

EVM User's Guide: XWRL1432BOOST

Low Power 77GHz mm-Wave Sensor



Description

The xWRL1432BOOST from Texas Instruments is an easy-to-use evaluation board for the xWRL1432 mmWave sensing device, with standalone operation and direct connectivity to the DCA1000EVM for raw ADC capture and signal processing development. This EVM contains everything required to start developing software for on-chip Hardware accelerator and low power ARM® Cortex® - M4F controllers.

Get Started

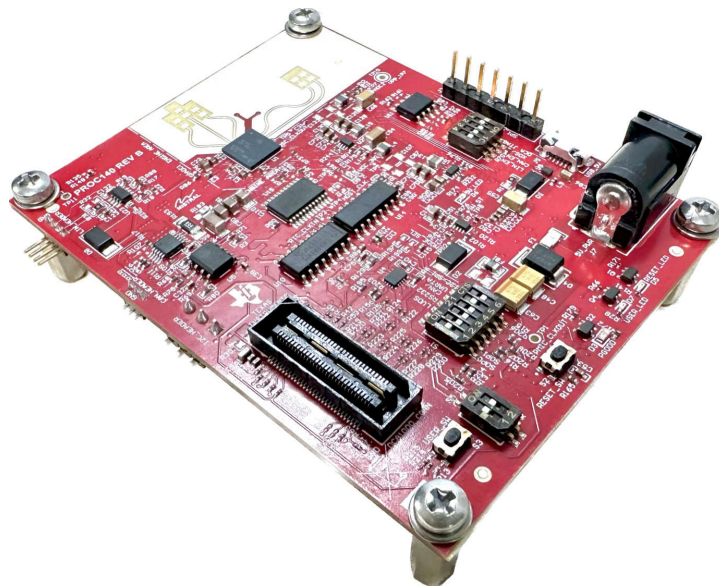
1. Visit the xWRL1432BOOST EVM product page. Automotive - [AWRL1432BOOST](#). Industrial - [IWRL1432BOOST](#).
2. Configure the SOP Switches (S1 and S4), for functional mode(SOP4).
3. Visit the TI Developer Zone for essential software like SDK and Radar Toolbox. Automotive - [AWRL1432BOOST](#). Industrial - [IWRL1432BOOST](#).
4. Navigate to the *Radar Toolbox*.
5. The user's guide is located at:

Radar Toolbox\Example Projects\Out of Box Demo\WRL1432 Out of Box Demo\.

6. Explore the *Radar Toolbox* for more information, applications, and resources.

Features

- High RF performance RO4835LoPro PCB substrate
- Wide field of view antenna, targeted for wall mount applications
- XDS110 JTAG interface with USB connectivity for code development and debugging
- Power optimized discrete DCDC power management
- Serial port for onboard QSPI flash programming
- 60-pin, high-density (HD) connectors for raw analog-to-digital converter (ADC) data
- Onboard CAN-FD transceiver
- Onboard LIN PHY transceiver for automotive variant.
- USB powered standalone mode of operation
- EVM is designed as a booster pack to connect with other LaunchPad EVMs
- Onboard 16Mbit QSPI flash



XWRL1432BOOST EVM

Figure 1-1 shows the functional block diagram. The EVM contains the essential components for the TI mm-Wave radar system: DCDC, SFLASH, SOP configuration, Filter, TI mmWave Radar chip, a USB to UART converter, and a 60-pin Samtec connector for interfacing with the DCA1000. The board also hosts a booster pack connector which can be connected to TI's LaunchPad boards.

1.4 Device Information


The documents in Table 1-1 provide information regarding Texas Instruments integrated circuits used in the assembly of the xWRL1432BOOST EVM. This user's guide is available from the TI web site under literature number SWRU613. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document.

Table 1-1. Related Device Documentation

Devices Used on the EVM	Data Sheet
TMP112-Q1	TMP112AQDRLRQ1
TS3A5018	TS3A5018RSVR
TCAN1042HGV-Q1	TCAN1042HGVDQ1
INA228A	INA228AIDGST
TPD4E004D	TPD4E004DRYR
SN65LVDS31MD	SN65LVDS31MDREP
TS3A44159	TS3A44159PWR
TPS79601D	TPS79601DRBR
TS3A27518E	TS3A27518EPWR
TPS2116D	TPS2116DRLR
SN74LVC1G11D	SN74LVC1G11DSFR
TPS628502-Q1	TPS6285021HQDRLRQ1
TPS6285020-Q1	TPS6285020MQDRLRQ1
LM4040C25Q	LM4040C25QDBZR
TLIN1039-Q1	TLIN1039DDFRQ1

2 Hardware

CAUTION



Hot surface. Contact can cause burns. Do not touch.

The XWRL1432BOOST includes three receivers and two transmitters with a wide field of view hosted on a High RF Performance RO4835LoPRO PCB substrate.

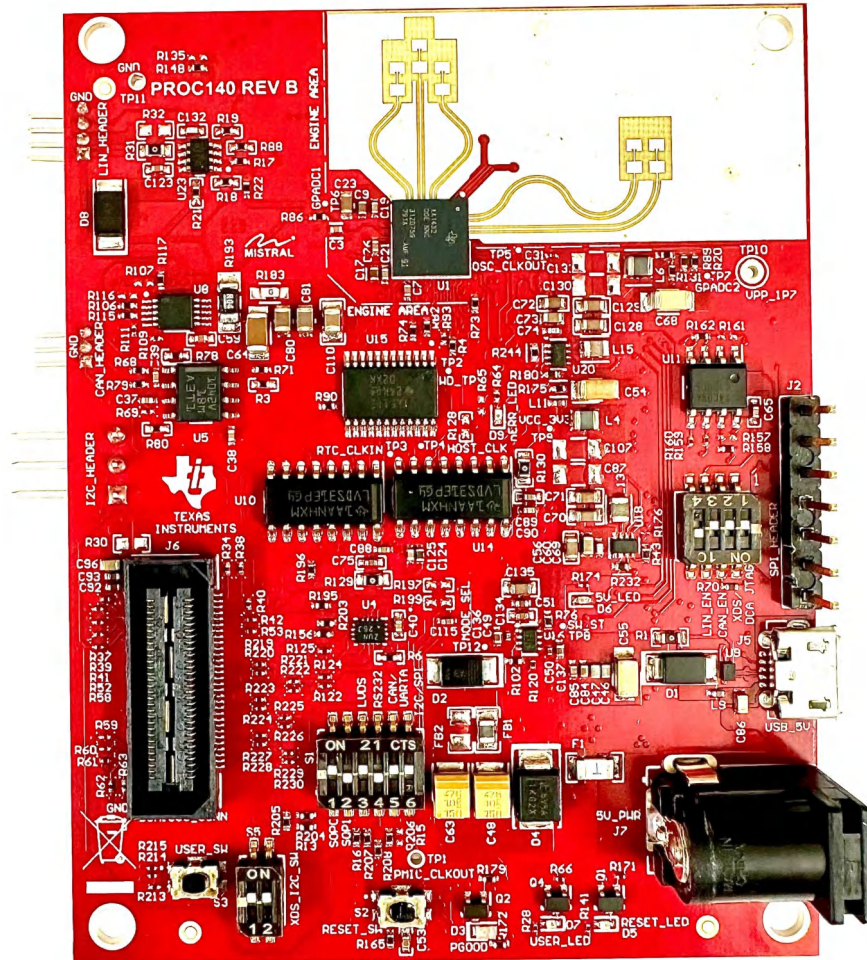


Figure 2-1. XWRL1432BOOST (Top View)

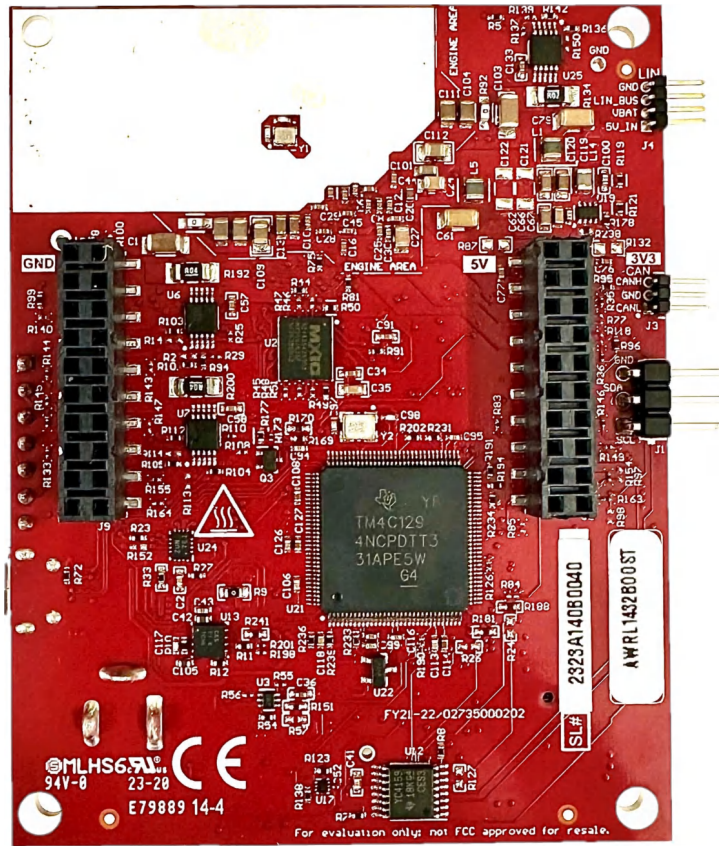


Figure 2-2. XWRL1432BOOST (Bottom View)

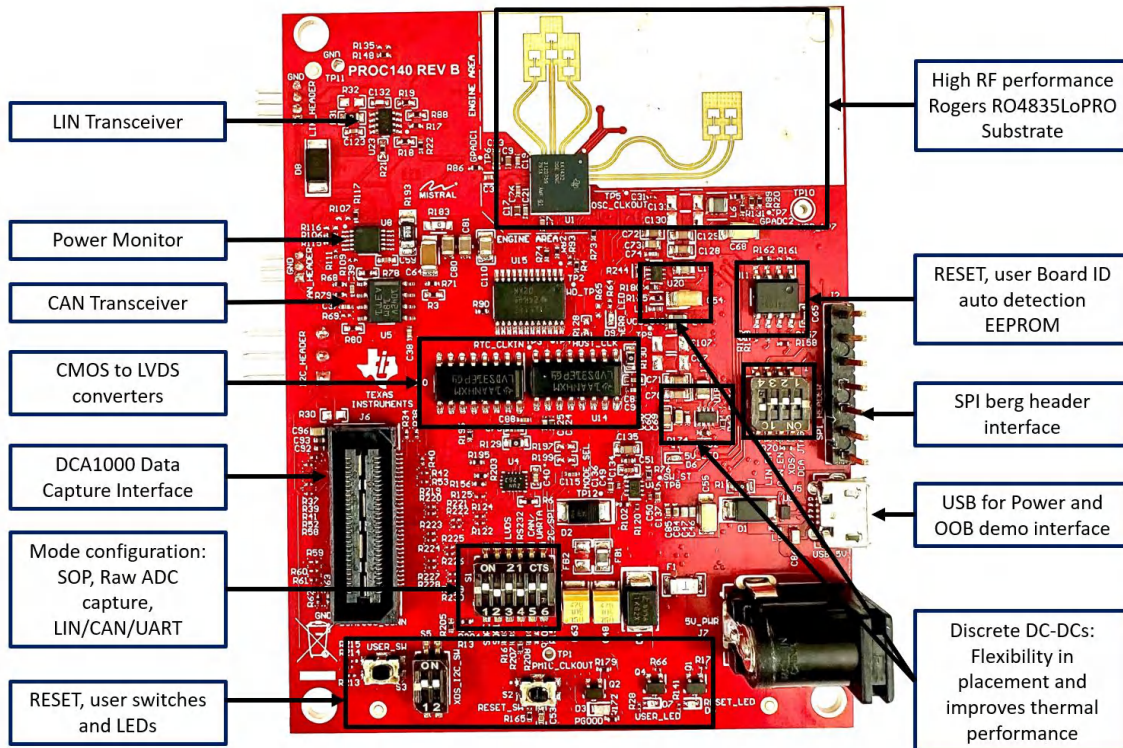


Figure 2-3. Salient Features of EVM (Top Side)

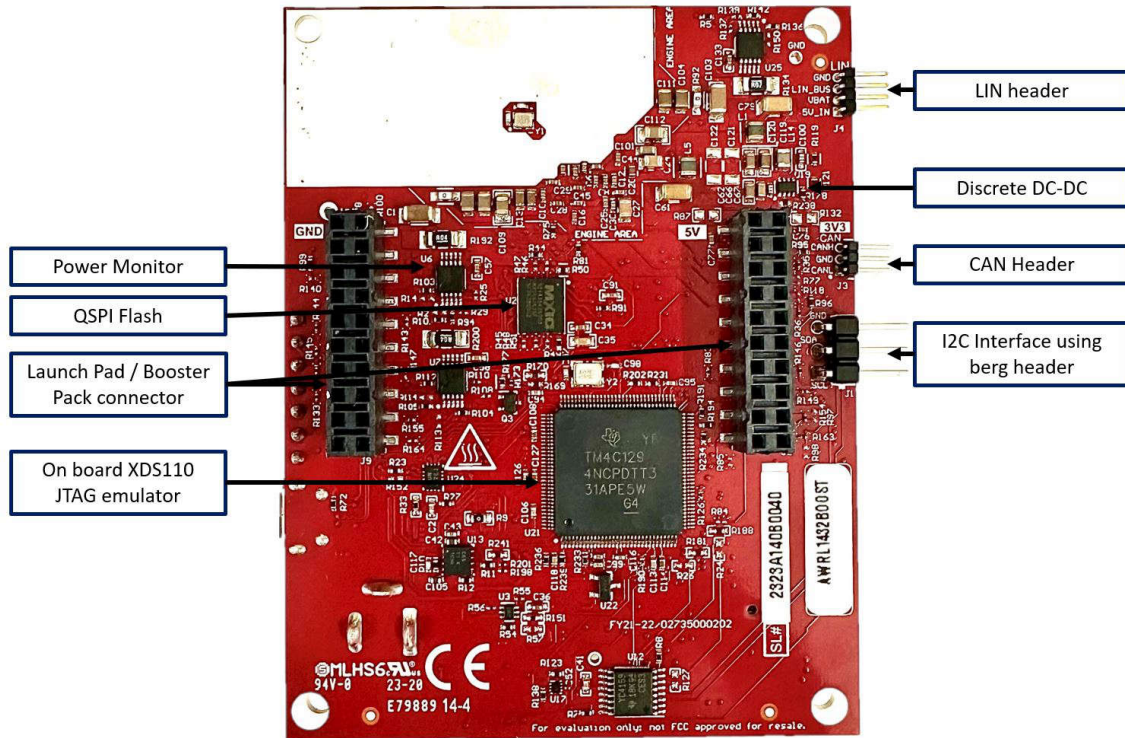


Figure 2-4. Salient Features of EVM (Bottom Side)

2.1 XWRL1432BOOST Antenna

The XWRL1432BOOST includes three receivers and two transmitters Rogers RO4835LoPro based antennas on the PCB. Figure 2-5 shows the antenna configuration.

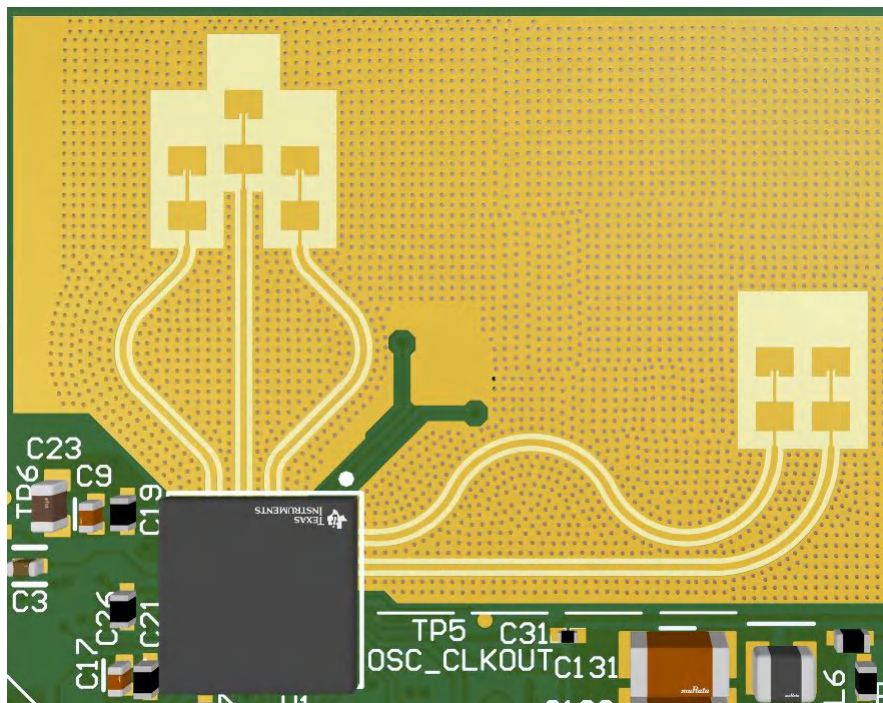




Figure 2-5. TX and Rx Antennas of the EVM

Note

The XWRL1432BOOST has an antenna gain of approximately 5-6 dBi across different antenna pairs.

2.1.1 PCB Material

Material used for this PCB is Rogers RO4835LoPro of 4mil thickness with rolled copper for the Antenna and transmission lines and 370HR is used for the rest of the layers.

Type	Layer	Total Cu Thickness		Final Thickness		Construction
		μm	mils	μm	mils	
Solder Mask				20	0,8	 IMM SILVER
	1	40	1,6	23 17	0,9 0,7	Plating Cu (Total Cu final minimum = 34μm) Copper
	2	35	1,4	102 35	4,0 1,4	Core RO4835LoPro Copper
	3	35	1,4	145 35	5,7 1,4	Prepreg 370HR Copper
	4	35	1,4	254 35	10,0 1,4	Core 370HR Copper
	5	35	1,4	145 35	5,7 1,4	Prepreg 370HR Copper
	6	35	1,4	254 35	10,0 1,4	Core 370HR Copper
	7	35	1,4	145 35	5,7 1,4	Prepreg 370HR Copper
	8	40	1,6	102 17 23	4,0 0,7 0,9	Core 370HR Copper Plating Cu (Total Cu final minimum = 34μm)
Solder Mask				20	0,8	 IMM SILVER
Total Thickness :				1,477	mm	± 10%
				0,0581	(inch)	

2.1.1.1 Transmitter and Receiver Virtual Array

The transmitter and receiver antennas positions in [Figure 2-6](#) form a virtual array of six transmitter and receiver pairs. This allows object detections finer azimuthal angular resolution (29°) and coarse elevation angular resolution (58°). Receiver antennas are spaced at distance D ($\lambda/2$) apart in azimuth plane and distance D ($\lambda/2$) apart in elevation plane. The transmitter antennas are spaced at distance D ($\lambda/2$) apart in azimuth plane and are not apart in elevation plane.

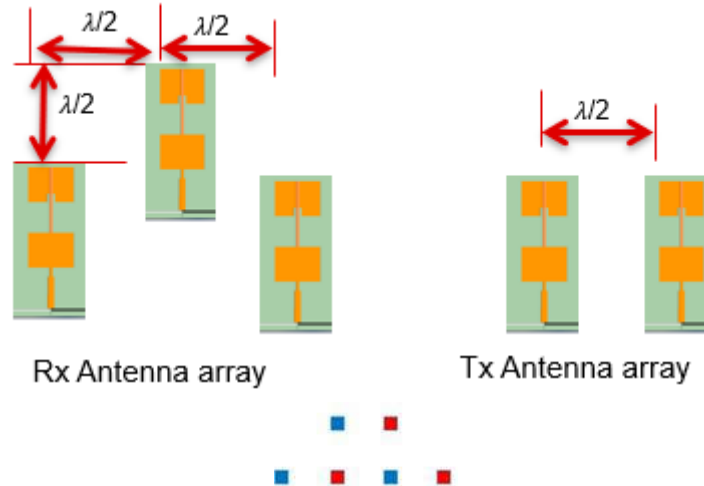


Figure 2-6. Virtual Antenna Array

[Figure 2-6](#) shows the antenna radiation pattern with regard to azimuth and [Figure 2-7](#) shows the antenna radiation pattern with regard to elevation for TX1 and TX2. Both figures show the radiation pattern for TX1 and TX2 and RX1, RX2 and RX3 together. All of the measurements were done with a Tx and Rx combination together. Thus, for the -6dB beam width, the user must see a 12dB drop (6dB from Tx and 6dB from Rx).

Note

Wavelength (λ) is computed based on a frequency of 78.5GHz . Antenna placements were made according to this frequency.

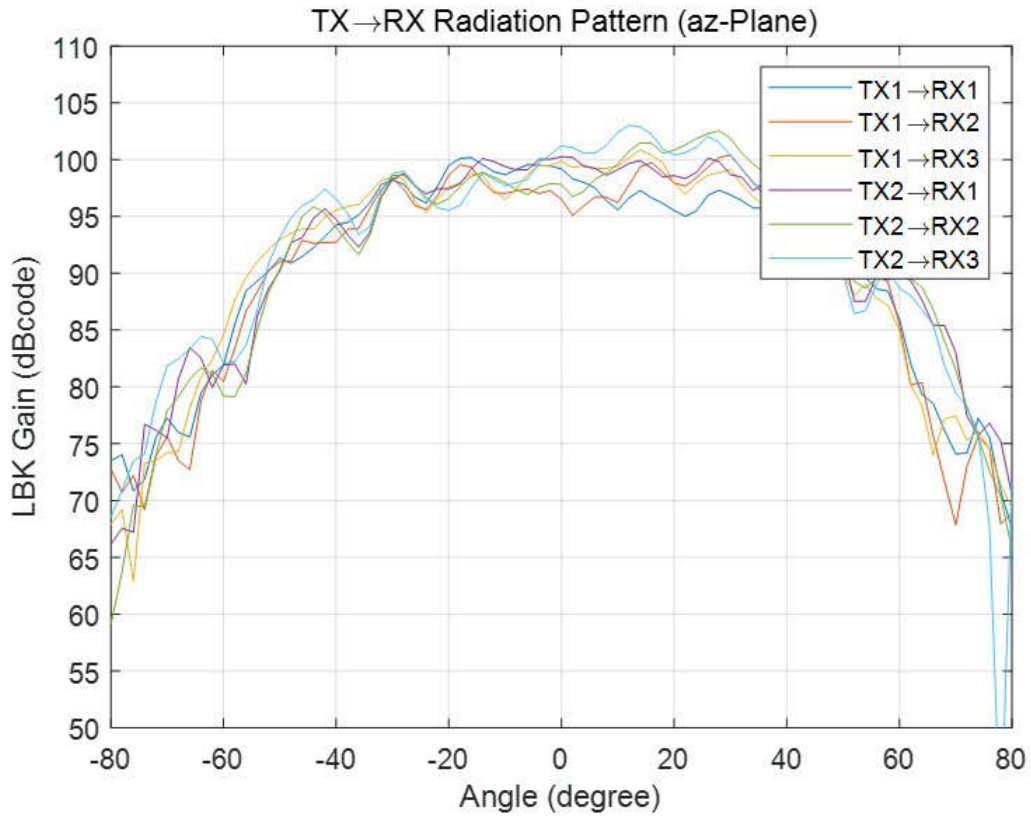


Figure 2-7. xWRL1432BOOST EVM Azimuth Antenna Radiation Patterns

Measured azimuthal radiation pattern for all Tx to Rx pairs (corner reflector placed at approximately 5 meters with a 4- GHz bandwidth chirp starting at 76GHz).

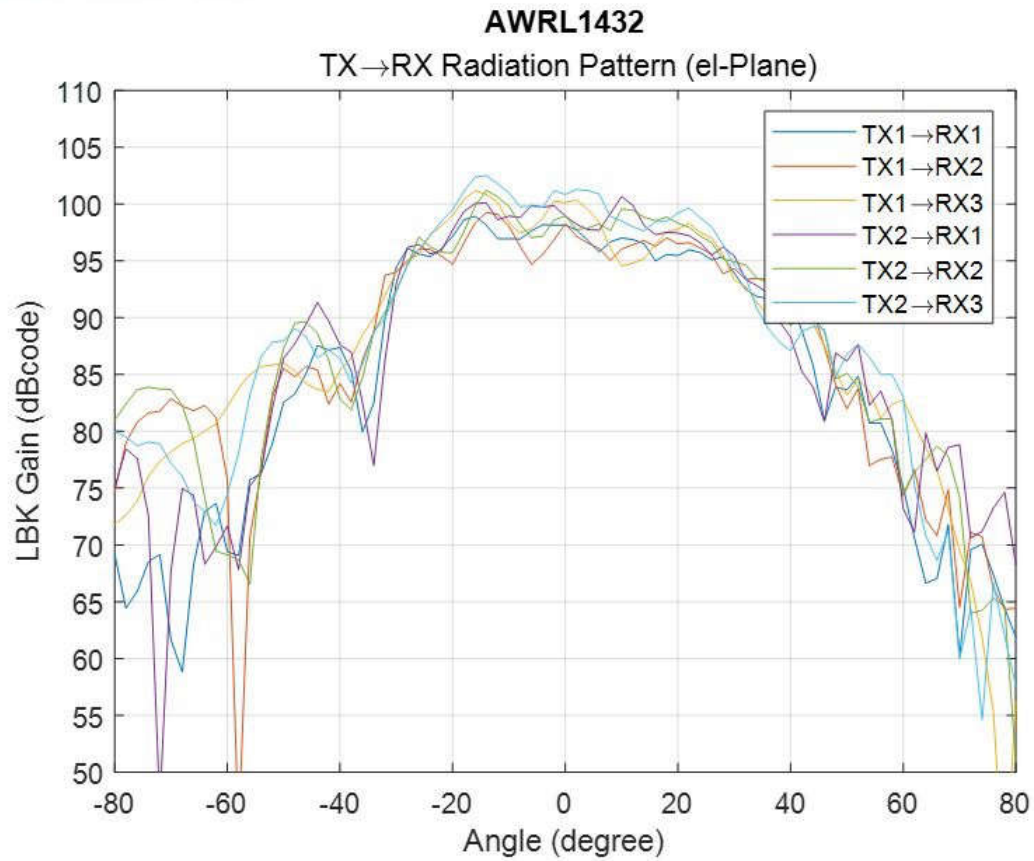


Figure 2-8. xWRL1432BOOST EVM Elevation Antenna Radiation Patterns

Measured elevation radiation pattern for all TX to RX pairs (corner reflector placed at approximately 5 meters with a 4GHz bandwidth chirp starting at 76GHz).

Note

In accordance with the EN 62311 RF exposure test, a minimum separation distance of 20 centimeters must be maintained between the user and the EVM during operation.

2.2 EVM Mux Block Diagram

Figure 2-9 shows different muxing options for the digital signals. The xWRL1432 contains multiple internal IPs and features. Since the xWRL1432 is pin limited, the internal signals are multiplexed to specific pins. The EVM provides de-muxing options using various analog muxes and switches to improve the user experience. Figure 2-9 shows different switch and mux configurations to enable connection to different peripherals.

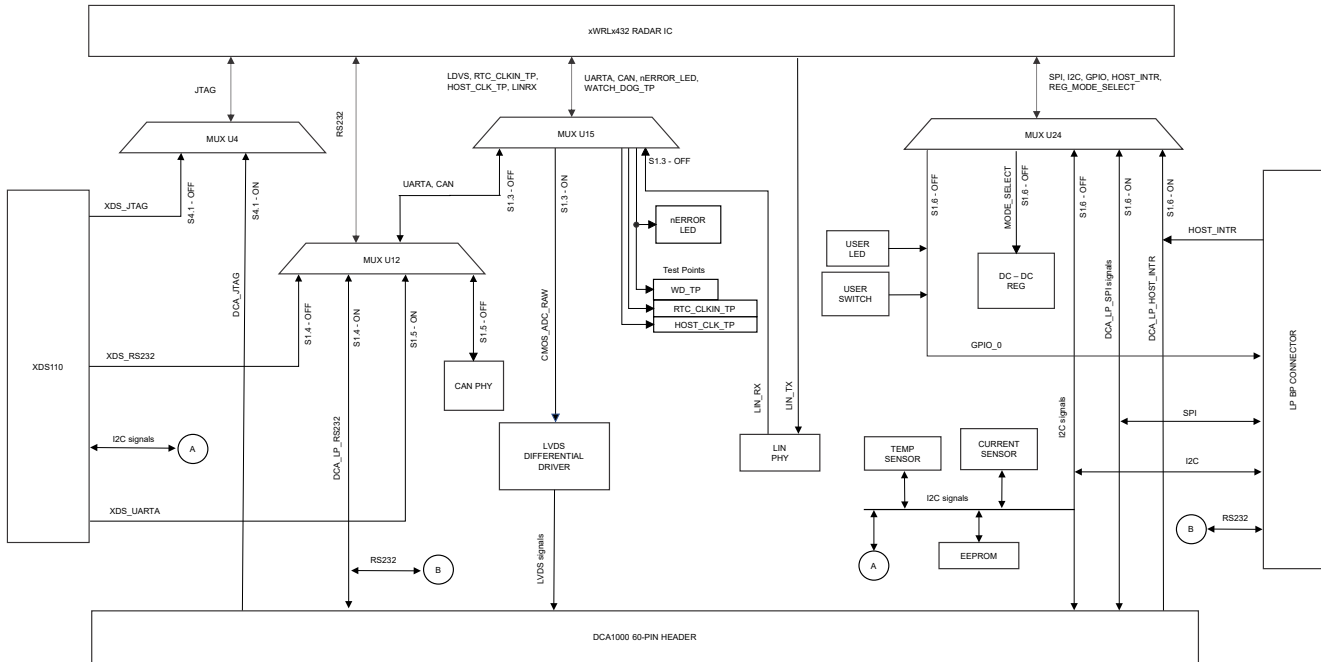


Figure 2-9. Muxing Options for the EVM

2.3 Switch Settings

Figure 2-10 shows the part designators and positions of the switches (S1 and S4) on the XWRL1432BOOST.

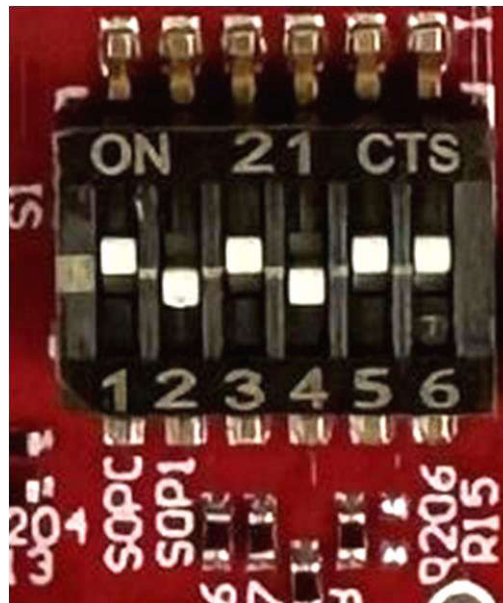


Figure 2-10. S1 Switch for Various Mode Settings

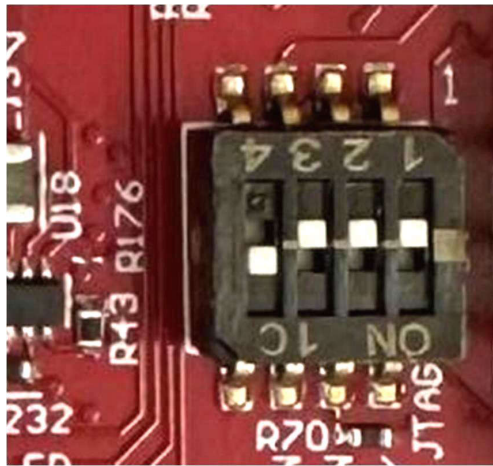


Figure 2-11. S4 Switch for Various Mode Settings

Figure 2-12 shows the different boot mode configurations for the device. xWRL1432 supports Application mode/ Functional mode, Device management mode/ QSPI flashing mode, and Debug modes. The mode (SOP) configurations shown below in Figure 2-12 must be exercised first. After the correct SOP mode is set, an nRESET must be issued to register the SOP setting. Figure 2-13 provides the switch position settings for the Muxed signals functionality.

SOP Mode	PMIC_CLK_OUT, TDO	Combination (S1.2, S1.1)
SOP_MODE1	Device Management Mode/ QSPI Flashing Mode	00
SOP_MODE2	Application mode/ Functional Mode	01
SOP_MODE4	Debug Mode	11

Figure 2-12. SOP Configuration

Reference Designator	Switch ON	Switch OFF
S1.1	SOP0 Pulled Up	SOP0 Pulled Down
S1.2	SOP1 Pulled Up	SOP1 Pulled Down
S1.3	LVDS	LIN_RX, XDS_UARTA/CAN, NERROR_LED, WATCH_DOG_TP, RTC_CLK_IN_TP, HOST_CLK_TP
S1.4	XDS_RS232	DCA_LP_RS232
S1.5	CAN	XDS_UARTA
S1.6	I2C, REG_MODE, LED_SW_GPIO	SPI
S4.1	XDS_JTAG	DCA_JTAG
S4.2	CAN PHY: Stand by Mode Disable	CAN PHY: Stand by Mode Enable
S4.3	LIN PHY: Enable	LIN PHY: Disable
S4.4	-	-

Figure 2-13. Switch Settings

2.4 LEDs

Table 2-1 contains the list of LEDs on the XWRL1432BOOST.

Table 2-1. List of LEDs

LED reference designators	Description
D6	5V power indication
D5	Reset LED
D9	NERROR LED <hr/> <p style="text-align: center;">Note</p> There is switch settings are needed to enable this.
D7	User LED: Customer programmable <hr/> <p style="text-align: center;">Note</p> There is switch settings are needed to enable this.
D3	Power good indication

2.5 Connectors

Higher current support: When using the EVM with the external power adapter, the 5V supply is provided by the external power adapter. For most use cases, this external power supply option is not used and power is derived from the USB interface.



Note

After the 5V power supply is provided to the EVM, TI recommends pressing the NRST switch one time to verify for a reliable boot-up state.

Note

All digital IO pins of the device (except NRESET) are not fail safe. Therefore, care needs to be taken that the digital IO pins are not driven externally without the VIO supply being present to the device.

2.6 USB Connector

The USB connector provides a 5V supply input to power the device; additionally the PC interface is brought out on this connector:

- UART for flashing the onboard serial flash, downloading FW through Radar Studio, and getting application data sent through the UART



Figure 2-14. USB Connector (J5)

2.7 DCA1000 HD Connector

The 60-pin HD connector shown in [Figure 2-15](#) provides the high-speed data and controls signals (SPI, UART, I2C, NRST, NERROR, and SOPs) to the DCA1000.

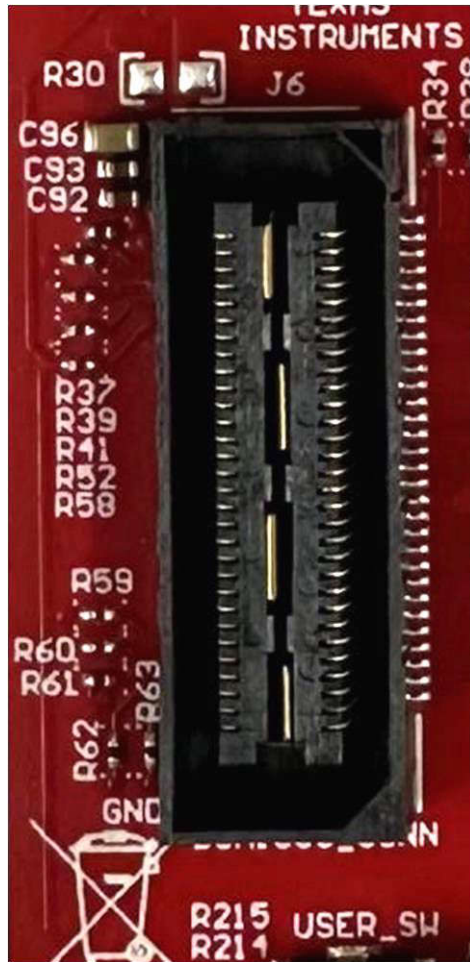


Figure 2-15. DCA1000 HD Connector

2.8 Booster Pack Connector for the LaunchPad Connectivity

J8/J9 are the booster pack connectors provided for the connectivity option with the other TI LaunchPad ecosystem.

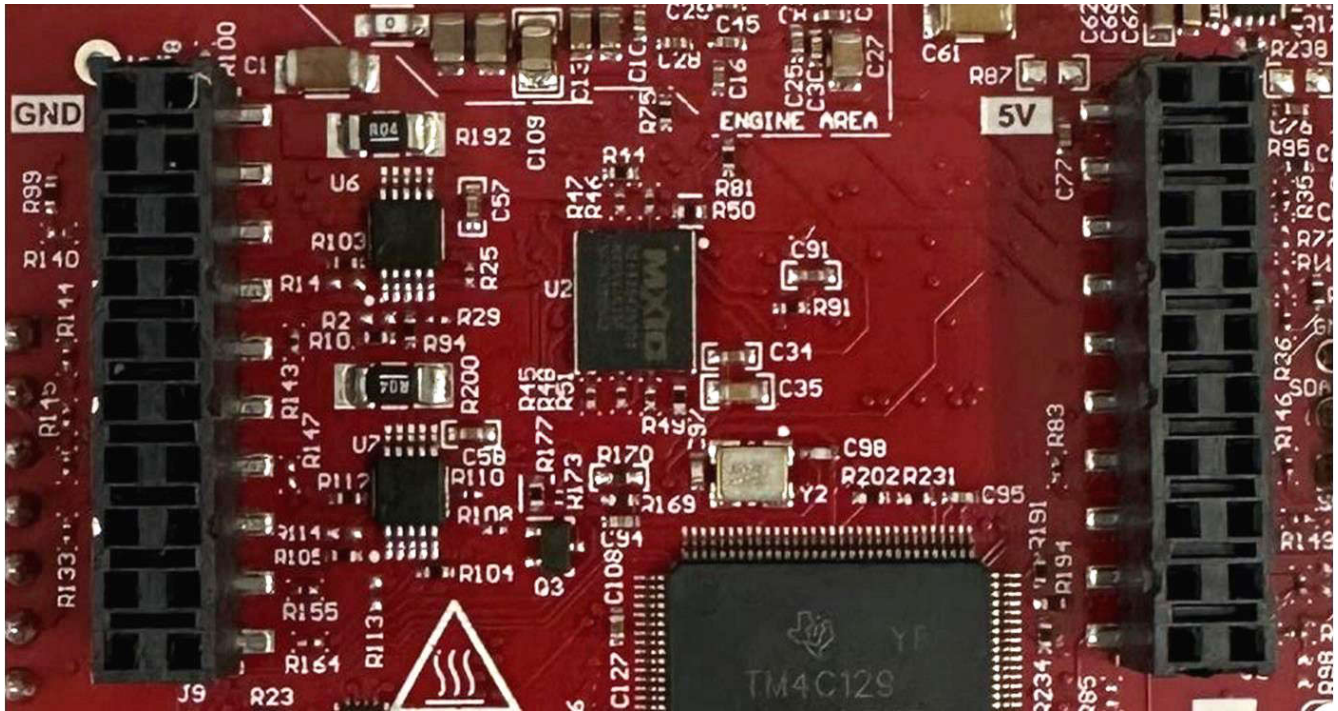


Figure 2-16. Booster Pack Connector

2.9 CANFD Connector

The CAN connector provides access to the CAN_FD interfaces (CAN_L and CAN_H signals) from the onboard CAND-FD transceivers. These signals can be directly wired to the CAN bus.



Figure 2-17. CANFD Connector

The J3 connector shown in [Figure 2-17](#) provides the CAN_L and CAN_H signals from the onboard CAND-FD transceivers (TCAN1042HGVDQR1). These signals are wired to the CAN bus after muxing with the SPI signals; one of the two paths must be selected. CAN signals are selected to PHY by changing the switch S1.5 to off position.

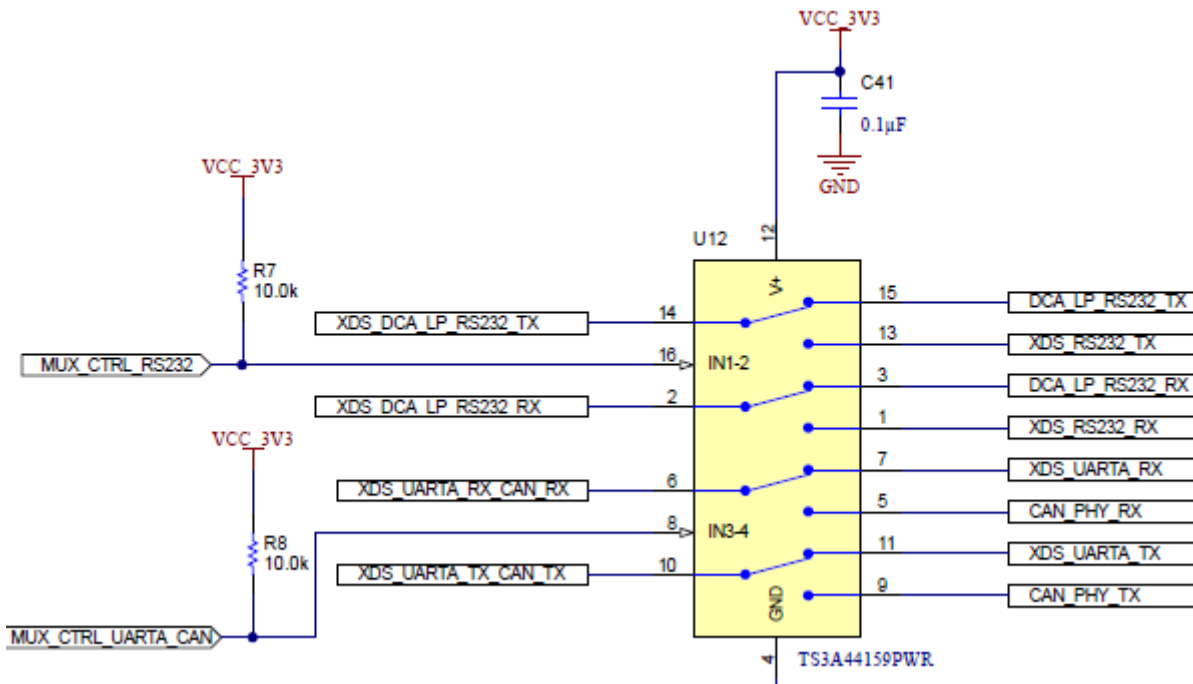


Figure 2-18. Analog Mux for the CAN PHY Switch

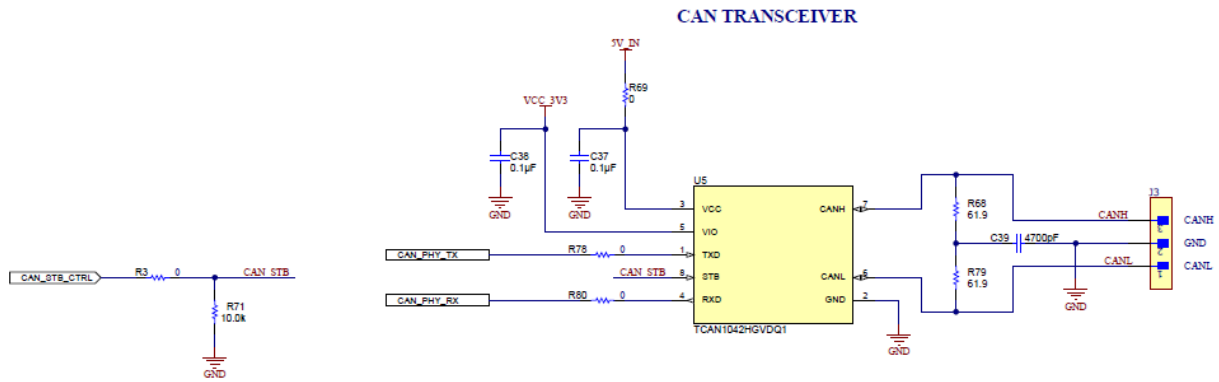


Figure 2-19. CAN FD PHY Used in the EVM

2.10 LIN PHY Connection

Figure 2-20 shows the LIN PHY (TLIN1039DDFRQ1) interface to the device. There are no switches for the LIN PHY interface. LIN PHY can operate with a different supply voltage than the mmWave sensor, an external VBAT option is provided for the LIN VDD supply, by default 5V_IN supply is provided.



Figure 2-20. LIN header and PHY Interface

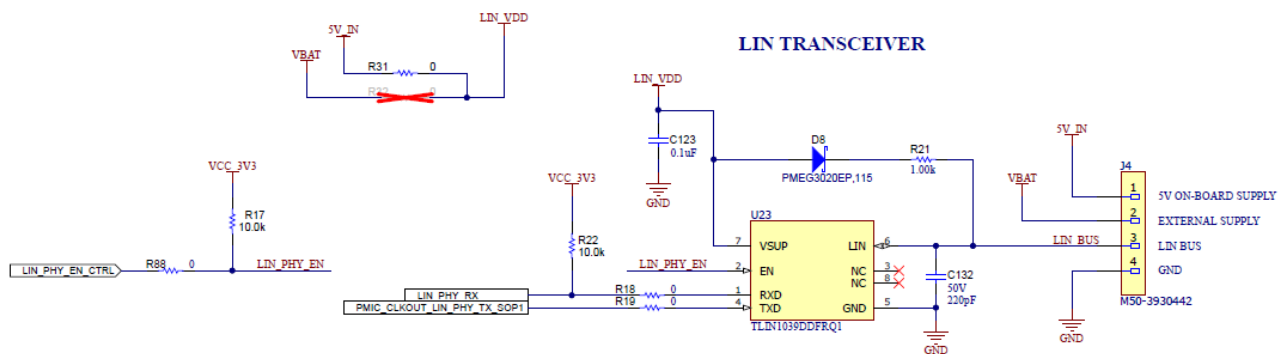


Figure 2-21. LIN PHY Interface

To enable the external VBAT supply, resistor R32 needs to be mounted and resistor R31 needs to be removed.

2.11 I2C Connections

The board features an EEPROM, current sensors, and temperature sensor for measuring on-board temperature. These are connected to the I2C bus and can be isolated using the zero Ω provided on the hardware. External I2C headers also provided for easy interface to I2C bus.

2.11.1 EEPROM

The board features an EEPROM for storing the board specific IDs (for the identification of the EVM through the XDS110 interface). Please refer to device schematics for the I2C addresses.

2.12 XDS110 Interface

J5 provides access to the onboard XDS110 (TM4C1294NCPDT) emulator. This connection provides the following interfaces to the PC:

- JTAG for CCS connectivity
- Application/user UART (Configuration and data communication to PC)

When used in standalone mode of operation as shown in [Figure 2-22](#), the power is supplied through a single USB connector; the same USB connector J5 is also used for configuration and data transfer through the XDS110 USB to UART converter. When enumerated correctly, the 2 UART ports from the XDS110 are displayed on the device manager as a virtual COM Port, similar to that shown in [Figure 2-22](#).

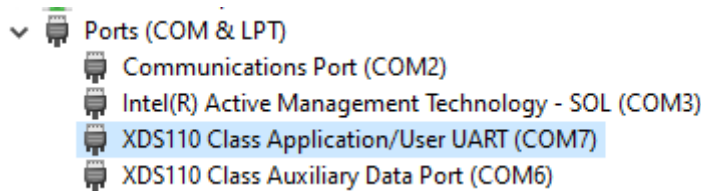


Figure 2-22. Virtual COM Port

If the PC is unable to recognize the above COM ports, install the latest [EMUpack](#).

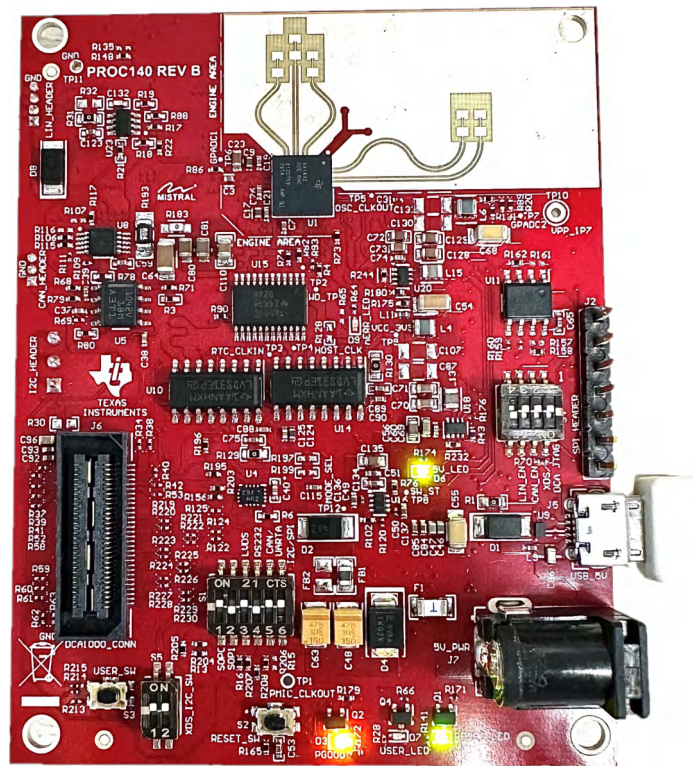


Figure 2-23. EVM in Functional Mode Using Standalone Operation

EVM uses single UART port for both device configuration and processed data communication to PC.

2.13 Flashing the Board

1. Verify that the drivers have been successfully installed and COM ports enumerated.
2. Configure the SOP to flashing mode.
3. Press the reset switch to verify that the board boots up in the right mode.
4. Run the visualizer and use the flashing tab and follow the instruction or use Uniflash tool.
5. Enter the application port number for the flashing interface.
6. Load image to serial flash. Please refer mmWave SDK for the flash binary for running out of box demos.

2.14 DCA1000EVM Mode

The setup for raw data capture using DCA1000EVM is shown in [Figure 2-24](#).

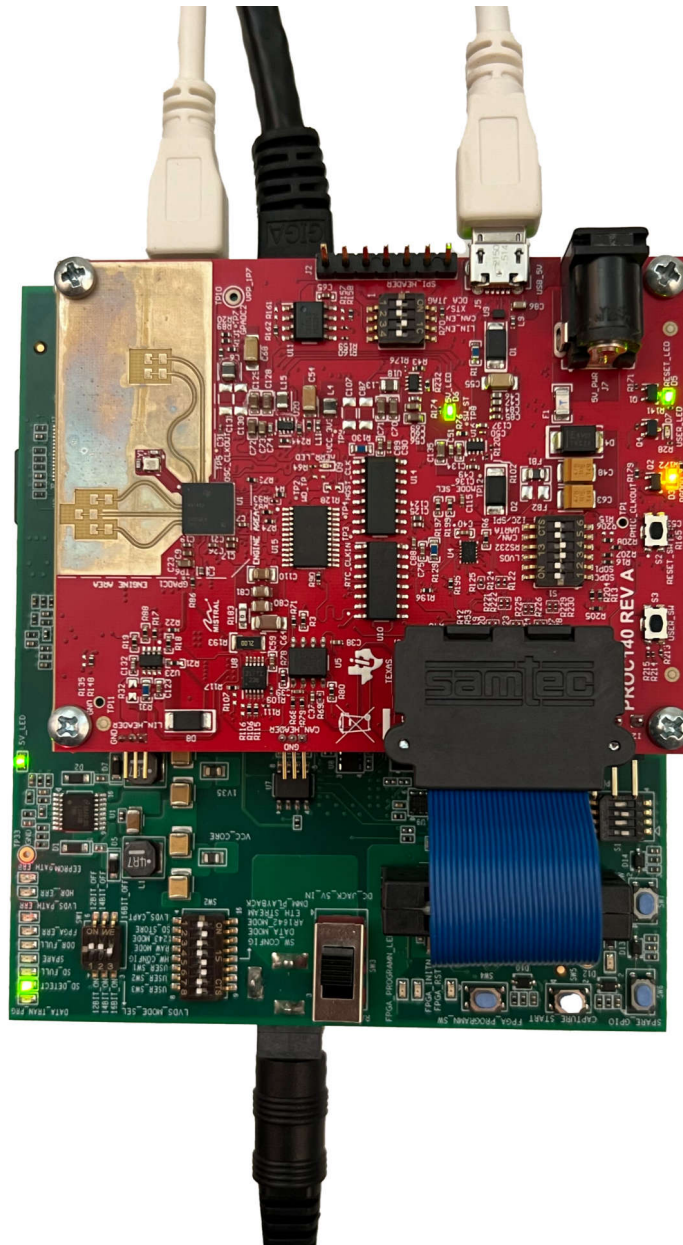


Figure 2-24. DCA1000EVM Mode (Top View)

Please refer to [Figure 2-13](#) shown in the beginning of this document for the switch settings for the DCA1000 raw ADC capture card.

2.14.1 RDIF Interface for Raw ADC Capture

The xWRL1432 doesn't have LVDS I/Os, mainly to reduce the overall power consumption of the SOC. However, the DCA1000 board needs LVDS signals on the clock and data interface for raw ADC capture. For that reason CMOS to LVDS converters are used on the board as shown below. The data capture interface uses RDIF (Radar Data interface) for transferring the data between mmWave device and DCA1000 capture card. There is no change needed in the DCA1000 capture card for this purpose, however a new low power mmWave studio needs to be used for this purpose. The low power mmWave studio interprets the RDIF interface and provides a raw ADC data visualization platform for further signal processing.

DIFFERENTIAL LVDS DRIVER

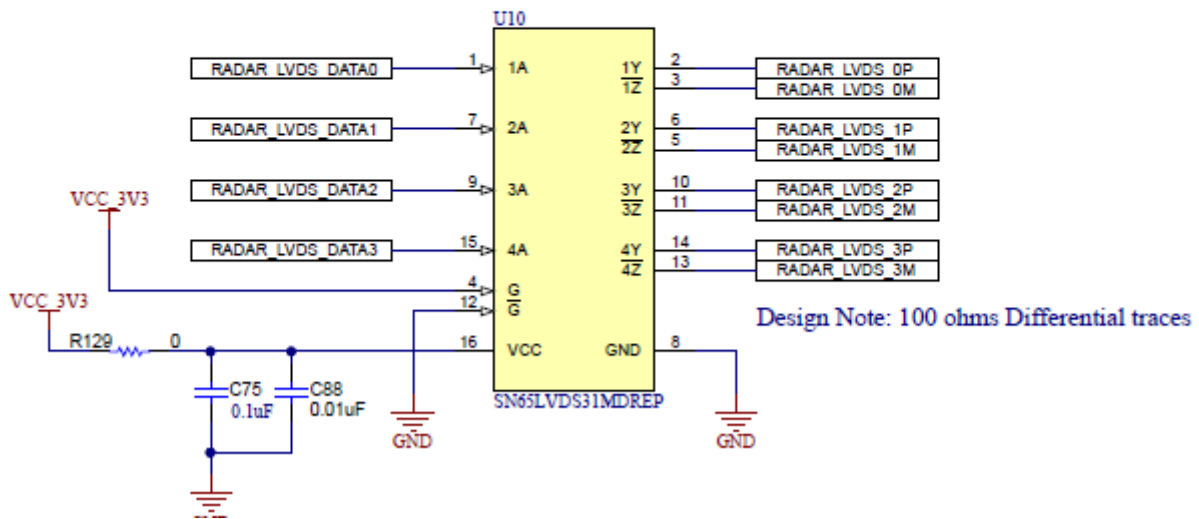


Figure 2-25. DCA1000 CMOS TO LVDS Conversion for Data Lines

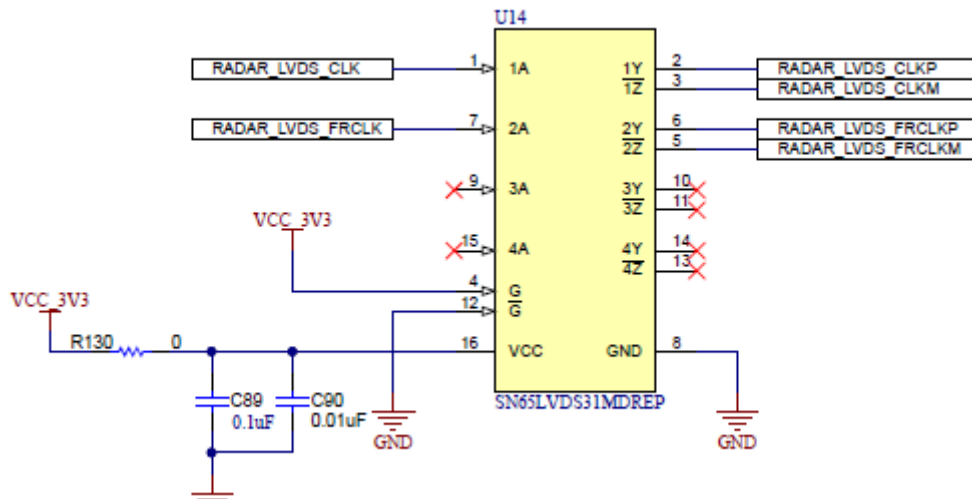


Figure 2-26. DCA1000 CMOS TO LVDS Conversion for Clock and Control Lines

2.15 PCB Storage and Handling Recommendations:

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 and operate on an antistatic work surface. For more information on proper handling, refer to [SSYA010](#).

2.15.1 PCB Storage and Handling Recommendations

The immersion silver finish of the PCB provides a better high-frequency performance, but is also prone to oxidation in open environment. This oxidation causes the surface around the antenna region to blacken, however mmWave Radar performance remains intact. To avoid oxidation, the PCB must be stored in an ESD cover and kept at a controlled room temperature with low humidity conditions. All ESD precautions must be taken while using and handling the EVM.

2.15.2 Higher Power Demanding Applications

Most of the EVM can be operated with a single USB cable. For higher power consumption applications where a single USB port cannot supply the power needed, use an external 5V/2A or higher power adapter.

3 Software

3.1 Software, Development Tools, and Example Code

To enable quick development of end applications on the ARM Cortex-M4F core in the XWR1432, TI provides a [MMWAVE-L-SDK](#) that includes demo codes, software drivers, emulation packages for debug, and more.

For more information, please refer to mmWave-L-SDK user's guide.

Follow the steps below to run the demo visualizer using the EVM.

3.1.1 XWR1432 Demo Visualization Getting Started

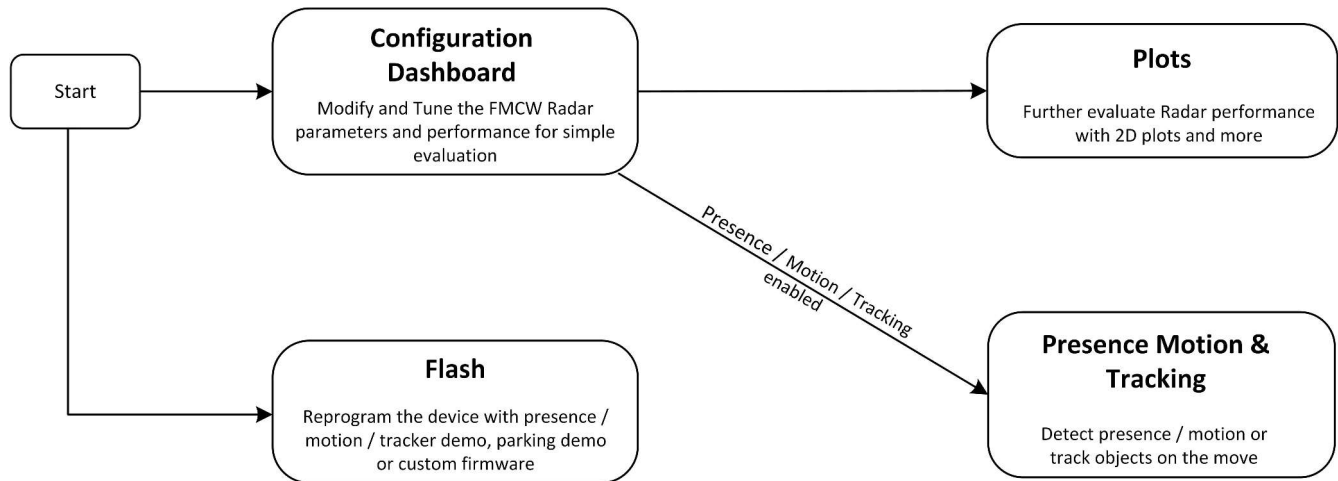


Figure 3-1. Demo Visualization Getting Started

Prerequisites:

1. Download latest SDK package of [MMWAVE-L-SDK](#).
2. Download latest XDS110 drivers. [This is bundled with Code Composer Studio \(CCS\)](#).

Steps for getting started:

- Step 1: Connect the EVM to the micro USB port. Users do not need to connect to the barrel jack.
- Step 2: Navigate to the MMWAVE-L-SDK download location and run the Low Power Radar Visualizer. The visualizer is located in `<MMWAVE_L_SDK_5_INSTALL_DIR>\tools\visualizer\Low_power_visualizer_5.x.x\visualizer.exe`
- Step 3: Connect the EVM to the PC via USB. Users do not need to connect to the barrel jack.
- Step 4 (Optional): Program a non-default firmware / app-image.
 1. Navigate to the Flash tab.
 2. AUTO detect COM ports (press refresh icon) and select device COM port (if not already selected).
 3. Follow the subsequent steps shown in the Visualizer.
- Step 5: Configure Device
 1. Navigate to the **Configuration Dashboard** tab.
 2. AUTO detect COM ports (press refresh icon) and select device COM port (if not already selected).
 3. Select preset configuration under **Configuration Selection**.
 4. Click on **Send Selected Config**.
- Step 5: Plots tab displays point cloud information.

4 Hardware Design Files

4.1 Schematics, PCB Layout and Bill of Materials (BOM)

xWRL1432BOOST EVM Schematic, PCB Layouts, and Bill of Materials (BOM) can be found on [SWRR184](#).

4.2 EVM Design Database

xWRL1432BOOST EVM Design Database containing Altium Project Source files can be found on [SWRR183](#).

5 Additional Information

5.1 Trademarks

Code Composer Studio™ and LaunchPad™ are trademarks of Texas Instruments.

ARM® and Cortex® are registered trademarks of ARM.

All trademarks are the property of their respective owners.

6 References

1. [DCA1000EVM Data Capture Card User's Guide](#)
2. [MMWAVE-L-SDK](#)

6.1 TI E2E Community

Search the forums at e2e.ti.com. If you cannot find the answer, then post the question to the community.

7 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (July 2023) to Revision A (August 2024)	Page
• Updated description of the <i>Introduction</i> section.....	2
• Added information on Rogers RO4835LoPro material based antennas used in <i>XWRL1432BOOST Antenna</i> section.....	6
• Updated description about transmitter antennas placement in <i>Transmitter and Receiver Virtual Array</i> section	8
• Updated description in <i>EVM Mux Block Diagram</i> section.....	11
• Updated description and Removed SOP Switches table in <i>Switch Settings</i> section.....	11
• Added Switch settings table and SOP configuration table in <i>Switch Settings</i> section.....	11
• Updated DCA1000 images to show correct Debug Mode Pin settings in <i>DCA1000EVM Mode</i> section.....	19
• Added mmWave-L-SDK link to the description in <i>Software, Development Tools, and Example Code</i> section	22
• Added prerequisites and steps for getting started in <i>XWRL1432 Demo Visualization Getting Started</i> section	22

STANDARD TERMS FOR EVALUATION MODULES

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 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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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 DEGRADATION 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/lstds/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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの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 2 4 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/lstds/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.

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- 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.
 6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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