

# **RS-485 Half-Duplex Evaluation Module**

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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 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.

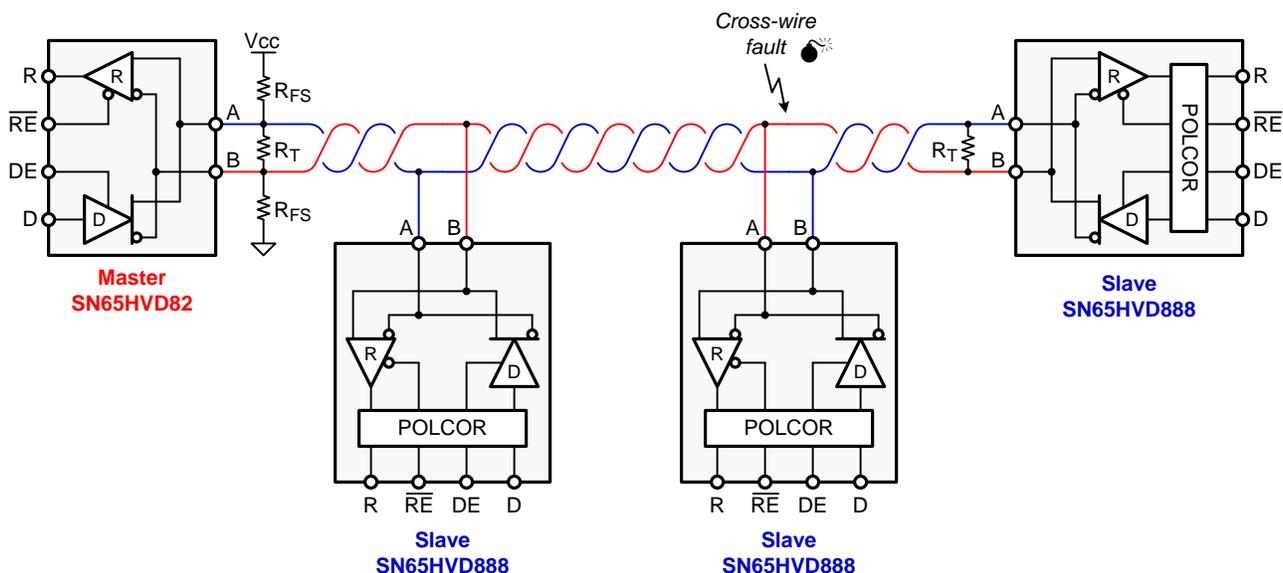
### Using the SN65HVD888 with Bus Polarity Correction Feature

This EVM can support the SN65HVD888 half-duplex RS-485 transceiver with bus polarity correction (See [Figure 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 master node) to set logic reference and define the signal polarity of the bus,
- a slave node must have its receiver enabled and its driver disabled ( $\overline{RE} = DE = \text{Low}$ ),
- the bus must be idling for the failsafe time,  $t_{FS-max}$ .

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  $t_{FS-min}$  can accidentally trigger a wrong polarity correction and must be avoided.*



**Figure 1. Typical Applications Diagram**

## 2 EVM Setup and Precautions

Figure 2 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.

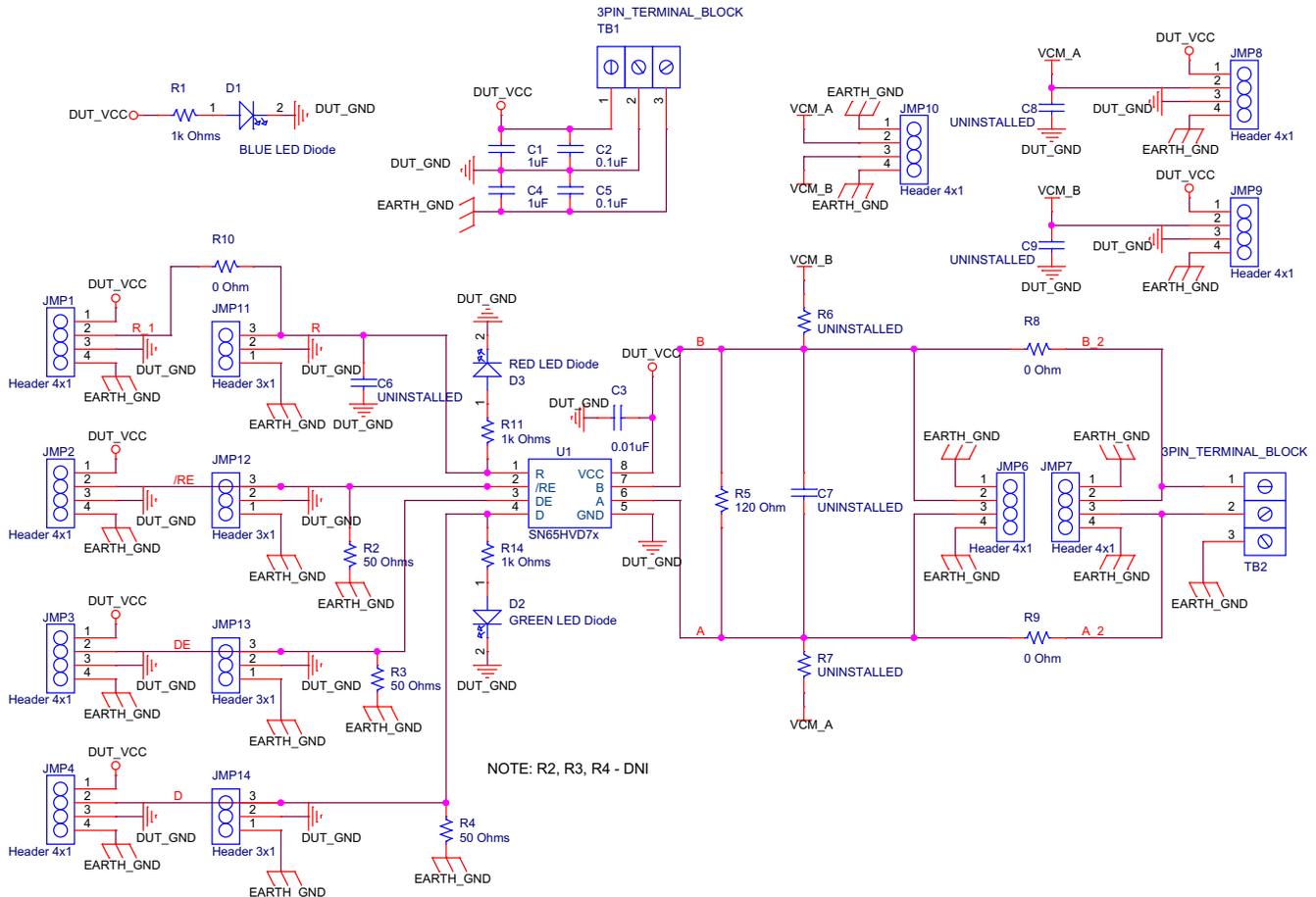
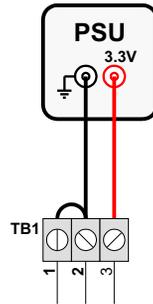


Figure 2. RS-485 Half-Duplex EVM Schematic

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.

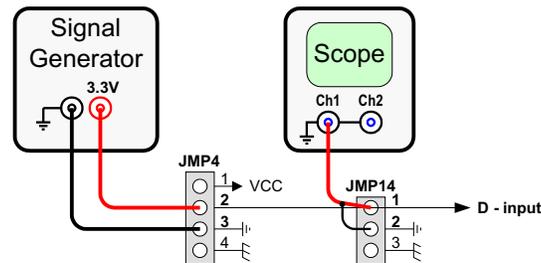


**Figure 3. Bridging DUT\_GND with EARTH\_GND**

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- $\Omega$  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  $\Omega$ , their output signal is twice the required signal voltage, and assumes that the on-board 50- $\Omega$  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 4. Example for Stimulus and Probe Points with JMP4 and JMP14**

Figure 4 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  $\overline{DE}$  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- $\Omega$  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.

### 3 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-k $\Omega$  pull-up resistor provides logic high instead. However, due to the small input current, D2 will remain off.

#### 3.1 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.

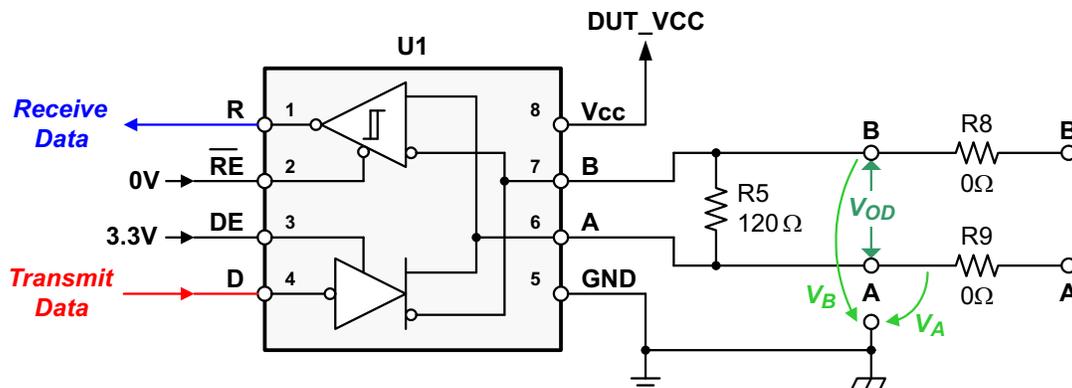
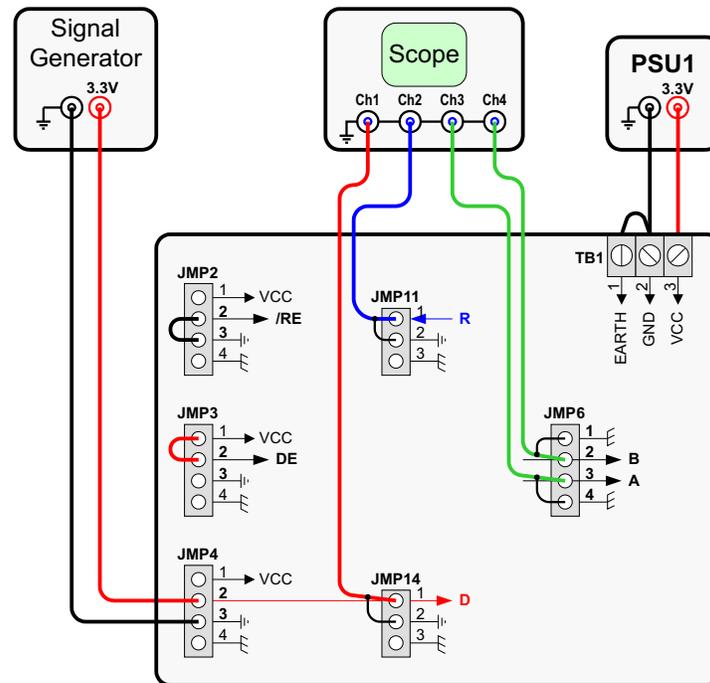


Figure 5. Transceiver Configuration for Normal Operation

Figure 6 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).

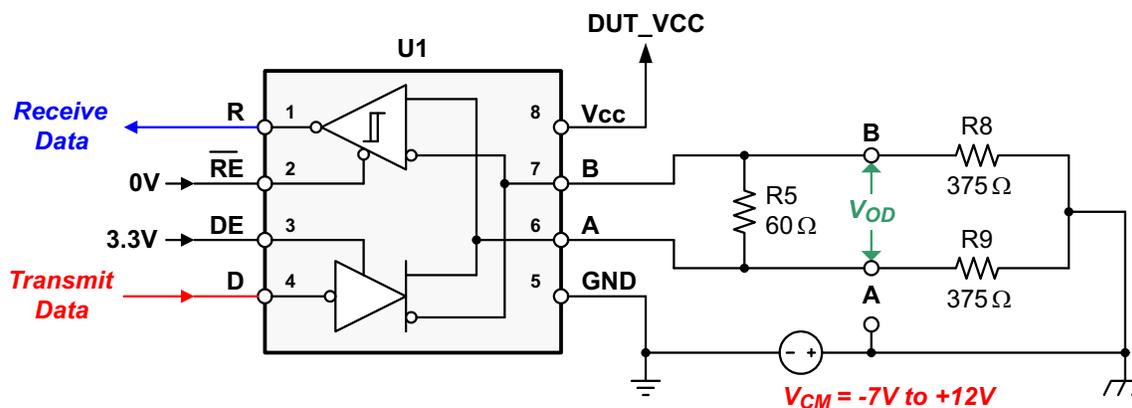


**Figure 6. RS-485 Half-Duplex EVM Setup for Normal Transceiver Operation**

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  $60\ \Omega$ , a maximum common-mode load of  $375\ \Omega$  for each bus wire, and a receiver common-mode voltage range from  $-7\ \text{V}$  to  $+12\ \text{V}$ . Figure 7 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 7. 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 8.

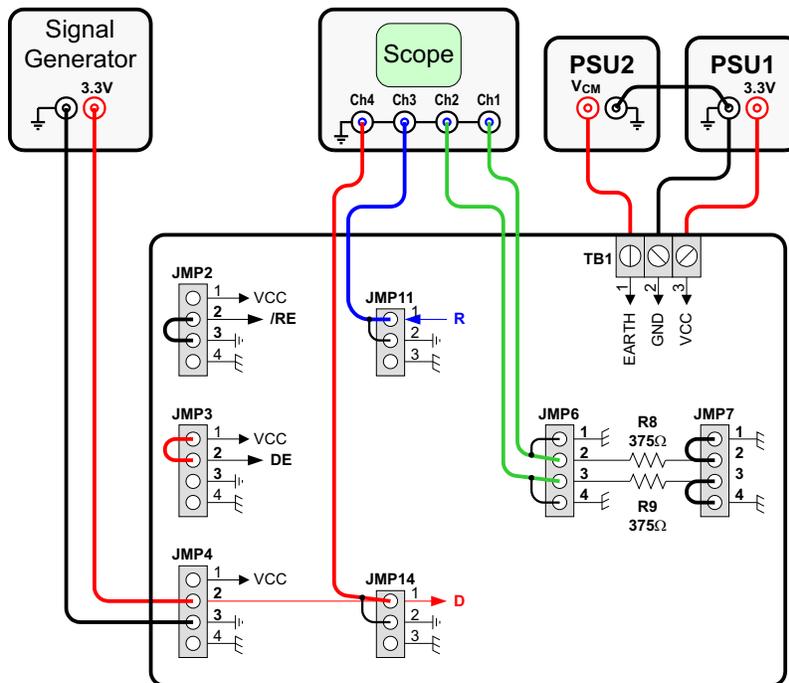


Figure 8. RS-485 Half-Duplex EVM Setup for Maximum Loading

Note that Figure 8 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.

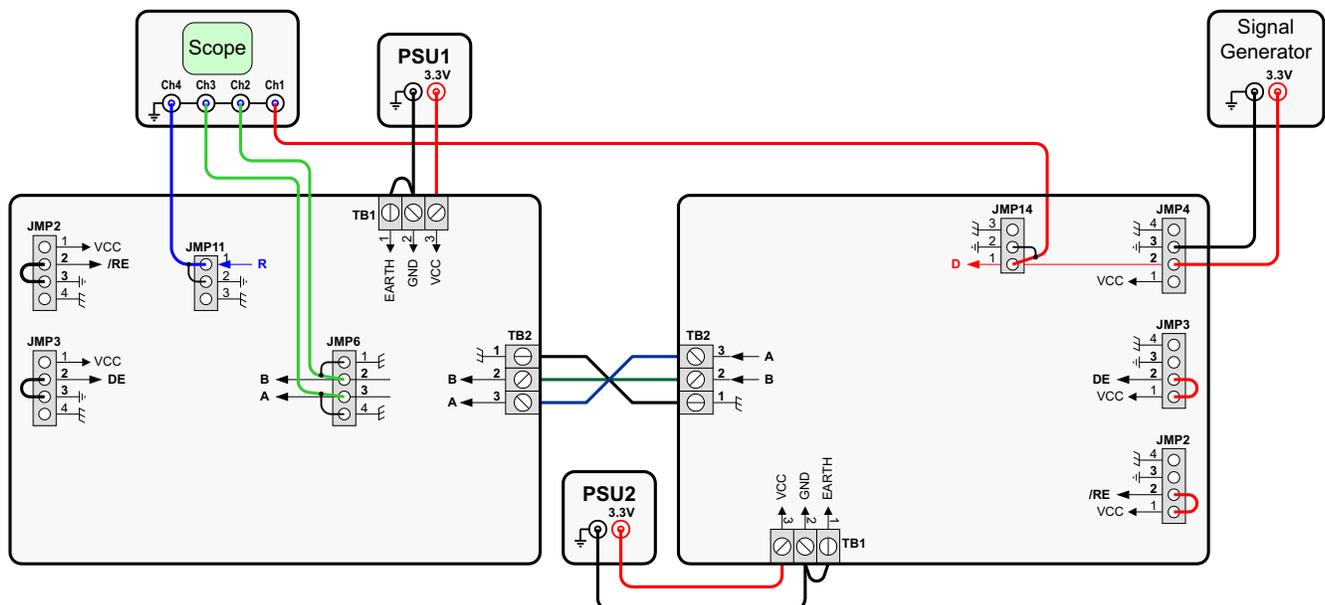


Figure 9. RS-485 Half-Duplex EVM Configurations: Left as Receiver EVM, Right as Transmitter EVM

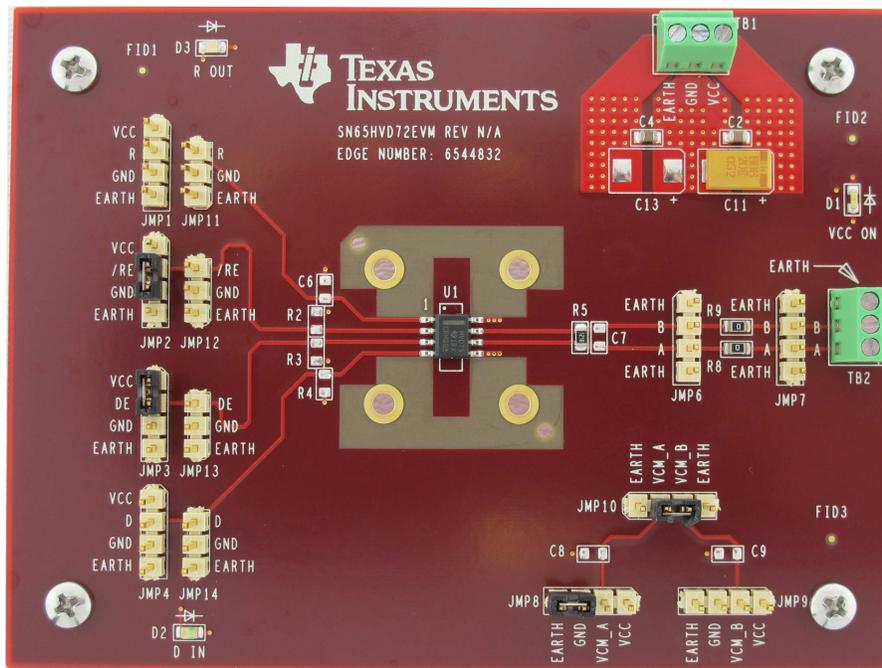


Figure 10. Top View of RS-485 Half-Duplex EVM

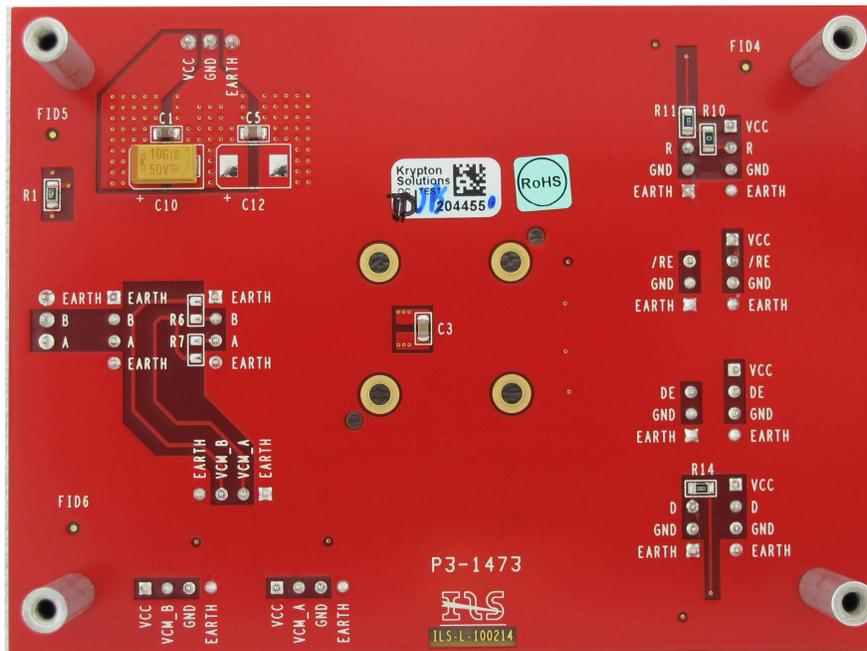


Figure 11. Bottom View of RS-485 Half-Duplex EVM

For detailed information on the device parameters see the data sheet of the selected device at [www.ti.com](http://www.ti.com)

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### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

#### Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

### **FCC Interference Statement for Class B EVM devices**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

### **Concerning EVMs including detachable antennas**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **Concernant les EVMs avec appareils radio**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### **Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

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3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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