

RS-485: High-Fault Protection, Wide-Input Common Mode, and Deglitch Function



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ABSTRACT

In this application note, some useful features in RS-485 transceivers for example, ± 70 -V high fault voltage, ± 25 -V wide input common mode range, deglitch function are discussed.

Table of Contents

1 Introduction	2
2 Features	2
2.1 High Voltage Fault Protection	2
2.2 Wide Input Common Mode Range.....	2
2.3 Slowing Fast Edges.....	4
2.4 Deglitch Function.....	6
3 Summary	8

List of Figures

Figure 2-1. THVD2410 Devices Work with Ground Potential Difference.....	2
Figure 2-2. THVD2410 Working with +25 V Common Mode Signal.....	3
Figure 2-3. THVD2410 Working with -25 V Common Mode Signal	3
Figure 2-4. SN65HVD1780 Rise and or Fall Time.....	4
Figure 2-5. THVD2450 Rise and or Fall Time.....	5
Figure 2-6. THVD2450 with 120- Ω With the Added 8200-pF Differential Capacitor.....	5
Figure 2-7. THVD2450 Rise and or Fall Time With 8200-pF Capacitive Load.....	6
Figure 2-8. THVD2450 Receiver Enable Deglitch Test Setup.....	6
Figure 2-9. THVD2450 Enabled with a Short Shutdown Time.....	7
Figure 2-10. THVD2450 Enabled with a Long Shutdown Time.....	8

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1 Introduction

The RS-485 interface works using differential signaling which is effective in rejecting common-mode noise making it a popular choice for long-distance communication. RS-485 transceivers currently come with many different features a designer can choose from. This application note will help designers understand how features like fault protection, input common mode ranges, and deglitch enables can help designers to create a more robust RS-485 system. In this application note, each feature is discussed and lab tested using THVD24x0 devices (supports the listed features) with results. THVD2410 and THVD2450 are ± 70 -V fault-protected, half-duplex, RS-422/RS-485 transceivers operating on a single 3-V to 5.5-V supply. By leveraging these useful features, the RS-485 system design become much easier and the system is more robust.

2 Features

2.1 High Voltage Fault Protection

In some applications, the RS-485 bus might be exposed to high voltage, due to various reasons like direct shorts to power supplies, mis-wiring faults, connector failures, damaged cables, and tool mis-applications. The ± 70 -V fault-protection of THVD24x0 means that bus interface pins are protected against up to ± 70 -V DC overvoltage conditions mentioned above. For example, the A and B pins are accidentally shorted to 48-V power supply in an industrial automation equipment. THVD24x0 devices will not be damaged in this fault condition. As the communication fails, the fault condition can be detected and cleared. After the 48-V DC short is resolved, the devices resume working normally without requiring a power cycle.

2.2 Wide Input Common Mode Range

In several systems especially for long-distance communication, the ground potential of different locations can vary greatly. This ground potential becomes the common-mode shift with respect to the differential signal of the bus. For example, in a long-distance point-to-point communication, the output signal of the A and B pins toggle from 1-V to 3-V at node 1. If node 2 has a -7 V ground potential shift relative to node 1, the bus signal is alternating between 8-V to 10-V with respect to the local ground of node 2. Larger input common mode range of RS-485 devices allow for the system to work in wider ground shift scenarios. The following lab measurement demonstrates THVD24x0 devices work with ± 25 -V input common-mode range.

In the tests, two the half-duplex EVMs are populated with THVD2410 and 120- Ω termination resistor (Figure 2-1). The two boards are connected with two 10-ft (3-m) cables. Ground potential is created between two boards and the ground potential difference is modulated to vary from time to time. As one board is configured as the transmitter and the other one as the receiver, the communication data being sent is a 1-MHz clock signal.

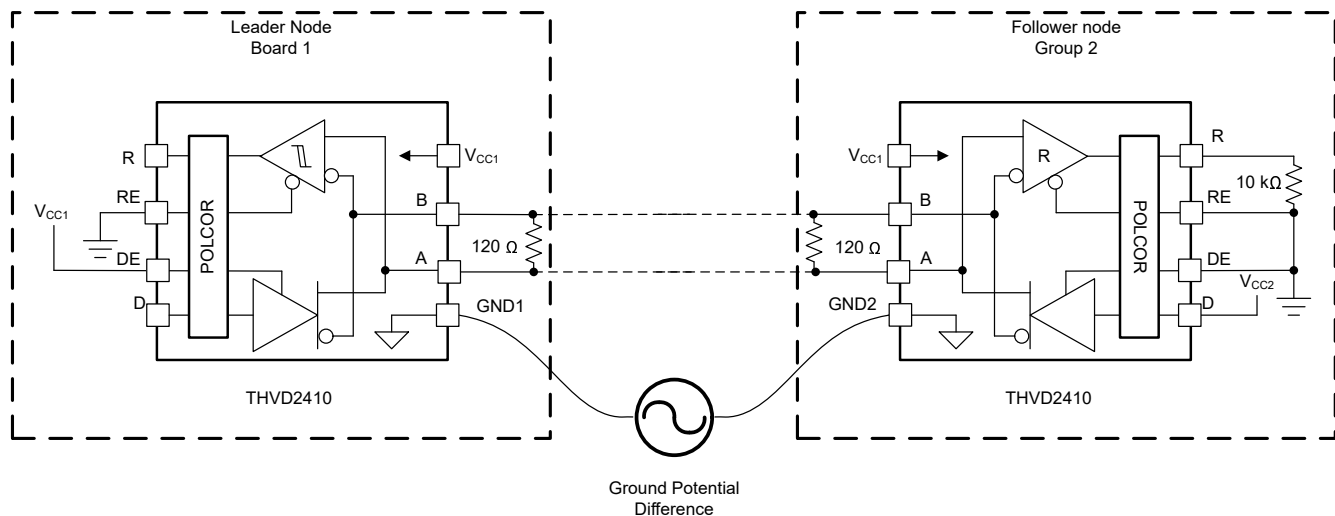


Figure 2-1. THVD2410 Devices Work with Ground Potential Difference

In Figure 2-2, the signal is measured at the bus pins (pin 6 and 7 – channel 4 in plot) and the R pin (pin 8 – channel 1 in plot) of the receiving node with respect to the board’s local ground (GND2). The input signal shifts from 11-V to 25-V peak to peak at a 50-kHz rate. While the differential bus signal varies about 12-V common-mode wise, the receiver output generates the correct signal. Similarly, if the ground potential difference is positive, the received bus signal has a negative common-mode shift (Figure 2-3). In this test, the device works well with -11-V to -25-V peak to peak differential signal. The two measurements show that THVD24x0 devices not only work with extended common-mode range but also relatively frequently varying common-mode voltage.

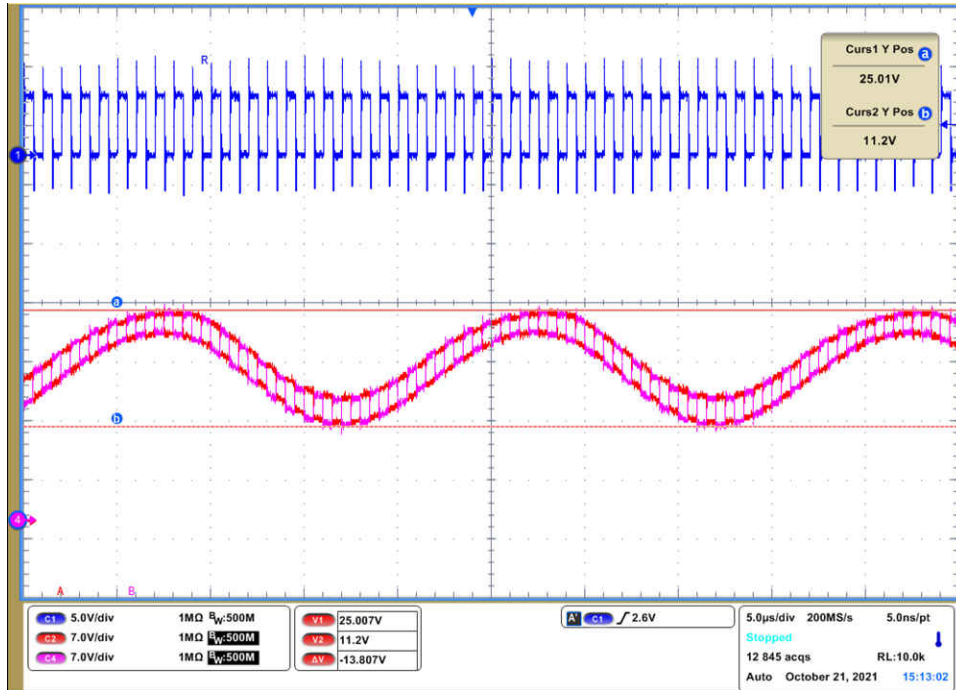


Figure 2-2. THVD2410 Working with +25 V Common Mode Signal

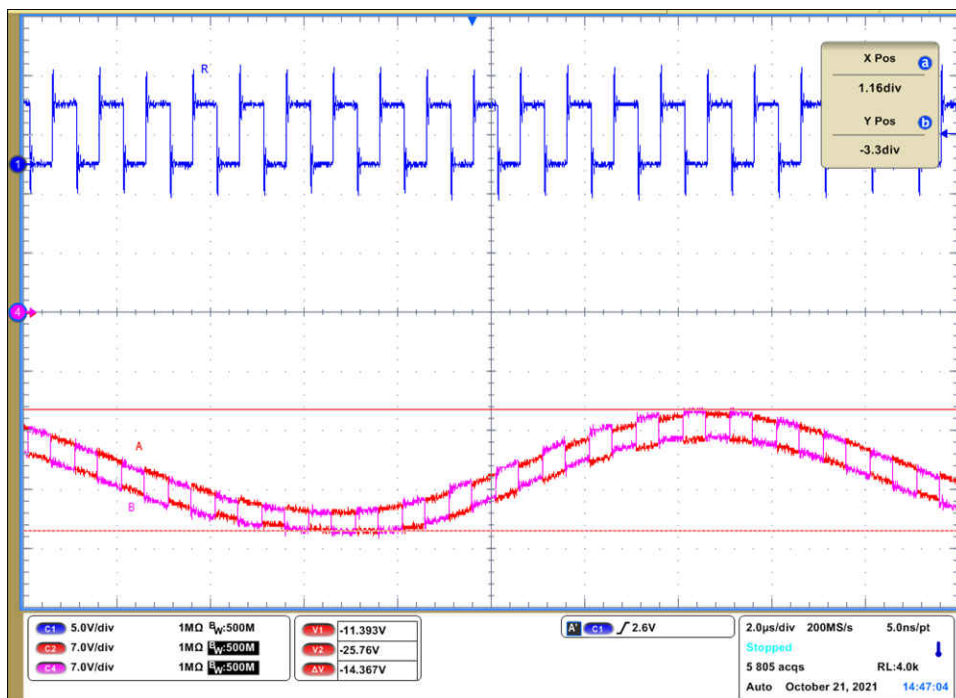


Figure 2-3. THVD2410 Working with -25 V Common Mode Signal

2.3 Slowing Fast Edges

In several applications, the data rate is not perfectly aligned with the recommended data rate of the device. For example, THVD2450 works at a maximum data rate of 50-Mbps, while THVD2410 works at a maximum data rate of 500-kbps defined by the data sheet. In applications, data rates may fall in between these two values, which raises a common question – can high-speed RS-485 devices be used in low-speed applications? In general, high-speed devices have fast edges (short rise/fall time). These sharp edges may generate unexpected emissions in low-speed applications due to the high frequency components of fast edges. To smooth the bus signal, differential capacitor can be added on the bus to form a low pass filter.

For comparison, SN65HVD1780 is chosen as the benchmark. This device also has high fault voltage (± 70 -V) protection, while working with low data rates – up to 115-kbps. With 5-V V_{cc} and 120- Ω termination resistor, [Figure 2-4](#) shows the SN65HVD1780 bus pin output with a 100kHz clock input. The differential bus signal (channel 4) shows about 2- μ s rise and or fall time, which aligns with the data sheet specification.

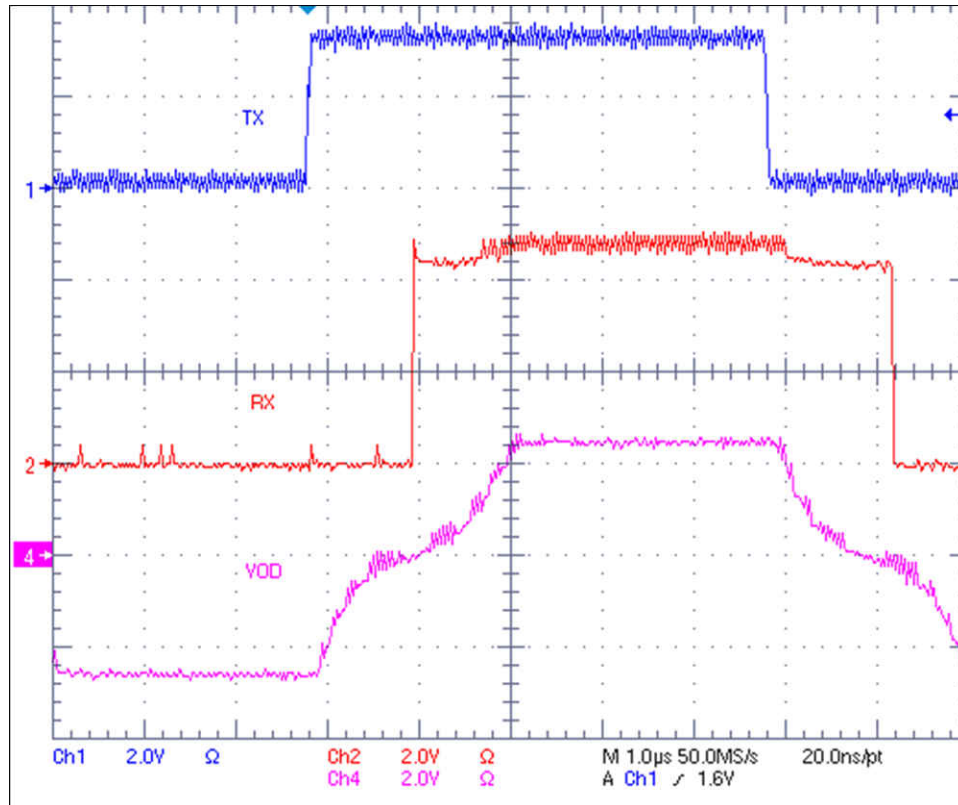


Figure 2-4. SN65HVD1780 Rise and or Fall Time

While using the same set up as the SN65HVD1780 used, THVD2540 results in sharp edges which are expected since the device has 5 ns rise and or fall time ([Figure 2-5](#)).

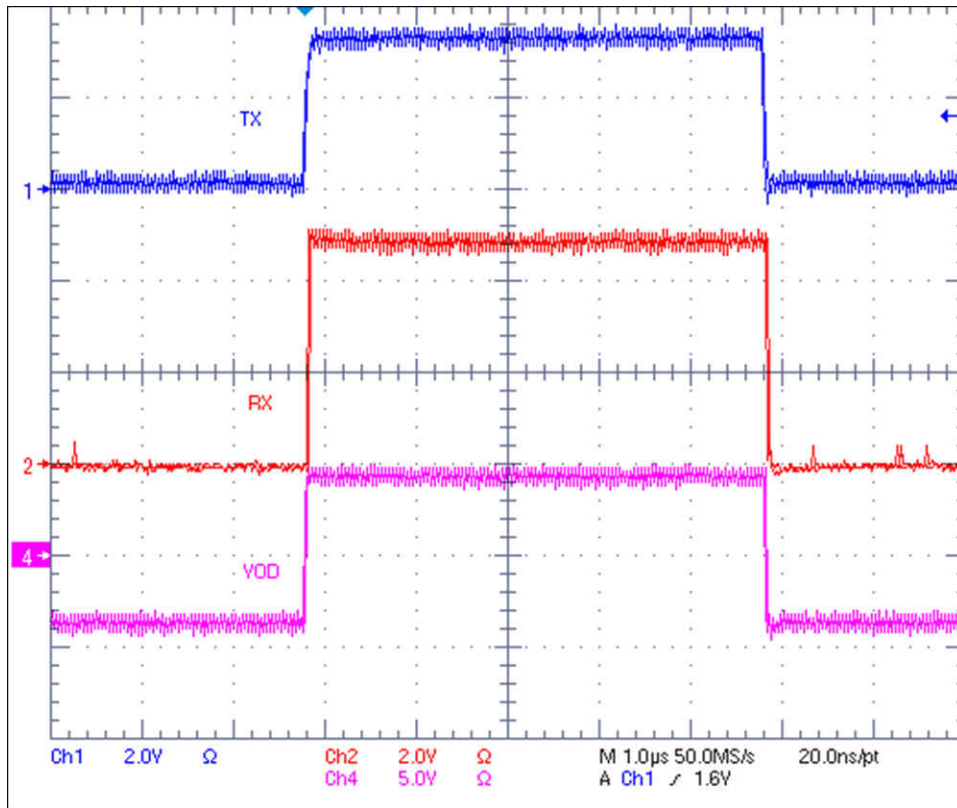


Figure 2-5. THVD2450 Rise and or Fall Time

Populating a differential capacitor can effectively slow down fast edges on the THVD2450. The capacitor is parallel to the termination resistor, while two components can be placed side by side on the board, like Figure 2-6.

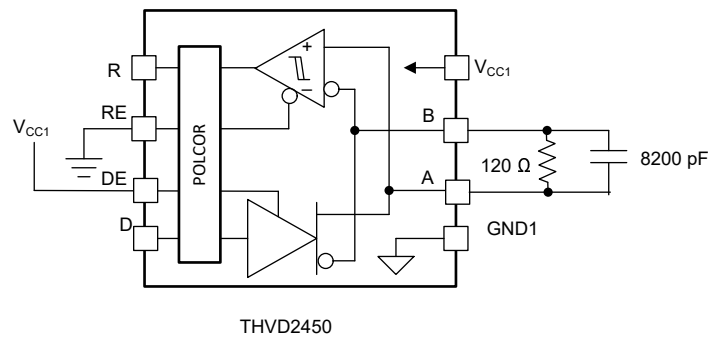


Figure 2-6. THVD2450 with 120-Ω With the Added 8200-pF Differential Capacitor

Figure 2-7 is the results of THVD2450 with an extra 8200-pF differential capacitor placed on the bus, while the other test setup is the same as before. THVD2450's driver takes time to charge and discharge the large capacitor, making the fast edges rounded. With the 8200-pF capacitor, the rise/fall time is now longer than 1-µs, which is very close to that of SN65HVD1780 in Figure 2-4. This experiment shows that the high-speed devices can be used in low-speed applications, while adding a differential capacitor can effectively mitigate electromagnetic interference (EMI) concerns.

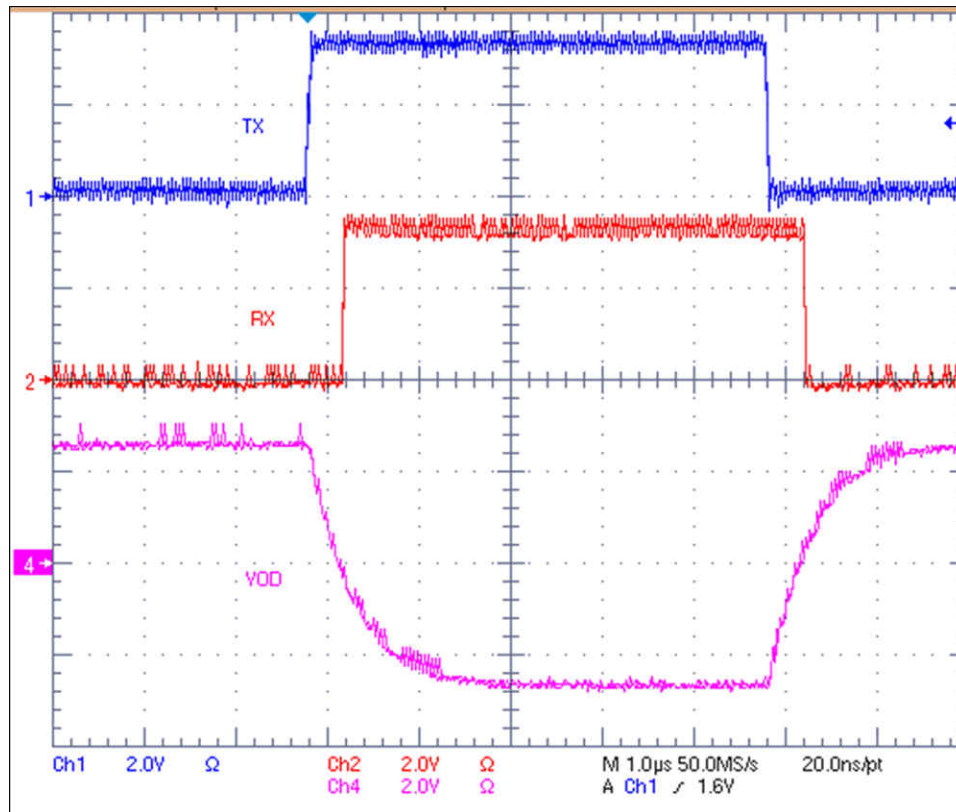


Figure 2-7. THVD2450 Rise and or Fall Time With 8200-pF Capacitive Load

2.4 Deglitch Function

The THVD24x0 device enters shutdown mode to save power if both driver and receiver are disabled by setting the DE pin low and REB pin high. In shutdown mode, power consumption is only 0.1- μ A typical without any load. Please note that the device takes a longer time to wake up from shutdown mode. For example, THVD2450 driver's enable time is 2- μ s from shutdown mode, while the enable time is 7-ns if the receiver is kept on. The same concept applies to the receiver enable time. The deglitch function is integrated in the enable pins to make them more robust in noisy environments. The specification is called t_{SHDN} (time to shutdown) and the following experiment shows how to interpret this value.

In this test (Figure 2-8), THVD2450 is set up in receiver mode with both DE and REB pin low. The receiver output is pull-down to ground with 4.7-k Ω resistor. With a 5-V supply, a 15-MHz 5-V peak to peak differential clock is fed to A and B pins.

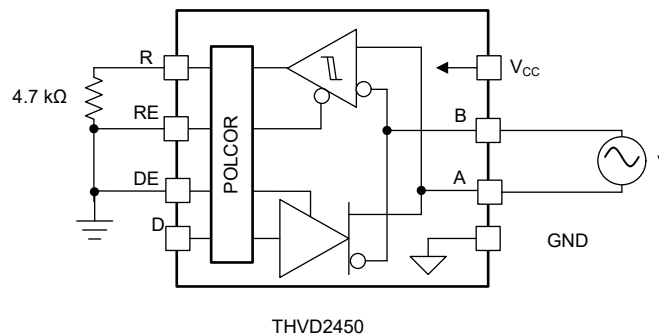


Figure 2-8. THVD2450 Receiver Enable Deglitch Test Setup

With the disabled driver, the device will enter the shutdown mode if the receiver is also disabled. Because of the deglitch feature, the device does not shut down if the disable pulse at the REB pin (pin 2) is narrow. Figure

2-9 shows the THVD2450 receiver resumes working immediately as the REB pin toggles from high to low. This 212-ns *glitch* is filtered out so that the device does not shut down.

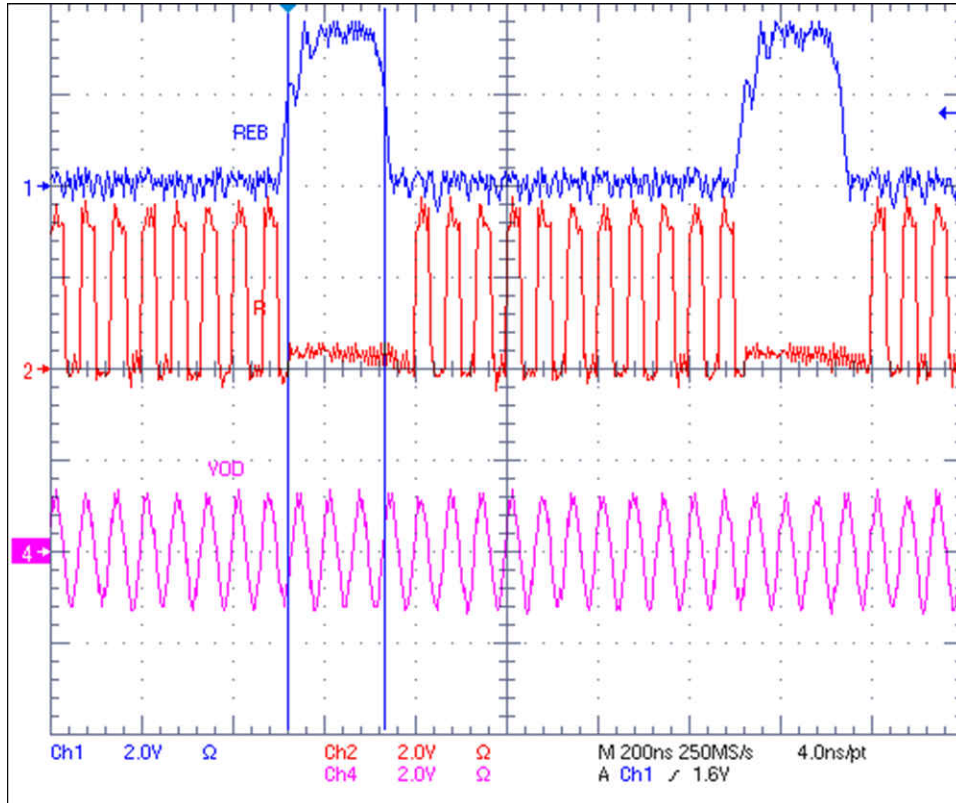


Figure 2-9. THVD2450 Enabled with a Short Shutdown Time

If the disable time is longer than the 500-ns maximum of t_{SHDN} in data sheet (Figure 2-10), the condition of both driver and receiver disabled makes THVD2450 enter shutdown mode. As the receiver is enabled, the wake-up time is about 2.2- μ s. In many applications, DE and REB pins are shorted. Therefore, one GPIO pin of microcontroller can control the mode of the transceiver. From this experiment, it is clear that THVD24x0 will not enter shutdown mode by toggling this control pin. The same feature applies to the driver enable pin (DE – pin 3) as well. If the two enable pins are controlled separately, short glitches in enable pins will not make THVD24x0 shutdown either.

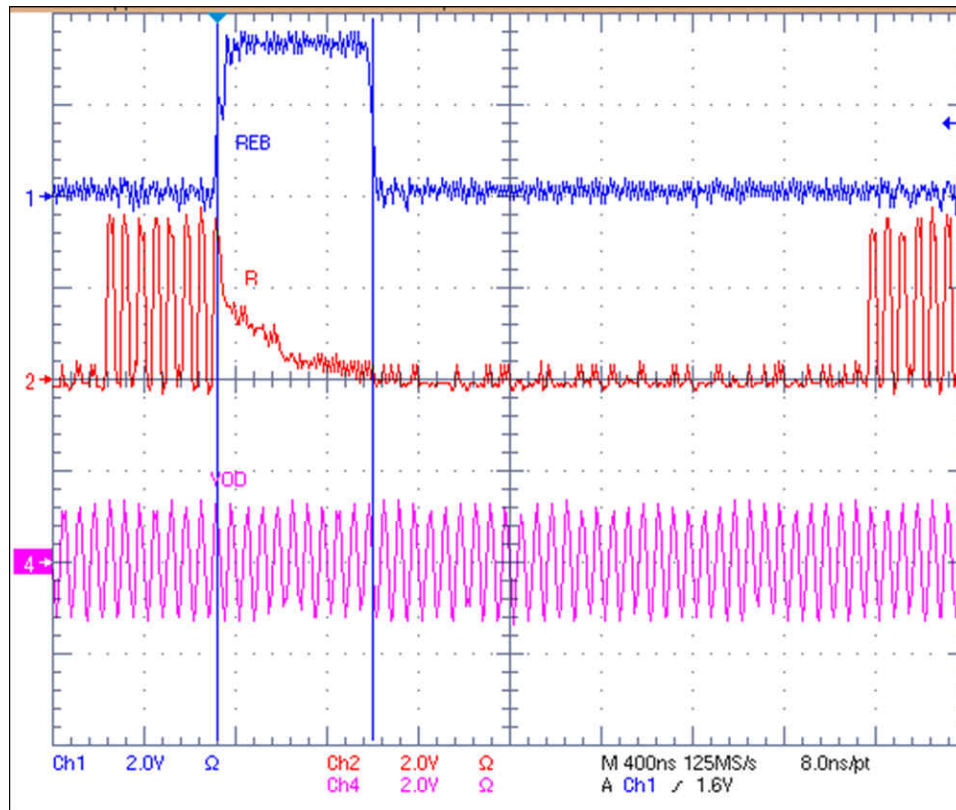


Figure 2-10. THVD2450 Enabled with a Long Shutdown Time

3 Summary

In this application note, some useful features in RS-485 transceivers like high fault voltage, wide common mode range, deglitch enable are discussed. The devices with these features like THVD24x0 can make the system much easier to design around. For example, high fault voltage and integrated IEC ESD protection can eliminate the need for external system-level protection components. Extended $\pm 25\text{-V}$ input common-mode range greatly helps establish reliable data communication over longer cable run lengths and/or in the presence of large ground loop voltages. The deglitch feature at the enable pins make the device a great fit for noisy environment.

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