

# EVM User's Guide: XWRL1432BOOST-BSD

## Low Power 77GHz mmWave Sensor



### Description

The xWRL1432BOOST-BSD 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

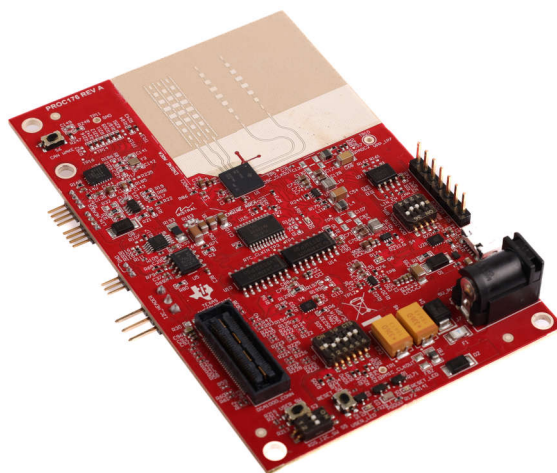
1. Visit xWRL1432BOOST EVM product page.  
Automotive - [AWRL1432BOOST-BSD](#).  
Industrial - [IWRL1432BOOST-BSD](#).
2. Configure the SOP Switches (S1 and S4), for functional mode(SOP4).
3. Visit TI Developer Zone for essential software like SDK and Radar Toolbox.  
Automotive - [AWRL1432BOOST-BSD](#).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

*Radar Toolbox\Example Projects\ADAS\Blind Spot Detection\.*

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

### Features

- High RF Performance RO3003 PCB substrate
- Wide field of view antenna, targeted for Blind Spot Detection 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-SPI transceiver using 12V input
- Onboard CAN-FD transceiver
- Onboard LIN PHY transceiver for automotive variant.
- USB powered standalone mode of operation
- EVM is designed as booster pack to connect with other LaunchPad EVMs
- On board 16Mbit QSPI flash



**xWRL1432BOOST-BSD EVM**

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## 1 Evaluation Module Overview

### 1.1 Introduction

The xWRL1432 mmWave Sensor device is an integrated single chip mmWave sensor based on FMCW radar technology. The device is capable of operation in the 76-GHz to 81-GHz band. The xWRL1432 is designed for low power, self-monitored, ultra-accurate radar systems in the Automotive and Industrial space of applications.

xWRL1432BOOST-BSD is an easy-to-use 70 GHz mmWave sensor evaluation kit based on xWRL1432 device with on board ROGERS RO3003 High Performance Antenna. This board enables access to point-cloud data and power over USB interface. The xWRL1432BOOST-BSD supports direct connectivity to the DCA1000EVM development kit. The xWRL1432BOOST-BSD also has a 12V operated TCAN4550 for Automotive applications. This kit is supported by mmWave tools, demos and software including mmWave software development kit (mmwave\_mcuplus\_sdk) and TI's Code Composer Studio.

Additional boards may be used to enable additional functionality. For example, DCA1000EVM enables access to sensor's raw ADC data capture. On board XDS110 enables software development via TI's CCS.

xWRL1432BOOST-BSD can interface with the MCU LaunchPad™ development kit ecosystem.

### 1.2 Kit Contents

xWRL1432BOOST-BSD includes the following:

- xWRL1432BOOST-BSD Evaluation board
- Micro USB cable
- Quick Start Guide

### 1.3 Specification

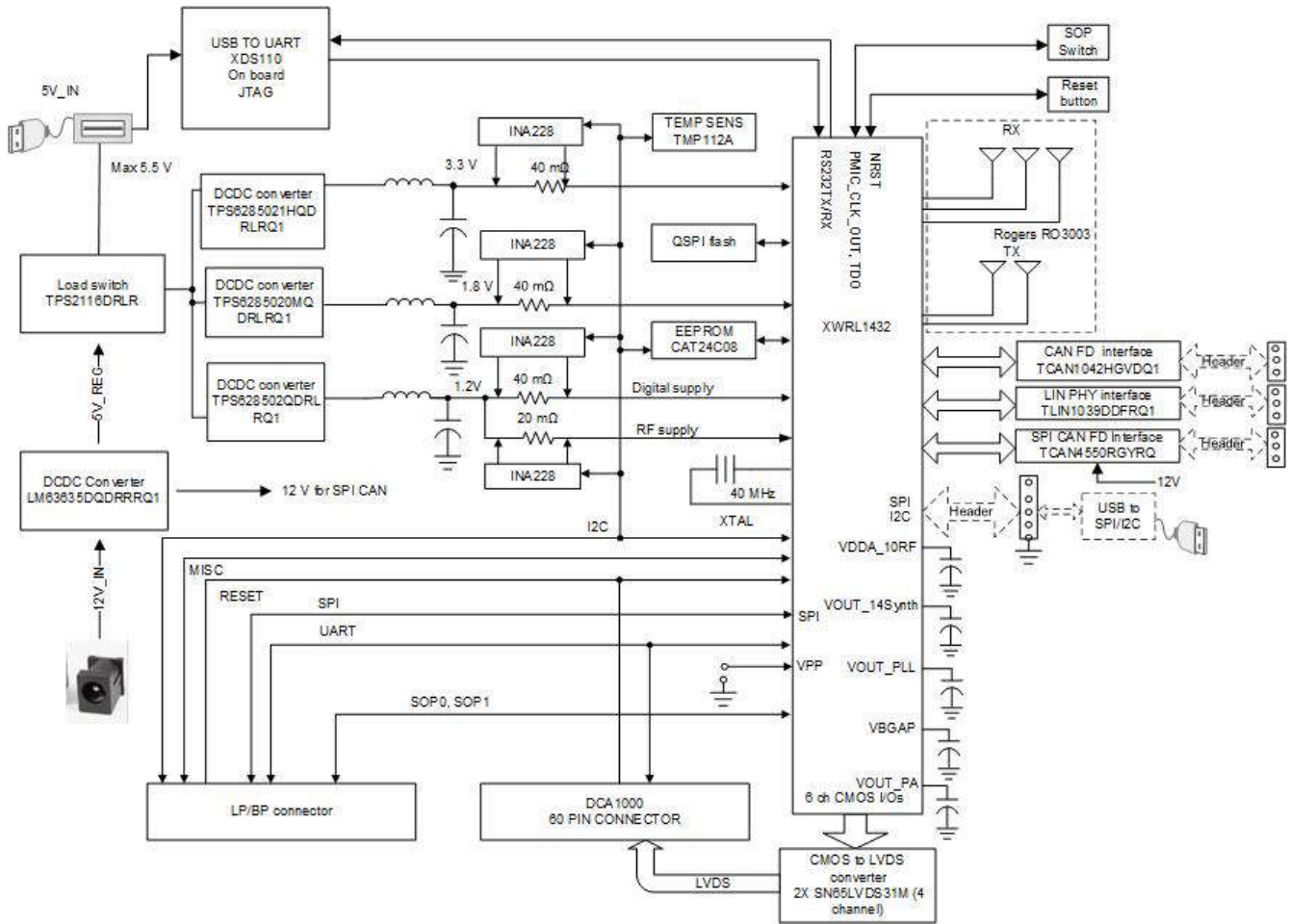


Figure 1-1. Functional Block Diagram

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-BSD EVM. This user's guide is available from the TI web site under literature number SWRU619. 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	<a href="#">TMP112AQDRLRQ1</a>
TS3A5018	<a href="#">TS3A5018RSVR</a>
TCAN1042HGV-Q1	<a href="#">TCAN1042HGVDQ1</a>
INA228A	<a href="#">INA228AIDGST</a>
TPD4E004D	<a href="#">TPD4E004DRYR</a>
SN65LVDS31MD	<a href="#">SN65LVDS31MDREP</a>
TS3A44159	<a href="#">TS3A44159PWR</a>
TPS79601D	<a href="#">TPS79601DRBR</a>

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**Table 1-1. Related Device Documentation (continued)**

Devices Used on the EVM	Data Sheet
TS3A27518E	<a href="#">TS3A27518EPWR</a>
TPS2116D	<a href="#">TPS2116DRLR</a>
SN74LVC1G11D	<a href="#">SN74LVC1G11DSFR</a>
TPS628502-Q1	<a href="#">TPS6285021HQDRLRQ1</a>
TPS6285020-Q1	<a href="#">TPS6285020MQDRLRQ1</a>
LM4040C25Q	<a href="#">LM4040C25QDBZR</a>
TLIN1039-Q1	<a href="#">TLIN1039DDFRQ1</a>
TCAN4550-Q1	<a href="#">TCAN4550RGYRQ1</a>

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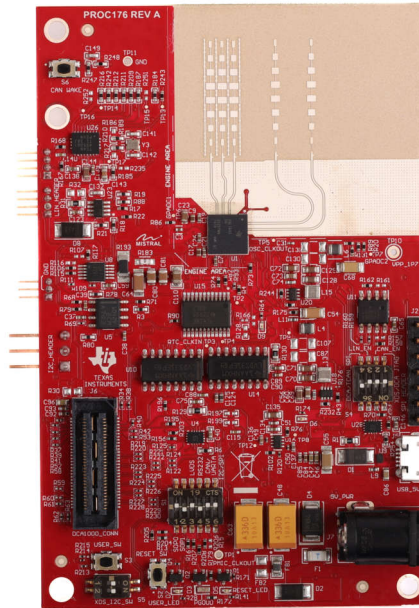
## 2 Hardware



### CAUTION

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

The xWRL1432BOOST-BSD includes three receivers and two transmitters with a wide field of view hosted on a High RF Performance RO3003 PCB substrate.



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**Figure 2-1. xWRL1432BOOST-BSD (Top View)**



Figure 2-2. xWRL1432BOOST-BSD (Bottom View)

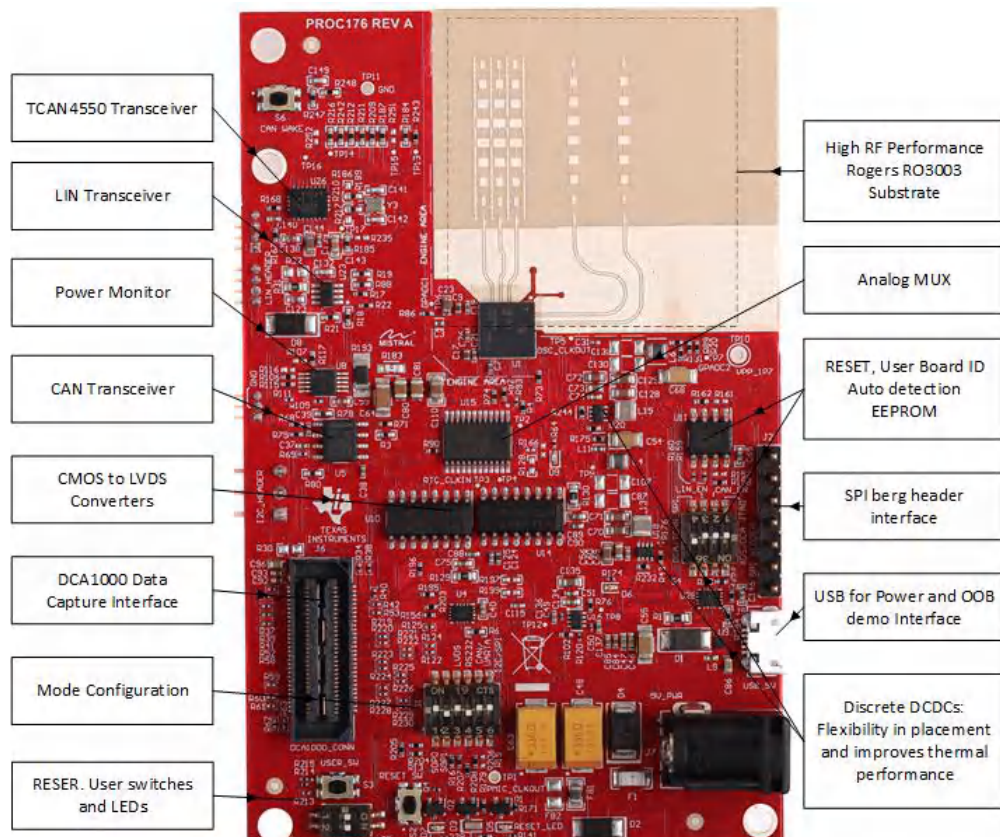


Figure 2-3. Salient Features of EVM (Top Side)

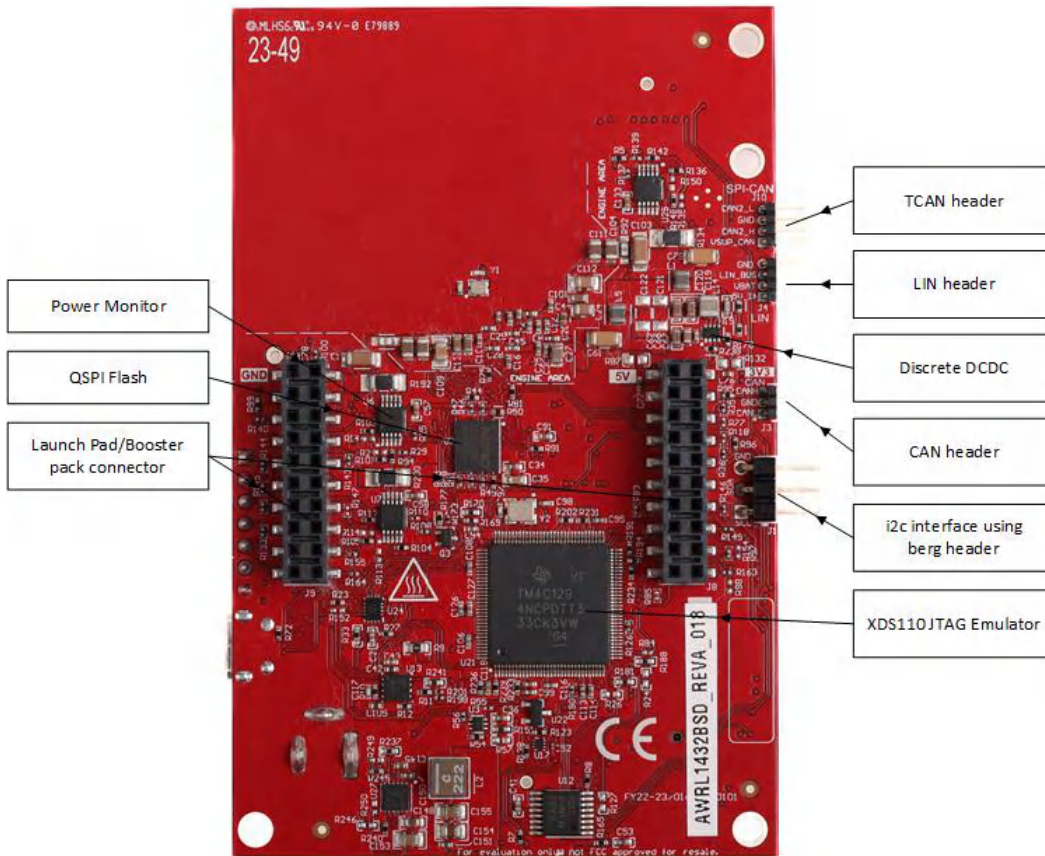
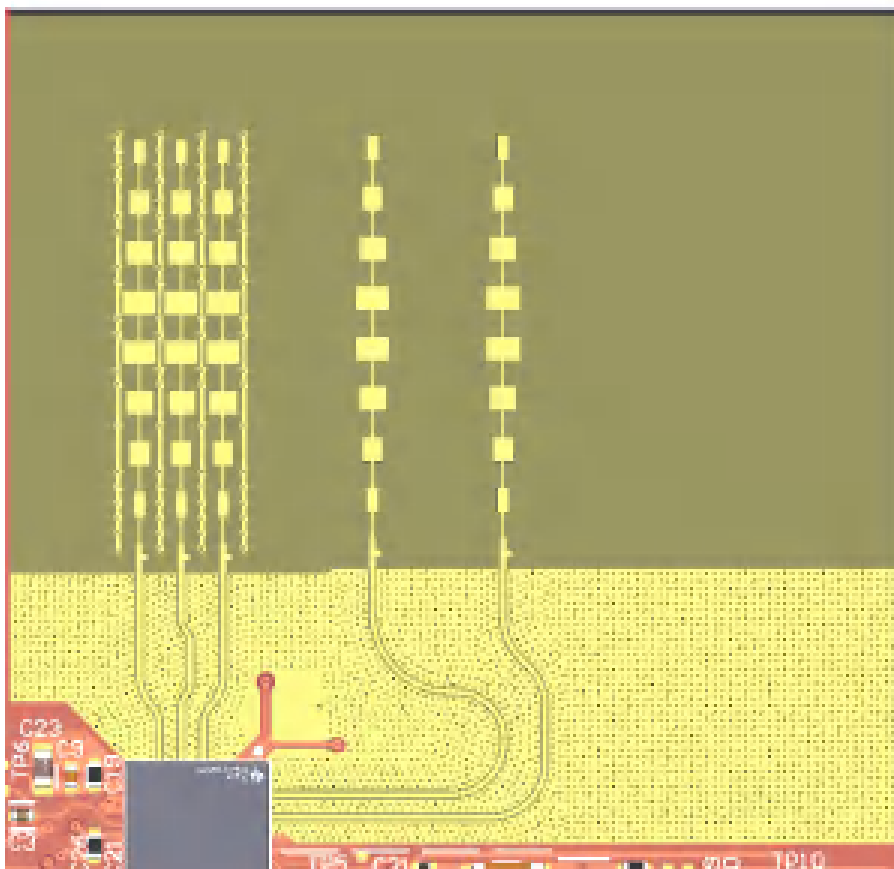


Figure 2-4. Salient Features of EVM (Bottom Side)

## 2.1 xWRL1432BOOST-BSD Antenna

The xWRL1432BOOST-BSD includes three receivers and two transmitters Rogers RO3003 based antennas on the PCB. [Figure 2-5](#) shows the antenna configuration.

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

**Note**

The xWRL1432BOOST-BSD has an antenna gain of approximately 13 dBi across the antenna pair.

**2.1.1 PCB Material**

Material used for this PCB is Rogers RO3003 of 5mil thickness with rolled copper for the Antenna and transmission lines and 370HR is used for the rest of the layers.

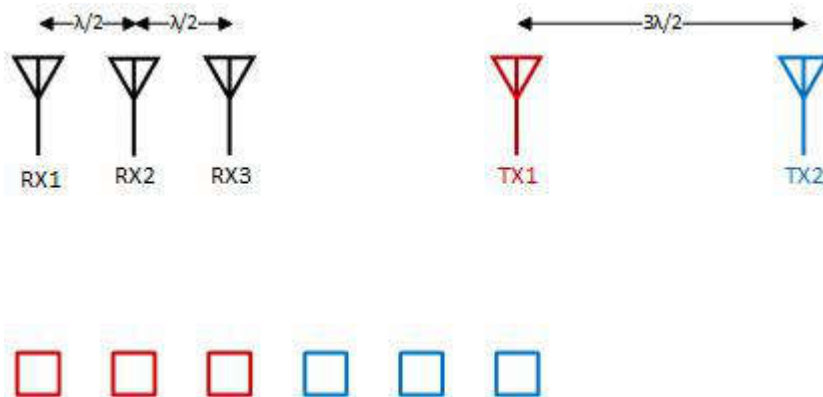


#	Name	Material	Type	Weight	Thickness	Dk	Df
	Top Overlay		Overlay				
	Top Solder	Solder Resist	Solder Mask		0.8mil	1	
1	Top Layer		Signal	1oz	1.6mil		
	Dielectric 1	RO3003	Core		5mil	3	
2	L2_GND1		Signal	1oz	1.4mil		
	Dielectric 2	PCL370HR	Prepreg		5.85mil	3.9	
3	L3_SIG1		Signal	1/2oz	1.2mil		
	Dielectric 3	PCL370HR	Core		10mil	4.25	
4	L4_PWR1		Signal	1/2oz	1.2mil		
	Dielectric 4	PCL370HR	Prepreg		5.65mil	3.9	
5	L5_PWR2		Signal	1/2oz	1.2mil		
	Dielectric 5	PCL370HR	Prepreg		10mil	4.25	
6	L6_SIG2		Signal	1/2oz	1.2mil		
	Dielectric 6	PCL370HR	Core		5.5mil	3.9	
7	L7_GND2		Signal	1/2oz	1.2mil		
	Dielectric 7	PCL370HR	Core		5mil	4.25	
8	Bottom Layer		Signal	1oz	1.6mil		
	Bottom Solder	Solder Resist	Solder Mask		0.8mil	1	
	Bottom Overlay		Overlay				

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**2.1.1.1 Transmitter and Receiver Virtual Array**

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 (19°). Receiver antennas are spaced at distance D (Lambda/2) and Transmitter antenna Tx1 and Tx2 spaced at 1.5D (3lambda/2) in azimuthal plane and no spacing in elevation plane.

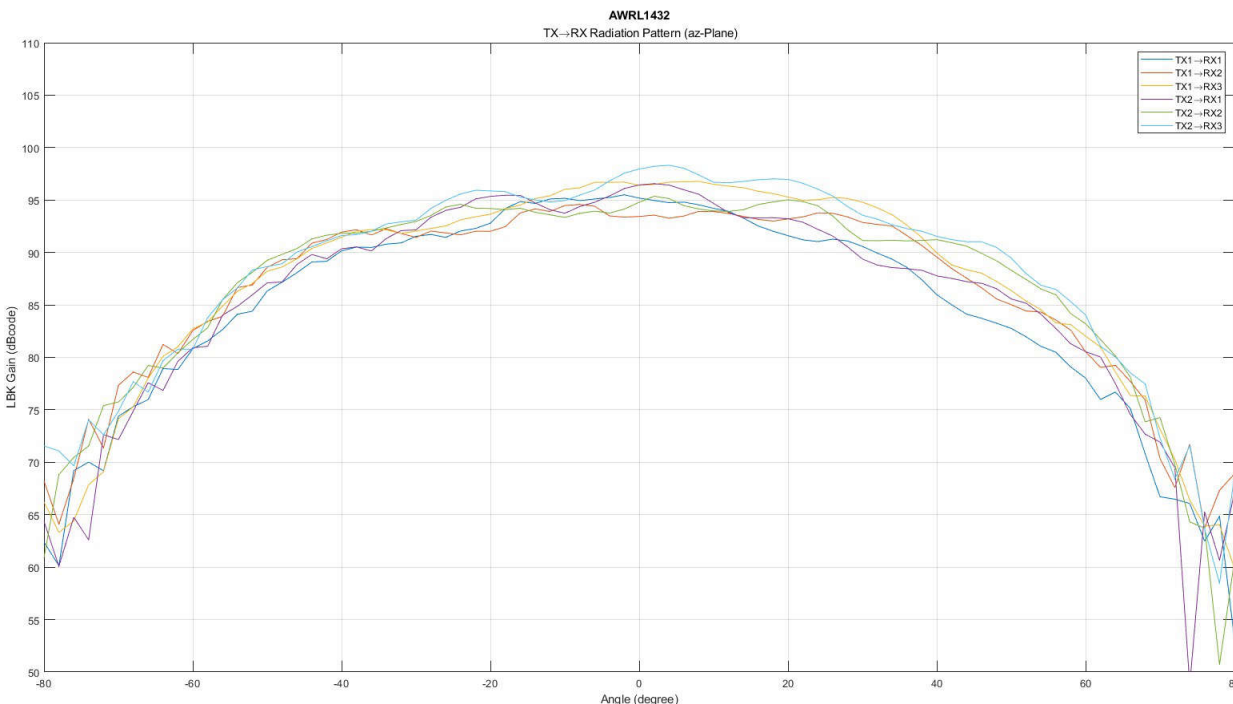


**Figure 2-6. Virtual Antenna Array**

Figure 2-6 shows the antenna radiation pattern with regard to azimuth and 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 (Tx (-6dB) + Rx(-6dB)) number from the boresight.

**Note**

Wavelength (Lambda) is computed based on a frequency of 78.5 GHz. Antenna placements are according to this frequency.



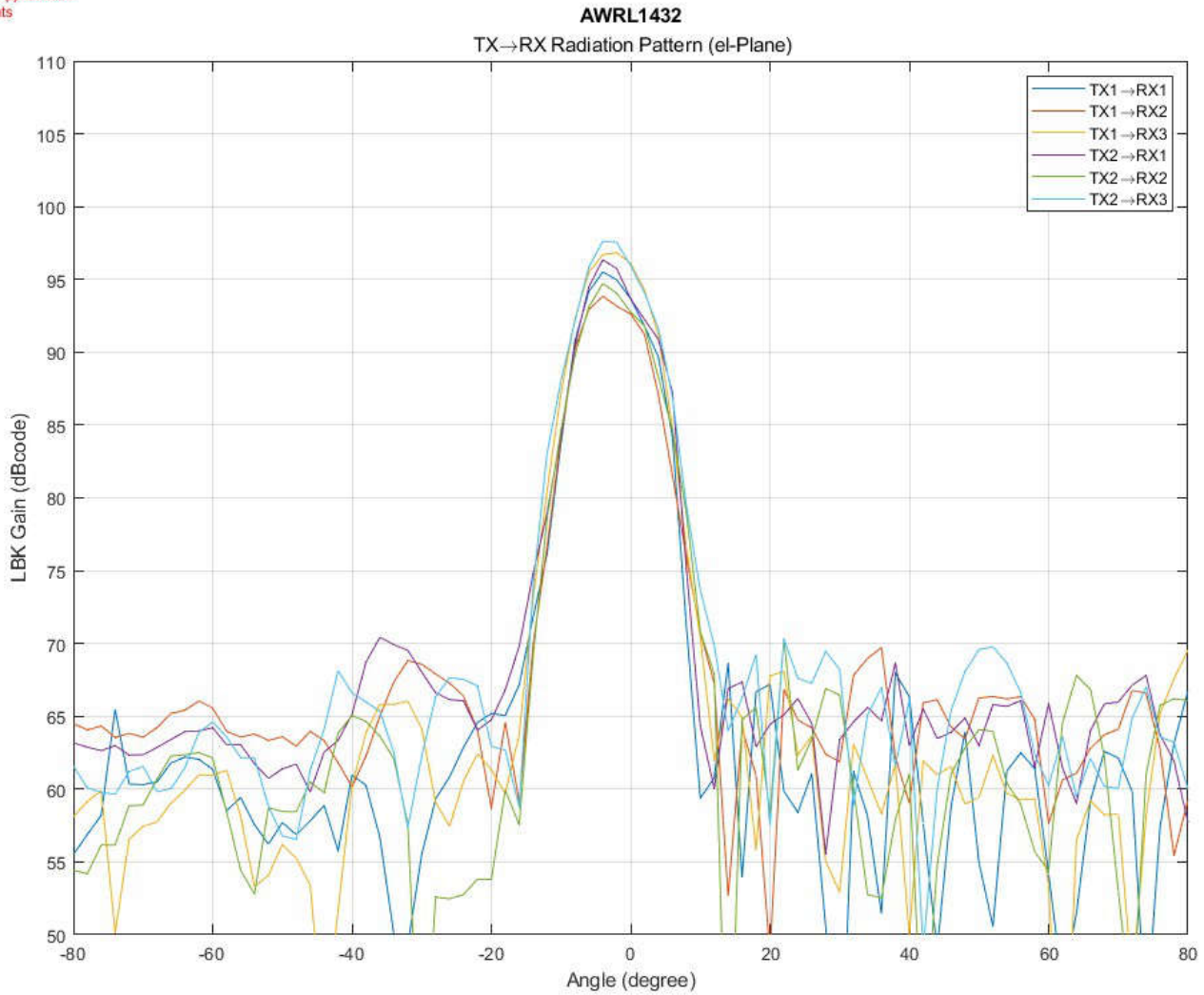
**Figure 2-7. xWRL1432BOOST-BSD EVM Azimuth Antenna Radiation Patterns**

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System Applications  
Texas Instruments

Measured azimuthal radiation pattern for all Tx to Rx pairs (Corner reflector placed at approximately 5 meters with a 1.5- GHz bandwidth chirp starting at 76 GHz)

Radar Platform Applications  
Texas Instruments



**Figure 2-8. XWRL1432BOOST-BSD EVM Elevation Antenna Radiation Patterns**

Measured elevation radiation pattern for all TX to RX pairs (Corner reflector placed at approximately 5 meters with a 1.5-GHz bandwidth chirp starting at 76 GHz)

**Note**

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

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## 2.2 EVM Mux Block Diagram

Figure 2-9 shows different muxing options for the digital signals. The device is pin limited to support different features simultaneously; hence various internal IPs and signals are pin multiplexed. EVM provides de-muxing options using various analog mux and sliding switch options. Figure 2-9 shows different muxing switch positions to enable different muxing options to connect to different peripherals.

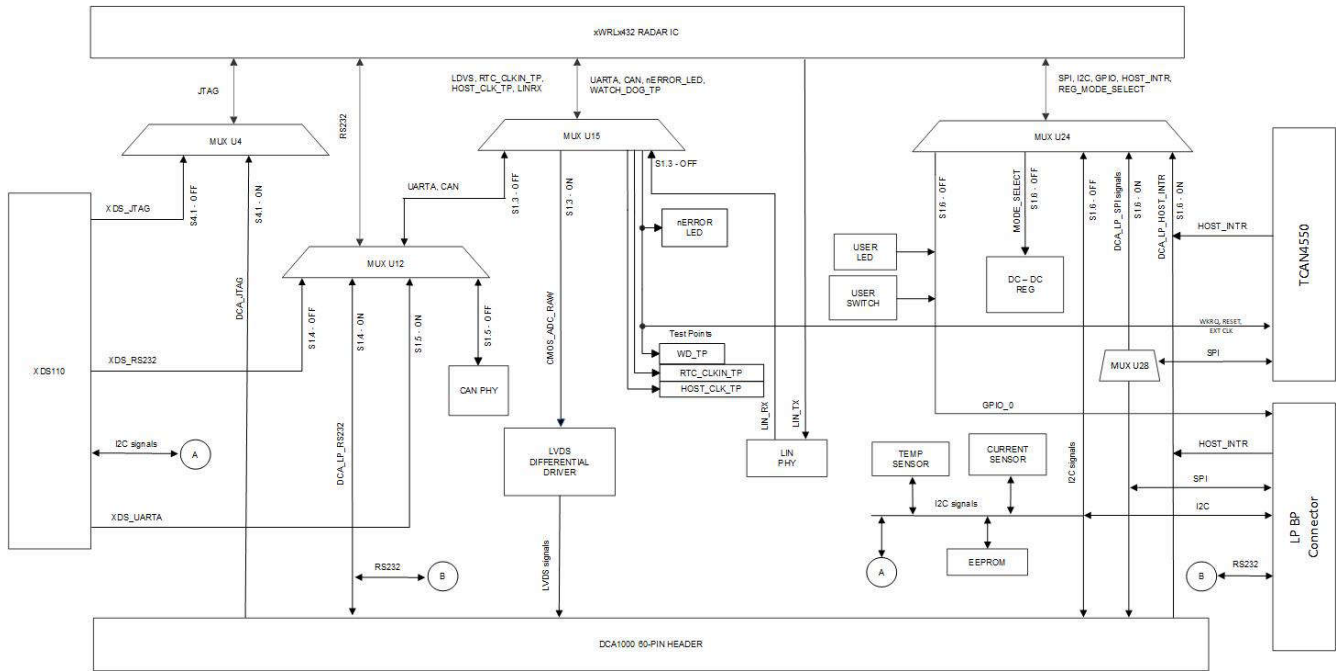


Figure 2-9. Muxing Options for the EVM

## 2.3 Switch Settings

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

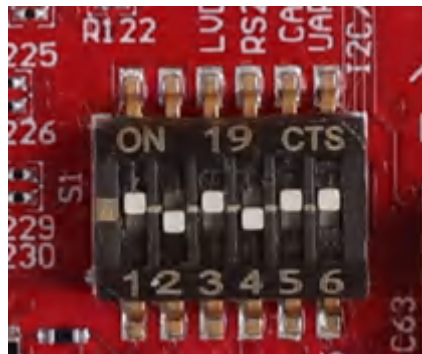


Figure 2-10. S1 Switch for Various Mode Settings

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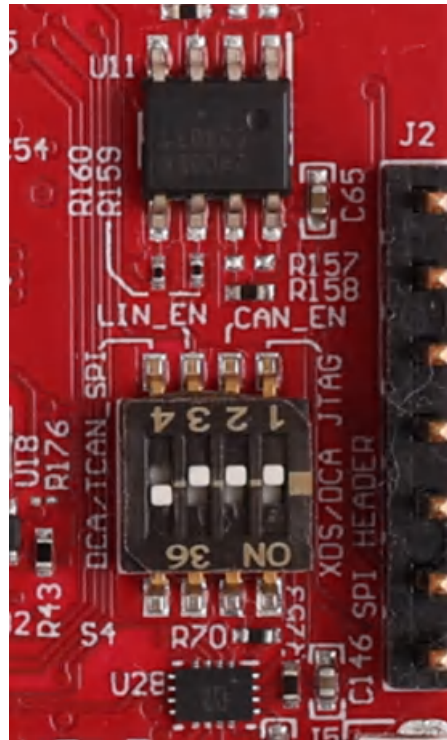


Figure 2-11. S4 Switch for Various Mode Settings

Figure 2-12 provides the different boot mode configurations to the device. Device supports application mode, QSPI flashing mode (Device management mode), and debug modes. This mode (SOP) configuration shown below in Figure 2-12 must be exercised first. After the SOP settings nRESET need to be issued to register the SOP settings. Figure 2-12 also provides the switch position for different modes of operation supported by the device and EVM.

	OFF	On	Flashing	Functional	Debug Mode (w/ DCA1000)
S1.1			Off	On	On
S1.2			Off	Off	On
S1.3	LVDS	LIN_RX, XDS_UARTA/Can, NERROR_LED, WATCH_DOG_TP, RTC_CLK_IN_TP, HOST_CLK_TPA	Off	Off	Off
S1.4	XDS_RS232	DCA_LP_RS232	Off	Off	Off
S1.5	CAN	XDS_UARTA	On	On	On
S1.6	I2C_REG_MODE, LED_SW_GPIO	SPI	On	On	On
S4.1	XDS_JTAG	DCA_JTAG	Off	Off	Off
S4.2	CAN PHY: Stand by Mode Disable	CAN PHY: Stand by Mode Enable	Off	Off	Off
S4.3	LIN PHY: Enable	LIN PHY: Disable	On	On	On
S4.4	-	-	-	-	-

Figure 2-12. SOP Switches

## 2.4 LEDs

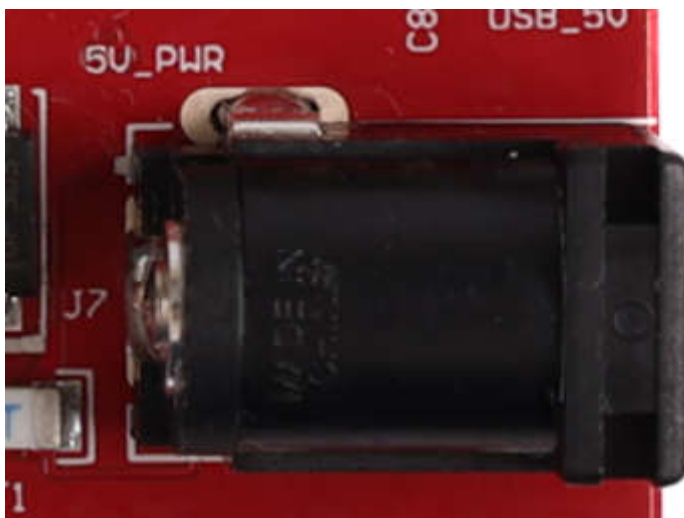
Table 2-1 contains the list of LEDs on the xWRL1432BOOST-BSD.

**Table 2-1. List of LEDs**

LED reference designators	Description
D6	5 V Power indication
D5	Reset LED.
D9	NERROR LED Note: There is switch settings are needed to enable this.
D7	User LED: Customer programmable. Note: 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 12-V supply is provided by the external power adapter. This power supply must be connected when working with the onboard TCAN4550. For all other use cases, this external power supply option is not used and power is derived from the USB interface.



**Note**

After the 12-V 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 5-V 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

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Figure 2-13. USB Connector (J5)

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## 2.7 DCA1000 HD Connector

The 60-pin HD connector shown in [Figure 2-14](#) provides the high-speed data and controls signals (SPI, UART, I2C, NRST, NERROR, and SOPs) to the DCA1000.

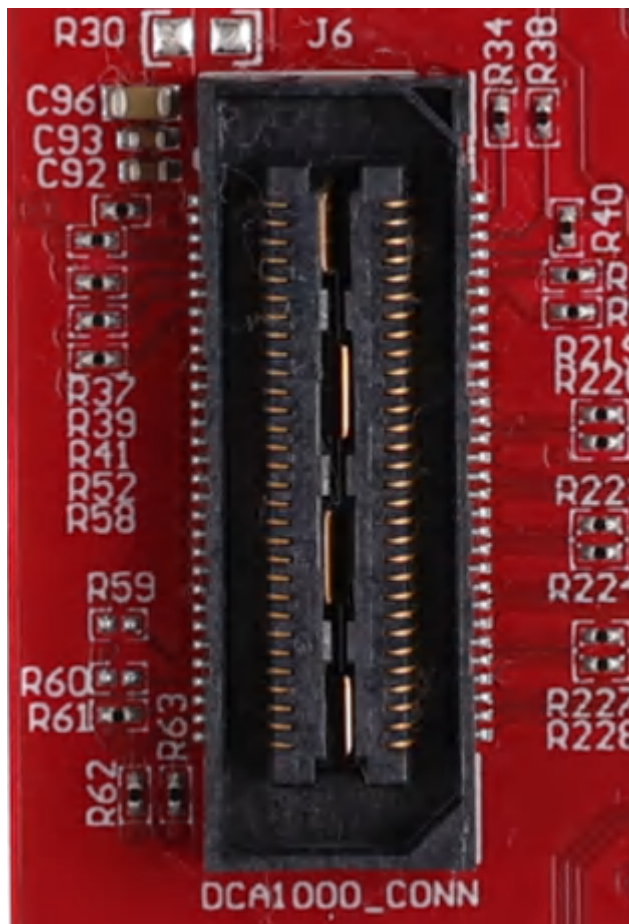


Figure 2-14. DCA1000 HD Connector

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## 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.

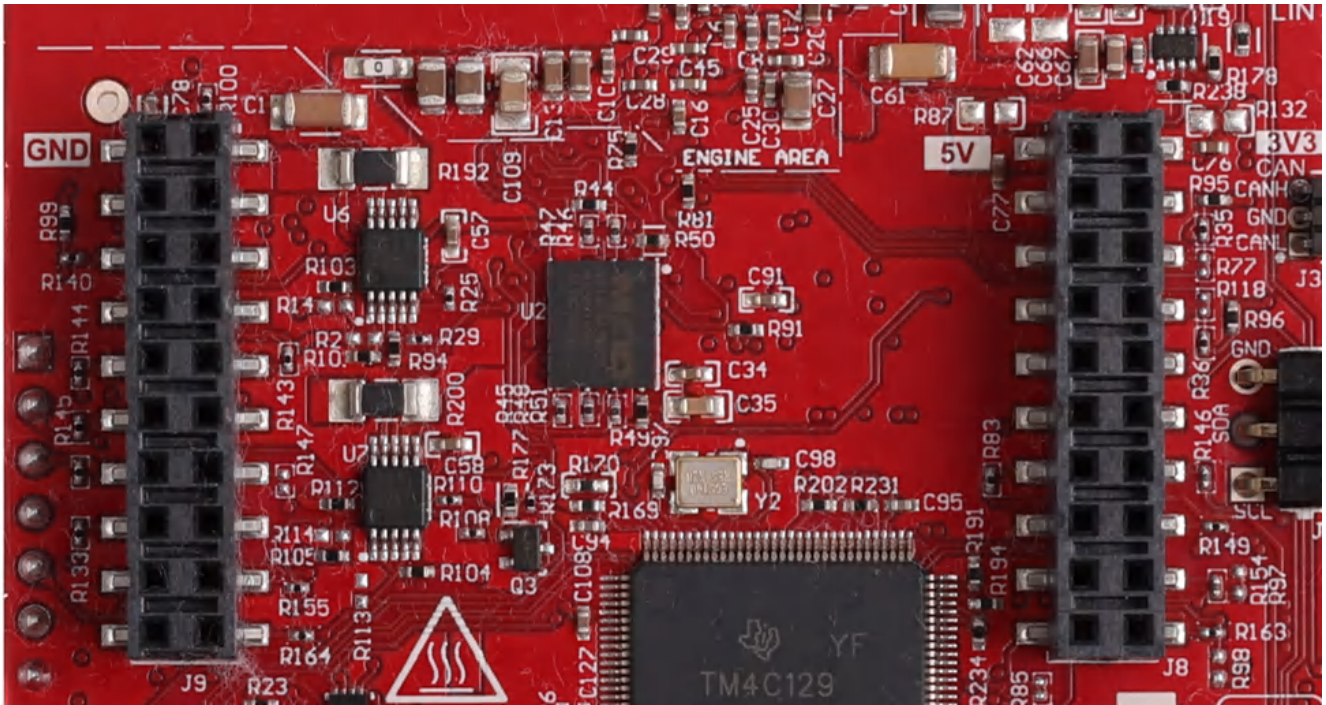


Figure 2-15. Booster Pack Connector

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## 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.

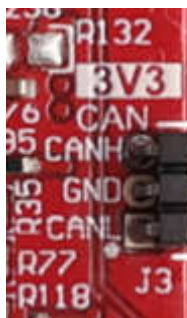


Figure 2-16. CANFD Connector

The J3 connector shown in Figure 2-16 provides the CAN\_L and CAN\_H signals from the onboard CAND-FD transceivers (TCAN1042HGVDQ1). 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.

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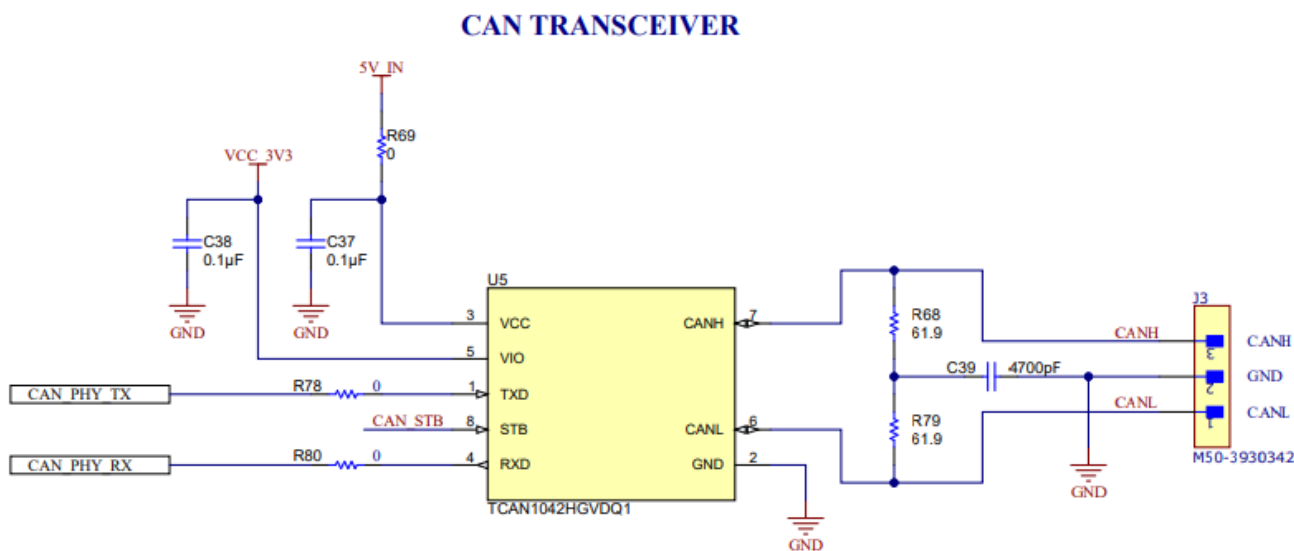


Figure 2-17. CAN FD PHY Used in the EVM

## 2.10 LIN PHY Connection

Figure 2-18 shows the LIN PHY (TLIN1039DDFRQ1) interface to the device. There are no switches for the LIN PHY interface. LIN PHY can operate with different supply voltage than the mmWave sensor, hence external VBAT option is provided for the LIN VDD supply, by default 5V\_IN supply is provided. To enable external VBAT supply, R32 resistor need to be mounted and R31 resistor need to be removed.



Figure 2-18. LIN header and PHY Interface

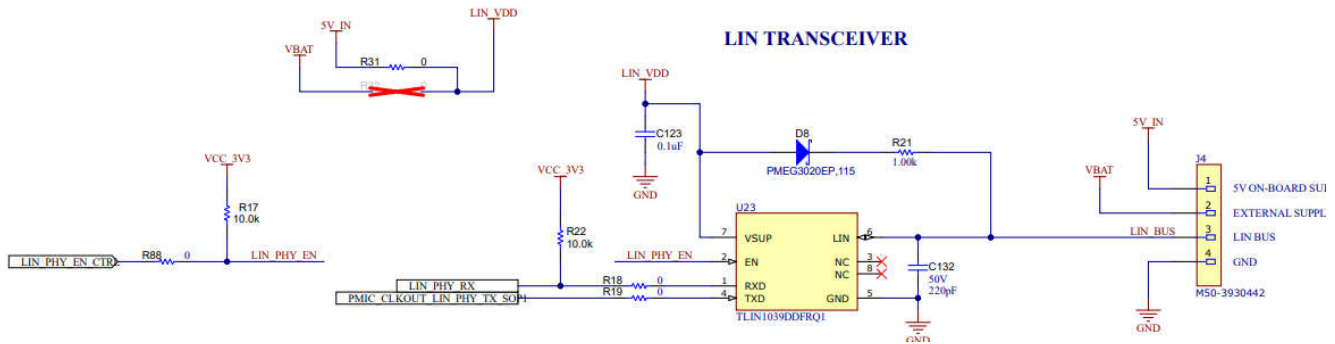


Figure 2-19. LIN PHY Interface

## 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  $\Omega$  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 2-20](#), 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 2-20](#).

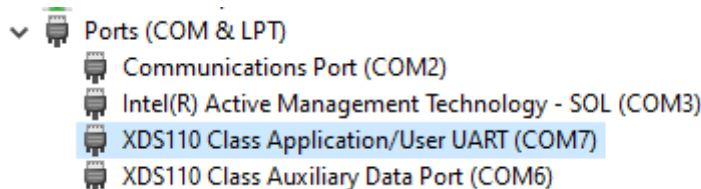


Figure 2-20. Virtual COM Port

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

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 2-21](#).

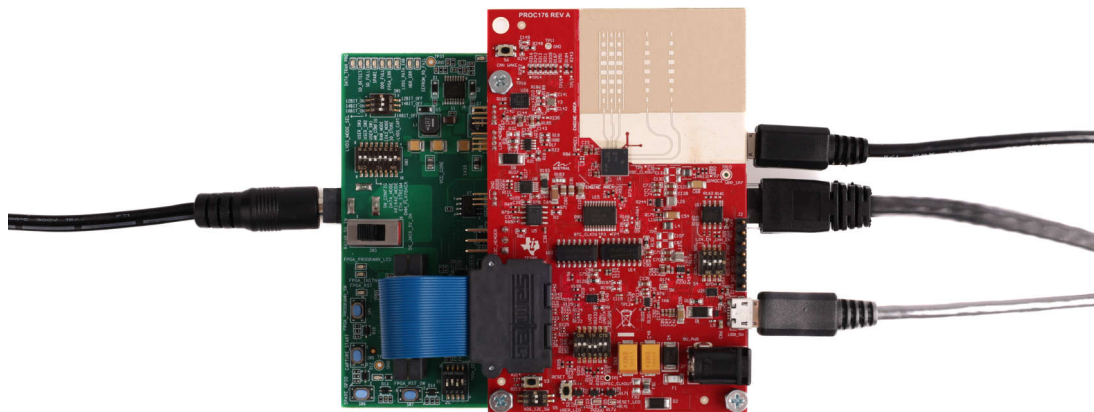
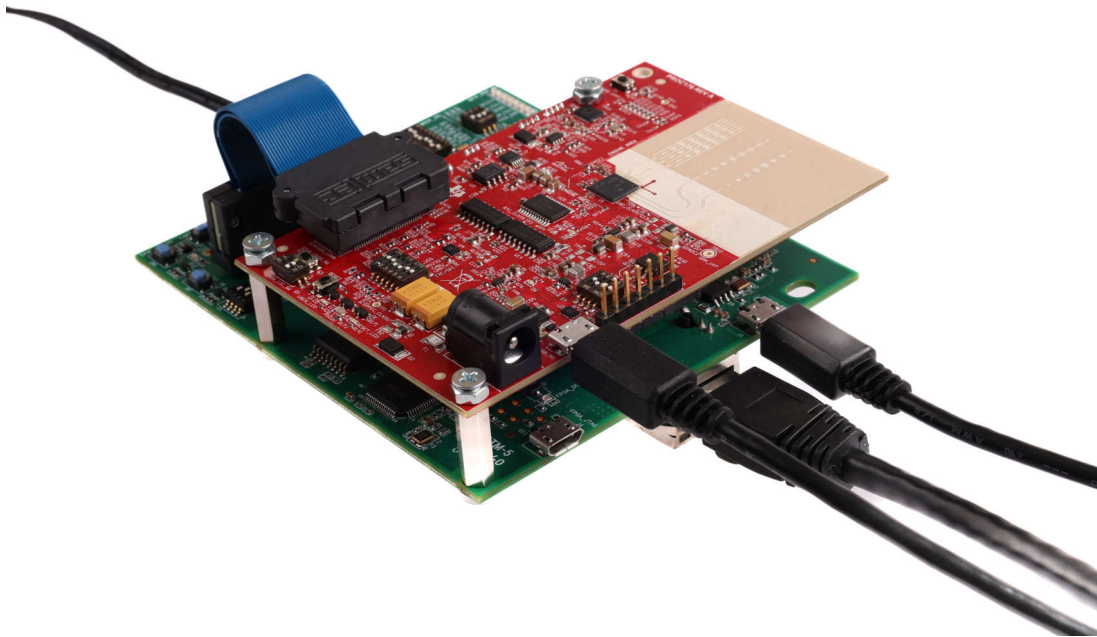


Figure 2-21. DCA1000EVM Mode (Top View)



**Figure 2-22. DCA1000EVM Mode (Side View)**

Please refer to [Figure 2-12](#) 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**

xWRL1432 doesn't have LVDS I/Os, mainly to reduce the overall power consumption of the SOC. However, DCA1000 board needs LVDS signals on the clock and data interface for raw ADC capture so CMOS to LVDS converters are used on the board as shown below. 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 need to be used for this purpose. Low power mmWave studio interpret the RDIF interface and provides the raw ADC data visualization platform for further signal processing.

## DIFFERENTIAL LVDS DRIVER

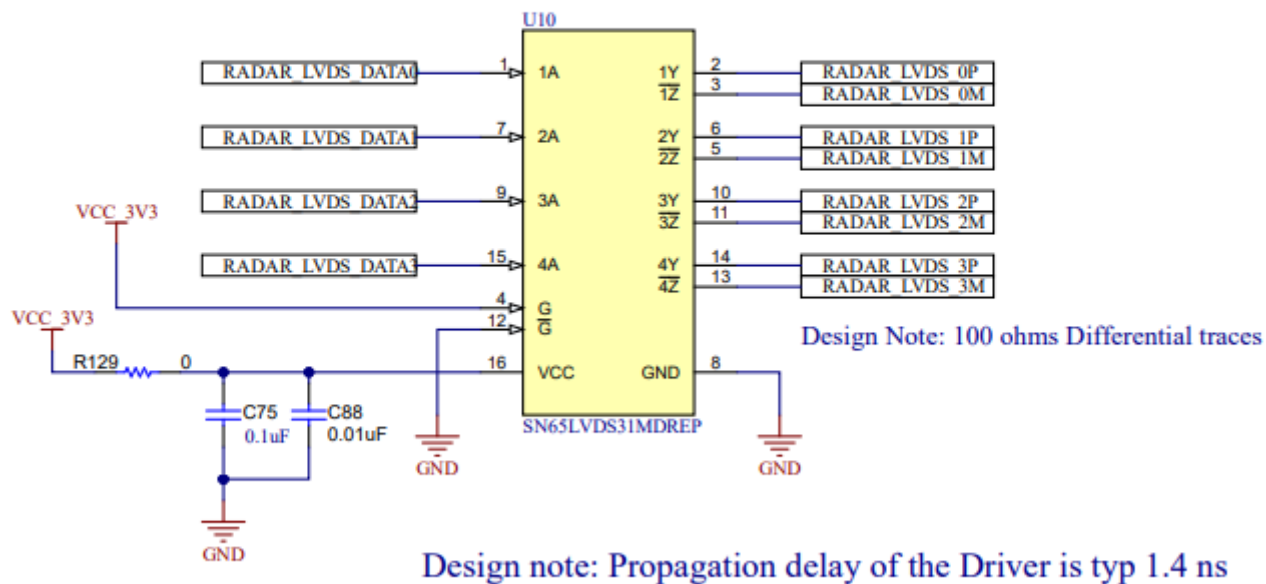


Figure 2-23. DCA1000 CMOS TO LVDS Conversation for Data Lines

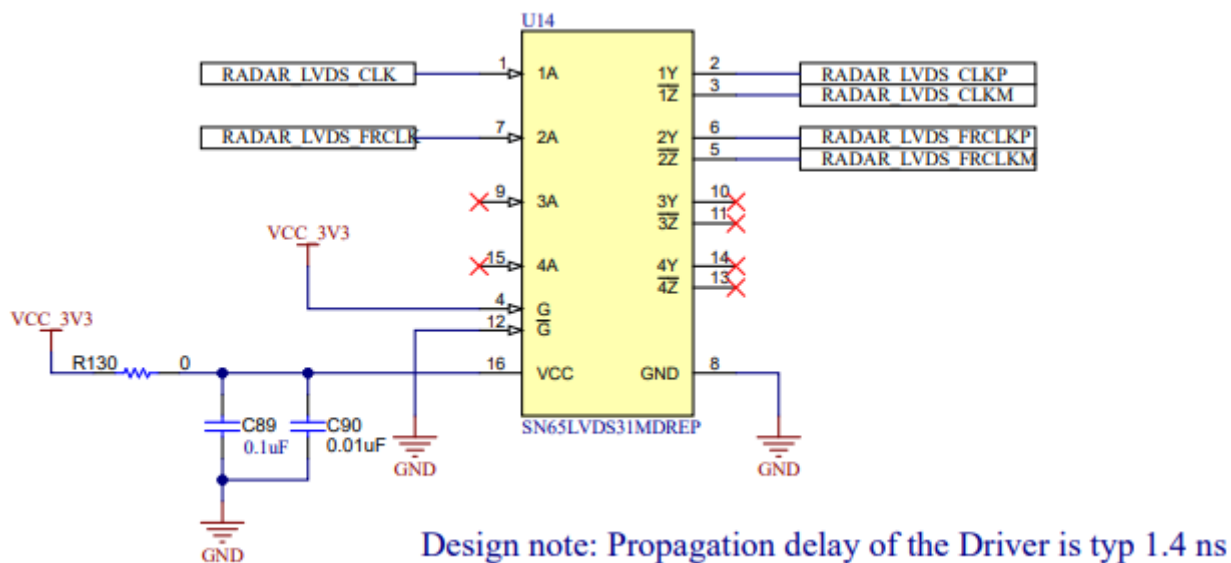


Figure 2-24. DCA1000 CMOS TO LVDS Conversation for Clock and Control Lines

### 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](#).

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### **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 itself. For higher power consumption applications where a single USB-port cannot supply the power needed, use an external 12 V/2A or higher power adapter.

## 3 Software

### 3.1 Software, Development Tools, and Example Code

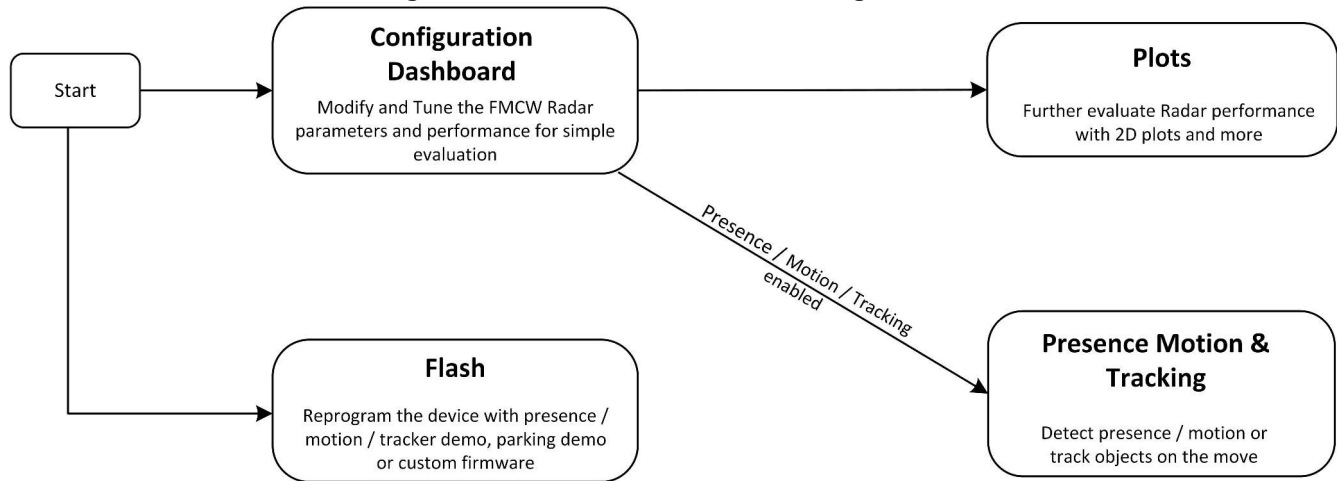
To enable quick development of end applications on the ARM Cortex-M4F core in the xWRL1432, TI provides a software development kit (SDK) that includes demo codes, software drivers, emulation packages for debug, and more.

For more information, please refer to mmWave low power SDK user's guide.

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

#### 3.1.1 XWRL1432 Demo Visualization Getting Started

**Figure 3-1. Demo Visualization Getting Started**



- Step1 : Connect the EVM to the PC via USB.
- Step 2 (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 3: 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 4: Plots tab displays point cloud information.



## 4 Hardware Design Files

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

xWRL1432BOOST-BSD 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

### Trademarks

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](http://e2e.ti.com). If you cannot find your answer, post your question to the community!

## Revision History

DATE	REVISION	NOTES
July 2024	*	Initial Release

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