EVM User's Guide: THVD4431EVM THVD4431

THVD4431EVM

Description

The THVD4431 is Texas Instruments' first RS-485 and RS-232 multi-protocol transceiver. This configuration allows for 3T5R RS-232 communication, half duplex RS-485 communication, full duplex RS-485 communication, and loopback modes for both RS-232 and RS-485 to allow for on chip diagnostic testing.

Get Started

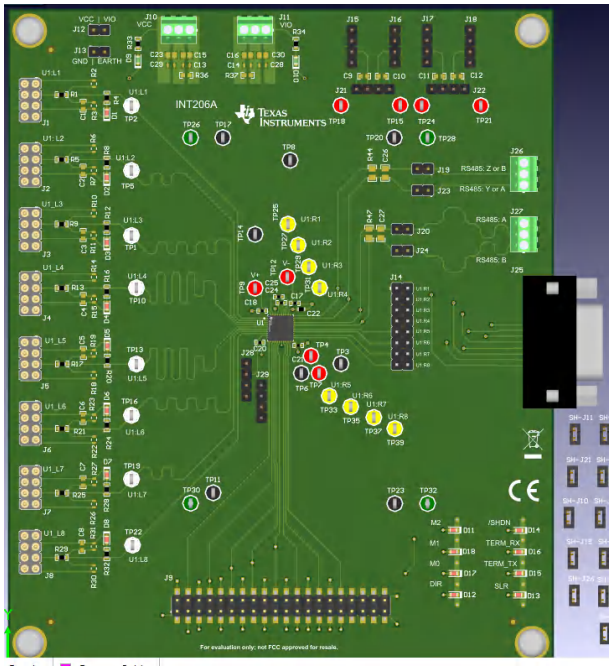
1. Order the EVM at TI.com here
2. See the latest product information and data sheet for THVD4431 (SLLSFS1)

Features

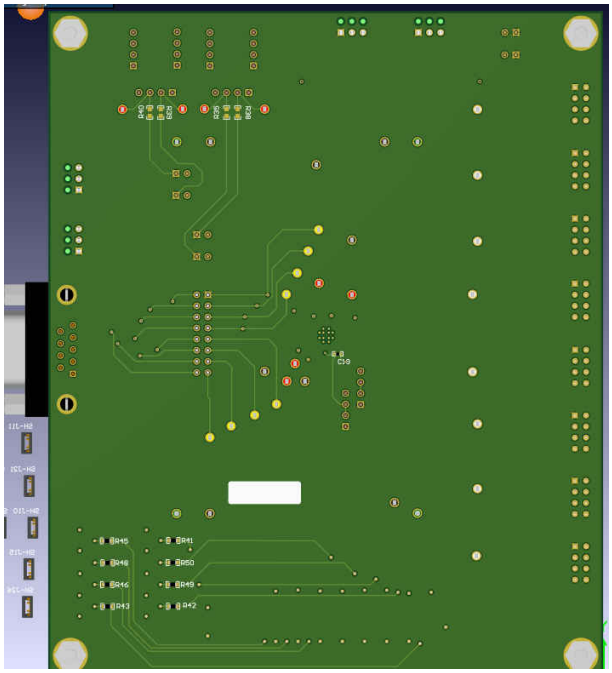
- THVD4431RHA preinstalled onto evaluation module.
- 8 additional power-supply decoupling capacitor pads for VCC and VIO connections.
- 0603 Resistor Pads Available to create resistive link between GND and EARTH Connections for both VIO and VCC terminals.
- Terminal and Header pin access to RS-232 and RS-485 bus signals.
- LED Indicators for control and data signals (VIO >= 3.3V Only)

Applications

- Industrial PC
- Factory automation and control
- HVAC systems
- Building automation
- Point-of-sale terminals
- Grid infrastructure
- Industrial transport



THVD4431EVM (Top Side)



THVD4431EVM (Bottom Side)

1 Evaluation Module Overview

1.1 Introduction

This document is the EVM user's guide for the THVD4431EVM, which provides a quick way to evaluate TI's THVD4431EVM. This user's guide describes the THVD4431EVM and the intended use. The information in the warning statement is provided for personal protection and the information in the caution statement is provided to protect the equipment from damage. Read each caution and warning statement carefully.

Caution	

This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in the supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, see Electrostatic Discharge (ESD).

1.2 Kit Contents

- THVD4431EVM with THVD4431 installed.
- 30 Shunts for interfacing with EVM headers.

Please see Section 2.3 for a detailed look at which components are installed by default on the EVM.

1.3 Device Information

THVD4431 is a highly integrated and robust multiprotocol transceiver supporting RS-232, RS-422 and RS-485 physical layers. The device has three transmitters and five receivers to enable 3T5R RS-232 port. Device also integrates one transmitter and one receiver to enable half and full duplex RS-485 port. MODE selection pins enable shared bus and logic pins for the protocols to share a common single connector. Integrated termination for RS-485 bus pins and for RS-232 receiver inputs verify no external components are needed to realize a fully functional communication port. These devices have a slew rate select feature that enables the devices to be used at two maximum speeds based on the SLR pin setting.

These devices feature integrated Level 4 IEC ESD protection, eliminating the need for external system level protection components. Diagnostic loopback mode for both RS-232 and RS-485 is provided to check for logic to bus and bus to logic path functional integrity and check for cable and connector shorts. In addition, the RS-485 receiver fail-safe feature drives logic high on received logic output when the bus inputs are open or shorted together or when the bus is idle. Shutdown mode consumes ultra-low current (10 uA typical), which is an excellent choice for power-sensitive applications. The device needs 3 to 5.5 V supply that powers the charge pump for RS-232 and the drivers/receivers for both RS-232 and RS-485. A separate logic supply VIO (1.65 V to 5.5 V) enables interface with low level microcontrollers.

For more specific device information please see data sheet (SLLSFS1).

2 Hardware

2.1 Power Requirements

THVD4431 IC Variant Considerations

The most modern variants of the IC THVD4431RHA Pin 9 is VIO. Pin 16 is a no connect; however, this EVM includes the original pinout of the THVD4431RHA, which is slightly different. The original pinout has pin 9 connected to VCC and pin 16 being a VIO connection. To remedy this, jumpers J28 and J29 must be configured before operation. With J12 and J13 oriented at the top left of the board, J28 and J29 are positioned vertically below U1.

Component ID	Comment
J28 – Original pinout THVD4431	Shunt bottom pin to 3rd pin to connect VCC
J28 – Current pinout THVD4431	Shunt top pin to 2nd pin to connect VIO
J29 – Original pinout THVD4431	Shunt top pin to 2nd pin to connect VIO
J29 – Current pinout THVD4431	Leave jumper open to keep Pin 16 no connect

Single Supply Operation (Logic Supply Equals Main Voltage Supply)

The THVD4431 Transceiver in the RHA (QFN) package from TI has an additional logic supply pin, *VIO*. This is used to power the internal digital logic circuits inside of the device. In single supply operation mode for the THVD4431RHA, the VIO pin must be shorted to VCC by shorting the header pins of J12, so that the digital circuits are properly powered.

Component ID	Comment
J10	VCC Power terminal – Attach voltage source of 3 V to 5.5V to terminal block.
J11	VIO Power terminal – Leave open for single supply operation.
J12	Shunted for single supply operation.
J13	Shunted for applications with no separation between EARTH and GND.

To apply power onto the board, VCC is applied through the J10 terminal. With the board oriented with J12 on the top left side of the board, as shown in Figure 2-1, the signals are, from right to left, VCC, GND, EARTH. The EARTH and GND distinction are used to help the end user determine operational qualities with respect to ground potential differences. If testing methods on reducing ground loop current install a resistor on pad R16.

Dual Supply Operation (Separate Digital Logic and Driver Supplies)

The THVD4431 transceiver in the RHA (QFN) package from TI has an additional logic supply pin, *VIO*. This is used to power the internal digital logic circuits inside of the device. In dual supply operation, the digital circuit supply *VIO* supplies the Logic Signal Pins (L1 – L8) and the control signal pins (SLR,DIR,M2,M0,M1,TERM_TX,TERM_RX, and /SHDN). This supply can operate from 1.65V to 5.5V to allow controllers to communicate with the transceiver at 2.5V and 1.8V logic levels. J12 must be left open for dual supply operation.

Component ID	Comment
J10	VCC Power terminal – Attach voltage source of 3 V to 5.5V to terminal block.
J11	VIO Power terminal – Attach voltage source of 1.65V to 5.5V to terminal block.
J12	Left open for dual supply operation.
J13	Shunted for applications with no separation between EARTH and GND.

Powering the board up is similar to the single supply operation. J10 is powered as described in Single Supply Operation (Logic Supply Equals Main Voltage Supply). Using the same orientation as before, (J12 and J13 are top left of the board) and the inputs for the VIO power terminal (J11) are reversed from VCC (J10) – from left to right, is EARTH, GND, VIO. Additional supply decoupling pads are available for VIO terminal block if more decoupling capacitance is needed.

2.2 Setup

Operational Modes and Control Signals

After the power supply of THVD4431EVM has been configured, set up the board for operation. Before any operation of the board can occur, the operational mode and control pins must be configured. In Figure 2-1, the map to the J9 header pins is shown. Assume that the board is oriented with J12 and J13 in the top left of the EVM. The numbered boxes correspond to the pin number for J9 as indicated in the schematic.

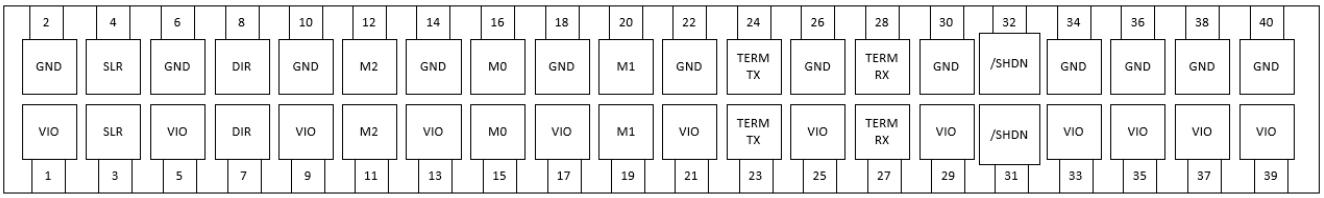


Figure 2-1. THVD4431EVM: IC Control Header (J9) Map

To select a configuration option, find the signal of interest on J9 according to Figure 2-1. If a low value is wanted, then shunt the top row header pin connected to the signal of interest to the pin on the left. If a high is wanted shunt, then connect the bottom row header pin to the signal of interest to the pin on the left. If VIO is >= 3.3V, then the indicator board indicates what state each control line is in with the aid of an LED. Next, the mode of operation needs to be determined. The operational mode is controlled by the M0, M1, and M2 connected to U1 via J9-15/16, J9-19/20, and J9-11/12, respectively.

Table 2-1. Mode Selection

M2 (J9-11;J9-12)	M1 (J9-19;J9-20)	M0 (J9-15;J9-16)	Mode	Comment
0	0	0	RS-232 Loopback	Internal shorts for U1: U1:R3 – R1 U1:R4 – R2 U1:R6 – R5 U1:R6 – R7 U1:R6 – R8
0	0	1	RS-232	3T5R RS-232 Mode
0	1	0	Half duplex RS-485	2-Wire RS-485
0	1	1	RS-485 Full duplex	4-Wire RS-485
1	0	0	Not used	N/A
1	0	1	Not used	N/A
1	1	0	Not used	N/A
1	1	1	RS-485 Loopback	Internal shorts for U1: U1:R1 – R4 U1:R2 – R3

After the mode has been selected, the other features and control signals can be configured or connected to a signal source for the DIR and /SHDN signals.

Table 2-2. Control Signals

Signal	Signal Jumper+ Pin ID	Associated GND Pin	Logic '0' Operation	Associated VIO Pin	Logic '1' Operation
SLR	J9-3; J9-4	J9-2	RS485: 20Mbps RS232: 1Mbps	J9-1	RS485: 500kbps RS232: 250kbps
DIR	J9-7; J9-8	J9-6	RS485: RX mode	J9-5	RS485: TX mode
TERM_TX	J9-23; J9-24	J9-22	RS485 TX: unterminated	J9-21	RS485 TX: terminated with 120 Ω
TERM_RX	J9-27; J9-28	J9-26	RS485 RX: unterminated	J9-25	RS485 RX: terminated with 120 Ω
/SHDN	J9-31; J9-32	J9-30	device in shutdown mode	J9-29	Device Operational

The mode pins, along with the TERM_TX and TERM_RX pins, must be configured before communication starts for proper operation.

Logic and Bus Pins of the THVD4431

All the various modes of the THVD4431 share the use of the logic pins (denoted with the prefix "L") and the bus pins (denoted with the prefix "R").

Logic pins are for use when interfacing the THVD4431 with a controller. The Logic pins are supplied and bounded by the VIO voltage – meaning that these pins can accept GND to VIO input voltages and can output GND to VIO voltages. All logic pins L1 – L8 are accessible through 4x2 headers J1-J8 that populate the left side of the board when the pins are oriented with J12 and J13 in the top left corner. Figure 2-2 shows the headers pinouts.

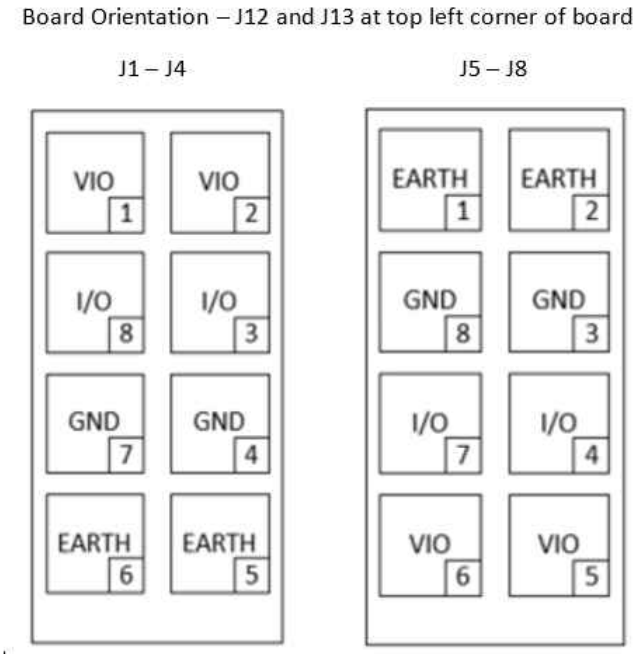


Figure 2-2. THVD4431EVM "L" Pin Header Map

The function of each individual "L" pin depends on the mode in which the THVD4431 is being operated in.

Bus pins on the other hand are the higher voltage tolerant pins for use with RS-485 or RS-232 depending on chosen operation mode. The bus pins are accessible in a few different ways depending on mode of use. Both RS-232 and RS-485 modes have all "R" pin signals routed to an 8x2 header J14. If headers J19 and J23 are shunted, then R1 and R2 signals are available on terminal block J26. If headers J20 and J24 are shunted, then

R3 and R4 signals are available on terminal block J27. If every row of header J14 is shunted, then all signals R1-R8 are available on the D-SUB connector J25. A brief summary is given in Table 2-3.

Table 2-3. Output Configuration

U1 Pin	Output Option 1	Output Option 2	Output Option 3	Output Option 4
R1	J14; Row 1; column 1	J19; column 1	J26 (if J19 is shunted)	J25 (if J14 row 1 is shunted)
R2	J14; Row 2; column 1	J23; column 1	J26 (if J23 is shunted)	J25 (if J14 row 2 is shunted)
R3	J14; Row 3; column 1	J20; column 1	J27 (if J20 is shunted)	J25 (if J14 row 3 is shunted)
R4	J14; Row 4; column 1	J24; column 1	J27 (if J24 is shunted)	J25 (if J14 row 4 is shunted)
R5	J14; Row 5; column 1	J25 (if J14 row 5 is shunted)	N/A	N/A
R6	J14; Row 6; column 1	J25 (if J14 row 6 is shunted)	N/A	N/A
R7	J14; Row 7; column 1	J25 (if J14 row 7 is shunted)	N/A	N/A
R8	J14; Row 8; column 1	J25 (if J14 row 8 is shunted)	N/A	N/A

How these pins are connected depends on the chosen operation mode and personal preference of the end user.

RS-232 Operation

With an understanding of the general architecture of the device and EVM a more thorough look at the RS-232 modes of operation is important. When entering the mode 001 for M2, M1, and M0 respectively the device enters RS-232 mode which has the transceiver setup as shown in Figure 2-3.

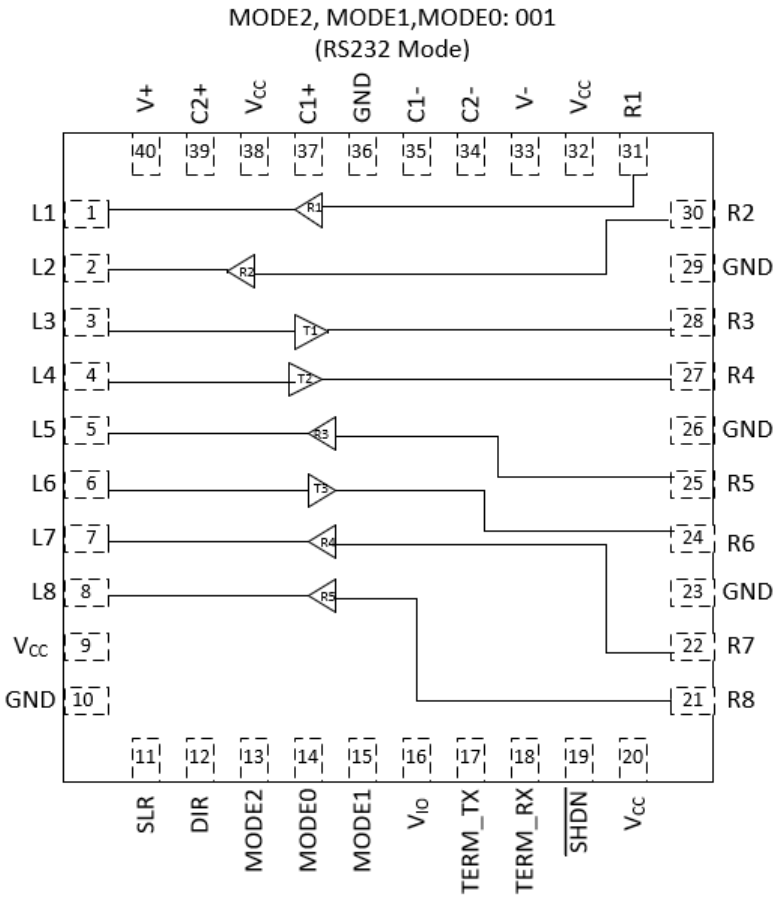


Figure 2-3. THVD4431EVM: MODE 001 (RS232 Mode)

This is commonly referred to as a 3T5R setup as there are three transmitters and 5 receivers. At an individual transceiver level, the type of RS-232 signal being transmitter or received is not important to the transceiver as the PHY layer characteristics are the same regardless of RS-232 signal type. However, the specific configuration

is generally used with the following RS-232 signals: TX, RX, TRS, CTS, DSR, DTR, RI, and DCD. While this configuration of signals isn't strictly required – most 3T5R RS-232 applications use these signals and require this configuration and if J25 (the DSUB connector) is used the pinout of the connector mimics the standard placement of the aforementioned RS-232 cables – this is summarized in Table 2-4.

Table 2-4. RS-232 Circuit Mnemonics

U1 Pin	Standard RS-232 Circuit Mnemonic	J25 Pin
R1	DCD	1
R2	RX	2
R3	TX	3
R4	DTR	4
R5	DSR	6
R6	RTS	7
R7	CTS	8
R8	RI	9

Many RS-232 test plans typically require a loop back test as well. The THVD4431 integrates a RS-232 loopback mode to make this testing quick and simple. When putting the device into mode 000 for M2, M1, and M0 respectively and a logical diagram is shown in Figure 2-4.

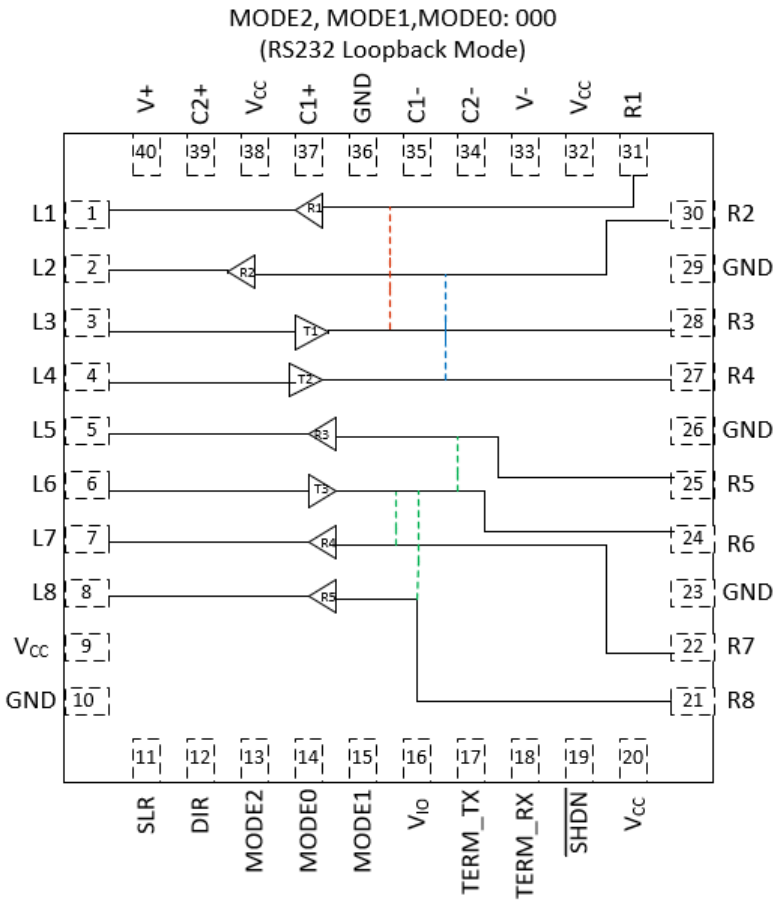


Figure 2-4. THVD4431EVM MODE 000 (RS232 Loopback Mode)

RS-485 Operation

This section is a brief overview of the RS-485 operation modes. There are three different operational modes of the RS-485 portion of the transceiver: Half Duplex, Full Duplex, and RS-485 loopback mode.

Half duplex operation is a very common implementation of RS-485 and entered when the mode is 010 for M2, M1, M0 respectively. In half duplex operation, the receive and transmit pins are shared by the transceiver allowing for asynchronous bi-directional communication on two wires with the trade-off being that the bus can only have one driver at a time and a device cannot receive and transmit data simultaneously. Figure 2-5 shows the internal configuration of the THVD4431 in half duplex RS-485 mode.

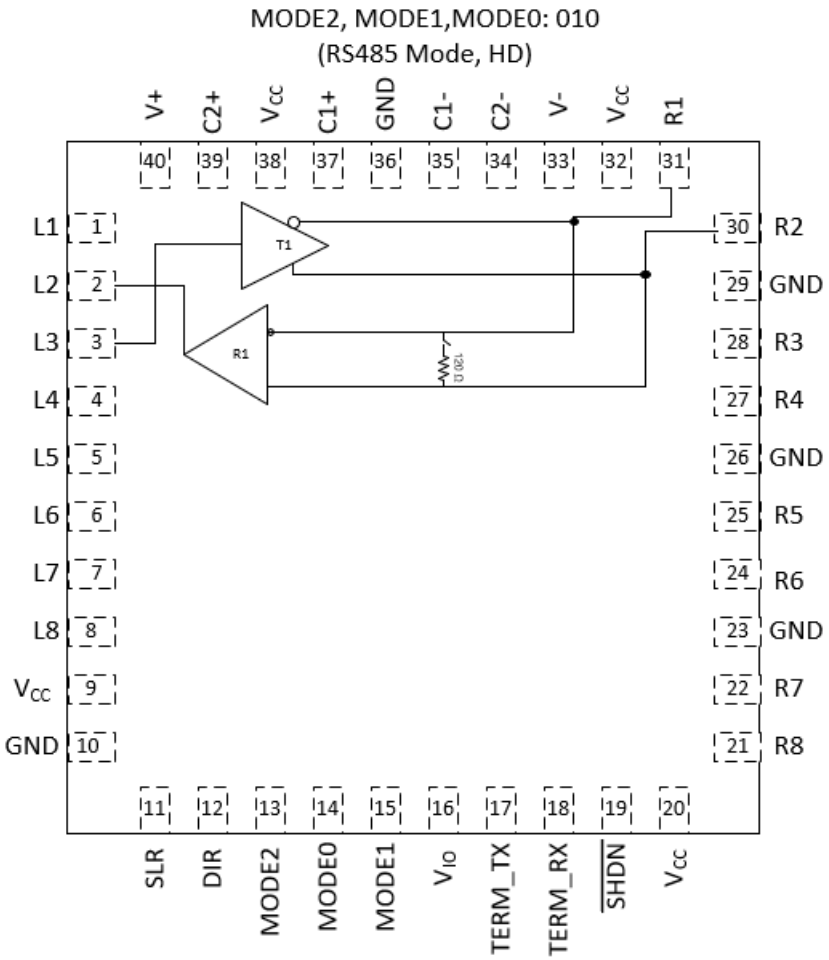


Figure 2-5. THVD4431EVM: MODE 010 (RS485 Half Duplex Mode)

The termination resistor shown is disabled by default. In Half-Duplex mode, TERM_RX is a don't care value and the integrated termination is only controlled by TERM_TX. Driver input is connected to L3 and the RS-485 console side output is L2.

The next mode of operation is full duplex operation, which is mode 011 for M2, M1, M0, respectively. This mode of operation separates the driver and receiver of the RS-485 transceiver, which leads to a 4-signal wire interface. This is shown in Figure 2-6.

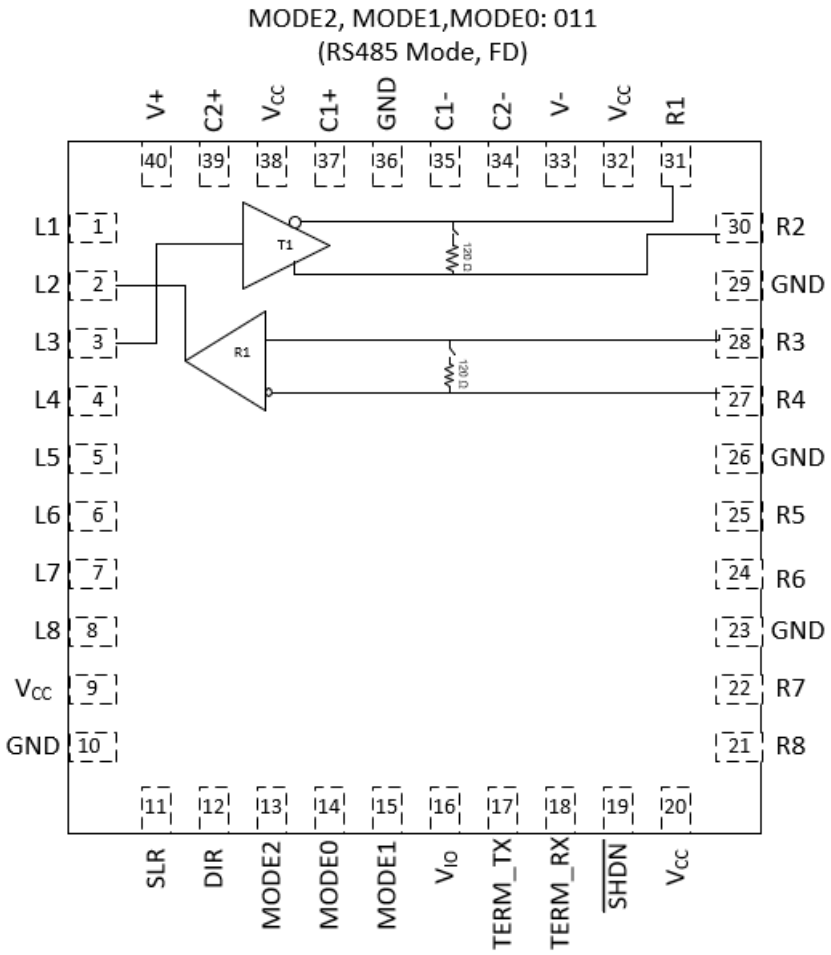


Figure 2-6. THVD4431EVM: MODE 011 (RS485 Full Duplex Mode)

Finally, the last RS-485 operation mode that is supported is RS-485 loopback, which is entered by mode 111 for M2, M1, M0, respectively. This mode shorts the driver output to the receiver inputs to allow for diagnostic testing of the THVD4431 as shown in Figure 2-7.

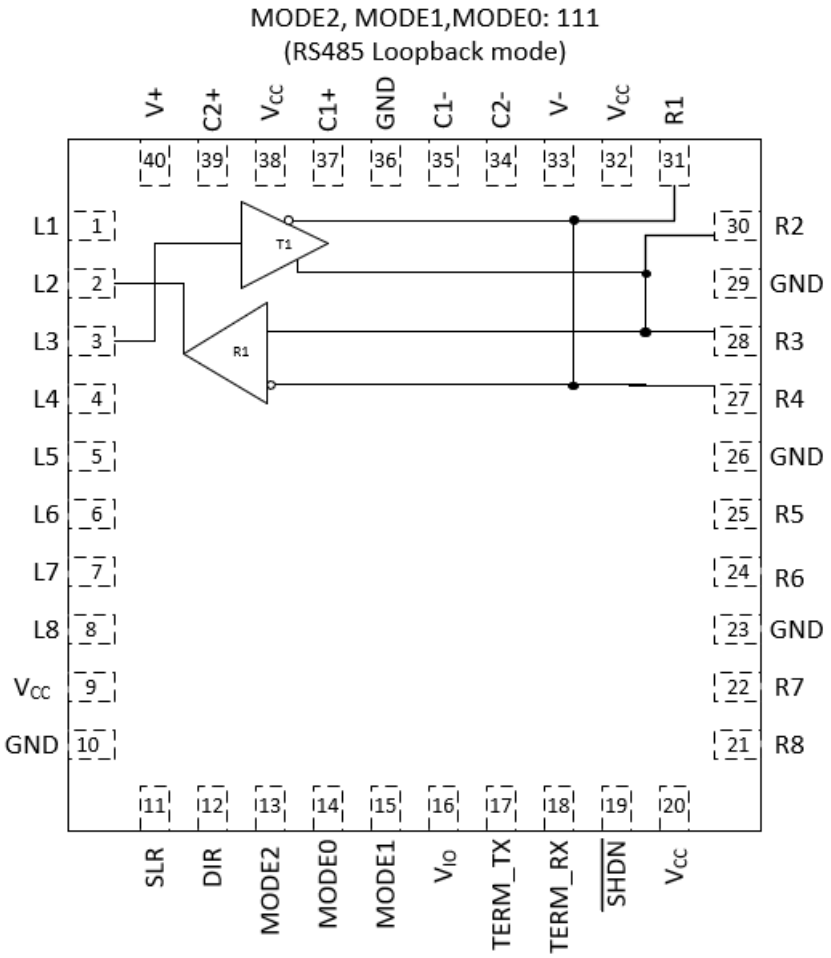


Figure 2-7. THVD4431EVM: MODE 111(RS485 Loopback Mode)

2.3 Component Information

The THVD4431EVM comes with THVD4431RHA pre-installed at U1. All the signal, signal jumpers, and IO connections (J1 – J29) come pre-installed on the board. Please see Table 2-5 for a description of every pad on the board and if the pads come pre-installed by default.

Table 2-5. Headers, Jumpers, and Interfaces

Jumper ID	Function	Package	Comment	Installed
J1	L1 I/O	4x2 header	L1 Pin on U1	Yes
J2	L2 I/O	4x2 header	L2 Pin on U1	Yes
J3	L3 I/O	4x2 header	L3 Pin on U1	Yes
J4	L4 I/O	4x2 header	L4 Pin on U1	Yes
J5	L5 I/O	4x2 header	L5 Pin on U1	Yes
J6	L6 I/O	4x2 header	L6 Pin on U1	Yes
J7	L7 I/O	4x2 header	L7 Pin on U1	Yes
J8	L8 I/O	4x2 header	L8 Pin on U1	Yes
J9	Control signals inputs	2x20 header	THVD4431 Control Signal Access	Yes
J10	VCC input	3 pin terminal block	Power, GND, and EARTH connections	Yes
J11	VIO input	3 pin terminal block	Power, GND, and EARTH connections	Yes
J12	VCC to VIO jumper	1x2 header	Used in single supply applications (shunt jumper)	Yes
J13	GND to EARTH jumper	1x2 header	Used when no Earth is present (shunt jumper)	Yes
J14	RS-232 Bus signal jumper	8x2 header	Shunt each row to connect to D-SUB	Yes
J15	RS-485 “A” common mode input	4x1 header	N/A	Yes
J16	RS-485 “B” common mode input	4x1 header	N/A	Yes
J17	RS-485 “Y” common mode input	4x1 header	N/A	Yes
J18	RS-485 “Z” common mode input	4x1 header	N/A	Yes
J19	RS-485 “Z” jumper	1x2 header	Shunt jumper to connect to terminal block	Yes
J20	RS-485 “A” jumper	1x2 header	Shunt jumper to connect to terminal block	Yes
J21	RS-485 “A,B” common mode input	4x1 header	N/A	Yes
J22	RS-485 “Y,Z” common mode input	4x1 header	N/A	Yes
J23	RS-485 “Y” jumper	1x2 header	Shunt jumper to connect to terminal block	Yes
J24	RS-485 “B” jumper	1x2 header	Shunt jumper to connect to terminal block	Yes
J25	RS-232 D-Sub connection	D-sub connector	Shunt J14 to use D-sub connection	Yes
J26	RS-485 “Z” and “Y” connection	3 pin terminal block	Shunt J19 and J23 to use terminal block	Yes
J27	RS-485 “A” and “B” connection	3 pin terminal block	Shunt J20 and J24 to use terminal block	Yes
J28	Pin 9 variant jumper	4x1 header	Check data sheet for current pin-out – Pin 9 can be VIO or VCC	Yes
J29	Pin 16 variant jumper	4x1 Header	Check data sheet for current pin-out – Pin 16 can be VIO or No Connect	Yes

Table 2-6. Resistors

R1	0 Ohm Resistor	0603	J1 to U1:L1	Yes
Resistor ID	Function	Package	Comment	Installed?
R2	Pull up resistor	0603	U1:L1	No
R3	Pull down resistor	0603	U1:L1	No
R4	LED current limiting resistor	0603	Limits current to D1	Yes
R5	0 Ohm resistor	0603	J2 to U1:L2	Yes
R6	Pull up resistor	0603	U1:L2	No
R7	Pull down resistor	0603	U1:L2	No
R8	LED current limiting resistor	0603	Limits current to D2	Yes
R9	0 Ohm resistor	0603	J3 to U1:L3	Yes
R10	Pull up resistor	0603	U1:L3	No
R11	Pull down resistor	0603	U1:L3	No
R12	LED current limiting resistor	0603	Limits current to D3	Yes
R13	0 Ohm resistor	0603	J4 to U1:L4	Yes
R14	Pull up resistor	0603	U1:L4	No
R15	Pull down resistor	0603	U1:L4	No
R16	LED current limiting resistor	0603	Limits current to D4	Yes
R17	0 Ohm resistor	0603	J5 to U1:L5	Yes
R18	Pull up resistor	0603	U1:L5	No
R19	Pull down resistor	0603	U1:L5	No
R20	LED current limiting resistor	0603	Limits current to D5	Yes
R21	0 Ohm resistor	0603	J6 to U1:L6	Yes
R22	Pull up resistor	0603	U1:L6	No
R23	Pull down resistor	0603	U1:L6	No
R24	LED current limiting resistor	0603	Limits Current to D6	Yes
R25	0 Ohm resistor	0603	J7 to U1:L7	Yes
R26	Pull up resistor	0603	U1:L7	No
R27	Pull down resistor	0603	U1:L7	No
R28	LED current limiting resistor	0603	Limits current to D7	Yes
R29	0 Ohm resistor	0603	J8 to U1:L8	Yes
R30	Pull up resistor	0603	U1:L8	No
R31	Pull down resistor	0603	U1:L8	No
R32	LED current limiting resistor	0603	Limits current to D8	Yes
R33	LED current limiting resistor	0603	Limits current to D9	Yes
R34	LED current limiting resistor	0603	Limits current to D10	Yes
R35	RS-485 “B” common mode impedance pad	0603	Common mode impedance minimum value = 375 Ω	No
R36	GND to EARTH resistor	0603	N/A	No
R37	GND to EARTH resistor	0603	N/A	No
R38	RS-485 “A” common mode impedance pad	0603	Common mode impedance minimum value = 375 Ω	No
R39	RS-485 “Y” common mode impedance pad	0603	Common mode impedance minimum value = 375 Ω	No
R40	RS-485 “Z” common mode impedance pad	0603	Common mode impedance minimum value = 375 Ω	No
R41	LED current limiting resistor	0603	Limits current to D11	Yes
R42	LED current limiting resistor	0603	Limits current to D12	Yes
R43	LED current limiting resistor	0603	Limits current to D13	Yes
R44	RS-485 “Z,Y” termination resistor	0805	120 Ohm Termination Resistor pad	No

Table 2-6. Resistors (continued)

R1	0 Ohm Resistor	0603	J1 to U1:L1	Yes
R45	LED current limiting resistor	0603	Limits current to D14	Yes
R46	LED current limiting resistor	0603	Limits current to D15	Yes
R47	RS-485 “A,B” termination resistor	0805	120 Ohm termination resistor pad	No
R48	LED current limiting resistor	0603	Limits current to D16	Yes
R49	LED current limiting resistor	0603	Limits current to D17	Yes
R50	LED current limiting resistor	0603	Limits current to D18	Yes

Table 2-7. Capacitors

Capacitor ID	Function	Package	Comment	Installed?
C1	Load Capacitance for U1:L1	0603	N/A	No
C2	Load Capacitance for U1:L2	0603	N/A	No
C3	Load capacitance for U1:L3	0603	N/A	No
C4	Load capacitance for U1:L4	0603	N/A	No
C5	Load capacitance for U1:L5	0603	N/A	No
C6	Load capacitance for U1:L6	0603	N/A	No
C7	Load capacitance for U1:L7	0603	N/A	No
C8	Load capacitance for U1:L8	0603	N/A	No
C9	100 nF | 25 V decoupling capacitor	0603	RS-485 “A” line common mode decoupling capacitor	No
C10	100 nF | 25 V decoupling capacitor	0603	RS-485 “B” line common mode decoupling capacitor	No
C11	100 nF | 25 V decoupling capacitor	0603	RS-485 “Y” line common mode decoupling capacitor	No
C12	100 nF | 25 V decoupling capacitor	0603	RS-485 “Z” line common mode decoupling capacitor	No
C13	1 uF | 25 V decoupling capacitor	0603	GND to EARTH capacitor	No
C14	1 uF | 25 V decoupling capacitor	0603	GND to EARTH capacitor	No
C15	4.7uF | 25 V decoupling capacitor	0805	GND to EARTH capacitor	No
C16	4.7uF | 25 V decoupling capacitor	0805	GND to EARTH capacitor	No
C17	100 nF | 25 V decoupling capacitor	0603	Negative charge pump output decoupling capacitor	Yes
C18	100 nF | 25 V decoupling capacitor	0603	Positive charge pump output decoupling capacitor	Yes
C19	100 nF | 25 V decoupling capacitor	0603	U1: Pin 16 decoupling capacitor	Yes
C20	100 nF | 25 V decoupling capacitor	0603	U1: Pin 9 decoupling capacitor	Yes
C21	100 nF | 25 V decoupling capacitor	0603	VCC decoupling capacitor	Yes
C22	1 uF | 25 V decoupling capacitor	0603	VCC decoupling capacitor	Yes
C23	4.7uF | 25 V decoupling capacitor	0805	VCC decoupling capacitor	No
C24	100 nF | 25 V charge pump capacitor	0603	Charge pump capacitor	Yes
C25	100 nF | 25 V charge pump capacitor	0603	Charge pump capacitor	Yes
C26	100 nF | 25 V termination capacitor for RS-485 bus	0805	N/A	No
C27	100 nF | 25 V termination capacitor for RS-485 bus	0805	N/A	No
C28	1uF | 25 V decoupling capacitor	0603	VIO supply decoupling capacitor	No
C29	1uF | 25 V decoupling capacitor	0603	VIO supply decoupling capacitor	No
C30	4.7uF | 25 V decoupling capacitor	0805	VIO supply decoupling capacitor	No

Table 2-8. LEDs

LED ID	Function	Package	Comment	Installed?
D1	U1:L1 signal LED (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D2	U1:L2 signal LED (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D3	U1:L3 signal LED (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D4	U1:L4 signal LED (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D5	U1:L5 signal LED (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D6	U1:L6 signal LED (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D7	U1:L7 signal LED (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D8	U1:L8 signal LED (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D9	U1 VCC indicator diode (Green)	Non-Standard	N/A	Yes
D10	U1 VIO indicator diode (Green)	Non-Standard	May not light up for VIO < 3.3V	Yes
D11	U1: M2 indicator diode (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D12	U1: DIR indicator diode (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D13	U1: SLR indicator diode (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D14	U1: /SHDN indicator diode (Red)	Non-Standard	May not light up for VIO < 3.3V	Yes
D15	U1: TERM_TX indicator diode (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D16	U1: TERM_RX indicator diode (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D18	U1: M0 indicator diode (Red)	Non-standard	May not light up for VIO < 3.3V	Yes
D18	U1: M1 indicator diode (Red)	Non-standard	May not light up for VIO < 3.3V	Yes

Table 2-9. IC

IC ID	Function	Package	Comment	Installed?
U1	THVD4431 – RS-485 and RS-232 Multiprotocol Transceiver	RHA	Comes pre-installed with THVD4431RHA	Yes

Table 2-10. Test Points

Test Point ID	Color	Signal
TP1	White	L3
TP2	White	L1
TP3	Black	GND
TP4	Red	VCC
TP5	White	L2
TP6	Black	GND
TP7	Red	VIO
TP8	Black	GND
TP9	Red	V+
TP10	White	L4
TP11	Black	GND
TP12	Red	V-
TP13	White	L5
TP14	Black	GND
TP15	Red	Common mode R4
TP16	White	L6
TP17	Black	GND
TP18	Red	Common mode R3
TP19	White	L7
TP20	Black	GND
TP21	Red	Common mode R1
TP22	White	L8

Table 2-10. Test Points (continued)

Test Point ID	Color	Signal
TP23	Black	GND
TP24	Red	Common mode R2
TP25	Yellow	R1
TP26	Green	EARTH
TP27	Yellow	R2
TP28	Green	EARTH
TP29	Yellow	R3
TP30	Green	EARTH
TP31	Yellow	R4
TP32	Green	EARTH
TP33	Yellow	R5
TP35	Yellow	R6
TP37	Yellow	R7
TP39	Yellow	R8

3 Hardware Design Files

3.1 Schematics

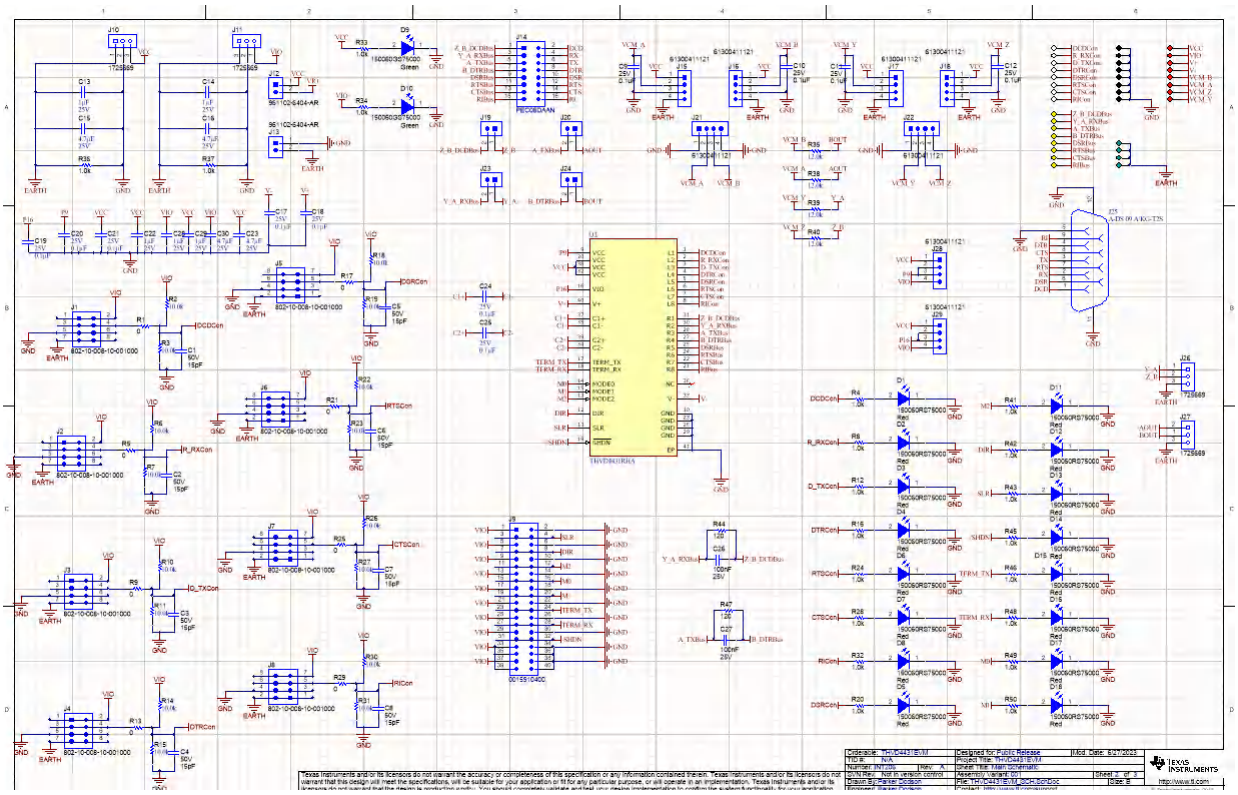


Figure 3-1. THVD4431EVM - Generic Schematic (No Variation Shown)

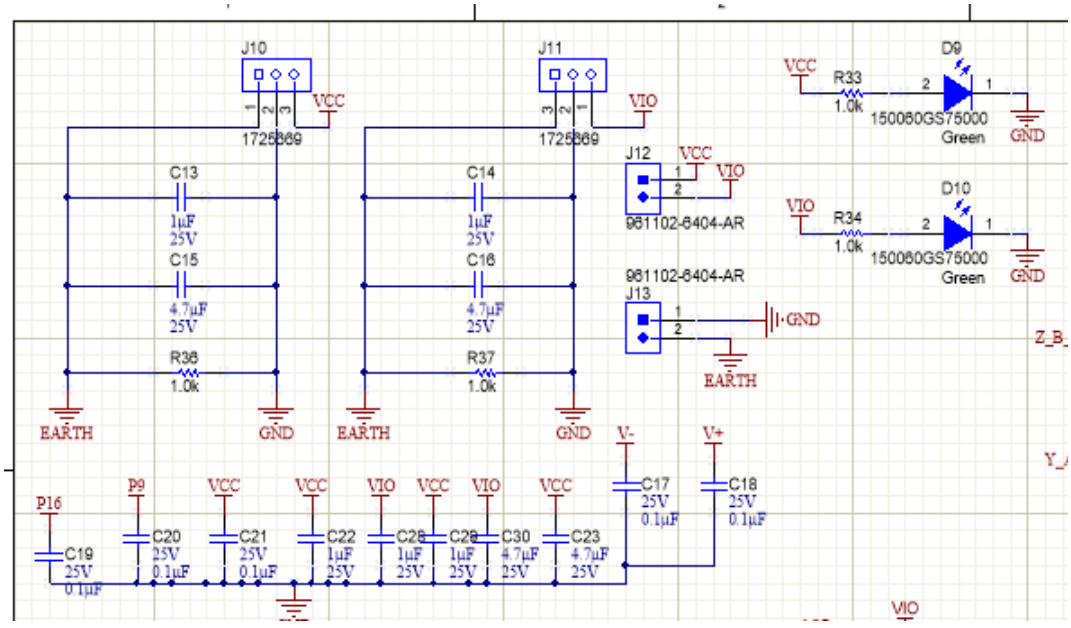


Figure 3-2. THVD4431EVM: Schematic Close Up- Power Input

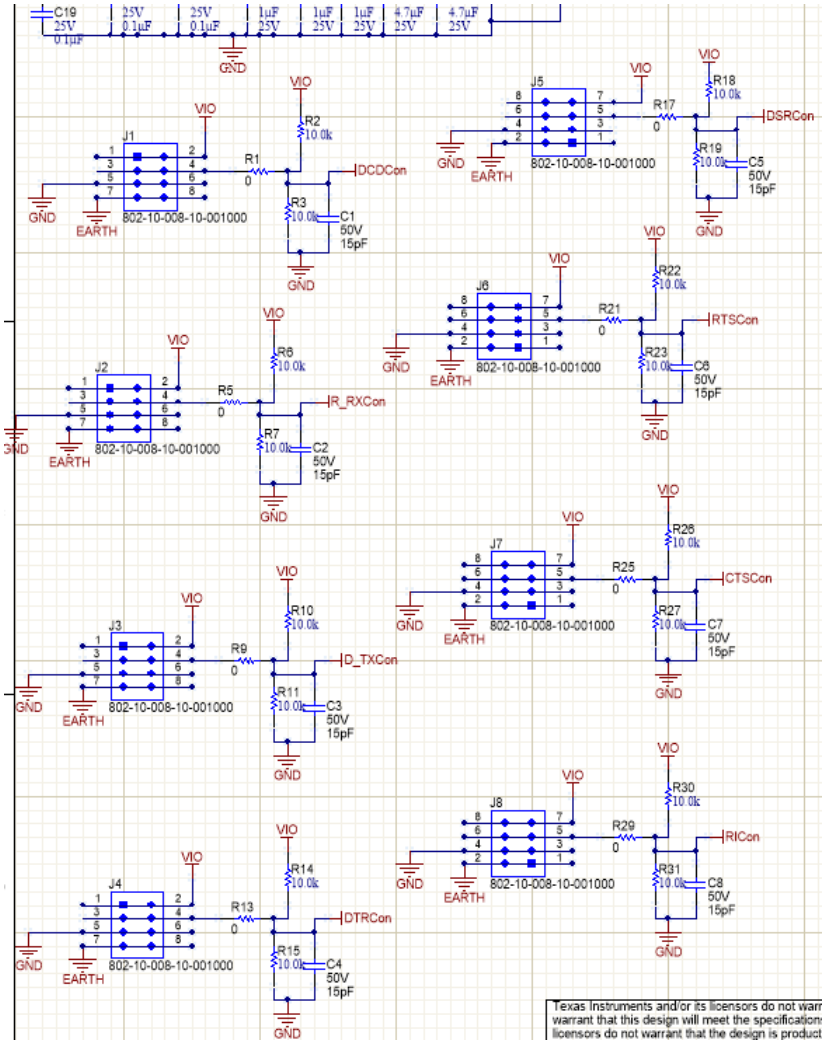


Figure 3-3. THVD4431EVM: Schematic Close Up- "L" Pin Headers

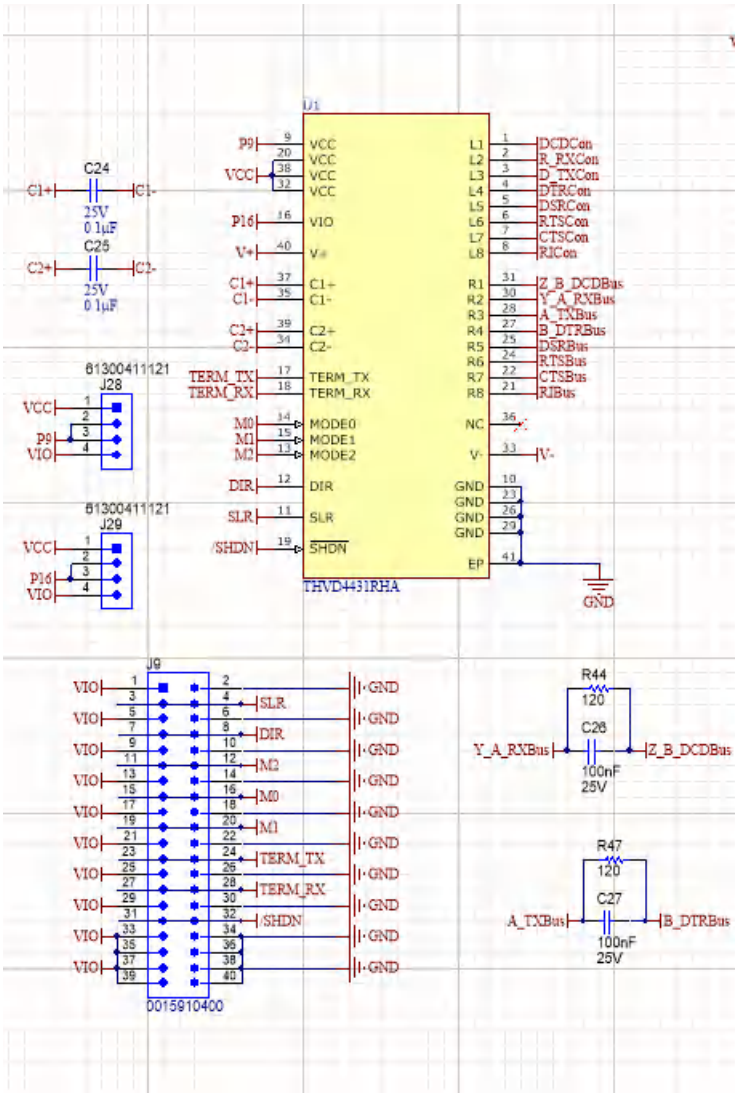


Figure 3-4. THVD4431EVM: Schematic Close Up- Main IC + Control Block

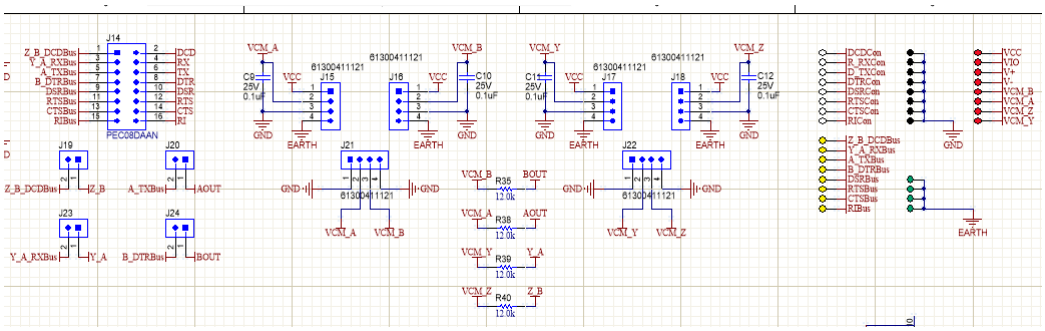


Figure 3-5. THVD4431EVM: Schematic Close Up- Interface Selection and Common Mode Input

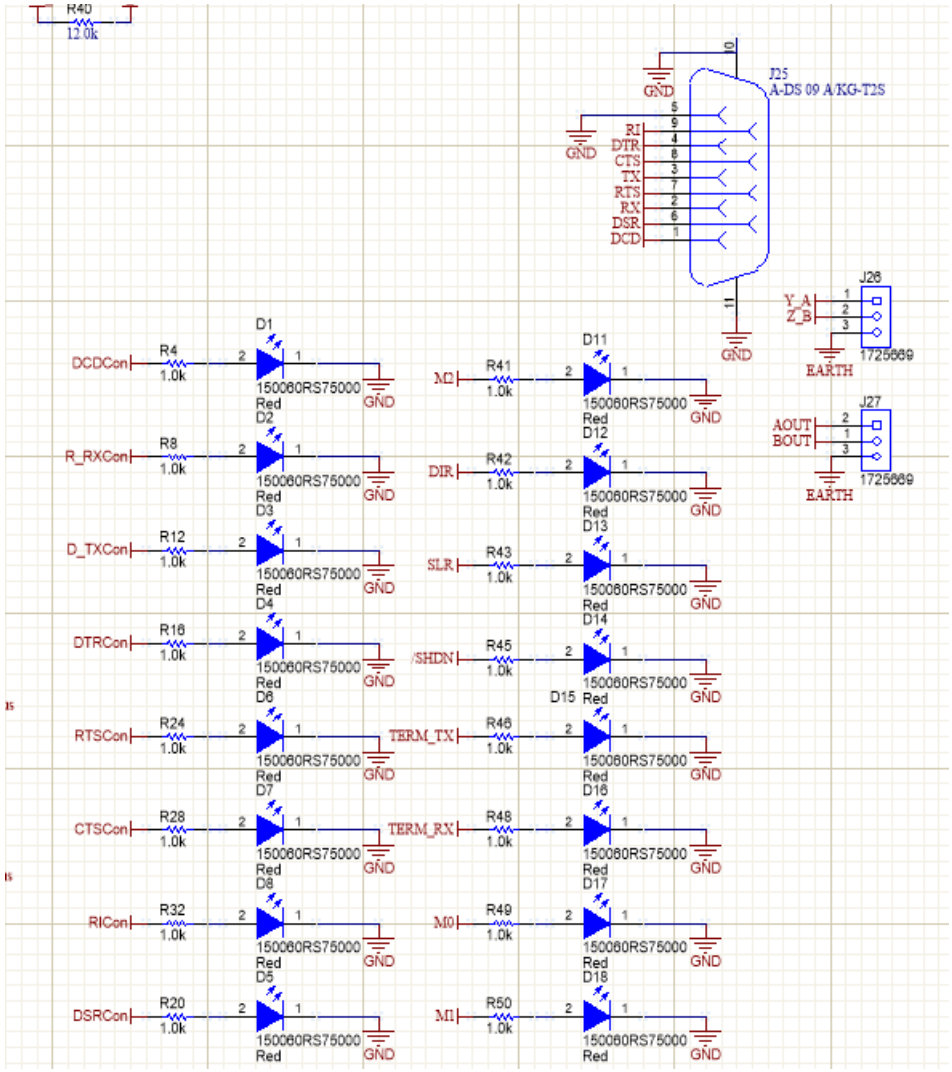


Figure 3-6. THVD4431EVM: Schematic Close Up- Signal Output and LED Indicators

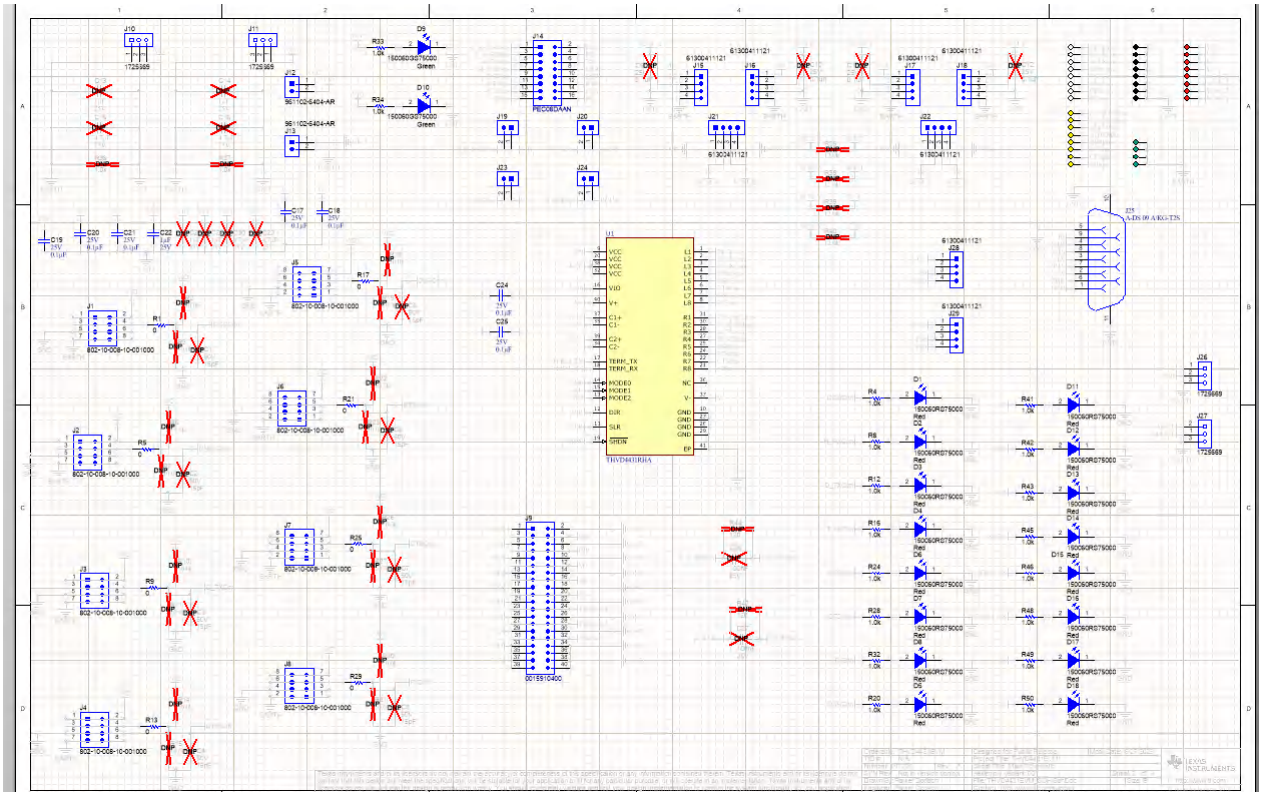


Figure 3-7. THVD4431EVM: Schematic - Default Variant

3.2 PCB Layouts

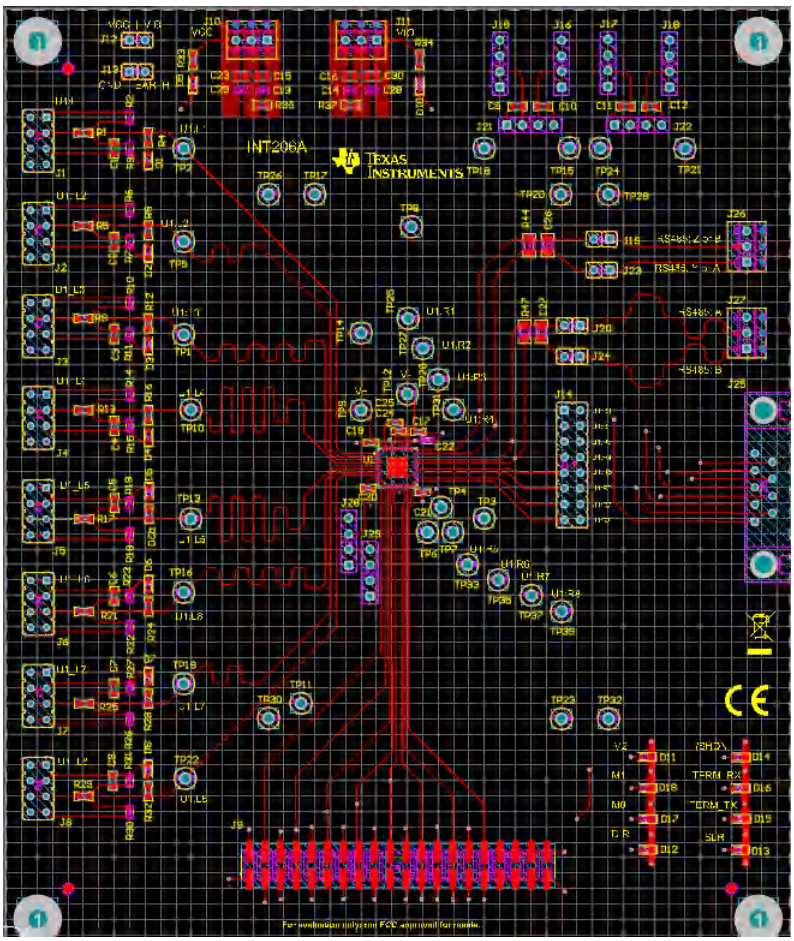


Figure 3-8. THVD4431EVM: Layout - Top Layer

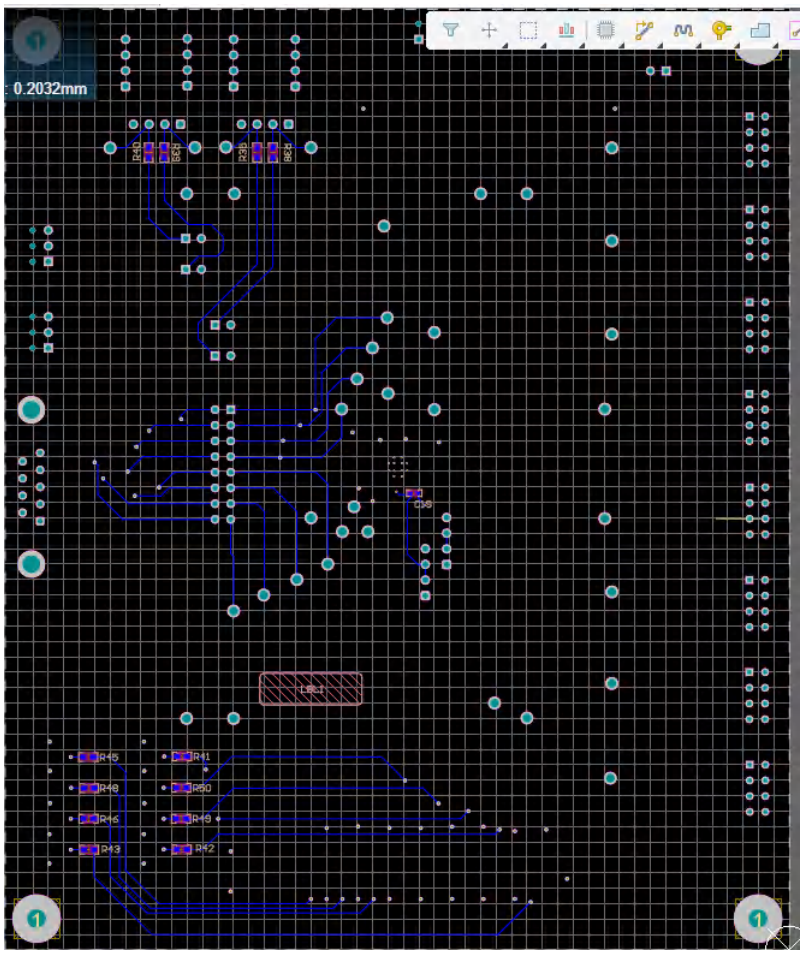


Figure 3-9. THVD4431EVM: Layout Bottom Layer

	Layer Name	Type	Material	Thickness (mm)	Dielectric Material	Dielectric Constant	Pullback (mm)	Orientation	Coverlay Expansion
	Top Overlay	Overlay							
	Top Solder	Solder Mask/...	Surface Mat...	0.01016	Solder Resist	3.5			0
1	Top Layer	Signal	Copper	0.03556				Top	
	Dielectric 2	Dielectric	Core	1.143		4.2			
2	GND	Internal Plane	Copper	0.03599			0.508		
	Dielectric 3	Dielectric	Prepreg	0.254		4.2			
3	EARTH	Internal Plane	Copper	0.03599			0.508		
	Dielectric 4	Dielectric	Core	0.254		4.2			
4	VCC	Internal Plane	Copper	0.03599			0.508		
	Dielectric1	Dielectric	Prepreg	0.254	FR-4	4.2			
5	VIO	Internal Plane	Copper	0.03599			0.508		
	Dielectric 5	Dielectric	Core	1.143		4.2			
6	Bottom Layer	Signal	Copper	0.03556				Bottom	
	Bottom Solder	Solder Mask/...	Surface Mat...	0.01016	Solder Resist	3.5			0
	Bottom Over...	Overlay							

Figure 3-10. THVD4431EVM: Layout - Layer Stackup

3.3 Bill of Materials (BOM)

Table 3-1 lists the bill of materials.

Table 3-1. Bill of Materials

Quantity	PartNumber	Designator	Manufacturer
7	CGA2B3X7R1E104K050BB	C17, C18, C19, C20, C21, C24, C25	TDK
1	CGA3E1X7R1E105K080AC	C22	TDK
16	150060RS75000	D1, D2, D3, D4, D5, D6, D7, D8, D11, D12, D13, D14, D15, D16, D17, D18	Wurth Elektronik
2	150060GS75000	D9, D10	Wurth Elektronik
4	NY PMS 440 0025 PH	H1, H2, H3, H4	B&F Fastener Supply
4	1902C	H5, H6, H7, H8	Keystone
8	802-10-008-10-001000	J1, J2, J3, J4, J5, J6, J7, J8	Mill-Max
1	0015910400	J9	Molex
4	1725669	J10, J11, J26, J27	Phoenix Contact
6	961102-6404-AR	J12, J13, J19, J20, J23, J24	3M
1	PEC08DAAN	J14	Sullins Connector Solutions
8	61300411121	J15, J16, J17, J18, J21, J22, J28, J29	Wurth Elektronik
1	A-DS 09 A/KG-T2S	J25	Assman WSW
1	THT-14-423-10	LBL1	Brady
8	RCS06030000Z0EA	R1, R5, R9, R13, R17, R21, R25, R29	Vishay-Dale
18	CRCW06031K00JNEA	R4, R8, R12, R16, R20, R24, R28, R32, R33, R34, R41, R42, R43, R45, R46, R48, R49, R50	Vishay-Dale
30	QPC02SXGN-RC	SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20, SH-J21, SH-J22, SH-J23, SH-J24, SH-J25, SH-J26, SH-J27, SH-J28, SH-J29, SH-J30	Sullins
8	5012	TP1, TP2, TP5, TP10, TP13, TP16, TP19, TP22	Keystone
8	5011	TP3, TP6, TP8, TP11, TP14, TP17, TP20, TP23	Keystone Electronics
8	5010	TP4, TP7, TP9, TP12, TP15, TP18, TP21, TP24	Keystone Electronics
8	5014	TP25, TP27, TP29, TP31, TP33, TP35, TP37, TP39	Keystone Electronics
4	5126	TP26, TP28, TP30, TP32	Keystone
1	THVD4431RHA	U1	Texas Instruments

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 References

THVD4431 data sheet: SLLSFS1

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   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *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

NOTE: 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

NOTE: 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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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.

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.

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.

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. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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西新宿三井ビル

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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