RS4 has a control line to force the transmitted characters to be echoed back to the receiver if this is desired.

Simple Software Driver

The ISO3RS4 adapter uses only conventional 3 volt RS232 signals plus one 3 volt signal to control transmit echo. These signals are available on most 3 volt processor chips. The ISO3RS4 can simply be considered as a serial port.

2.1 ISO3RS4 External Interfaces

The ISO3RS4 adapter has two external interfaces: a 4 wire screw terminal block on the RS485 external side and two 1 x 5 pin connectors on the host processor side. The first 1 x 5 connector is only for host side signal connections and the second 1 x 5 is an alternate for the RS485 external side for boards on which the external connections are elsewhere on the board and are routed to this second 1 x 5 connector.

If the screw terminal is used, it must be connected properly to the transmission line:

Pin 01: VRS4 - power supply voltage

This is the 6 to 28 volt power input to the ISO3RS4 adapter from the transmission line side. It powers the RS485 chip and any bias resistors.

Pin 02: RS485+ - Positive RS485 signal
Pin 03: RS485- - Negative RS485 signal

These are the RS485 signals attached to all the RS485 adapters on the line.

Pin 04: RS4_GND - RS485 signal and power ground

This ground is floating relative to the host processor ground.

On the ISO3RS4 adapter, these external pins can either be connected to an optional screw terminal header with 4 terminals or to the second a .1 inch center 1 x 5 pin header on the host processor board. In the latter case, the four RS485 external connections are routed on the host processor board to some kind of RS485 connector.

Note that the ISO3RS4 screw terminal only provides for 4 wires. If the unit is being inserted in the middle of a transmission line, these signals must be connected to the transmission line with splice wires that are as short as possible. This is particularly important for the two signal wires so as not to interfere with the characteristic impedance of the transmission line.

On the host processor connector side of the ISO3RS4 the following defines the functions of the pins.

Pin 01: VCC - 3V to 5V power

This is the nominal 3.3 volts supplied from the host processor board to power one side of the opto isolators. In most host processor boards 3.3 volta are provided for peripheral power. However, the IS3RS4 is tolerant to use of up to 5 volt supplies. Only small amounts of current are used by the ISO3RS4 and only when actively transmitting a "0" vlaue (or the "space" portion) of a character and the start bit.

Pin 02: RX - Received Input from RS485

This is the digital output from the RS485 receiver after going through an opto isolator. This signal is routed by the host

board to a CMOS compatible 3 volt RS232 input on the host processor.

Pin 03: TX_ECHON - Tx Echo if low
This pin controls the echo of transmitted chareacters. This is normally set high by the setup driver to force the RS485 chip to not echo transmitted characters back to the receiver. If this input is pulled low, transmitted characters are echoed back to the RX on pin 2.

Pin 04: TX - Transmitted Output to RS485
This is the digital input to the RS485 transmitter after going through an opto isolator. This signal is routed by the host processor board from the CMOS compatible 3 volt serial RS232 output on the host processor.

Pin 5: GND
This pin is tied to host board ground. It serves as ground for the VCC and signals used on other pins 2,3 and 4.

Pin 06: RS4_GND - RS485 signal and power ground
This ground is the RS485 ground floating relative to the host processor ground.
Pin 07: RS485- - Negative RS485 signal
Pin 08: RS485+ - Positive RS485 signal
These are the RS485 signals attached to all the RS485 adapters on the line.

Pin 09: VRS4 - power supply voltage
This is the 6 to 28 volt power input to the ISO3RS4 adapter from the transmission line side. It powers the RS485 chip and any bias resistors.

Pin 10: NC - No Connection (Key pin)
This has no connection. It can be used as a Key to ensure that the ISO3RS4 is properly positioned in its socket.

Note that pins 1 to 5 are on the first 1 x 5 header and pins 6 to 10 are on the second 1 x 5 header.

3.0 ISO3RS4 Power, Termination and Bias Resistors

In any RS485 network termination resistors and bias resistors are critical for proper operation. It is assumed that the user is familiar with RS485 termination and bias resistor rules.

3.1 ISO3RS4 Power

The ISO3RS4 adapter needs a 6 to 28 volt power source across external pins 1 and 4. This power could be provided at each host processor board on the network with all the grounds on pin 4 on a common wire but then the transmission line would no longer be isolated.

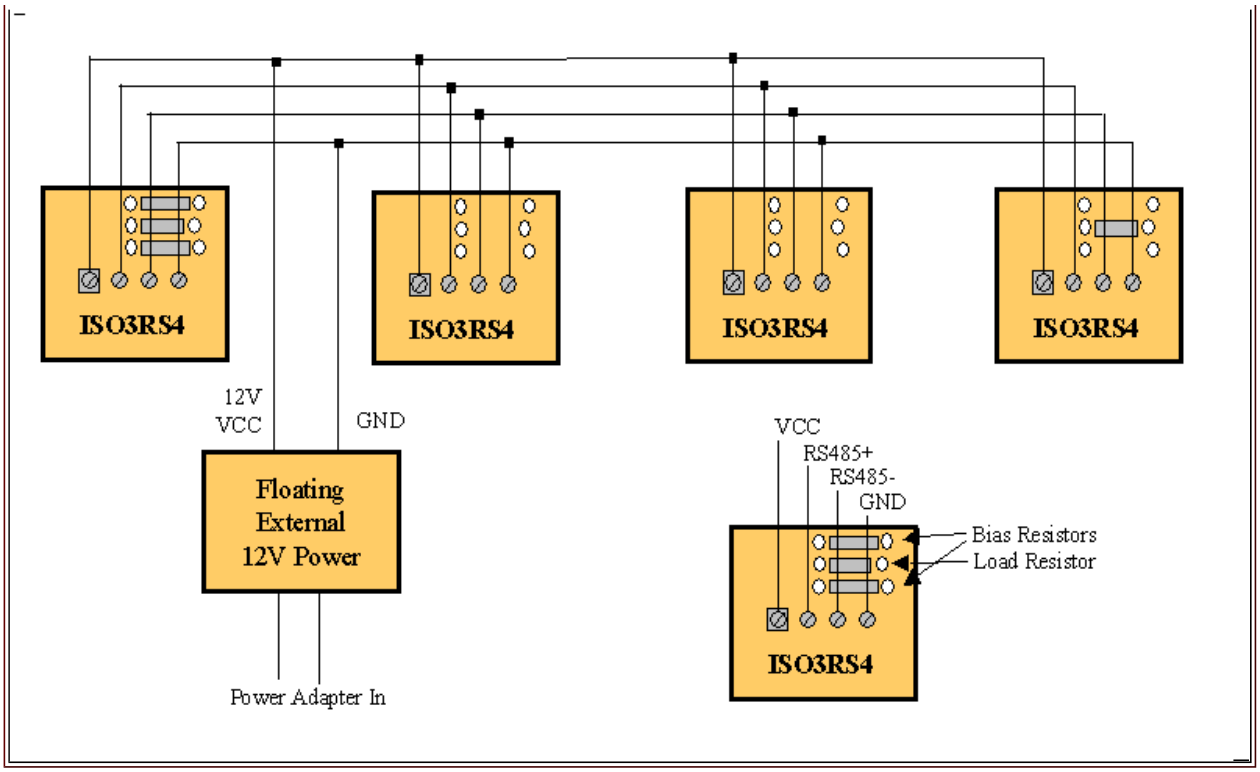
In many cases the most practical powering method is to have a 4 wire transmission line or at least a 4 wire cable, each wire connected to the proper external ISO3RS4 pin. The two signal wires must be twisted with a fixed characteristic impedance. The ground and the VRS4 connected wire can be twisted or straight; they could also be lower gauge for a lower per distance resistance.

The resistance of the power and ground wires in the cables must be considered when calculating the voltages needed. All ISO3RS4 adapters must have at least 6 volts between pin 1 and 4 when they are running in transmit mode, the highest load for the input power.

3.2 ISO3RS4 Termination and Bias Resistors

In any RS485 network termination resistors and bias resistors are critical for proper operation. In brief, the transmission line must be terminated at both ends with a termination resistor that has the same resistance as the characteristic impedance of the transmission line, typically 100 to 120 ohms. All RS485 transceivers between the end units do not have termination resistors. The following figure shows 4 ISO3RS4 units connected via a 4 wire transmission line.

ISO3RS4 Adapter Transmission Line Network Connections



On each ISO3RS4 adapter there are positions for 3 resistors. The top and bottom are the bias resistors and the center is the load resistor. The equivalent load resistor should be about the same as the characteristic impedance of the RS485+ and RS485- transmission line. Note that only the leftmost and rightmost adapters have the load resistor populated. Any adapters in between should not have load resistor.

Bias resistors are needed to force the transmission line voltages to be about at half the line driving voltage when none of the transceivers are transmitting. In the configuration shown only one set of bias resistors are shown since the transmission line is assumed relatively short.

For the ISO3RS4 to work properly, biasing is important because of the ADDC RS485 transceiver being used. When transmitting a character, the start bit and the 0 bits in the character causes the RS485- terminal to be pulled high to 5V and the RS485+ pulled low to GND. This is called the "Space" transmission in the RS485 specification terminology. It is also the high power state when the RS485 chip is providing the highest current through the load resistor and the transmission line.

The 1 bits in the character and the stop bit put the RS485 into the "Mark" or relaxed state. The RS485+ moves to its bias point at about 2.6 volts and the RS485- moves to its bias point at about 2.4 volts. The bias resistors must be low enough to ensure that the voltage difference between RS485+ and RS485- is at least 200 millivolts during a "Mark" or idle state.

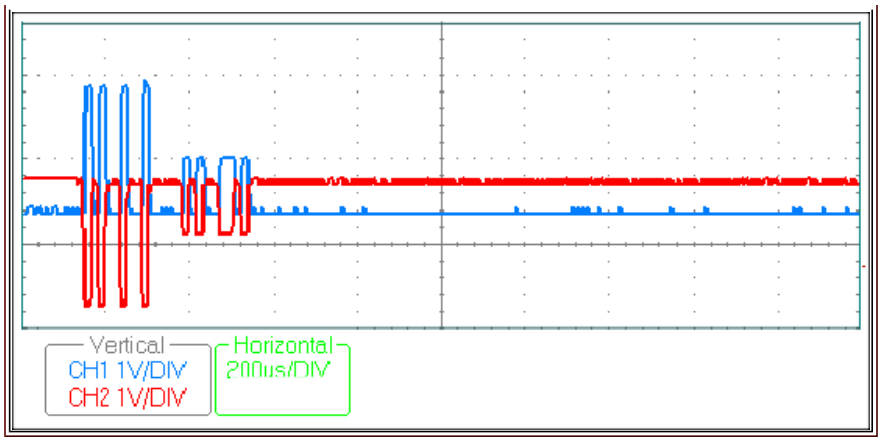
There is typically only one set of bias resistors RS485+ to +5V and RS485- to GND in the entire set of RS485 transceivers on a transmission line. However, if the transmission line is very long bias resistors may be needed at both ends of the line and even in the middle. The system designer must chose resistors carefully so that the combination of the load and bias resistors in conjunction with the distributed resistance of the VRS4 and GND transmission line wires satisfies both the termination rules and the 200mv relaxed transmission mode rule as well as the minimum voltage of 6 volts at the VRS4 terminal 1 input.

If the characteristic impedance of the line is 100 ohms (such as for Cat5 cable) The termination resistor at one end is 120 ohms with bias resistors of 680 ohms. The termination resistor at the other end is 100 ohms but without bias resistors.

3.3 ISO3RS4 Representative Waveforms

To show the real time response of the slave to the master, the following waveform was captured.

ISO3RS4 Slave Response Waveforms, Red RS485+, Blue RS485-



This shows that the slave starts to respond to the master in as little as a few hundred microseconds. This illustrates the benefits of not having to explicitly control the transmit enable for the ISO3RS4. The received character waveform is smaller because the slave was at the end of a 2000 ft transmission line and the attenuation represents losses in the line. Even at 4000 ft the received signal is still within RS485 spec and is properly received by the master.

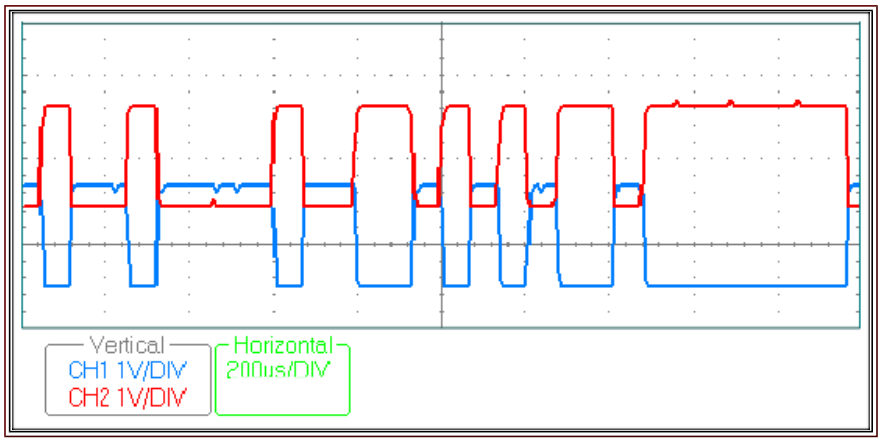
4.0 More ISO3RS4 Information

The ISO3RS4 adapter can be used in systems also using the Tech9 XBRS4 adapter or any other RS485 adapter. A demonstration network using XBRS4 and ISO3RS4 adapters was put together for testing and capturing wavefors.

4.1 ISO3RS4 Demo Transmission Waveforms

The following is the basic waveform at the master node with the RS485+ in blue and RX485- in red. This is at 57600 baud and is what properly biased and loaded transmissions should look like. In the relaxed state the input signal is high (also called Mark) and the RS485+ is a few hundred millivolts higher than the RS485-. During a power pulse when the input signal goes low (also called Space), the two voltages separate, the RS485- going high and RS485+ going low. When the input signal goes high again they relax to the unpowered biased state.

Base ISO3RS4 output trace Blue RS485+, Red RS485-



When there is a long transmission line between ISO3RS4 units, the transmitted signals get attenuated. But for a message to be received the RS485+ and RS485- lines need only reverse voltages by at least 200 millivolts. This makes the RS485 very robust and capable of distances of up to 4000 ft.

To show the effect of signal attenuation over a transmission line of 2000 ft a waveform trace was made to show the trailing bits in a master message and the start of the slave response message. The slave is at the end of a 2000 ft CAT5e cable pair with proper termination. The RS485- trace is red and the RS485+ trace is blue. Note that the slave response message on the right is significantly attenuated compared to the originating waveform on the left. If we were to monitor the slave terminals, the slave message transmitted would produce a similar originating waveform as on the left.

xbrs4_MNred_Pblu_S1_2K_576.bmp