User's Guide

RS-485 Half-Duplex Evaluation Module

TEXAS INSTRUMENTS

Joe Fockler

ABSTRACT

This manual describes the RS-485 Half-Duplex Evaluation Module (EVM). This EVM helps designers evaluate the device performance, supporting the fast development and analysis of data transmission systems using any of the TI RS-485 half-duplex devices in an 8-pin SOIC package.

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1 Trademarks

All trademarks are the property of their respective owners.

2 Overview

TI RS-485 half-duplex devices in the 8-pin SOIC package have robust drivers and receivers in a small package for demanding industrial applications. The bus pins are robust to ESD events, with high levels of protection to Human-Body Model and IEC Contact Discharge specifications. These devices each combine a differential driver and a differential receiver, which operate from a single power supply. The driver differential outputs and the receiver differential inputs are connected internally to form a bus port suitable for half-duplex (two-wire bus) communication, and all feature a wide common-mode voltage range making the devices suitable for multi-point applications over long cable runs. TI's RS-485 devices are characterized for industrial applications.

Note

This EVM comes without a transceiver soldered on to the board. The user can order any TI half-duplex, 8-pin SOIC RS-485 transceiver and solder it down on the board for evaluation. The EVM Tools Folder contains links to devices that work with this EVM. See http://www.ti.com/tool/rs485-hf-dplx-evm for more information.

Using the SN65HVD888 with Bus Polarity Correction Feature

This EVM can support the SN65HVD888 half-duplex RS-485 transceiver with bus polarity correction (See Figure 2-1). The SN65HVD888 transceiver corrects a wrong bus signal polarity caused by a cross-wire fault. In order to detect the bus polarity all three of the following conditions must be met:

- a failsafe biasing network must be implemented (at the controller node) to set logic reference and define the signal polarity of the bus,
- a target node must have its receiver enabled and its driver disabled ($\overline{RE}$ = DE = Low),
- the bus must be idling for the failsafe time, $t_{FS\text{-}max}$.

After the failsafe time has passed, the polarity correction is complete and is applied to both, receive and transmit channels. The status of the bus polarity is latched within the transceiver and maintained for subsequent data transmissions.

Note: Data streams of consecutive 0's or 1's with durations exceeding $t_{FS\text{-}min}$ can accidently trigger a wrong polarity correction and must be avoided.

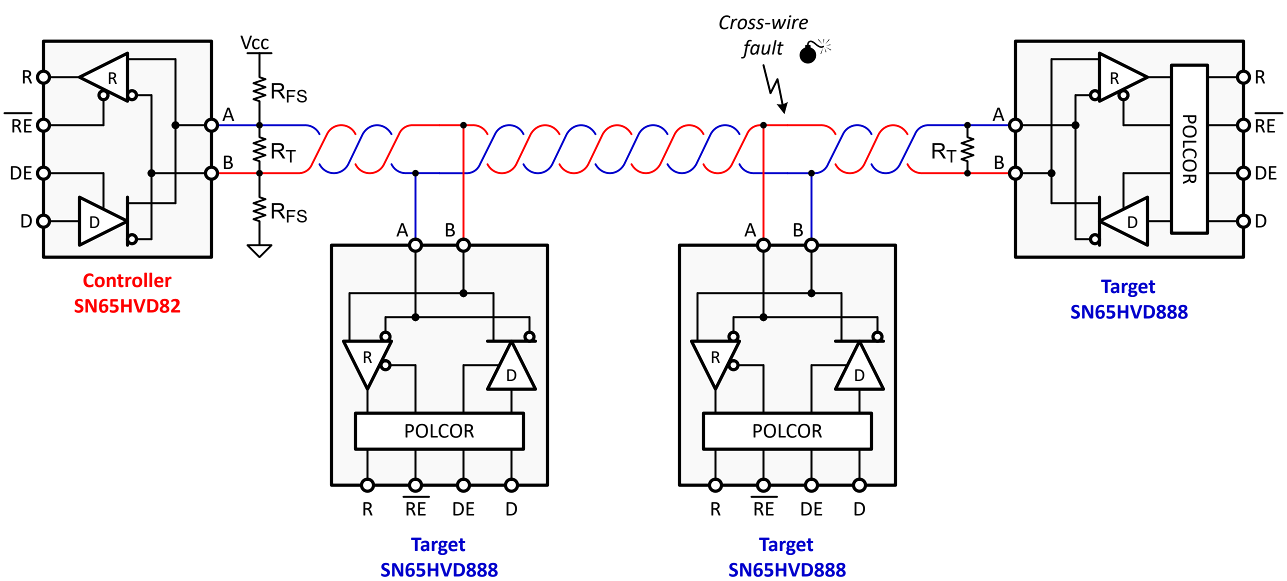

Figure 2-1. Typical Applications Diagram

3 EVM Setup and Precautions

Figure 3-1 shows the schematic of the EVM. The EVM board has headers labeled from JMP1 to JMP14 (JMP5 is omitted) and two 3-pin terminal blocks labeled TB1 and TB2. These headers support device evaluation for a wide range of system configurations.

Note

The examples in this document show a 3.3-V signal generator and a 3.3-V power supply unit. Depending on the Texas Instruments RS-485 device chosen, the user may need to provide a 5-V signal generator input and 5-V power supply.

- Pin 1 (EARTH) is a second ground pin that allows applying an external voltage between GND and EARTH to simulate common-mode voltage conditions.
- Pin 2 (GND) is connected to the negative output or ground terminal of the PSU. This pin represents the ground potential of the device-under-test and the entire EVM. It also connects to various jumpers on the board.
- Pin 3 (VCC) is connected to the positive output of a regulated power supply unit (PSU) as it represents the positive supply voltage of the device-under-test and also connects to various jumpers on the board.

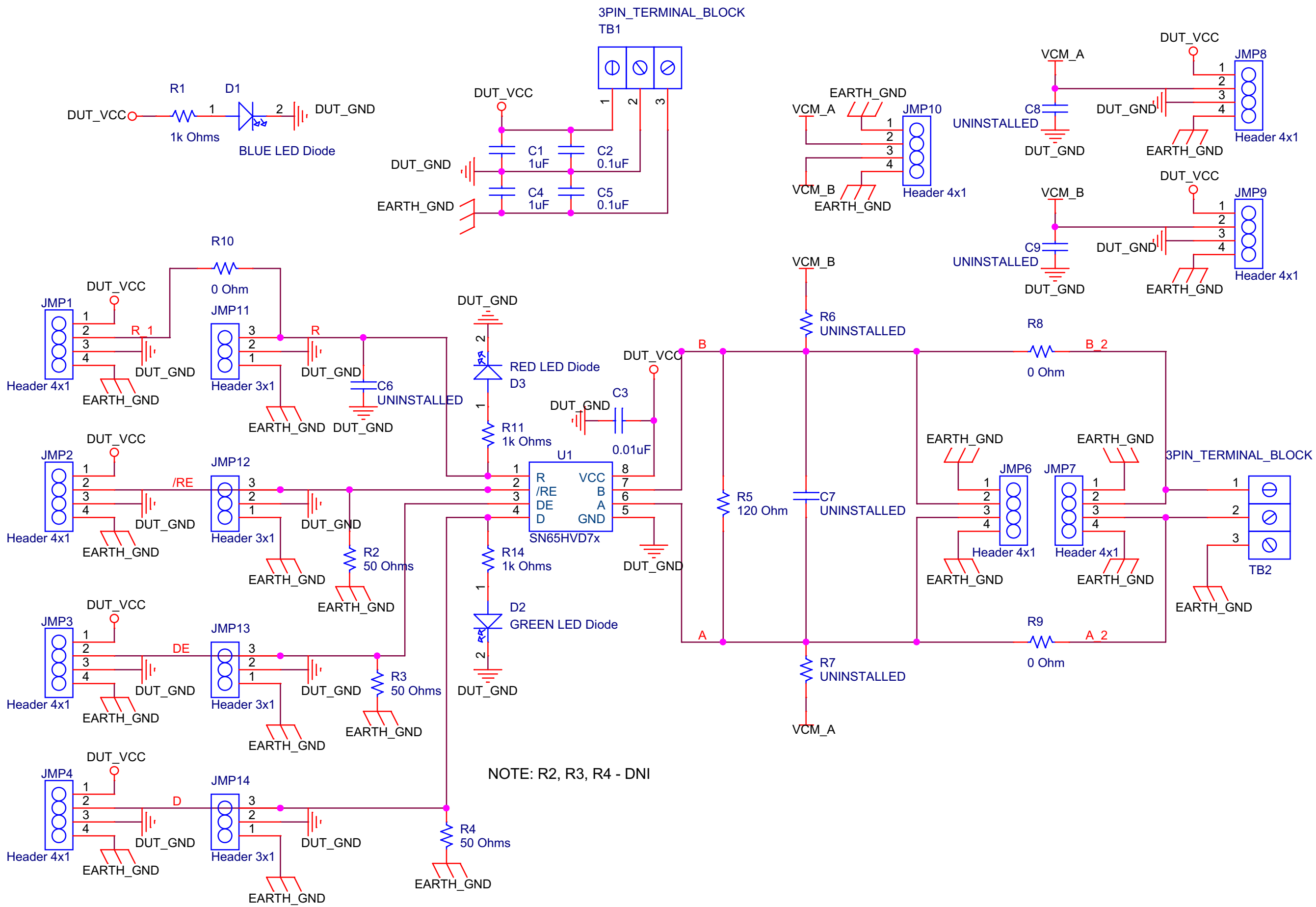

Figure 3-1. RS-485 Half-Duplex EVM Schematic

For the first measurements, ignore the common-mode simulation and connect EARTH to GND through a wire-bridge between pin 1 and pin 2 of TB1.

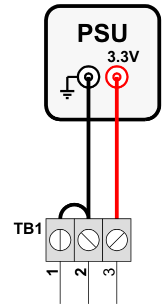

Figure 3-2. Bridging DUT_GND with EARTH_GND

While JMP2 to JMP4 are stimulation points, or headers through which the control and data signals for the RS485 Half-Duplex EVM are applied, JMP1, and JMP11 to JMP14 are probe points, or headers at which these signal can be measured.

Note that the 50-Ω resistors, R2, R3, and R4, have the index *n.a.*, indicating that these components are *not assembled*. Because signal generators have a typical source impedance of 50 Ω, their output signal is twice the required signal voltage, and assumes that the on-board 50-Ω resistors divide this voltage down to the correct signal level.

Without these resistors; however, this voltage divider action is not accomplished, and the generator output voltage must be reduced to match the V_{CC} requirements of the RS-485 device.

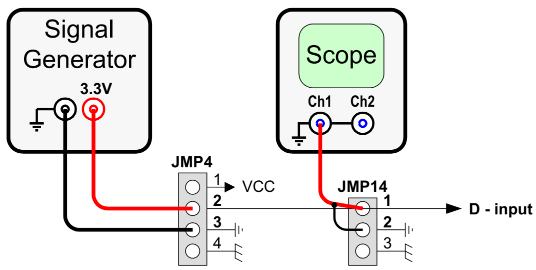

Figure 3-3. Example for Stimulus and Probe Points with JMP4 and JMP14

Figure 3-3 gives an example for entering a data signal into the driver section of the transceiver. The signal output of the generator is adjusted to match the device V_{CC} power supply requirements . The generator's ground terminal is connected with pin 3, and the signal output terminal with pin 2 of JMP4. The data signal is measured through an oscilloscope with its signal input connected to pin 1 and its ground wire connected to pin 2 of JMP14.

The same setup applies to the DE and $\overline{RE}$ inputs through their corresponding headers JMP2 and JMP12 and JMP3 and JMP13. JMP1 however, must not receive a signal stimulus. Like JMP11, it represents the receiver output, R, of the half-duplex RS-485 device.

Instead of using signal generators, the EVM can directly interface to the micro controller I/O. Then the non-assembled 50-Ω resistors are of no concern. However, for proper operation, it must be assured that the high-level input voltage $V_{IH} \geq 2$ V and the low-level input voltage $V_{IL} \leq 0.8$ V.

4 Powering Up the EVM and Taking Measurements

The generally recommended procedure for taking measurements is listed:

1. Install the required ground connections.
2. Connect the oscilloscope with the respective probe points you want to measure.
3. Adjust the power-supply to match the V_{CC} requirements of the selected RS-485 device.
4. Adjust the generator outputs for a maximum output signal level, based on the V_{CC} requirements of your selected RS-485 device, or check the logic switching levels of the controller I/O.
5. Connect the power supply conductor with pin 3 of TB1 and observe the blue LED (D1) turning on.
6. Connect signal conductors from the controller or the generator with their corresponding EVM inputs at JMP2 to JMP4.
7. Logic high at the receiver output, R, will turn on the red LED (D3), and logic high at the driver input, D, turns on the green LED (D2). If D is left open, an internal 100-kΩ pull-up resistor provides logic high instead. However, due to the small input current, D2 will remain off.

4.1 Measurement Examples

Each of the following measurement examples show the equivalent circuit diagram and the corresponding EVM setup. Only the measurement relevant headers and terminal blocks are shown, and not necessarily at their exact location on the EVM.

1. Standard Transceiver Configuration

   Normal transceiver operation requires both the driver and the receiver sections being active. Therefore, the receiver enable pin ($\overline{RE}$) must be at logic low potential and the driver enable pin (DE) at logic high.

   Transmit data entering at the D-input terminal appear as the differential output voltage ($V_{OD} = V_A – V_B$) on the bus wires, A and B. Via the active receiver, it is possible to sense the data traffic in transmit direction.

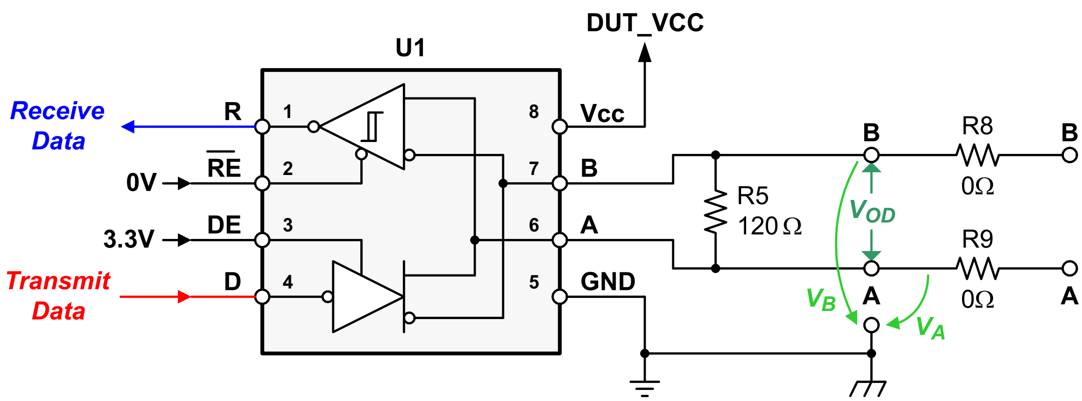

Figure 4-1. Transceiver Configuration for Normal Operation

Figure 4-2 shows the corresponding EVM setup. EARTH and GND receive the same reference potential, PSU-ground, through the wire-bridge from pin 1 to pin 2 at the terminal block, TB1, while pin 3 (VCC), in this example, is connected to the 3.3-V output of a power-supply unit (PSU).

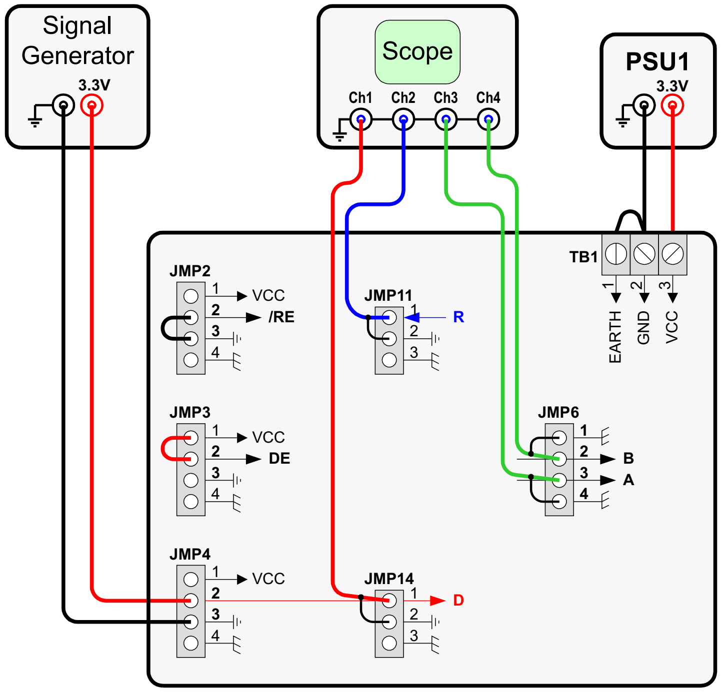

Figure 4-2. RS-485 Half-Duplex EVM Setup for Normal Transceiver Operation

The low potential for $\overline{RE}$ is provided by the wire-bridge from pin 2 to pin 3 at JMP2, and the high potential for DE through a wire-bridge from pin 2 to pin 1 at JMP3. Data from the signal generator enter the board at pin 2 and pin 3 of JMP4. This data is measured via channel 1, which is connected to pin 1 and pin 2 of JMP14. Channel 2 measures the receive data at JMP11, and channels 3 and 4 the bus voltages, V_A and V_B, at JMP6.

2. Operation Under Maximum Load

EIA-485 (RS-485) specifies three maximum load parameters: a maximum differential load of 60 Ω, a maximum common-mode load of 375 Ω for each bus wire, and a receiver common-mode voltage range from –7 V to +12 V. Figure 4-3 reflects these requirements through R5, R8, R9, and V_{CM}. Note that under maximum load conditions the transceiver must be capable of sourcing and sinking bus currents of up to 55 mA. The purpose of this test is to show the robustness of V_{OD} over the entire common-mode voltage range at maximum load.

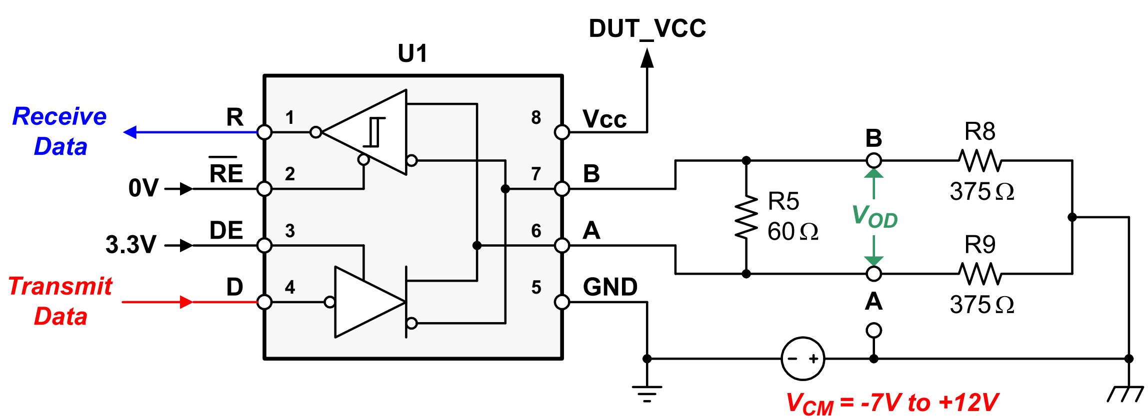

Figure 4-3. Configuration for Maximum Loading

While the cable connections of the signal generator and the oscilloscope remain the same as in the previous example, the following board changes need to be implemented to reflect maximum load conditions:

- replace R5 (120-Ω default) with 60 Ω
- replace R8 and R9 (0-Ω default) with 375 Ω
- connect pin 2 of JMP7 with pin 1 and pin 3 with pin 4

- replace the previous wire-bridge at TB1 with a second power supply unit (PSU2) and connect the ground terminals of both, PSU1 and PSU2 with a wire-bridge, as shown in Figure 4-4.

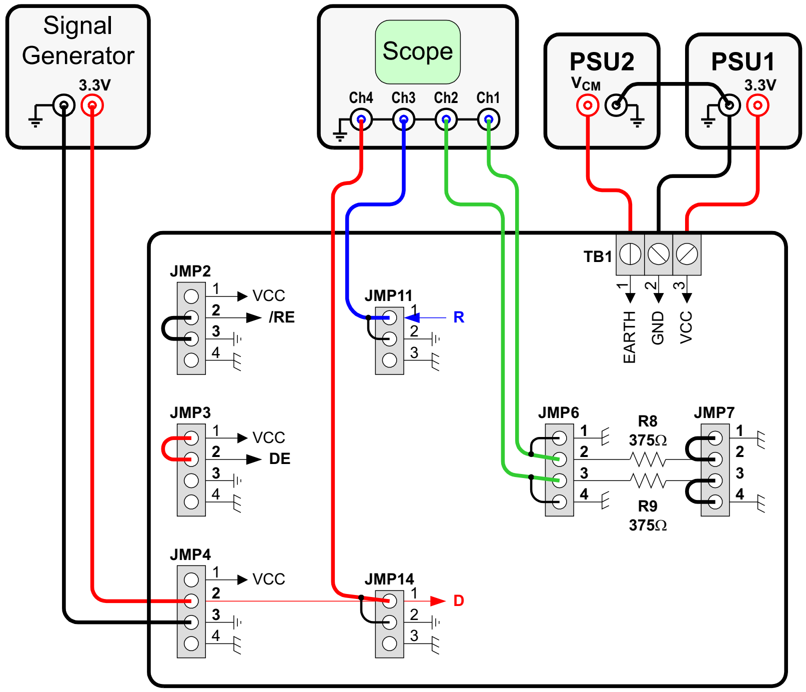

Figure 4-4. RS-485 Half-Duplex EVM Setup for Maximum Loading

Note that Figure 4-4 only shows the wiring of PSU2 for positive common-mode voltages. For negative V_{CM}, connect the ground terminal of PSU2 with pin 1 of TB1 (EARTH), and the V_{CM}-output of PSU2 with the ground terminal of PSU1.

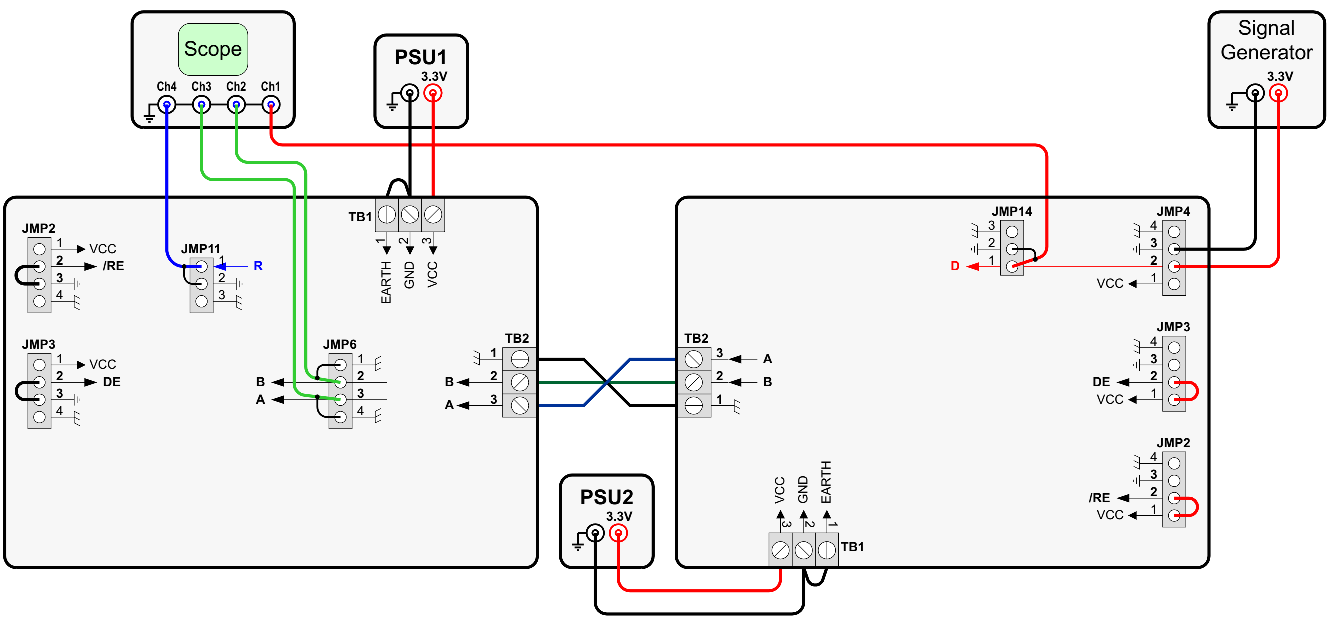

Figure 4-5. RS-485 Half-Duplex EVM Configurations: Left as Receiver EVM, Right as Transmitter EVM

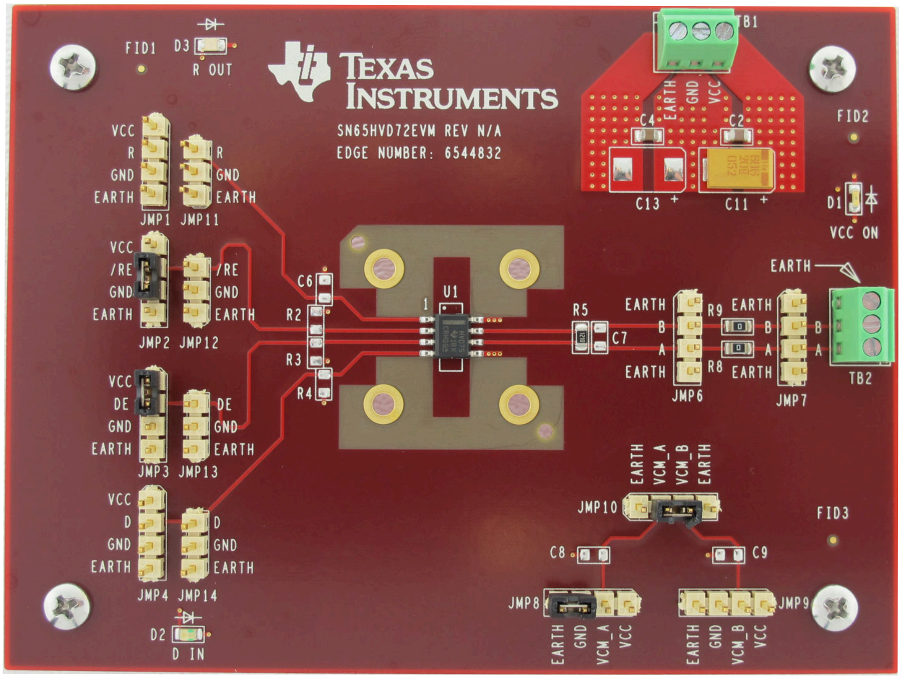

Figure 4-6. Top View of RS-485 Half-Duplex EVM

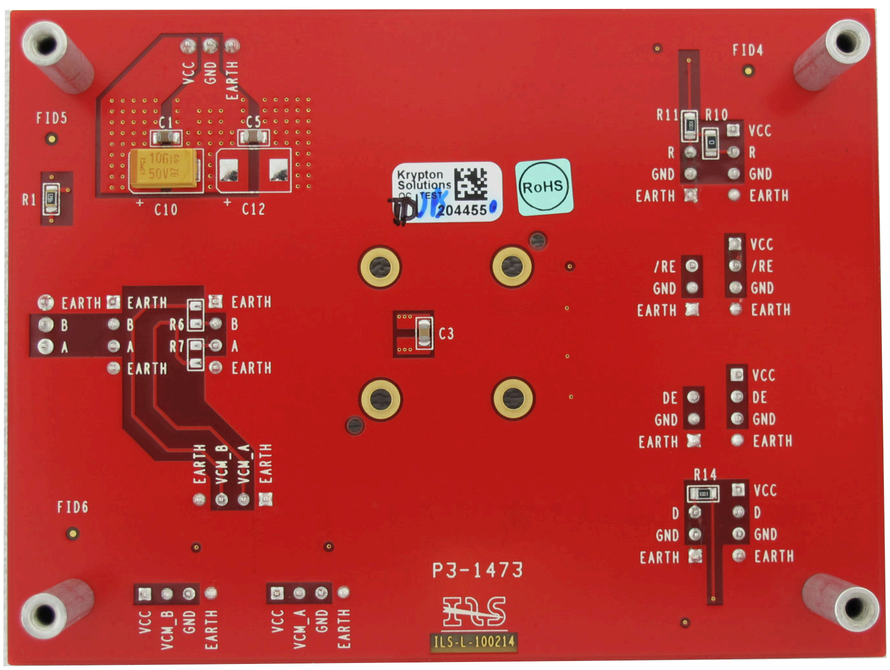

Figure 4-7. Bottom View of RS-485 Half-Duplex EVM

For detailed information on the device parameters see the data sheet of the selected device at www.ti.com

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (June 2013) to Revision C (September 2021)	Page
• Globally changed instances of legacy terminology to controller and target where mentioned	1