

CB-485 Bare PCB

Details

The PCB-CB-485 is a bare PCB to build the CB-485 logic-level to RS-485 adapter. This is an unpopulated board and no parts are included. The BOM (bill of materials) and schematic diagram are available at <http://www.busboard.us/products/CB-485/> to construct the circuit. Soldering is required and prior experience with electronic assembly is recommended. A PCB soldermask helps prevent solder bridges on tracks and a silkscreen legend provides part locations. All thru-hole construction allows for easy assembly, maintenance, and modification.

The CB-485 uses the ComBoard standard for interchangeable serial interface modules. Various build options are possible including 4-wire serial, 1x10-pin female ComBoard header, or a 2x5-pin shrouded header for use with ribbon cables. With the 1x10 male header option, the CB-485 can be used with solderless breadboards. The 0.1" spacing of parts and mounting holes allow it to be soldered onto prototyping boards. It can be plugged into microcontroller dev boards with ComBoard serial port headers allow the serial port type to be easily changed.

The CB-485 provides an RS-485 interface for microcontroller projects. The RS485 chip converts CMOS level transmit (Tx) and receive (Rx) lines to differential RS485 voltages that can be sent over long distances. RS485 allows multi-drop connects to create device networks with many devices talking to each other. The ComBoard RTS input line controls the driver enable line so the device only talks when it is enabled.

The CB-485 can be used with a wide number of RS-485 converter ICs using the common MAX483 and MAX485 half-duplex 8-pin DIP pinout. A DIP IC socket should be used to allow easy IC replacement to use different speed/feature parts or to replace damaged parts. ICs with this pinout are available from Texas Instruments, Analog Devices, Linear Technologies, Exar, Maxim and others. Note that the different ICs have different data rates, bus loading (maximum # devices), and built-intransient protection features. Select devices that match your project needs. See the BOM for some suggested parts.

Either a 4 position terminal block (5mm pitch) or RJ45 connectors can be fitted for the RS-485 connectors. This allows either twisted pair cables to be used with terminal blocks, or Ethernet Cat5e or Cat6e cable to be used with RJ45 jacks.

What is ComBoard?

ComBoard is an open standard for USART peripheral modules that can provide all 9 pins of the serial handshaking signals (8 signals plus ground). Many modules only need 2 signals (Receive and Transmit) or 4 signals (adding RTS and CTS flow control). However, it is helpful to have all the signals available on a development board for the modules that need them. The CB-485 module uses Tx, Rx, and RTS (for driver enable).

A tenth signal is added to the connector, which is power for the module. Either +5V or +3.3V is used depending on the module and the microcontroller requirements.

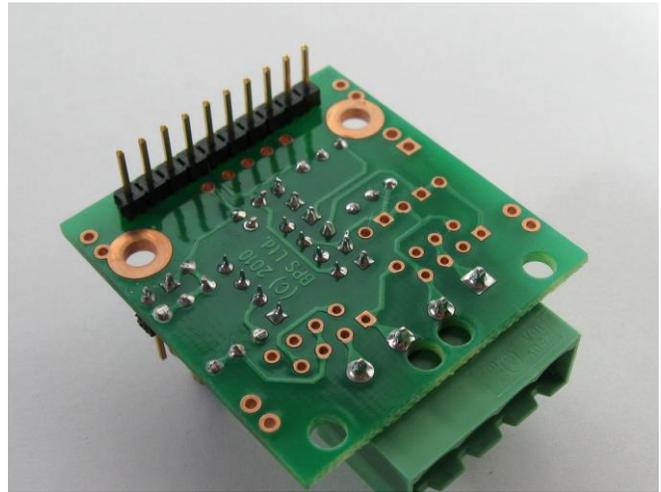
Various connectors can be used with ComBoard depending on the application.

ComBoard Connector Style	Key Application
1 x 10 Header Pins on Bottom	Plugs into solderless breadboards and development boards. All signals available.
1 x 4 Wired Connector	The 4 wire connector can NOT be used with CB-485 because RTS is required for the Driver Enable.
2 x 5 Ribbon Cable Header	Ribbon cable connected modules with polarized (shrouded) connectors. All signals available.

The ComBoard 1x10 header style can be inserted into solderless breadboards or soldered into prototyping boards. Serial adapters with dual row headers can't be used with breadboards.

1x10 Header (J10), UART Logic Levels

The 1x10 header is usually installed on the bottom of the PCB to allow the adapter to be inserted in a breadboard or development board, or soldered into a prototyping board.



The ComBoard 1x10 pinout is as follows:

Pin	Name	Description	Signal Direction
1	GND	Ground	
2	Rx	Receive Data	Input (to MCU)
3	Tx	Transmit Data	Output (from MCU)
4	+5V (or +3.3V)	Power	Power to ComBoard
5	Ring	Ring	Input (to MCU)
6	CTS	Clear To Send	Input (to MCU)
7	RTS	Request To Send, Used for RS-485 Driver Enable	Output (from MCU)
8	DSR	Data Set Ready	Input (to MCU)
9	DCD	Data Carrier Detect	Input (to MCU)
10	DTR	Data Terminal Ready	Output (from MCU)

The DTE names are used for logic-level signals (Tx is an output).

All signal levels on this header are CMOS logic levels. MCU = the microcontroller.

Pins 5,6,8,9,10 Not Used on CB-485 modules.

The ComBoard 1x10 pin out provides all 9 pins required for full serial port handshaking plus a power pin. Some modules may only use some of the pins, such as Tx and Rx for 2-wire serial, or Tx, Rx, RTS and CTS for 4-wire serial with flow control.

The power supplied on pin 4 is +5V or +3.3V depending on the development board and jumper options.

The CB485, CB-232F and CB-232M modules use the same 1x10 connector signals so that they can be plugged in interchangeably on development boards. Note that DTE signals names and directions are used on the 1x10 connector regardless of whether the module and DB9 connector is DTE (DB9M) or DCE (DB9F).

Alternative: 2x5 Header (J5), UART Logic Levels

The ComBoard 2x5 header is an alternative pinout that allows the serial port to be used with 10-pin ribbon cables. This can be useful to interface to another board or to locate the serial driver away from the main board.

The ComBoard 2x5 pin out is as follows:

Direction	Signal Function	Pin	Pin	Signal Function	Direction
Input (to MCU)	DCD Data Carrier Detect	1	2	DSR Data Set Ready	Input(to MCU)
Input (to MCU)	Rx, Receive Data	3	4	RTS Request To Send	Output(from MCU)
Output (from MCU)	Tx, Transmit Data	5	6	CTS Clear To Send	Input(to MCU)
Output(from MCU)	DTR Data Terminal Ready	7	8	RING	Input (to MCU)
	GND Ground	9	10	+5V (or +3.3V)	Output

MCU = the microcontroller

All signal levels on this header are CMOS logic levels.

Pins 1,2,6,7,8 Not Used on CB-485 module

Polarized (shrouded) 2x5 headers should be used with polarized IDC ribbon cable plugs to avoid reversed connections.

2x5 Pinout Details

Note1: One side of the 2x5 connector overlaps and shares 5 pins with the 1x10 ComBoard connector which saves PCB space.

Note2: The ComBoard 2x5 pinout is different from the Olimex UEXT standard, which also uses 10-pin ribbon cables. ComBoard has all 9 serial signals plus power. UEXT connector serial signals only have the Tx, Rx, power, and ground.

RS485 Connector Option #1 - RJ45 Connectors (J1, J2)

The CB-485 adapter can be fitted with two RJ45 jacks to carry the RS485 signals over Cat-5e cables. The two jacks are connected in parallel, so it is easy to daisy-chain multiple RS485 devices for multi-drop configurations.

Cat5e uses twisted pairs which help to reduce the noise in long cable runs. RJ45 jacks are 8P8C eight position, eight conductor modular connectors.

RJ45 Pinout Features

The pinout is designed such that...

1. The RS485 A and B lines are twisted together to reduce EMI and noise pickup.
2. The RS485 A and B signals are each carried by two wires each for greater reliability.
3. The power and ground circuits are each carried by two wires for greater reliability and higher current handling ability.

Pin	T568 A Pair	T568A Color	Ethernet Signal	RS485 Signal
1	3	 White-Green	RX+	RS-485 (B)
2	3	 Green	RX-	RS-485 (A)
3	2	 White-Orange	TX+	Remote Power
4	1	 Blue	Not Used	Ground
5	1	 White-Blue	Not Used	Ground
6	2	 Orange	TX-	Remote Power
7	4	 White-Brown	Not Used	RS-485 (A)
8	4	 Brown	Not Used	RS-485 (B)

Wire graphics from <http://en.wikipedia.org/wiki/TIA/EIA-568-B>

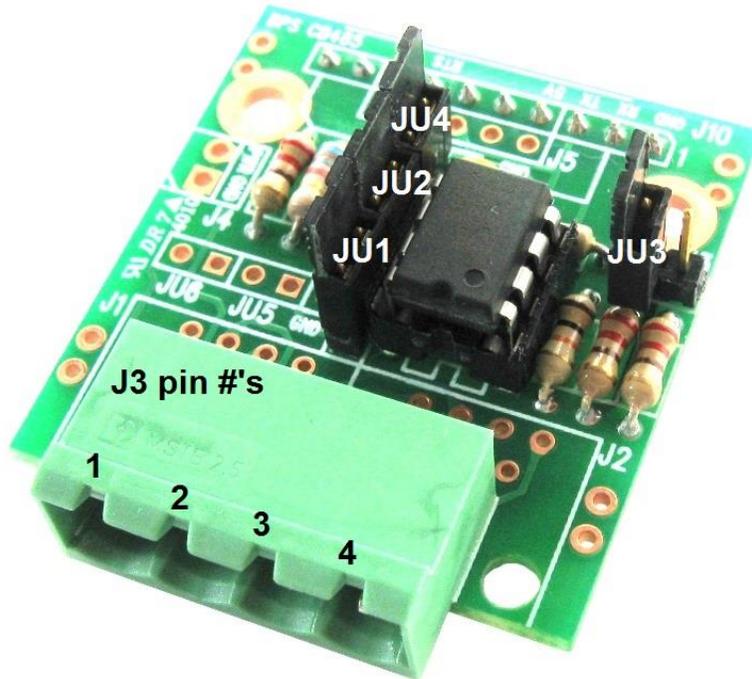
RS485 - 4 Pin Terminal Block Connection (J3)

The CB-485 can be assembled with a 4-pin removable terminal block (5.06mm, 0.2” pitch) instead of the RJ45 jacks. The terminal block allows heavier gauge wire to be used.

Ferrules are recommended for the wire ends to provide a secure connection with the terminal block contacts.

Pin 1 (Ground) is on the left on the terminal block on the device (looking into the pins).

1	2	3	4
Ground	RS-485 (A)	RS-485 (B)	+12V Power

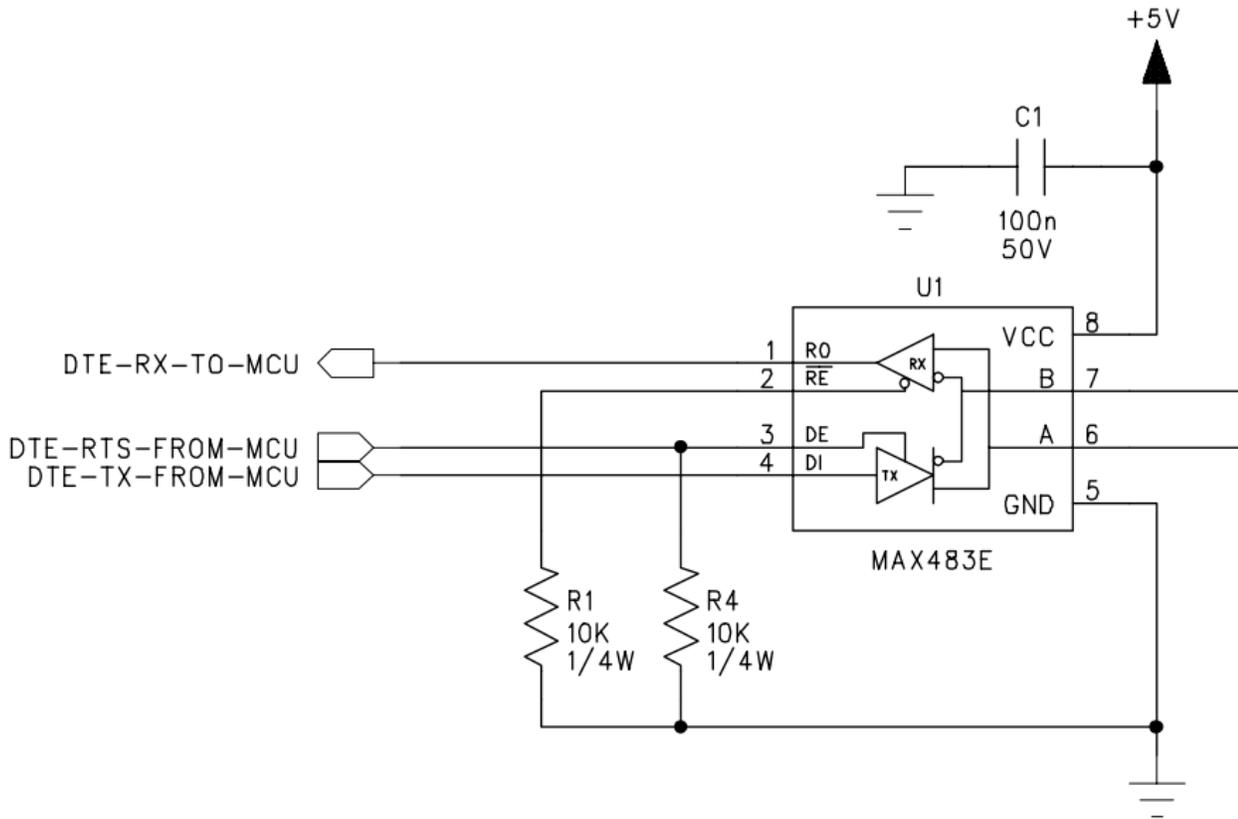


RS485 Protocol Transmit Control and Retries

Your embedded firmware will need to control the DE Drive Enable signal to transmit data (on the RTS pin). The DE signal is HI to enable transmit. It should be LO when not transmitting to avoid conflicting with other devices transmitting.

The firmware should incorporate the necessary features to reliably transmit data on a multi-drop bus.

- Transmits with retries and acknowledgements
- Collision detection, back off, and retries (for when 2 units transmit at the same time)
- Error detection (checksums or CRCs)



CB-485 Tx, Rx, and Driver Enable Signals

Termination Resistors

To provide the proper impedance and improve signal quality on longer cables, termination resistors are required for the two RS-485 devices at the ends of a cable. The resistors are not used for devices in the middle of the cable.

Jumpers JU1, JU2, and JU4 are installed to add the termination resistors.

Remote Power

Remote power and ground connections are provided. This allows remote devices to be powered through the cable. The remote power pins can be left unconnected if both sides are independently powered.

The power signals go to connector J4 which must be connected to a regulator and power protection circuit if needed. J4 is a MTA-100 2-pin connector, but the 0.1" spacing allows other connector types to be fitted.

Grounding

The grounds of the two devices talking must be close to the same potential. Although the RS485 signals are differential, they won't work correctly if the grounds differ by too much. The two grounds can either be connected directly, or connected through resistors.

If the two sides are at different potentials, undesirable current can flow in directly connected ground wires. The grounds throughout a building may vary and the equipment ground is not necessarily at 0 Volts relative to the other device.

Jumper JU3 selects whether ground resistors are used. The resistors allow the two units to be close to the same ground potential without directly connecting the grounds. Install JU3 to directly connect the grounds and remove JU3 to use series ground resistors.

If removing jumper JU3 and using the ground resistors does not solve a problem with a large potential difference, it may be necessary to use an optically-isolated interface.

Transient Protection

A RS-485 driver with transient protection may be needed if there are electrical surges. Long data cables can act as long antennas, picking up noise from lightning and man-made sources. Shielded cable can help protect the data lines from electrical disturbances.

We recommend selecting a RS-485 IC with built-in transient protection. Additional line filtering can reduce the amplitude of transients and help the IC protection work better. The tracks under JU5 and JU6 can be cut to install series ferrites or other filtering. An adjacent ground test point allows filter capacitors to be connected to ground.

RS-485 Resources

We hope the CB-485 module is helpful for your long distance or multi-drop communications project.

CB-485 documentation can be found at <http://www.busboard.us/products/CB-485/>

Related datasheets can be found at <http://www.busboard.us/products/CB-485/Datasheets/>

We recommend learning about how to apply RS-485 (and how it differs from RS-232 and RS-422) when selecting and designing a communication system.

RS-232 is good for two devices to communicate over short distances, up to 50 feet.

RS-422 uses 4 data wires, and is full duplex. It is good for communicating between 2 devices over a long distance. Since it is full duplex, both devices can transmit at the same time which can simplify the software over RS-485. RS-422 has only 1 sender, but it can have multiple receivers.

RS-485 uses only 2 data wires and more than 2 devices can send data on the bus over long distances.

RS-485 is typically half-duplex (one device sends at a time), but full-duplex RS-485 systems are also possible with 4-wire transceivers on each end (not possible with the CB-485).

Analog Devices has a good application note AN960 “RS-485 RS-422 Circuit Implementation Guide”.

<http://www.Analog.com> Full-duplex RS-485 systems are shown.

The Texas Instruments Application Note “The RS-485 Design Guide” slla272b.pdf gives a brief introduction to RS-485 technical details. There is a list of other articles at the end. <http://www.ti.com>

Circuit Cellar Ink magazine (<http://www.circuitcellar.com>) has articles on RS-485.

“The Art and Science of RS-485” By Bob Perrin, Circuit Cellar online, July 1999

“Designing RS-485 Circuits” By Jan Axelson, Circuit Cellar, June 1999

PDFs of these articles might be found online.

If you needed optical isolators, transient protection or other specialized RS-485 equipment, B & B Electronics has a wide variety of products to solve many communications problems.

They also have many papers and articles about serial communications. They can be found on their web site at <http://www.bb-elec.com/>.

Some recommended articles are:

- RS-422 and RS-485 Applications eBook
- Basics of the RS-485 Standard
- RS-485 Connections FAQ
- RS-485 Problem Solver - Trouble Shooting Guide Walks You Step by Step
- RS-485 Quick Guide - Just the Essentials on a Single Piece of Paper
- RS-485 Tips, Tricks, Questions & Answers.
- Polarities for Differential Pair Signals (RS-422 and RS-485)
- Isolation and Surge Protection
- Data Line Isolation Theory
- Dataline Surge Protection: Stop Fried Boards, Corrupted Data
- Isolation: Your Best Investment for Reliability
- How Optical Isolation Works

Appendix - Using Cat-5e Cable with the 4-pin Terminal Block

This is the recommended wiring pattern to use Cat5e cable with the 4-pin terminal block.

1. Two wires are used for each signal for greater reliability.
2. The A and B data lines are twisted together for better noise immunity.

RS485 Terminal Block Pinout

Pin 1 (Ground) is on the left on the terminal block on the device.

1	2	3	4
Ground	RS-485 (A)	RS-485 (B)	Power
 White-Blue	 White-Green	 White-Brown	 Wh-Orange
 Blue	 Brown	 Green	 Orange

Important: The wire colors shown above are for T568A. Ensure the T568A wiring standard is used for the RJ45 connector on both ends of the cable (i.e. Green and Brown are the outer pairs on the RJ45 plug). Some cables using the outdated T568B standard swaps the green and orange pairs.

Alternate Diagram - Terminal Block Connections Using Cat-5e Cable

The T568A pin numbers and pair numbers are shown in this diagram.

Pin 1 (Power) is on the left on the terminal block on the device.

Block Pin	RS485 Signal	T568A Color	8P8C Pin	T568A Pair
4	Power	 White-Orange	3	2
	Power	 Orange	6	2
3	RS-485 (B)	 White-Green	1	3
	RS-485 (B)	 Brown	8	4
2	RS-485 (A)	 Green	2	3
	RS-485 (A)	 White-Brown	7	4
1	Ground	 Blue	4	1
	Ground	 White-Blue	5	1

Note: The T568A Pair is the twisted pair# used for telephone service over Cat5e.