2.75kV$_{RMS}$ Isolated 500kbps Half-Duplex RS-485 Transceiver Using the MAX14946

MAXREFDES1158

Introduction

The MAXREFDES1158 is a 5V supplied, 2.75kV$_{RMS}$ isolated, 500kbps, RS-485 module using the MAX14946. This reference design demonstrates how to build an isolated RS-485 module with a low-cost transformer to provide isolated power. A transformer from HanRun, the HR600755, is used in this design. The power supply on the reference design is derived from a single 5V source. Connect the design board to a USB port or connect an external supply from GNDA to VDDA to supply the 5V to the logic side (A). The integrated push-pull transformer driver and external transformer (TX1) generate an isolated supply for powering the isolated side (B) of the board.

The MAX14946 is an isolated RS-485/RS-422 transceiver that provides 2750V$_{RMS}$ (60s) of galvanic isolation between the cable side (RS-485/RS-422 driver/receiver side) and the UART side of the device. This device allows for robust communication up to 500kbps and includes an integrated 450kHz transformer driver for power transfer to the cable side of the transceiver using an external transformer. An integrated LDO provides a simple and space-efficient architecture for providing power supply to the cable-side of the IC. The device includes one half-duplex driver/receiver channel. The receiver is 1/8-unit load, allowing up to 256 transceivers on a common bus. Integrated true fail-safe circuitry ensures a logic-high on the receiver output when inputs are shorted or open. Undervoltage lockout disables the driver when the cable-side or UART-side power supplies are below functional levels. The driver outputs/receiver inputs are protected from ±30kV electrostatic discharge (ESD) to GNDB on the cable side, as specified by the Human Body Model (HBM). Table 1 shows an overview of the MAXREFDES1158 specification.

Designed – Built – Tested

This document describes the hardware shown in Figure 1. The isolated RS-485 communication module has been built and tested.

Table 1. Design Specification

PARAMETER	SYMBOL	MIN	MAX
Supply Voltage	V_{DDA}	3.3V	5.5V
LDO Output Voltage B Side	V_{DDBO}	4.5V	5.5V
Cable-Side Power Input	V_{DDBI}	4.68V	14V
Common-Mode Transient Immunity	CMTI	35kV/µs 5V	
Standby Current	$I_{STANDBY}$	18mA	
Withstand-Isolation Voltage	V_{ISO}	2.75kV for 60s	
Maximum Data Rate	DR_{MAX}	500kbps	
Temperature Range	$T_{OPERATION}$	-40°C	+85°C

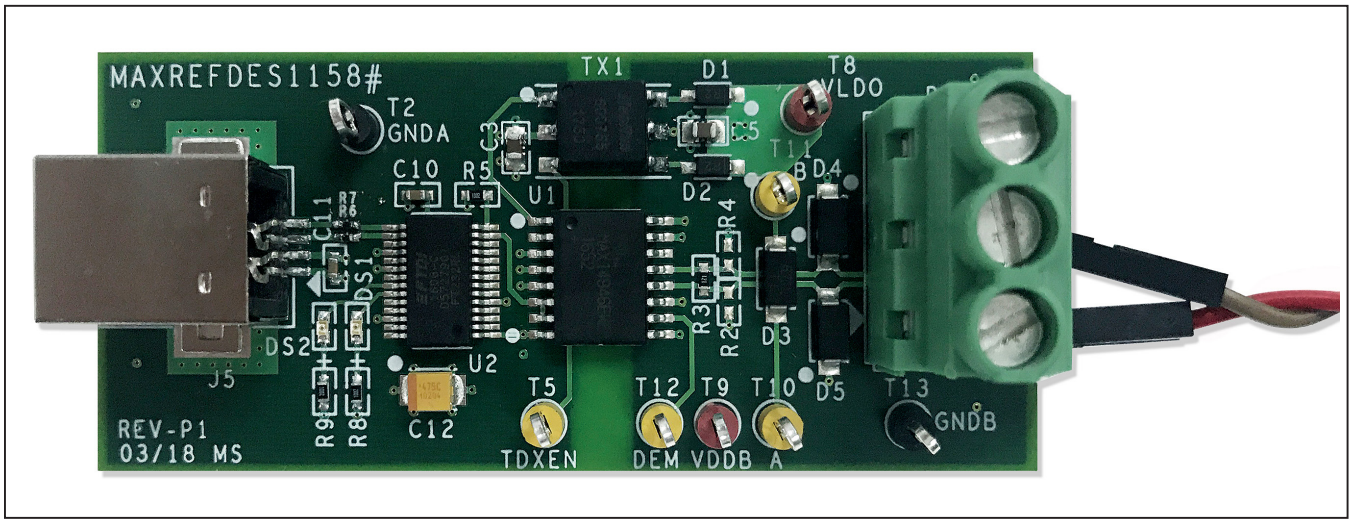

Figure 1. MAXREFDES1158 hardware.

MAXREFDES1158 Design

The MAXREFDES1158 uses the MAX14946 to provide 2750V_{RMS} (60s) of galvanic isolation between the RS-485/RS-422 cable side of the transceiver and the UART side. Both data and power can be transmitted across the isolation barrier in the MAX14946. To achieve data isolation, integrated capacitive isolation allows data transmission between the UART and cable sides of the transceiver. To achieve power isolation, the MAX14946 features an integrated-transformer driver to drive an external center-tapped transformer, that can transfer operating power from the UART side across the isolation barrier to the cable side. In this reference design, the primary side of an external transformer connects to the MAX14946's transformer driver outputs to provide a completed RS-485 isolation solution.

Transformer Selection

The integrated push-pull transformer driver allows the transmission of operating power from the UART side, across the isolation barrier, to the isolated cable side of the device. The 450kHz transformer driver operates with center-tapped primary transformers. Select a transformer with an ET product greater than or equal to the ET of the driver to ensure that the transformer does not enter saturation. E is the voltage applied to the transformer and T is the maximum time it is applied during any one cycle. Calculate the minimum ET product for the transformer primary as follows:

$$ET = \frac{V_{MAX}}{(2 \times f_{MIN})}$$

where V_{MAX} is the worst-case maximum supply voltage on V_{DDA}, and f_{MIN} is the minimum frequency at that supply voltage. For example, when using 5.5V and 350kHz, the required minimum ET product is 7.9Vµs. In this reference design, we chose the HanRun HR600755 low cost transformer where ET = 6 x 10^{-6}.

Passive Components on the RS-485 Line

For this reference design, we chose a 120Ω termination resistor. Pullup and pulldown resistors are generally used on the receiver inputs to guarantee a known state if all nodes on the bus are in receive mode or the cable becomes disconnected. Note that the MAX14946 features true fail-safe receiver inputs that ensure RXD is high when the receiver inputs are shorted, open, or connected to an idle bus. We reserved the pullup and pulldown resistor for the customer to test external RS-485 devices without a fail-safe function. We added TVS diodes between the A-B, A-GNDB and B-GNDB lines to enhance protection.

USB to UART Design

The FTDI™ USB to serial UART interface, FT232RL, is used in this design to perform RS-485 communication. For the half-duplex configured RS-485, the transmitter driver and receiver use the same differential line for communication, so the control pin prevents the receiver from receiving the transmitted data from the same device.

Normally, the receiver enable pin is active low, and the transmitter enable pin is active high. We can connect the two pins together so that when the device is in standby mode, the pin is active low, the receiver is enabled and waiting for the data. When the host sends out data, the pin is pulled high to enable the transmitter.

The system block is shown in Figure 2.

Design Resources

Download the complete set of **Design Resources** including the schematics, bill of materials, PCB layout, and test files.

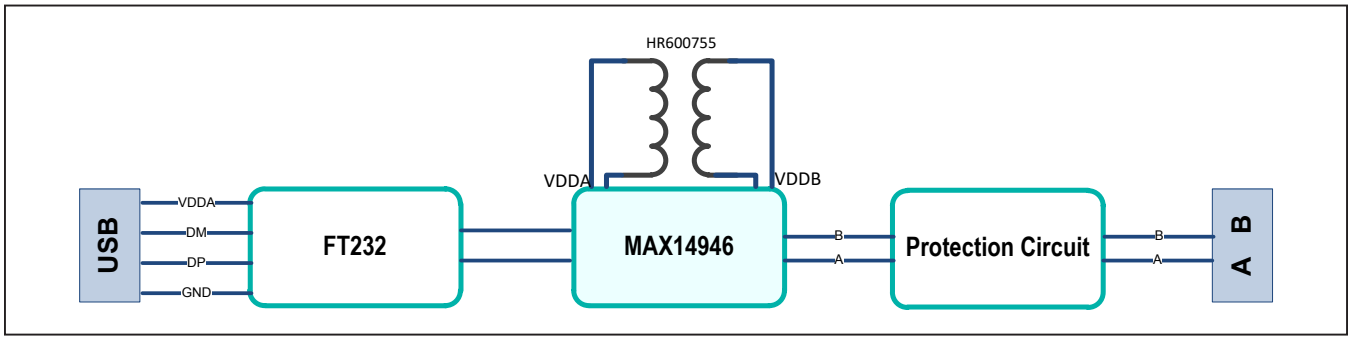

Figure 2. MAXREFDES1158 system block.

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/19	Initial release	—