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RDC485IC USERS MANUAL

ISOLATED RS-232 TO RS-485 CONVERTER
FOR 2 AND 4-WIRE RS-485 WITH GROUND WIRE
(DEFAULT FACTORY SETTING: 4-WIRE MODE)

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1. INTRODUCTION

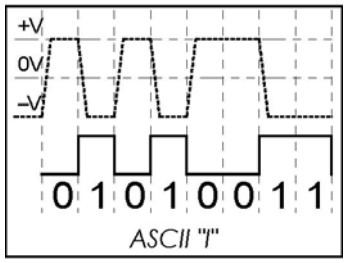
RS-485 has become one of the most common data communication standards in "open" multi-vendor automation projects. More robust than RS-232 and more flexible than RS-422, it allows a single master device to communicate with multiple slave devices. This manual is supplemented by application notes AN003 (*Example RS-485 2-wire*) and AN004 (*Example RS-485 4-wire*), which are more of an RS-485 tutorial and introduction.

1.1. Product Overview

For robust operation, the rdc485ic3 is an essential component of your industrial applications. It provides the following unique combination of features:

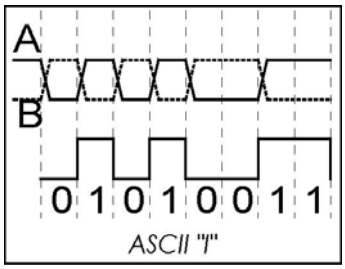
- Safely converts between EIA standard RS-232 and RS-485 signals.
- Isolates and protects the data signals and power supply grounds.
- With floating grounds, RS-232 cable runs up to 50m can be guaranteed with quality, capacitance cable like Beldon 1422A at 42pF/m. (RS-232 requires < 2500pF per signal wire.)
- Over 2500v isolation between the RS-232 and RS-485 ports (5kv test optical isolation) and 2500v galvanic isolation between the RS-485 port and the power supply (3kv test isolation).
- The full isolation 3-port model also provides isolation between the RS-232 port and the power supply.
- Transmit, receive and power status are indicated via LEDs for rapid troubleshooting.
- Wide power supply range (9 to 36 Vdc) with spike protection allows the use of 9, 12, 15 and 24-volt power supplies or direct power up from 12 or 24 volt battery systems.
- Offers the option of 9-pin d-sub shell connector (AT style) or large capacity (2.5mm²) compression screw terminals, giving maximum flexibility for the installation in panels and terminal boxes.
- 9-pin female "DCE like" ports allow use of ribbon cables from 9-pin computer ports.
- 600 watt transient suppresser diodes are installed on isolated ports. (600w for 1ms with less than 1psec response to over-voltage)

1.2. Brief description of RS-232



RS-232 is an interface standard - not a data communication standard. This means it can only go short distances and has very limited driving power. It provides full duplex, point-to-point data transfer between two devices. The signal ground is included as one of the wires, so it is ***very*** susceptible to damage or interference from ground loops. Data is transmitted as a voltage polarity relative to the common signal ground. For example, here is the signal for an ASCII character 'I'. When the signal voltage is greater than 3 volts, the data is treated as logic '0'. When the signal voltage is less than –3 volts, the data is treated as logic '1'. A voltage signal between –3 and +3 volts is logically undefined. When the line is idling, it will be in the logic '1' state (i.e. –3 volts). This voltage signal is referenced to a shared ground and is thus quite susceptible to noise. Furthermore, the existence of the ground wire leads to grounding and surge problems.

1.3. Brief description of RS-485



RS-485 is a half-duplex data communication standard which can be used in 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.*** (i.e. 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 as A, and the other as B. Data is represented by the relative voltage of A to B. When $V_A < V_B$, the data is treated as logic '1'. When $V_A > V_B$, the data is treated as logic '0'. When the line is idling, it will be in the logic '1' state (i.e. $V_A < V_B$). This differential voltage signal is quite robust and is not susceptible to noise or minor shifts in the signal reference ground.

1.4. RS-485 - Two and Four Wire Mode

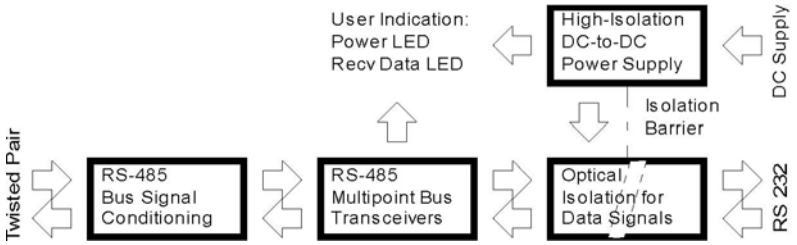
The 2-wire mode of the RS-485 is strictly half-duplex. One wire pair is used as a bi-directional bus. (i.e. one moment transmitting a "request" and the next moment, receiving a "response") Many industrial products support both the 2 and 4 wire mode by providing the 4-wire terminals and they include external jumpers to short the A signals and B signals for operating in 2 wire mode.

The 4-wire mode uses two-twisted wire pairs, one for transmitting and the other for receiving. Hence, the rdc485ic is capable of operating in full duplex mode. The transmit pair is used by a master device to communicate with the slave devices, and the receive pair is used by the slave devices to respond back to the master. The 4-wire mode of the RS-485 is more robust than the 2-wire mode when a low quality cable is used or when operating in high noise areas. It also reduces interruption during communication as compared to the 2-wire mode.

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

2. FUNCTIONAL DESCRIPTION

2.1. Isolated Power Supply



A power conditioning circuit steps down the DC supply (9-36 Vdc) to a non-isolated but stable 5 Vdc. The high isolation DC-to-DC converters convert this stable 5 Vdc to one or two isolated 5 Vdc supplies. (Depending on the 2p or 3p option respectively). If the 2p option is specified, the RS-485 port will be isolated from both the RS-232 port and the input DC supply but the RS-232 port will be powered from the non-isolated 5 Vdc. If the 3p option is specified, the RS-232 port will also be isolated from the input DC supply. This implies that the RS-232, RS-485 and input DC supply will be fully isolated from each other when the 3p option is specified.

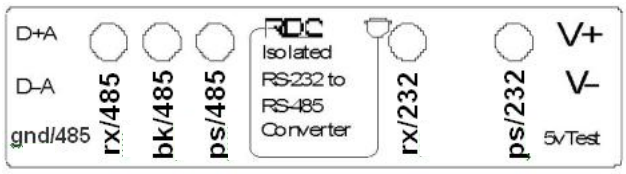
2.2. Optical Isolation for Data Signals

Digital opto-couplers are used to couple the data signals between the two sides of the converter. These are superior to the more common analog opto-couplers, as they do not contribute much to distortion and therefore support higher baud rates. 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. The full EIA/RS-485 specification is met by using SN75176 compatible chips. Complete software transparency is achieved by the rdc485ic especially when operating in 2-wire mode on a bi-directional bus that requires the unit to switch between transmit and receive.

2.4. User Indication



The green LEDs (ps/232 & ps/485) light up to indicate that both the RS-232 and RS-485 ports are powered. The yellow LEDs (rx/232 & rx/485) flash when data is received on the RS-232 and RS-485 port respectively. The red LED (bk/485) lights up when a signaling problem is detected at the RS-485 port. The problem may be due to a wrong connection (i.e. Tx+ to Rx-) or when the Tx+ line is shorted to ground etc.

2.5. Signal Conditioning

For normal operation, the rdc485ic has 6 jumpers installed to terminate and bias the RS-485 interface. Some of them have to be removed when more than two (2) units of

rdc485ic are connected to the same RS-485 wire pair. For example, if 4 units of rdc485ic connect to a wire pair, at least 2 of them must have their termination jumpers removed. Both ports have transient suppression diodes rated at 500w 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.

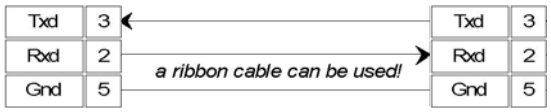
3.2. RDC's Naming Convention

RDC has chosen to names 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

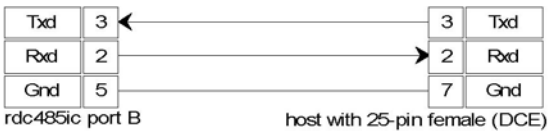
4.1. Making Standard RS-232 Cables

The rdc485ic has one 9-pin female connector which looks like a 9-pin "modem" or DCE port.



Cable A : host with 9-pin DTE port

Cable B : host with 25-pin DTE port



Cable C : host with 25-pin DCE port

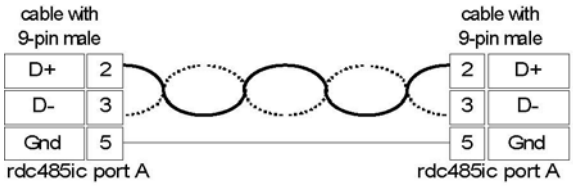
Standard RS-232 interface devices cannot be damaged by reverse wiring or short-circuits to the ground. However, some low-cost devices have used transistors to generate an approximate RS-232 signal and this built-in protection may not be there.

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

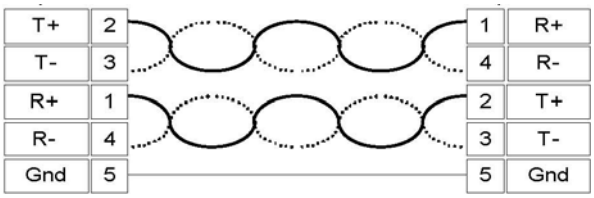
When connecting up as 2-wire mode, ensure that all '+' and '-' terminals are correctly wired. As a convention, RDC suggests choosing a darker wire (or solid color) for '+' and a lighter color (or striped pattern) for '-'. Since the bus is bi-directional, the "+" and "-" pair with switch between the transmit and receive modes as appropriate. *Remember, RS-485 is NOT a loop.* On the rdc485ic, 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 3rd 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.

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



RS-485 2-wire Cable



RS-485 4-wire Cable

With the 9-pin D-sub shell option, the same 2 or 4-wire signals are available on pins 2, 3, 5 and 1, 2, 3, 4, 5 respectively. The diagram above shows the wiring between 2 rdc485ic units. To facilitate multi-drop wiring, each signal (with the exception of ground) is wired on 2 pins as shown below.

Pin 1 (R+) = Pin 6
Pin 2 (T+) = Pin 7
Pin 3 (T-) =Pin 8
Pin 4 (R-) = Pin 9

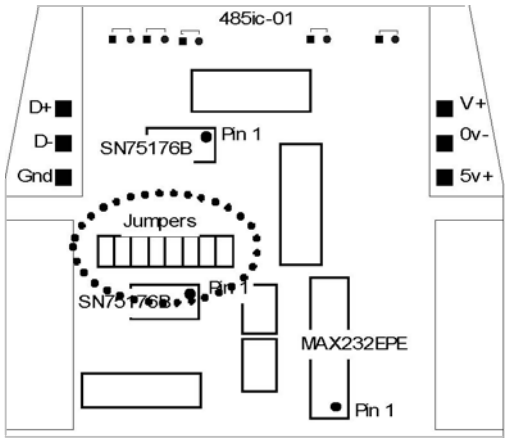
It is also ***critical that the Signal Ground be properly connected - you void your warranty if you do not connect this ground properly***. If the RS-485 bus does not have the 3rd ground wire, at least connect the Signal Ground (Gnd-A or SG) of the RS-485 port to the nearest device's digital ground.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

4.4. Placing your bus terminators

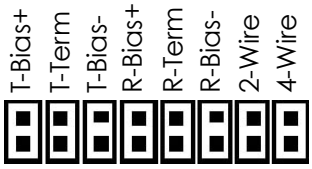
At the end of each RS-485 segment, a 120-ohm terminating resistor is required, assuming that the cable has a characteristic impedance of 120-ohms. It is recommended that only the last unit of both ends to have their terminations enabled. Besides the terminations, all signal lines are already biased by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



Jumper location
(Default factory setting: 4-wire mode)



Jumper Details

4.5. Planning the panel wiring

The rdc485ic-dv (9 to 36 Vdc) is fully protected from reverse wiring but not the rdc485ic-dv (5 Vdc +- 5%) model. Installing a fuse in the V+ supply wire will provide a limited form of protection for the 5-V version.

The ICs in the RS-485 interface are internally protected from short-circuits but the field wires should be protected by 250mA fuses. These fuses protect the system from over-voltages caused by wrong connections. (i.e. wiring the bus to a 110 Vac power line etc)

Standard lightning protection devices should also be used to protect the RS-485 field wires where necessary. RDC suggests 15v or 16v surge protection. While many vendors suggest clamping surges to 6 or 7 V, this disregards the fact that the RS-485 can provide a signal of up to 12 volts. Clamping at too low a voltage can cause the RS-485 drivers to drive at full current and operate at near short-circuit conditions. This can cause the unit and/or power supply to overheat.

4.6. 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 ±7 Vdc ground difference between devices
5.1.4. **Bias :** 470Ω pull-up (D+), 470Ω pull-down (D-), option to enable/disable via jumper
5.1.5. **Bus Termination :** 120 Ω, 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 and RS-232 port : 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 (175mA average)
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. **Weigh :** 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 50025 (32mm "asymetrical")

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