EVM User's Guide: RS485FLDPLXDRCEVM
RS485FLDPLXDRCEVM Evaluation Module

TEXAS INSTRUMENTS

Description

The RS485FLDPLXDRCEVM is an EVM from TI that allows quick prototyping of our Full Duplex RS-485 Transceivers in a DRC package. The board allows for testing of single and differential ended communication with potential modifications such as changing the termination resistance or adding a common mode bias to the bus to simulate ground potential differences that can be seen in systems with long cables that share a ground line with high current capacity. The board comes preinstalled with a THVD2412DRCR which allows full duplex communication at up to 250kbps powered by a 3 V to 5.5V power connection on VCC. The board also supports testing of systems with separate EARTH planes separate from the device ground reference plane.

Features

- Footprint for 10-Pin VSON (DRC) Full Duplex RS-485 Transceivers Indicated as U1
- THVD2412DRC Installed as U1 by Default

- Power Supply Terminals allow for Power, Board-Ground, and Earth Connections.
- Bulk Power Supply Coupling Capacitors installed (2, 47uF and 2, 10uF caps) with two between VCC and GND with the other two between GND and EARTH.
- Ground Current Limiting Resistor Pad (R14) Available Between Board Ground and Earth on J5
- Common Mode Voltage Connections (J6, J7, J8, J15, J16, and J17) Available to Add a Common Mode Voltage to the RS-485 Differential Bus (Pins A and B or Pins Y and Z)

Applications

- Motor drives
- Factory automation and control
- HVAC systems
- Building automation
- Grid infrastructure
- Electricity meters
- Process analytics
- Video surveillance
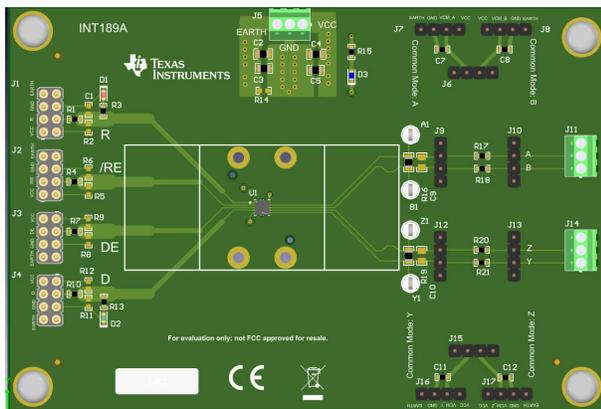
RS485FLDPLXDRCEVM - Front View
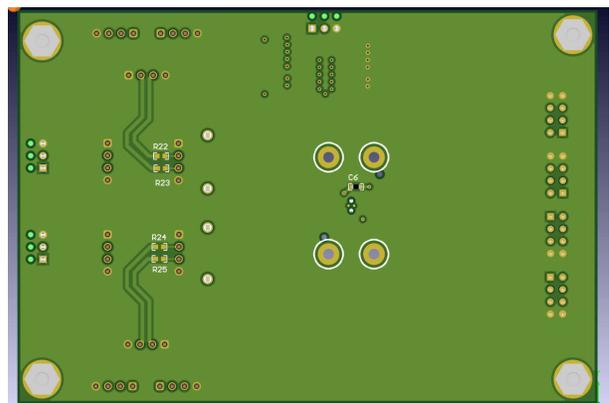
RS485FLDPLXDRCEVM - Back View

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the RS485FLDPLXDRCEVM and the intended use.

This document is the EVM user's guide for the RS485FLDPLXDRCEVM, which provides a quick way to evaluate TI's Full Duplex RS-485 Transceivers in 10-Pin VSON (DRC) Packages such as the THVD2412DRC. For more detailed description of operation, check the specific DUT data sheet (SLLSFR1).

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.

ATTENTION
STATIC SENSITIVE DEVICES

HANDLE ONLY AT
STATIC SAFE WORK STATIONS

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

The kit contains:

- 1 RS485FLDPLXDRCEVM board
- Preinstalled with THVD2412DRCR to work directly out of box

1.3 Specification

This board is a generic EVM, so specifications varies with end user selected DUT for U1. Please refer to device data sheet for more detailed specifications. A selection of common usage ranges for devices considered in the construction of the board are shown below.

- VCC input (at J5) is expected to be between 3 V and 5.5V for compatible devices.
- Signal inputs at J2, J3, and J4 are expected to be between 0 V and VCC.
- The device on board does not generate voltages above VCC by itself.
- Each board is equipped with a 120 Ohm termination resistor on each differential bus.
- Check specific common mode ratings on DUT data sheet for input ranges for common mode inputs.

1.4 Device Information

Please refer to specific chosen devices data sheet for more information. This board is meant to support Full Duplex RS-485 transceivers in a 10-pin VSON (DRC) package.

2 Hardware

2.1 Board Components and Pad Overview

The RS485FLDPLXDRCEVM Comes Ready to Operate Directly Out of Box with a THVD2412DRCR installed at U1. All the Signal and Power Jumpers/Inputs (J1 – J15) come pre-installed on board.

Table 2-1. Jumpers

Jumper ID	Function	Package	Installed?
J1	R Pin Output	8 Pin Header	Yes
J2	/RE Input	8 Pin Header	Yes
J3	DE Input	8 Pin Header	Yes
J4	D Pin Output	8 Pin Header	Yes
J5	VCC Power Input	3 Pin Terminal Block	Yes
J6	Common Mode Input Connection for A and B	4 Pin Header	Yes
J7	Common Mode Input Connection for A	4 Pin Header	Yes
J8	Common Mode Input Connection for B	4 Pin Header	Yes
J9	Differential Bus Jumper (A,B)	4 Pin Header	Yes
J10	Differential Bus Jumper (A,B)	4 Pin Header	Yes
J11	Differential Receiver Input Terminal Block	3 Pin Terminal Block	Yes
J12	Differential Bus Jumper (Y,Z)	4 Pin Header	Yes
J13	Differential Bus Jumper (Y,Z)	4 Pin Header	Yes
J14	Differential Driver Output Terminal Block	3 Pin Terminal Block	Yes
J15	Common Mode Input Connection for Y and Z	4 Pin Header	Yes
J16	Common Mode Input Connection for Y	4 Pin Header	Yes
J17	Common Mode Input Connection for Z	4 Pin Header	Yes

Table 2-2. Resistors

Resistor ID	Function	Package	Comment	Installed?
R1	0 Ω connection series resistor	0603	For R Pin	Yes
R2	Pull up resistor	0603	For R Pin	No
R3	Current limiting resistor for diode	0603	For R LED D1 (R pin)	Yes
R4	0 Ω connection series resistor	0603	For Enable 1 (DE on DRC Pkg and /RE on D Pkg)	Yes
R5	Pull up resistor	0603	For Enable 1 (DE on DRC Pkg and /RE on D Pkg)	No
R6	Pull down resistor	0603	For Enable 1 (DE on DRC Pkg and /RE on D Pkg)	No
R7	0 Ω connection series resistor	0603	For Enable 2 (/RE on DRC Pkg and DE on D Pkg)	Yes
R8	Pull up resistor	0603	For Enable 2 (/RE on DRC Pkg and DE on D Pkg)	No
R9	Pull down resistor	0603	For Enable 2 (/RE on DRC Pkg and DE on D Pkg)	No
R10	0 Ω connection series resistor	0603	For D Pin	Yes
R11	Pull up resistor	0603	For D Pin	No
R12	Pull down resistor	0603	For D Pin	No
R13	Current limiting resistor for diode	0603	For D LED D2 (D Pin)	Yes
R14	GND to EARTH pull down for VCC supply	0603	N/A	No

Table 2-2. Resistors (continued)

Resistor ID	Function	Package	Comment	Installed?
R15	Current limiting resistor for diode	0603	For VCC LED (D3)	Yes
R16	120 Ω termination resistor	0805	Needed for RS-485 applications (Terminal Nodes)	No
R17	0 Ω connection series resistor "A" line	0603	N/A	Yes
R18	0 Ω series connection resistor "B" Line	0603	N/A	Yes
R19	120 Ω Termination Resistor	0805	Needed for RS-485 applications (Terminal Nodes)	No
R20	0 Ω Connection Series Resistor "Z" line	0603	N/A	Yes
R21	0 Ω series connection resistor "Y" line	0603	N/A	Yes
R22	Common mode load "A" line	0603	N/A	No
R23	Common mode load "B" line	0603	N/A	No
R24	Common mode load "Z" line	0603	N/A	No
R25	Common mode load "Y" line	0603	N/A	No

Table 2-3. Capacitors

Capacitor ID	Function	Package	Comment	Installed?
C1	Load capacitance for "R"	0603	N/A	No
C2	47uF	10 V decoupling capacitor	0805	From GND to EARTH on VCC Supply	Yes
C3	10uF	6.3V decoupling capacitor	0805	From GND to EARTH on VCC supply	Yes
C4	47uF	10 V decoupling capacitor	0805	From VCC to GND on VCC Supply	Yes
C5	10uF	6.3V decoupling capacitor	0805	FROM VCC to GND on VCC Supply	Yes
C6	100 nF	6.3V decoupling capacitor	0603	From VCC pin on U1 to GND	Yes
C7	100 nF	25 V decoupling capacitor	0603	Common mode supply capacitance	No
C8	100 nF	25 V decoupling capacitor	0805	Common mode supply capacitance	No
C9	100 nF	25 V termination capacitor	0805	Optional termination capacitance	No
C10	100 nF	25 V termination capacitor	0603	Optional termination capacitance	No
C11	100 nF	25 V decoupling capacitor	0603	Common mode supply capacitance	No
C12	100 nF	25 V decoupling capacitor	0603	Common mode supply capacitance	No

Table 2-4. LEDs

LED ID	Function	Package	Comment	Installed?
D1	"R" Line LED – Red	Non-Standard	N/A	Yes
D2	"D" Line LED – Green	Non-Standard	N/A	Yes
D3	"VCC" LED – Blue	Non-Standard	N/A	Yes

Table 2-5. ICs

IC ID	Function	Package	Comment	Installed?
U1	Full Duplex RS-485 IC in DRC (10 Pin VSSON) Package	DRC	Comes pre-installed with THVD2412DRC	Yes

The default setup is optimized to work with the THVD2412DRCR operating without a common mode voltage.

2.2 Power Requirements

The RS485FLDPLXDRCEVM is ready to operate immediately outside of the box. To power the board, find J5 at the top center of the board. For systems with both GND and EARTH signals, attach the EARTH lead to the left most pin of J5 next to the text that displays *EARTH* and attach the GND lead to the center input of J5 above the text that displays *GND*. With systems with just a *GND* signal, EARTH can be left floating or connected to GND. The positive terminal of the power supply attached to the right most pin of J5 next to label displaying "VCC"; a 3 V to 5.5V supply can be used to operate the default IC, THVD2412DRC, in place on the board by default. For other devices that can be used, refer to specific device data sheet.

2.3 Default Operational Mode

With an understanding of how the board is setup and how to power the board, the next topic is how to operate the board. Out of the box the board, when powered, can operate the THVD2412 as a Full Duplex RS-485 transceiver. The devices pins can be broken down into four distinct groups: single ended communication pins, differential communication pins, power pins, and control pins. With the power pins already discussed, the other three categories are now covered.

The single ended communication pins are to be connected directly, through their respective jumpers, to a single ended bus – these pins are the "R" and "D" pins and represent RX and TX single ended data lines respectively. R is referenced to J1 and D is reference to J4; these are the signal connection points for the EVM.

The control signals that this board supports are an active high driver enable (DE) and an active low receiver enable (/RE). These pins follow TTL logic with 0 V to 0.8V for a logic low value and 2 V to VCC for a logic high value. The pins are accessed through Jumpers J3 and J2 respectively

Finally, the last group of signals are the differential bus pins A, B, Y, and Z. The A and B pins are the differential receiver and are connected to a 3-pin terminal block labeled J11 with additional access to the A and B lines through two 4-pin headers J9 and J10. The Y and Z pins are the differential driver pins and are connected to a 3-pin terminal block labeled J14 with additional access to the Y and Z lines through two 4-pin headers J12 and J13. Both differential lines have 0805 component pads for termination capacitances and resistances.

A single ended jumper configuration map can be used to help operate the board. Pin 1 of the header is the top left corner, with J5 at the top of the board, of the shown jumpers with every subsequent pin increasing by one in a clockwise direction.
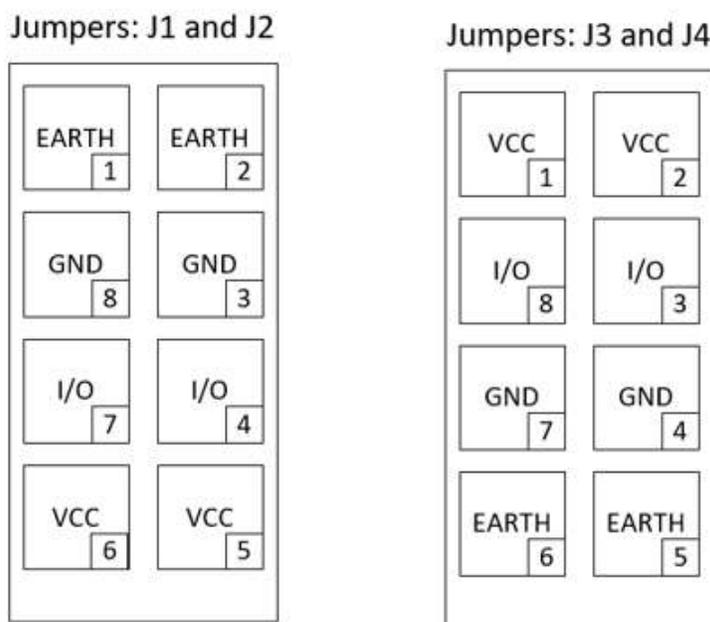

Figure 2-1. Single Ended (Console Side) Jumper Map

Jumper ID	Signal – Jumper Pin	Comment
J1	R –Pin 4 or 7	Receive Data – to keep always high or low shunt J1 I/O pins to VCC or GND.
J2	/RE – Pin 4 or 7	/RE - shunt J2 I/O pins to VCC or GND to set a constant state on pin.
J3	DE – Pin 3 or 8	DE– shunt J3 I/O pins to VCC or GND to set a constant state on pin.
J4	D – Pin 3 or 8	Transmit Data – to keep always high or low shunt J4 I/O pins to VCC or GND
J11	Differential bus input	A and B differential input data
J14	Differential bus output	Y and Z differential output data

2.4 Single Ended Bus (Controller Side) Modification Options

There are a few options with respect to the single ended data and control signals for modification on this EVM. Jumpers J1 through J4 all contain pads that are blank by default. For D, DE, and /RE signals there are 0603 sized pads for either pull-up or pull-down resistors to have a default logic on these pins with the added benefit of still being able to external signals to this pin. The R pin also contains a pull-up resistor 0603 sized, as is common in UART based applications, as well as a 0603 sized pad to ground for a capacitive load in case testing requires capacitive loading on the R pin.

Associated Jumper	Signal	Pad ID	Comment
J1	R	R2	Pull Up Resistor Pad
J1	R	C1	Capacitive Load Pad
J2	/RE	R5	Pull Up Resistor Pad
J2	/RE	R6	Pull Down Resistor Pad
J3	DE	R8	Pull Up Resistor Pad
J3	DE	R9	Pull Down Resistor Pad
J4	D	R11	Pull Up Resistor Pad
J4	D	R12	Pull Down Resistor Pad

2.5 Differential Bus (RS-485) Modification Options

The differential side of the RS-485 transceiver also has a few minor modifications that can be made. Both differential buses on the EVM have 0805 pads for a termination resistance and a termination capacitance to be added to test multiple configurations of the RS-485 or RS-422 bus. The other modification is by applying a common mode voltage through the common mode jumpers J6 through J8 for the differential input pair, A and B pins, which is connected to the main bus through the common mode loading resistors R22 and R23 and, by default, are not installed. The same common mode loading scheme is allowed for the Y and Z pins as well trough jumpers J15-J17 with common mode loading resistor pads R24 and R25. For full common mode testing, R22 through R25 needs to be selected to be 375 Ω as this is the standard for RS-485 devices.

Associated Jumper	Signal	`Pad ID	Comment
J7 and J6	VCM_A	R22	Common Mode Resistor Pad, 0603, to "A"
J8 and J6	VCM_B	R23	Common Mode Resistor Pad, 0603, to "B"
J9, J10, J11	A and B	C9	Termination Capacitor Pad, 0805
J9, J10, J11	A and B	R16	Termination Resistor Pad, 0805
J17 and J15	VCM_Z	R24	Common Mode Resistor Pad, 0603, to "Z"
J16 and J15	VCM_Y	R25	Common Mode Resistor Pad, 0603, to "Y"
J12, J13, J14	Y and Z	R19	Termination Capacitor Pad, 0805
J12, J13, J14	Y and Z	C10	Termination Resistor Pad, 0805

3 Hardware Design Files
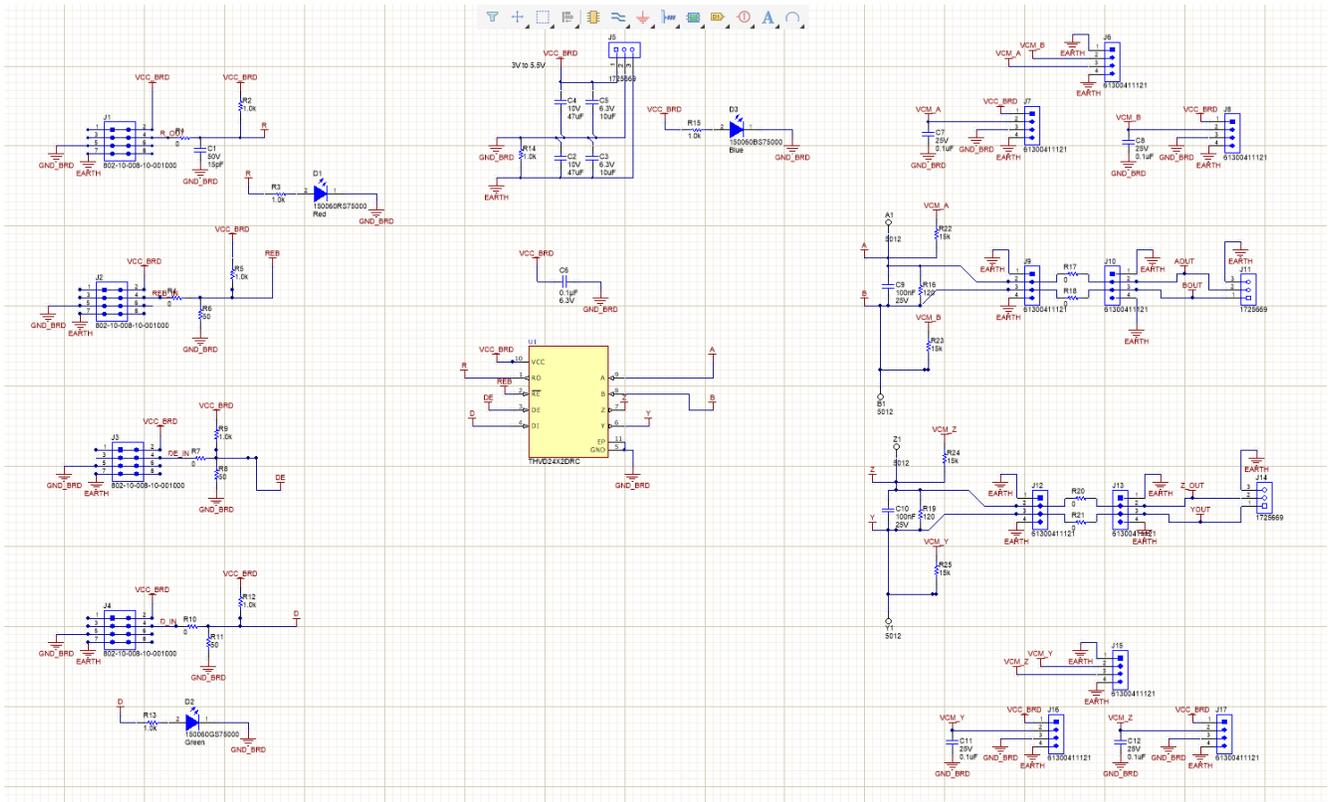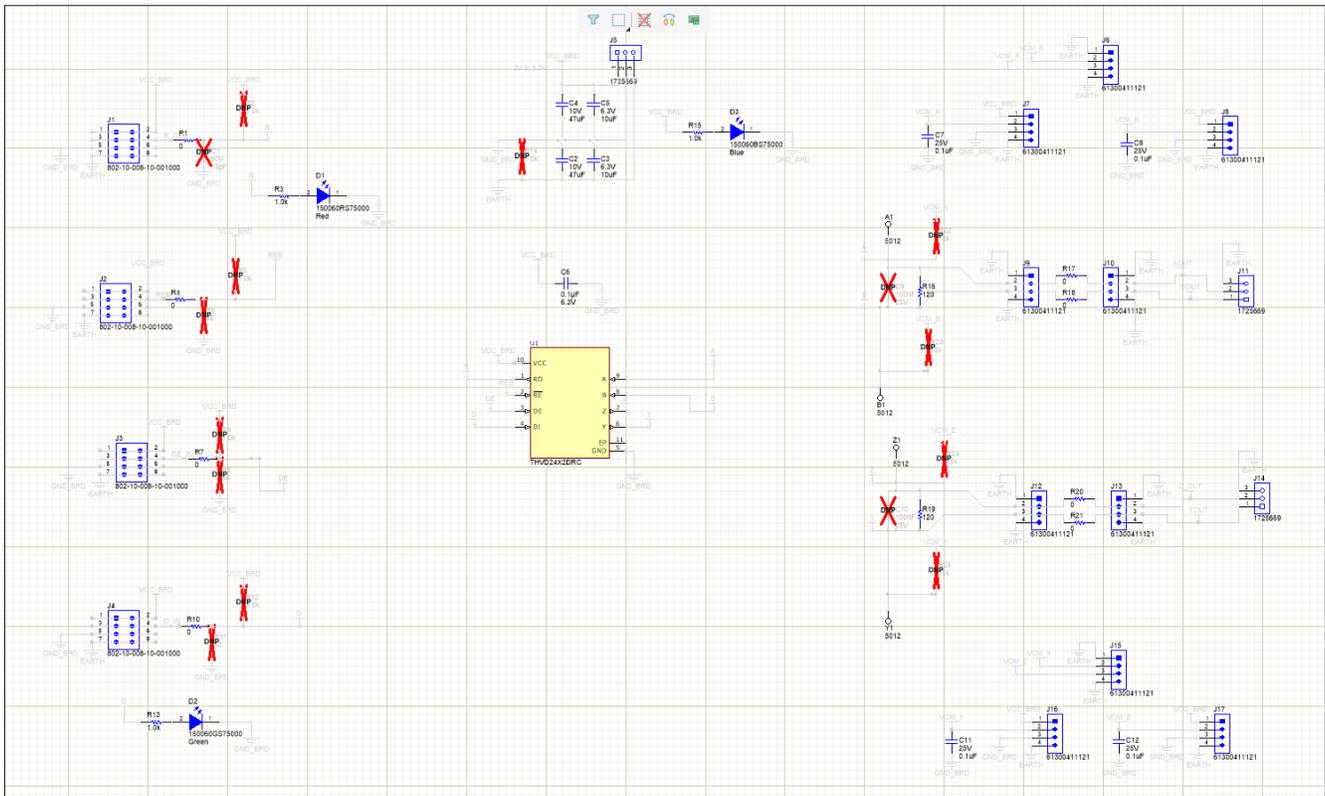
3.1 Schematics

Figure 3-1. Generic Schematic - All Components Shown

Figure 3-2. Schematic - Installed Components Only
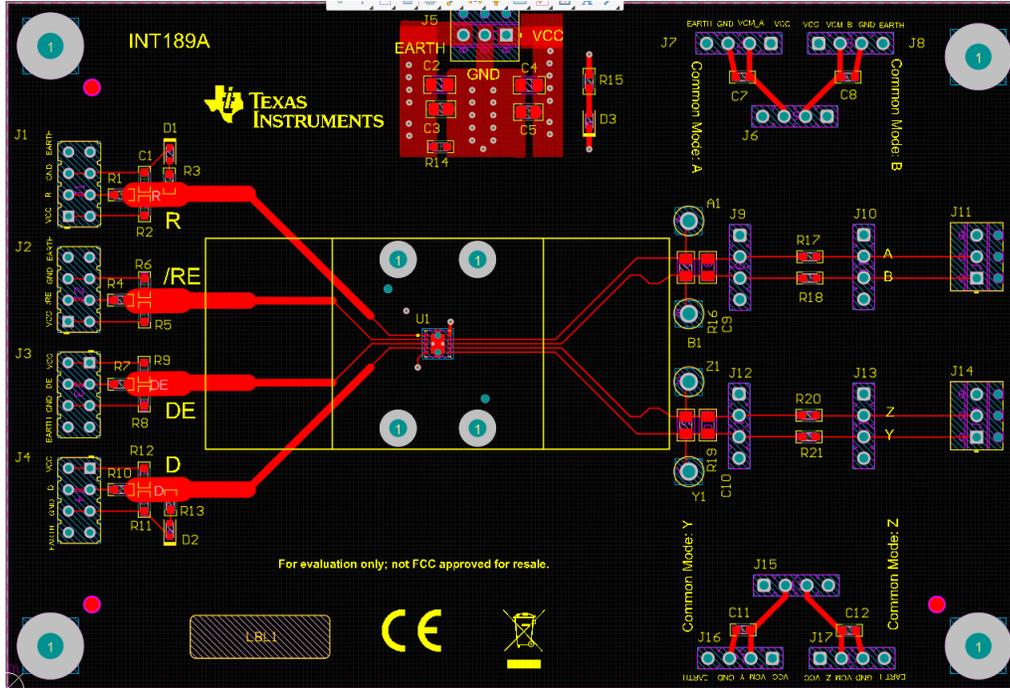
3.2 PCB Layouts
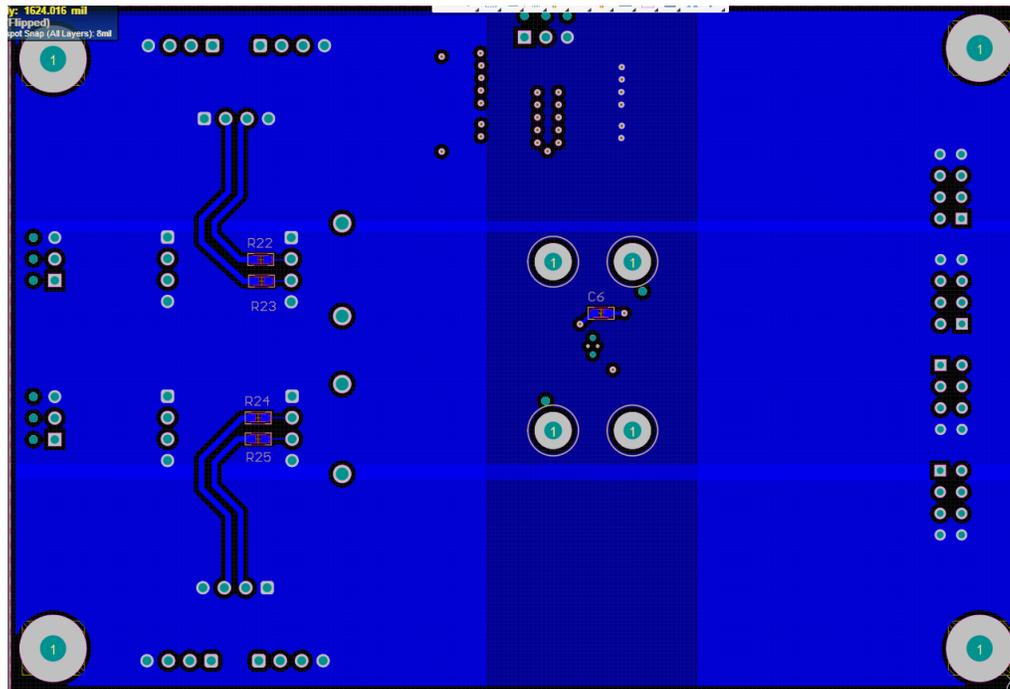

Figure 3-3. Top Layer

Figure 3-4. Bottom Layer

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Manufacturer	Part Number	Designator	Quantity
Keystone	5012	A1, B1, Y1, Z1	4
TDK	C2012X5R1A476M125AC	C2, C4	2
Samsung	CL21A106KQFNNNG	C3, C5	2
Kemet	C0603C104K9PAC7867	C6	1
TDK	C1608X7R1E104K080AA	C7, C8, C11, C12	4
Wurth Elektronik	150060RS75000	D1	1
Wurth Elektronik	150060GS75000	D2	1
Wurth Elektronik	150060BS75000	D3	1
B&F Fastener Supply	NY PMS 440 0025 PH	H1, H2, H3, H4	4
Keystone	1902C	H5, H6, H7, H8	4
Mill-Max	802-10-008-10-001000	J1, J2, J3, J4	4
Phoenix Contact	1725669	J5, J11, J14	3
Wurth Elektronik	61300411121	J6, J7, J8, J9, J10, J12, J13, J15, J16, J17	10
Brady	THT-14-423-10	LBL1	1
Vishay-Dale	RCS06030000Z0EA	R1, R4, R7, R10, R17, R18, R20, R21	8
Vishay-Dale	CRCW06031K00JNEA	R3, R13, R15	3
Panasonic	ERJ-P06J121V	R16, R19	2
Texas Instruments	THVD2412DRC	U1	1

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 References

THVD24x2 ±70-V Fault-Protected 3-V to 5.5-V Full Duplex RS-485 Transceivers With IEC ESD data sheet (SLLSFR1).

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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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措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。

2. 実験局の免許を取得後ご使用いただく。

3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

4 *EVM Use Restrictions and Warnings:*

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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