Application Note

XR34350 and SP339E/B to THVD4431 System Rollover Guide

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TEXAS INSTRUMENTS

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ABSTRACT

This application note outlines the necessary and potential steps for replacing the Maxlinear's XR34350 and SP339E/B multiprotocol (RS-232, RS-422, RS-485) transceivers with TI's THVD4431.

Table of Contents

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1 Introduction

While the Maxlinear XR34350 and SP339E/B multiprotocol transceivers have many similarities to TI's THVD4431, the THVD4431 multiprotocol transceiver offers several advanced features and more integration that enable diverse applications and improved system performance. This system rollover document outlines how to replace the Maxlinear XR34350 and SP339E/B multiprotocol transceivers with TI's THVD4431 by comparing the differences in feature set and pinout.

2 Key Feature Highlights of THVD4431 Over XR34350 and SP339E/B

While TI's THVD4431 is pin-to-pin compatible with the XR34350 and SP339E/B multiprotocol transceivers, the THVD4431 offers several advanced features in such a manner that new designs can develop a printed circuit board (PCB) that is common to both THVD4431 and XR34350/SP339. This section provides an overview of the unique features offered by THVD4431.

2.1 Regulated Output Voltage for RS-232

THVD4431 has an integrated high-efficiency and low-noise charge pump to generate large output voltages for RS-232 signaling. Charge pump consists of a voltage doubler and an inverter to regulate the voltage. Voltage is regulated to nominal ± 5.5V for a 3.3V V_{CC} or to ±9.5V for a 5V V_{CC} operation. The internal charge pump is controlled in a way that the output voltage stays regulated for varying load capacitance or varying data rate. Load capacitance emulates the capacitance offered by the cable between the driver and receiver RS-232 nodes. Also different applications can have different data rates, as such having regulated output voltage at any data rate is beneficial.

The Maxlinear XR34350 multiprotocol transceiver is not capable of regulating the RS-232 output voltage with varying load capacitance and data rate and as a result, output voltage drop can be observed when load capacitance and/or data rate increases.

A comparison of output voltage for RS-232 between TI's THVD4431 and Maxlinear's XR34350 is shown in Figure 2-1 and Figure 2-2. Figure 2-1 shows output voltage v.s. data rate and Figure 2-2 shows output voltage v.s. load capacitance. The high output voltage for RS-232 signaling of the THVD4431 multiprotocol transceiver enables high signal-to-noise ratio (SNR) which is beneficial for noisy industrial environments.
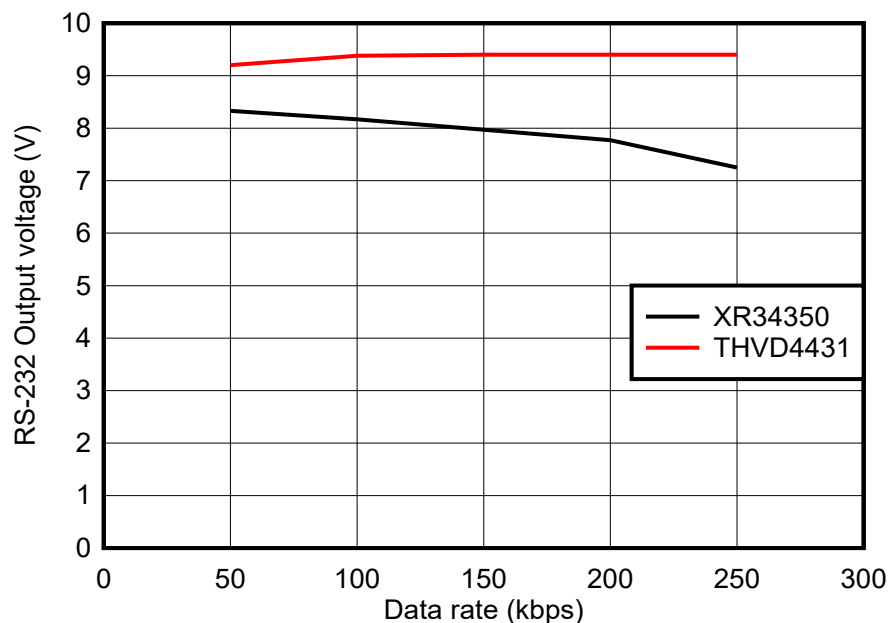

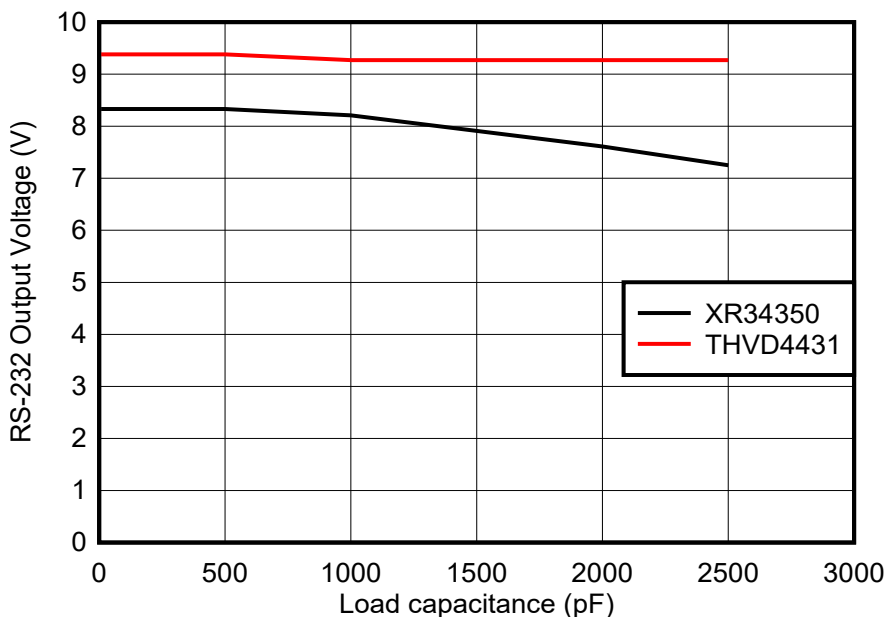**Figure 2-1. THVD4431 RS-232 Output Voltage vs Data Rate**

Figure 2-2. THVD4431 RS-232 Output Voltage vs Load Capacitance

2.2 Full Path Diagnostic Loopback

THVD4431 provides full path diagnostic loopback modes for both RS-232 and RS-485. These modes internally short the bus outputs to the bus inputs (shown in Figure 2-3 and Figure 2-4). So, if the digital logic data is toggled by MCU, data is translated to bus (as analog bus signals) and is reflected back on logic buffer output. This enables MCU to detect bus side shorts (due to shorted connector or cable) by comparing logic input and logic output.

While the Maxlinear XR34350 and SP339E/B multiprotocol transceivers also provide diagnostic loopback for RS-232, the transceivers provide logic loopback by connecting logic driver inputs to logic receiver outputs bypassing the analog driver and receiver circuitry. The analog/bus pins are internally disconnected in this mode. As a result, XR34350/SP339 devices are unable to detect bus side faults. Additionally, these devices do not have RS-485 loopback mode.

Clearly, for safety critical applications, THVD4431 offers enhanced functionality through diagnostic loopback modes eliminating any external circuitry in place to detect cable/connector shorts.

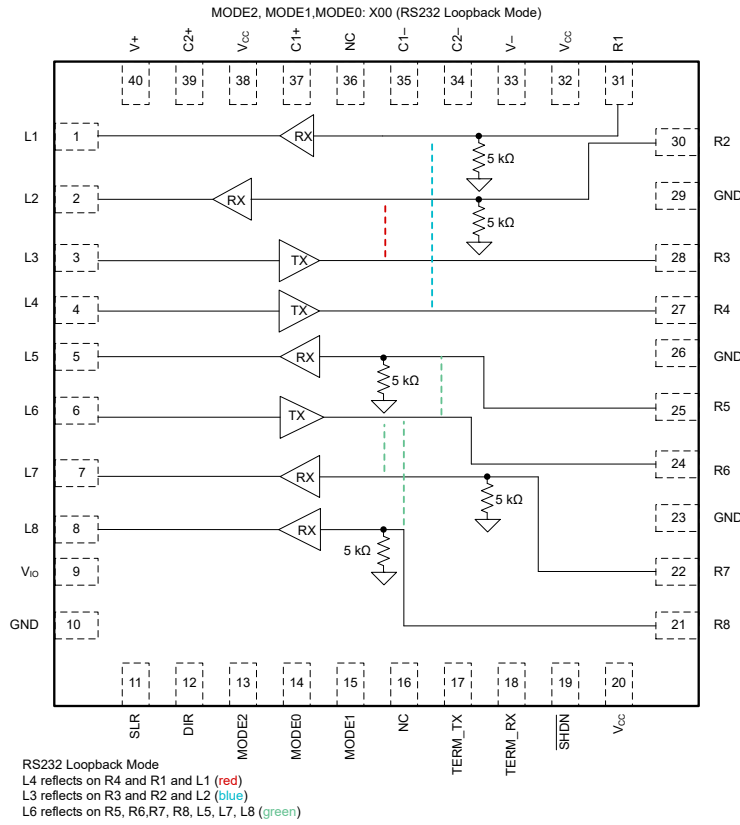RS232 Loopback Mode
L4 reflects on R4 and R1 and L1 (red)
L3 reflects on R3 and R2 and L2 (blue)
L6 reflects on R5, R6,R7, R8, L5, L7, L8 (green)

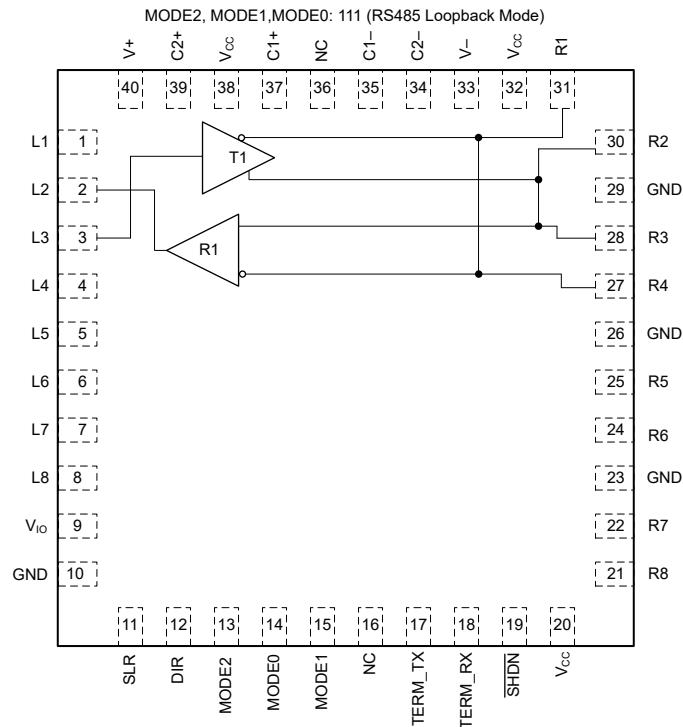**Figure 2-3. THVD4431 in RS-232 Loopback Mode**

Figure 2-4. THVD4431 in RS-485 Loopback Mode

2.3 Operating Ambient Temperature Range

THVD4431 makes sure that the electrical specifications in extended industrial temperature range (ambient) of -40°C to 125°C. Maxlinear XR34350/SP339 only makes sure performance in limited temperature range of -40°C to 85°C. Extended temperature range allows system designers to shrink overall system casing size or eliminate any air-cooling vents, allowing for larger power dissipation inside closer to the PCB as now the device is able to operate at much higher ambient temperatures.

2.4 Integrated Switchable Termination Resistor on Both Driver (R1/R2) and Receiver (R3/R4) Bus Pins

THVD4431 has two termination resistors of nominal 120Ω, one across R1/R2 and another across R3/R4 bus pins in RS-485 mode. Both termination resistors are enabled or disabled using TERM_TX and TERM_RX control pins as described in Table 7-2 of the THVD4431 data sheet. Both the termination resistors can be enabled or disabled independent of the state of driver or receiver. Termination is OFF in RS-232 loopback, RS-232 3T5R, RS-485 loopback, unpowered and thermal shutdown modes.

While the Maxlinear XR34350 and SP339E/B multiprotocol transceivers also provide 120Ω termination resistor across R3/R4, the transceivers do not offer one across R1/R2 bus pins. Therefore, THVD4431 is more flexible in RS-485 full duplex applications where it can be used at middle nodes or end nodes without the need of additional discrete termination resistor as well as control circuit, which helps save significant PCB area. An example RS-485 full duplex configuration with THVD4431 is shown in Figure 2-5.
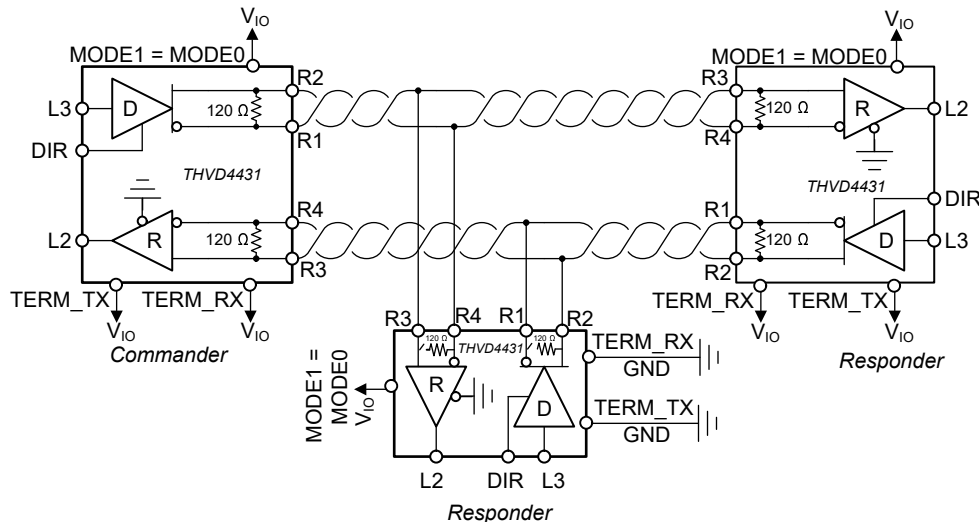

Figure 2-5. THVD4431 in Full Duplex RS-485 Network

2.5 1.65V to 5.5V Supply for Logic Data and Control Signals

THVD4431 provides a separate logic supply pin (pin 9), different than the main bus supply V_{CC}. V_{IO} allows users to interface THVD4431 with microcontrollers (MCU) operating at low voltage supply level such as 1.8V or 2.5V. Even for the applications which want to run RS-232 or RS-485 bus side circuitry at 5V, a 3.3V MCU interface is still possible with THVD4431. This application use case is not enabled by Maxlinear XR34350 or SP339E/B.

To enable this feature, connect the desired logic supply voltage to pin 9 and add a 100nF bypass capacitor close to pin 9, as shown in Figure 2-6. If this feature is not needed, simply connect pin 9 to the same voltage rail as other V_{CC} pins and keep the same bypass capacitor (100nF). Voltage within recommended operating condition is needed on pin 9V_{IO} for THVD4431 to function properly, this pin cannot be left floating.
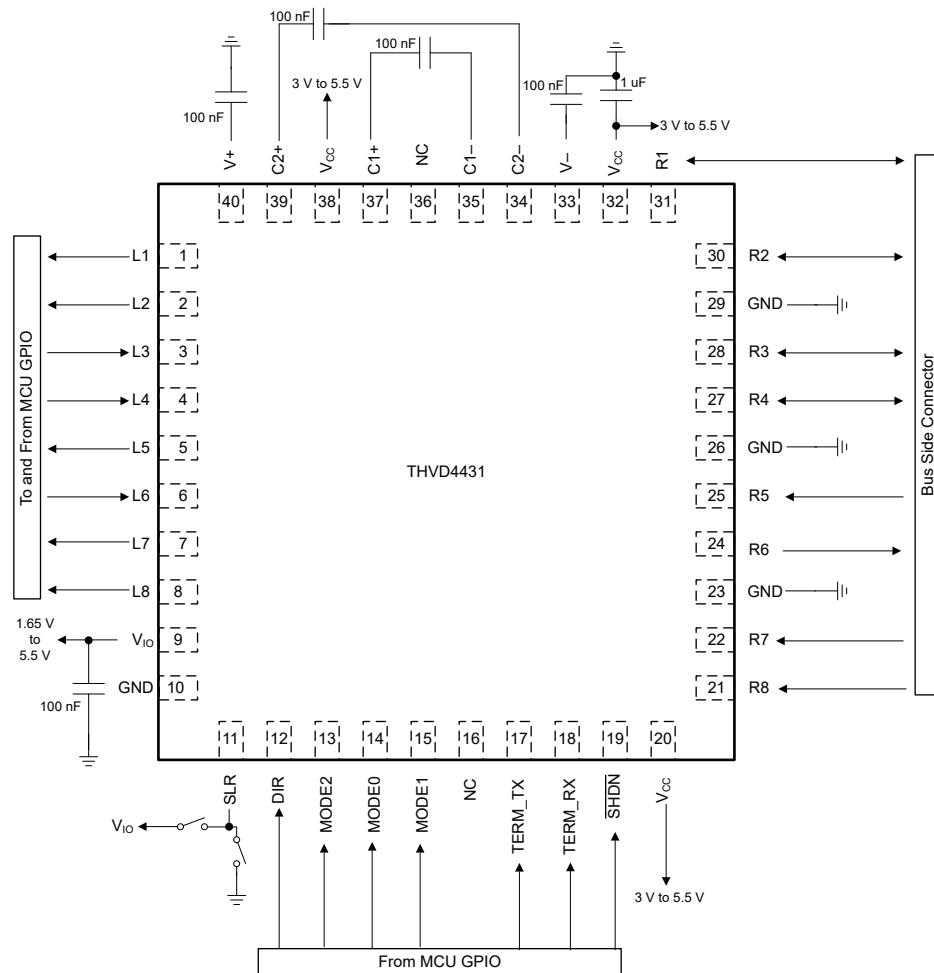
Figure 2-6. THVD4431 Application Schematic

3 Potential Design Changes

This section highlights few potential changes that system designers need to take into consideration when switching a design from Maxlinear's XR34350/SP339E/B to TI's THVD4431.

3.1 Pin 9 (V_{IO})

Connect this pin to V_{CC} if low I/O voltage support is not needed, this way THVD4431 fits exactly same design as XR34350/SP339E/B. Otherwise, connect this pin to the desired MCU I/O voltage (example, 1.8V, 2.5V, 3.3V), while keeping bus supply voltage V_{CC} to 3.3V or 5V. Please note, a bypass capacitor of 100nF close to pin 9 is needed for THVD4431.

3.2 Pin 13 (MODE2)

Pin 13 is NC (No Connect) for the Maxlinear XR34350 and SP339E/B multiprotocol transceiver. For TI's THVD4431, this pin enables/disables the RS485 diagnostic loopback feature (for details, please refer to THVD4431 data sheet Section 7.4). Pull this pin to V_{IO} if RS-485 loopback feature is needed in combination with MODE0, MODE1 also pulled high. Leave this pin as NC if same design as Maxlinear is needed.

3.3 Pin 17 (TERM_TX) and Pin 18 (TERM_RX)

As described earlier in this document, TI's THVD4431 provides 2 on-chip 120Ω termination resistors: one across the R1/R2 terminals (controlled by pin17 TERM_TX and is used in both RS-485 half duplex and full duplex modes), the other across the R3/R4 terminals (controlled by pin18 TERM_RX and is used in RS-485 full duplex mode).

Refer to Table 3-1 for a way to configure these pins the same as the XR34350 and SP339E/B devices.

Table 3-1. Pin 17 and Pin 18 Configuration for THVD4431 to Match XR34350 Functionality

	Pin 17 TERM_TX	Pin 18 TERM_RX
RS-485 half duplex	Pull up to V_{IO} to enable termination across R1/R2 or pull-down to GND to disable	NC
RS-485 full duplex	NC	Pull up to V_{IO} to enable termination across R3/R4 or pull-down to GND to disable

3.4 Pin 19 ($\overline{\text{SHDN}}$)

Pin 19 is $\overline{\text{SHDN}}$(shutdown) for TI's THVD4431 and is EN (enable) for Maxlinear's XR34350 and SP339E/B. These pins are identical in functionality – pull Pin 19 to V_{IO} to enable device operation and pull-down to ground to disable device operation. For both devices, asserting this function disables all blocks and the current drawn from the device is just the leakage current.

3.5 Pin 36 (NC)

Pin 36 of TI's THVD4431 is not internally connected. Pin 36 can be grounded without issue. Also, this pin is compatible with Maxlinear's XR34350 and SP339E/B.

4 Pinout Mapping

Table 4-1. Pinout Mapping of THVD4431 vs XR34350

	THVD4431 Pin Number	XR34350 and SP339E/B pin number	Description
Power and Ground Pins			
V_{CC}	20,32,38	9,20,32,38	3 to 5.5V supply voltage
V_{IO}	9	N/A	1.65V to 5.5V logic supply voltage
V-	33	33 (V_{SS})	Negative charge pump rail
C2-	34	34	Negative terminal of charge pump capacitor-2
C1-	35	35	Negative terminal of charge pump capacitor-1
C1+	37	37	Positive terminal of charge pump capacitor-1
C2+	39	39	Positive terminal of charge pump capacitor-2
V+	40	40 (V_{DD})	Positive charge pump rail
GND	10,23,26,29	10,23,26,29,36	Ground
Logic data pins			
L1	1	1	Logic output (RS-232)
L2	2	2	Logic output (RS-232/RS-485)
L3	3	3	Logic input (RS-232/RS-485)
L4	4	4	Logic input (RS-232)
L5 (L6 for the Maxlinear devices)	5	5	Logic output (RS-232)
L6 (L7 for the Maxlinear devices)	6	6	Logic input (RS-232)
L7 (L8 for the Maxlinear devices)	7	7	Logic output (RS-232)
L8 (L9 for the Maxlinear devices)	8	8	Logic output (RS-232)
Bus pins			
R1	31	31	RS-232 receiver input or RS-485 bus pin (Z or B)
R2	30	30	RS-232 receiver input or RS-485 bus pin (Y or A)
R3	28	28	RS-232 driver output or RS-485 non-inverting receiver input (A)
R4	27	27	RS-232 driver output or RS-485 inverting receiver input (B)
R5 (R6 for the Maxlinear devices)	25	25	RS-232 receiver input
R6 (R7 for the Maxlinear devices)	24	24	RS-232 driver output
R7 (R8 for the Maxlinear devices)	22	22	RS-232 receiver input
R8 (R9 for the Maxlinear devices)	21	21	RS-232 receiver input
Logic control pins			
SLR (SLEW for Maxlinear devices)	11	11	Slew rate control, internal pull-down resistor. SLR=H enables slow speed
DIR	12	12	RS-485 TX/RX enable/disable. Internal pull-down resistor
MODE2	13	N/A	MODE control pins, Integrated weak pull-down resistor
MODE0	14	14	
MODE1	15	15	
NC	16, 36	13,16, 18	Not connected internally. Can be connected to supply, ground or left open on PCB
TERM_TX (TERM for Maxlinear devices)	17	17	120Ω Termination enable/disable across R1/R2 terminals. Internal pull down resistor
TERM_RX	18	N/A	120Ω Termination enable/disable across R3/R4 terminals. Internal pull down resistor
$\overline{\text{SHDN}}$ (EN for Maxlinear devices)	19	19	Device enable/disable

5 Summary

By following the guidelines addressed in this application note, a system designer can co-layout a PCB common to TI's THVD4431 and Maxlinear's XR34350/SP339E/B. Alternatively, the report provides instructions on how to upgrade a system from Maxlinear's XR34350/SP339E/B to TI's THVD4431.

6 References

* Texas Instruments, *THVD4431 Multiprotocol (RS-232, RS-422, RS485) Transceiver with Integrated 120-Ω Switchable Termination Resistor and IEC-ESD Protection*, data sheet.

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