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## RDC485IR USER MANUAL

### ISOLATED RS-485 REPEATER FOR 2 AND 4-WIRE RS-485 WITH GROUND WIRE (DEFAULT FACTORY SETTING: 4-WIRE MODE)

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## 1. INTRODUCTION

RS-485 has become perhaps the most common data communication standards in "open" multi-vendor automation projects. More robust than RS-232 and more flexible than RS-422, it allows multiple devices to communicate over a single cable.

### 1.1. Product Overview

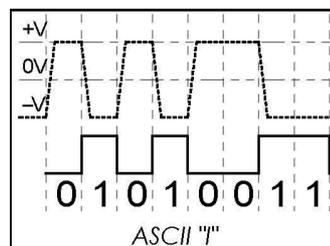
For robust operation, the rdc485ir is an essential component of your industrial applications. It provides the following unique combination of features:

- Convenient DIN-rail mount saves time installing and maintaining the product.
- Isolates and protects the data signals and power supply grounds.
- Fault isolation (FI) option prevents faulty line segments from interfering with working line segments
- Over 2500v optical isolation between two RS-485 sub-nets (5kv test isolation) and 2500v galvanic isolation between the RS-485 and power supply (3kv test isolation).
- For rapid troubleshooting, LED indicators for the TX, RX, and power status.
- Wide power supply range (9 to 36vdc) with spike protection allows use with 9v, 12v, 15v, 24v power supplies or direct from 12v or 24v battery systems – no AC "wall-wart" required.
- Offers the option of 9-pin d-sub shell connector or large capacity (2.5mm<sup>2</sup>) compression screw terminals, giving maximum flexibility in installation in panels and terminal boxes.
- 600 watt transient suppresser diodes are installed on isolated ports (600w for 1ms with less than 1psec re-sponse to over-voltage)
- Options for 48vDC +/- 20%

### 1.2. What is RS-485 ?

RS-485 is a half-duplex data communication standard that can be used for point-to-point or multi-drop applications. It uses twisted wire pairs. Data is transmitted by a differential voltage signal. **The two wires in a pair are not a loop** -- both are '+' signals sourcing current to a third "virtual" ground conductor.

For example, here is the differential signal for an ASCII character 'I'. Though labels vary from vendor to vendor, one wire of the pair is often labeled A and the other B. Data is represented by the relative voltage of A to B. When  $V_A < V_B$ , then the data is a binary 1. When  $V_A > V_B$ , then the data is a binary 0. An idle line with-out data will be in the binary 1 state. This differential voltage signal is quite robust and not susceptible to noise or minor shifts in signal reference ground.



### 1.3. Two or Four Wire RS-485

2-wire RS-485 is strictly half-duplex. One wire pair is used as a bi-directional bus, first transmitting a request and then receiving a response. 2-wire RS-485 can be Master-Slave or Peer-to-Peer. Many industrial products support both 2 or 4 wire RS-485, with either internal or external jumpers to short the two A signals and two B signals together for 2-wire.

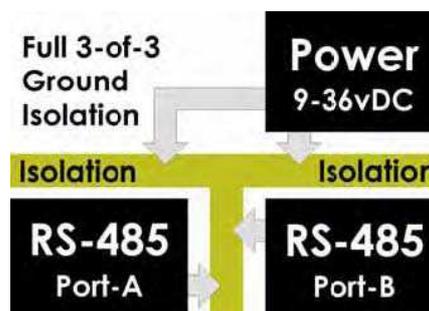
4-wire uses two twisted wire pairs - one for transmit and one for receive. 4-wire RS-485 is strictly Master-Slave. The TX pair is used by a master device to communicate with the slave devices, and the Rx pair is shared by the slave devices to respond. 4-wire RS-485 is more robust than 2-wire with low quality cable or high environmental noise. It also reduces the data communication interrupt load on the slave devices since they do not receive each other's re-sponses.

Note that there is a special form of 2-wire RS-485 which allows an optional 2nd wire pair to be used as a control (RTS) signal to manage repeaters in the system.

## 2. FUNCTIONAL DESCRIPTION

### 2.1. Isolated Power Supply

This is a key feature of Robust DataComm products. We take a standard, industrial grade 9 to 36vDC and condition it down to a clean, stable 5vdc +/- 0.5%. Then DC-to-DC converters with 2500 volt isolation create one or two isolated supplies. In all models (-2p and -3p), RS-485 port-A is fully isolated from both the incoming power supply and port-B. The full 3-of-3 port galvanic isolation model (option -3p) adds a 2<sup>nd</sup> isolated supply so that RS-485 port-B is fully isolated from both the incoming power supply and port-B.



### 2.2. Optical Isolation for Data Signals

Digital opto-couplers are used to move the data signals between the two sides of the converter. These are superior to the more common analog opto-couplers, as they add less distortion. The isolated power supplies and optical data signals complete the galvanic isolation required.

**2.3. RS-485 Bus Transceiver**

Line interface driver/receiver chips convert the field signals to standard TTL-level signals. Since 2-wire RS-485 is a bi-directional bus, it requires the transmitter/receiver circuits to switch between transmit and receive as appropriate - the rdc485ir uses an effective method to do this with 100% software transparency.

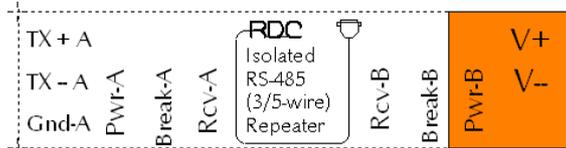
**2.4. Segment Fault Isolation (For "FI" models only)**

Repeaters do have a potential "bad habit" - during a bus fault on one segment, they may "repeat" that fault as a false signal on the good segment. The preferred behavior is for the repeater to "isolate" the fault and still allow the good segment to operate.

The line fault conditions include any open-circuit and any combination of line shorts to each other including ground.

**2.5. User Indication**

The face of the rdc485ir is shown here. Green LEDs (Pwr-A & Pwr-B) light showing isolated power is available from the isolated DC-to-DC converters. Yellow LEDs (Rcv-A & Rcv-B) light when data is received on the respective port (RS-485 is port A, RS-485 is port B). Red LED (Break-A and Break-B) are normally INSTALLED and indicate that the serial line has been in a "break" or binary "0" condition for approximately 30 msecs.



**2.6. Signal Conditioning**

For normal operation, the rdc485ir has 6 jumpers installed to terminate and bias the RS-485 interface. These are only removed when more than two (2) units of rdc485ir are connected to the same RS-485 wire pair. For example, if 4 units of rdc485ir connect to a wire pair, at least 2 of them must have jumpers removed. Both ports have transient suppression diodes rated at 600w or higher.

**3. DETERMINING THE RS-485 TERMINAL NAMES**

Due to a lack of naming conventions, wiring up multi-vendor RS-485 devices often ends up like wiring "apples" to "oranges" and it may require some bench-top experimentation to determine the pinouts. Fortunately, reverse wiring or short circuits to the ground will not damage the RS-485 or the RS-232 port.

**3.1. The EIA-485 Standard Naming Convention**

EIA-485 defines the labels "A" and "B" to be used as follows: Voltage of A shall be negative in respect to B for logic '1' and vice versa for logic '0'. Unfortunately, this is not the only logic system available and thus not everybody will stick to this convention. To avoid this issue, many vendors have selected other naming conventions.

### 3.2. RDC's Naming Convention

RDC has chosen to name the A/B terminals as “-” and “+” respectively. This is because the voltage of B will always be greater than the voltage of A when the line is in an idle state. Another common naming convention would be to label them as “X”/“not X”, where X is a name like DAT or BUS, and the “not” condition is marked either by a bar over the name or a leading ‘\*’. Another example would be to label them as “DAT+/DAT-” or “DAT/\*DAT”. Generally, the ‘-’ and “not” terminals correspond to “A”, but some vendors have been known to label them in the opposite manner here as well. Since there are so many naming conventions, it is easiest to identify the A/B terminals when the line is in an idle state. By using a multimeter, the terminal with the higher voltage can be easily identified as ‘+’ or ‘B’. This method of identification applies to the “transmit” wire pair. There is no way of telling the terminals apart for the “receive” wire pair.

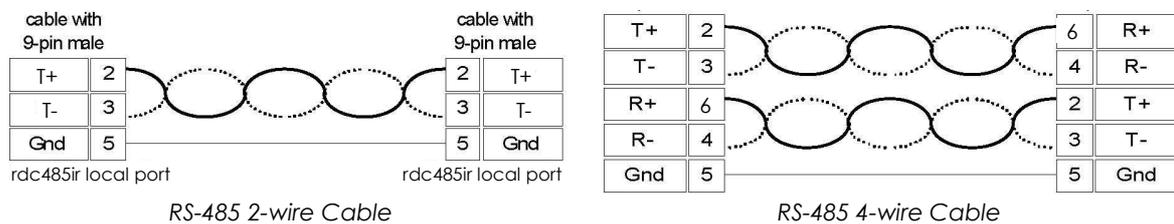
## 4. INSTALLATION

### 4.1. Plan your RS-485 wiring (Screw Terminal Models - cc & cd)

When connecting up as 2-wire mode, ensure that all ‘+’ and ‘-’ terminals are correctly wired. As a convention, RDC suggests choosing a darker wire (or solid color) for ‘+’ and a lighter color (or striped pattern) for ‘-’. Since the bus is bi-directional, the “+” and “-” pair with switch between the transmit and receive modes as appropriate. *Remember, RS-485 is NOT a loop.* On the rdc485ir, the top screw terminals are physically labeled D+, D-, gnd/485.

The terminals on the removable “terminal block have been labeled as T+, T-, R+, R-, SG. Note the “+” and “-” on the labels. The D+ and D- terminals on top of the rdc485ic are internally connected to the T+ and T- terminals respectively. They are provided so that wire lugs can be used. It is also **critical that the Signal Ground be properly connected - you void your warranty if you do not connect this ground properly.** If the RS-485 bus does not have the 3<sup>rd</sup> ground wire, at least connect the Signal Ground (gnd/485 or SG) of the RS-485 port to the nearest device’s digital ground. See the RDC application note AN005 (Grounding for RS-422/485) for more information on the importance and possible designs for this ground.

### 4.2. Plan your RS-485 wiring (D-Sub Shell Models - dd)



The diagram above shows the wiring between 2 rdc485ir units. With the 9-pin D-sub shell option, the 2-wire and 4-wire signals are available on pins 2, 3, 5 and 2, 3, 4, 5, 6 respectively. Note the difference in wiring between 2-wire and 4-wire operation.

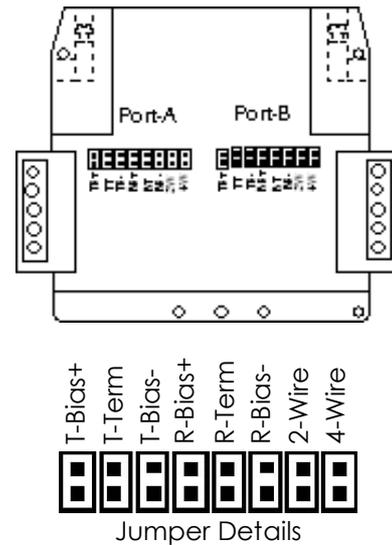
It is also **critical that the Signal Ground be properly connected - you void your warranty if you do not connect this ground properly**. If the RS-485 bus does not have the 3<sup>rd</sup> ground wire, at least connect the Signal Ground (Gnd-A or SG) of the RS-485 port to the nearest device's digital ground. See the RDC application note AN005 (Grounding for RS-422/485) for more information on the importance and possible designs for this ground.

#### 4.3. Placing your bus terminators

At the end of each RS-485 segment, a 120-ohm terminating resistor is required, assuming that the cable has a characteristic impedance of 120-ohms. It is recommended that only the last unit of both ends to have their terminations enabled. Besides the terminations, all signal lines are already biased by default.

The unit is configured to operate in 4-wire mode with all terminations and bias enabled when the product is shipped. This means the 2 pins that are next to every label are shorted by jumpers, except the one that is labeled as "2-wire". Unshorting the appropriate pins will disable the function as described by its respective label.

For example, to configure the product to run in 2-wire mode, simply remove the jumper from the 4-wire position and place it such that the 2 pins that are next to the 2-wire label are shorted.



#### 4.4. Planning the panel wiring

**Power Supply:** The rdc485ir with full 3-of-3 ground isolation (model -3p) is fully protected from reverse wiring and will sustain no damage. The rdc485ir with partial 2-of-3 ground isolation (model -2p) is partially protected and if a fuse is installed in the V+ supply wire, should not sustain any damage.

**RS-485 Fuses:** RS-485 field wires should be protected by 250mA fuses. RS-485 interface ICs are internally protected from short-circuits. These fuses protect the system from over-voltages caused by miswiring - for example wiring 110vac to the bus.

**RS-485 Lightning Protection:** If required, the RS-485 field wires should be protected by standard lightning protection devices. The rdCLPU product is optimized for isolated RS-485 devices such as the rdc485ir and provides 20,000 Amp protection. However, any +/- 15v surge device should work. While many vendors suggest clamping surges to 6v or 7v, this disregards that RS-485 can work up to +12 volts. Clamping at too low of a voltage can lead to the RS-485 drivers operating at near short-circuit conditions and driving at the full current. This can cause over-heating of device and/or power supply.

#### 4.5. Physical installation

The unit mounts on a standard DIN rail as listed in the specification.

## 5. TECHNICAL SPECIFICATION

### 5.1. RS-485 port Description

- 5.1.1. **2-wire Signals** : D+, D-, and gnd/485
- 5.1.2. **Duplex** : full duplex, half duplex, automatic direction switching
- 5.1.3. **Line Voltage** : -7v to +12v, permits  $\pm 7$  Vdc ground difference between devices
- 5.1.4. **Bias** : 470 $\Omega$  pull-up (D+), 470 $\Omega$  pull-down (D-), option to enable/disable via jumper
- 5.1.5. **Bus Termination** : 120  $\Omega$ , option to enable/disable via jumper
- 5.1.6. **Official maximum Bus Length** : 1000 m per EIA-485, 500m per ISO 8482
- 5.1.7. **Practical maximum Bus Length** : 3000 m with high-quality cable, dependent on other conditions
- 5.1.8. **Maximum Speed** : At least 115 Kbps

### 5.2. Isolation

- 5.2.1. **Power Supply** : between input supply and data signals, full galvanic isolation (3 KV test voltage)
- 5.2.2. **Data** : between RS-485 ports : optical isolation (5 KV test voltage)
- 5.2.3. **Encapsulant (if ordered)**: 14,000 V per mm
- 5.2.4. **Overall rating at least 2500 V**

### 5.3. Power Supply

- 5.3.1. **5 V Model** : Supply range 4.75 to 5.25 Vdc (200mA Max)
- 5.3.2. **9-36v Model** : 1.2 W @ 24 Vdc (about 50mA)
- 5.3.3. **38-58v Model** : 1.2 W @ 48 Vdc (about 25mA)

### 5.4. Environmental

- 5.4.1. **Ambient operating temperature** : -20 °C to +65 °C
- 5.4.2. **Ambient storage temperature** : -40 °C to +100 °C
- 5.4.3. **Relative Humidity** : 10 to 95% RH, non condensing
- 5.4.4. **Casing** : Good fungus and termite resistance
- 5.4.5. **Casing** : Flame characteristics : self-extinguishing

### 5.5. Mechanical Dimensions

- 5.5.1. **Height, Width, Depth** (See drawing)
- 5.5.2. **Weight** : 130 g
- 5.5.3. **Terminal Capacity** :  
 2.5mm strand (12 AWG)  
 4.0mm solid (12 AWG)
- 5.5.4. **Mounting Rail** :  
 DIN EN 50022 (35mm "symetrical")  
 DIN EN 50035 (32mm "asymetrical")

Note: it fits best on the DIN 50022 style rail.

