EVM User's Guide: AWRL6844EVM IWRL6844EVM
AWRL6844/IWRL6844 Evaluation module

TEXAS INSTRUMENTS

Description

The xWRL6844EVM from Texas Instruments is an easy-to-use evaluation module for the xWRL6844 mmWave radar sensor. The xWRL6844EVM supports both standalone operation as well as 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 DSP, Hardware accelerator and low power ARM® Cortex® - R5F controller. The EVM also includes on-board buttons, LEDs for quick integration of a simple user interface in addition to onboard emulation for programming and debugging.

Getting Started

For getting started guide and running out of box demo, please refer to SWRU636

Features

- 57GHz to 64GHz mmWave radar sensor
- On-Chip C66x DSP, ARM CORTEX-R5F controller and Hardware Accelerator (HWA 1.2)
- Onboard four-transmit and four-receive antennas (4TX/4RX) with High RF performance RO3003 PCB substrate
- TPS650365x based power management topology
- Direct interface with DCA1000 for debug and Raw ADC data capture.

Figure 1-1. xWRL6844EVM

SWRU630 – DECEMBER 2024
Submit Document Feedback

AWRL6844/IWRL6844 Evaluation module   1

Copyright © 2024 Texas Instruments Incorporated

1 Evaluation Module Overview

1.1 Introduction

The xWRL6844 mmWave radar Sensor is an integrated single chip mmWave sensor based on FMCW radar technology which operates in the 57GHz to 64GHz frequency band. The xWRL6844 is designed for low power, self-monitored, ultra-accurate radar systems in the automotive and industrial set of applications. The xWRL6844 EVM enables access to point-cloud data over XDS110 USB interface, as well as Raw ADC Data when interfaced with DCA1000 development kit. The xWRL6844EVM is supported by mmWave tools, demos and software including MMWAVE-L-SDK and TI's Code Composer Studio™(using the on-board XDS110 emulator). The xWRL6844EVM can also interface with the MCU LaunchPad™ development kit ecosystem by mounting LaunchPad BoosterPack connectors.

1.2 Key Features

- Wide 4GHz bandwidth (57GHz to 61GHz) on board etched antennas(4TX,4RX) with high RF performance ROGERS RO3003 PCB substrate
- XDS110 based JTAG emulation with serial port for onboard 64-bit QSPI flash programming
- UART to USB Debug port for terminal access using FTDI FT4232H
- 60-pin, high-density (HD) connector for debug, SPI, I2C and LVDS with direct mating to DCA1000 development kit.
- Onboard 2 x CAN-FD and 1 x LIN PHY transceivers
- EVM supports input voltage range (5V to 12V) using DC Jack to power the board
- 5V USB Powered standalone mode of operation
- On-board INA228A Current sensors to measure per rail power consumption of the Radar device

1.3 Kit Contents

xWRL6844EVM Kit includes the following:

- xWRL6844EVM Evaluation board
- Micro USB cable
- Quick Start Guide
- Screws, spacers and nuts to allow mounting of EVM
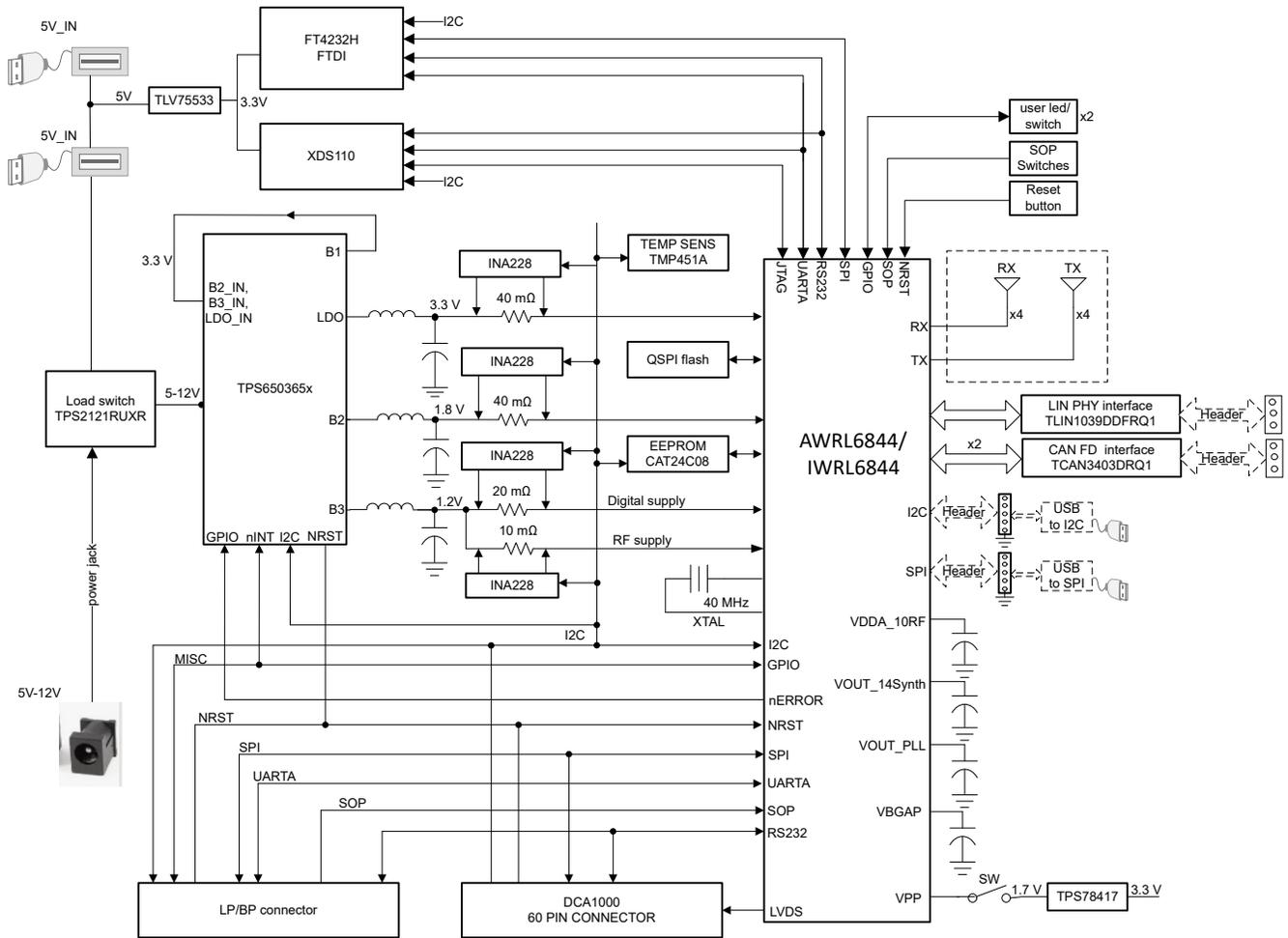
1.4 Specification

Figure 1-1. Functional Block Diagram

Figure 1-1 shows functional block diagram of xWRL6844EVM. The EVM contains all essential components for the TI mmWave radar system: PMIC, SFLASH, SOP configuration, Filter, mmWave Radar Sensor, USB to UART converter and a 60-pin Samtec connector for interfacing with DCA1000. The xWRL6844EVM has a provision to mount a launch-pad booster-pack connector which can be connected to TI's LaunchPad boards.

1.5 Device Information

The documents in Table 1-1 provide information regarding devices from Texas Instruments used in the assembly of xWRL6844 EVM. This user's guide is available from TI web site under literature number SWRU630. Any letter appended to literature number corresponds to the current 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
TMP451-Q1	TMP451AQDQFRQ1
TPDE004D	TPDE004DRYR
TPS2121	TPS2121
TPS65036501	TPS650365-Q1
TLV75533PDRV	TLV755P
TPS78417QDBVRQ1	TPS784-Q1
INA228A	INA228AIDGST
TS3A5018RSVR	TS3A5018
TS3A44159PWR	TS3A44159
TS3A24157DGSR	TS3A24157
TS3A27518EPWR	TS3A27518E
TM4C1294NCPDTT3	TM4C1294NCPDT
TCAN3403DRQ1	TCAN3403-Q1
TLIN1039DDFRQ1	TLIN1039-Q1
SN74LVC1G11DSFR	SN74LVC1G11D

2 Hardware

> **CAUTION**
>
> ⚠
>
> **Hot surface. Contact can cause burns. Do not touch.**

The xWRL6844EVM includes four receivers and four transmitters with a wide field of view antenna on a High RF Performance ROGERS3003 PCB substrate.
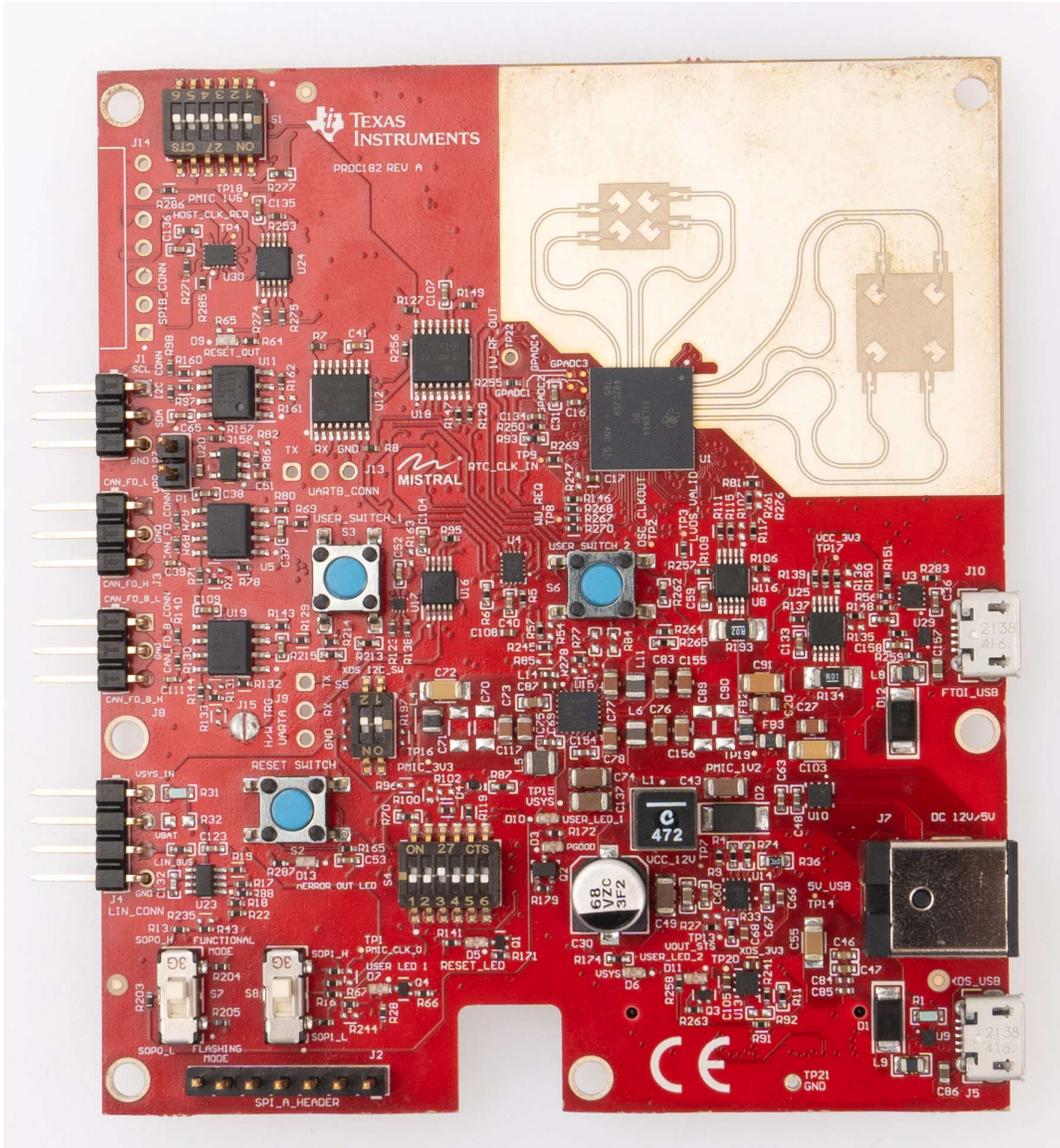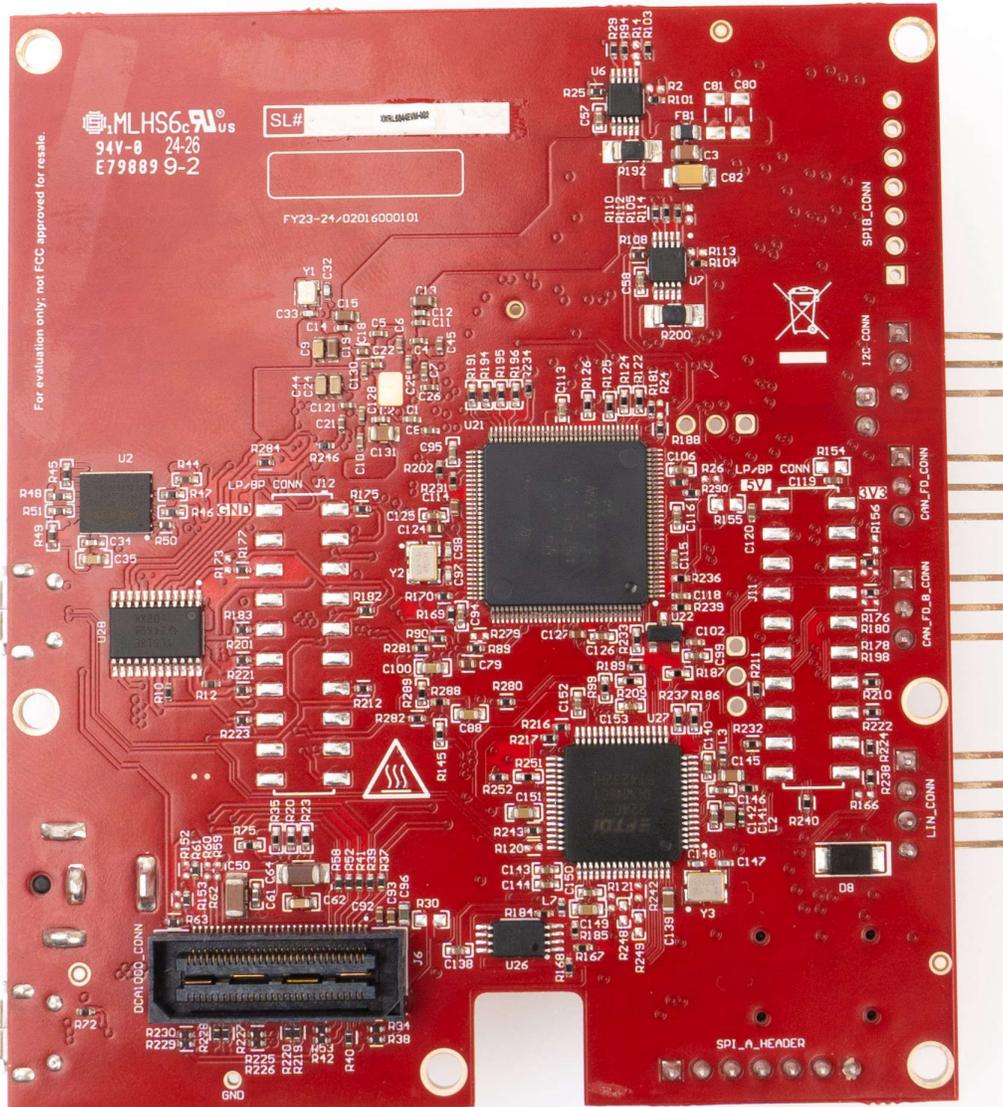

Figure 2-1. xWRL6844EVM (Top View)

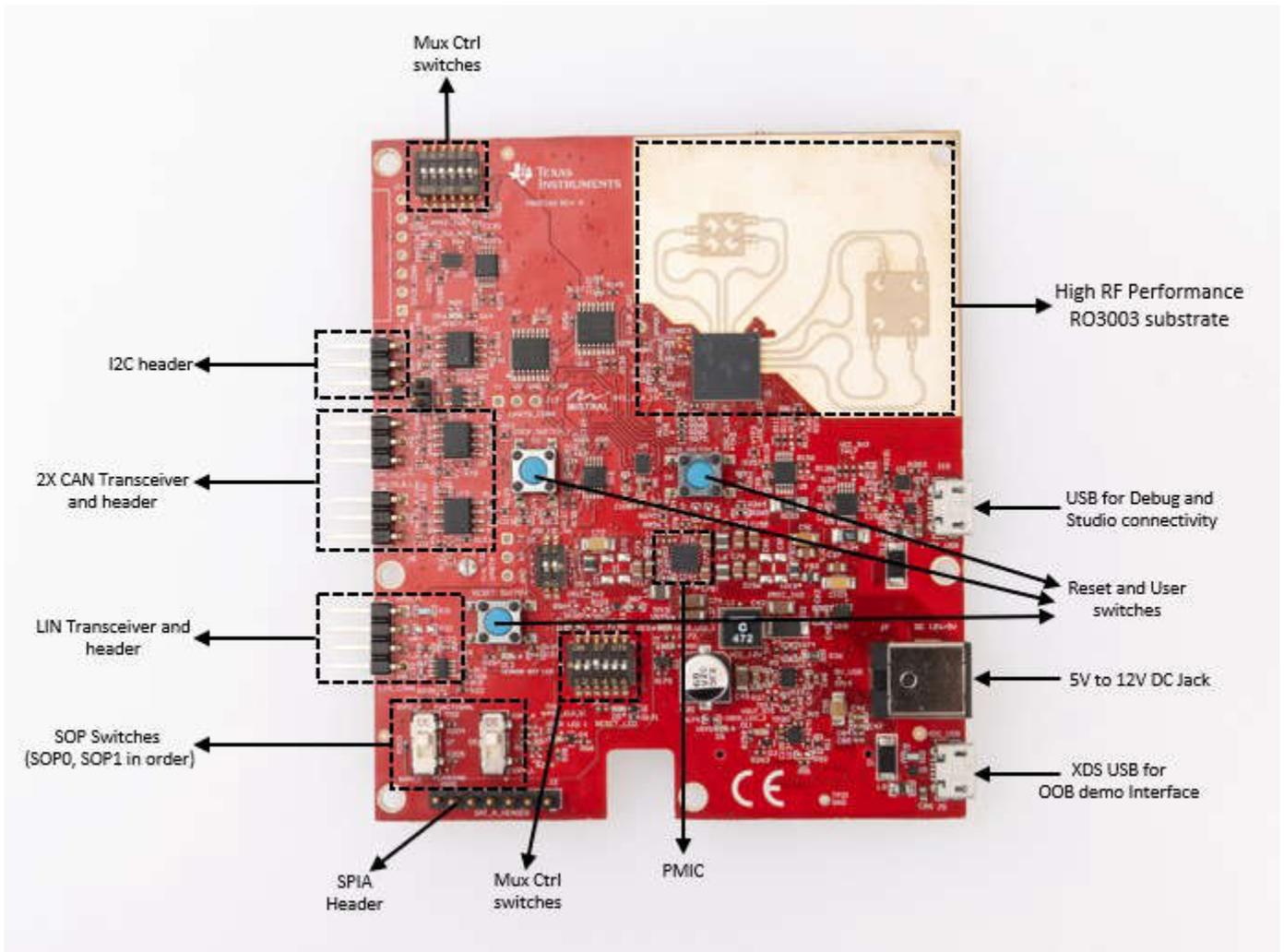**Figure 2-2. xWRL6844EVM (Bottom View)**
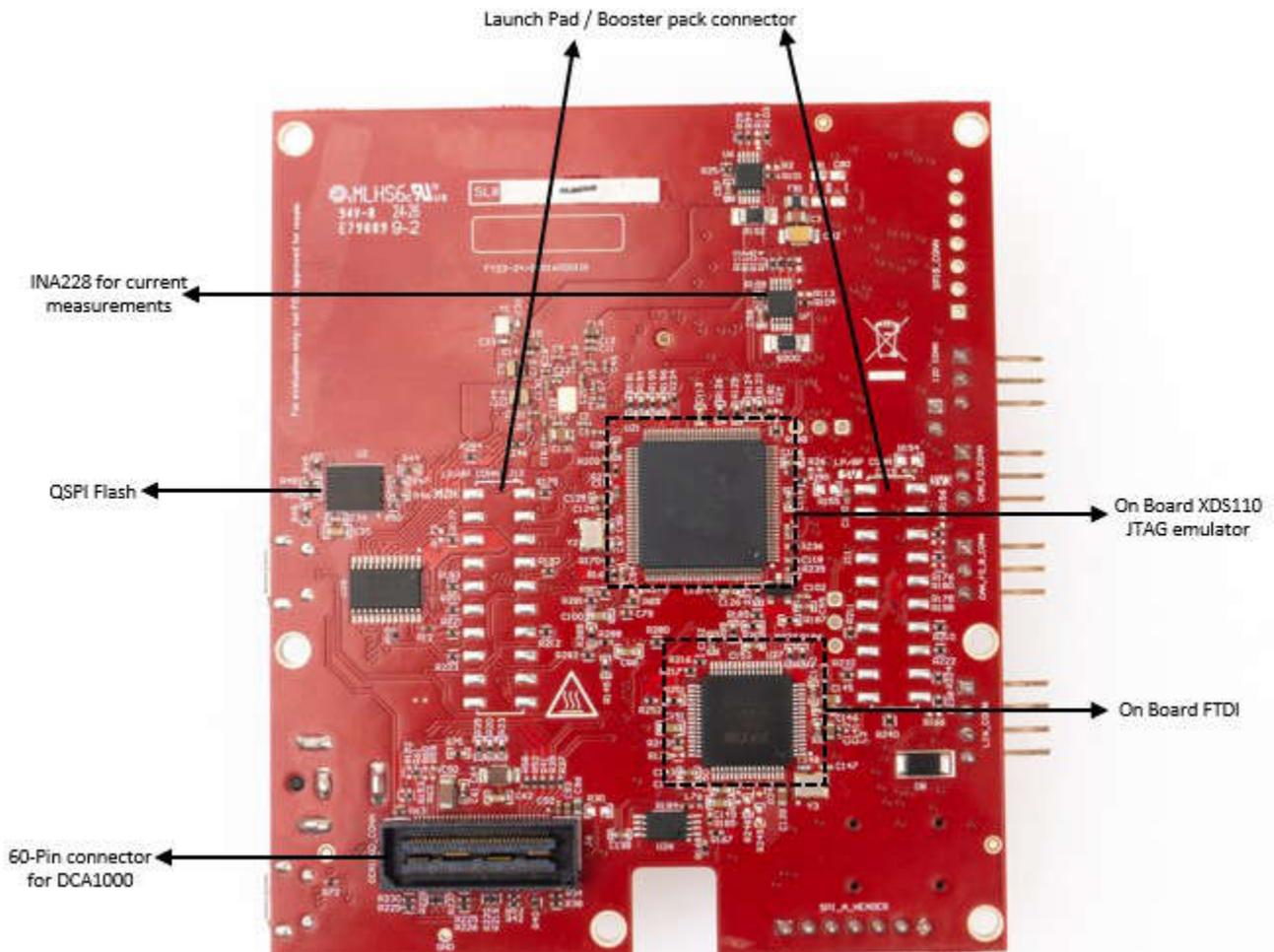
Figure 2-3. Salient Features of EVM (Top Side)

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

2.1 xWRL6844EVM Antenna

The xWRL6844EVM includes four transmitter and four receiver ROGERS RO3003 based antennas on the PCB. Figure 2-5 shows the antenna configuration.
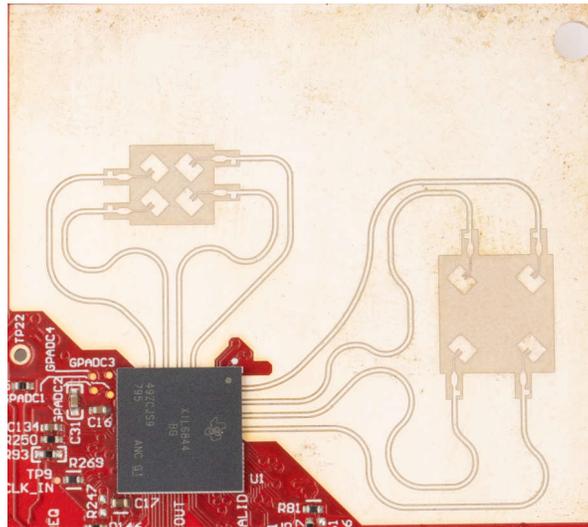

Figure 2-5. TX and Rx Antennas of the EVM

Note
The xWRL6844EVM has an antenna gain of approximately 5-6 dBi across each antenna element.

2.1.1 PCB Material

The dielectric material used for this PCB is ROGERS RO3003 of 5mil thickness with rolled copper for the Antenna and transmission lines while 370HR is used for the rest of the layers.

Type	Layer	Total Cu Thickness μm	Total Cu Thickness mils	Final Thickness μm	Final Thickness mils	Construction
Solder Mask				20	0,8	IMM SILVER
	1	40	1,6	23	0,9	Plating Cu (Total Cu final minimum = 34μm)
				17	0,7	Copper RA
				127	5,0	Core Rogers RO3003 RA
	2	35	1,4	35	1,4	Copper RA
				140	5,5	Prepreg 370HR
	3	35	1,4	35	1,4	Copper
				254	10,0	Core 370HR
	4	35	1,4	35	1,4	Copper
				140	5,5	Prepreg 370HR
	5	35	1,4	35	1,4	Copper
				254	10,0	Core 370HR
	6	35	1,4	35	1,4	Copper
				140	5,5	Prepreg 370HR
	7	35	1,4	35	1,4	Copper
				127	5,0	Core 370HR
	8	40	1,6	17	0,7	Copper
				23	0,9	Plating Cu (Total Cu final minimum = 34μm)
Solder Mask				20	0,8	IMM SILVER
Total Thickness :				**1,512** mm 0,0595 (inch)	± 10%	

2.1.1.1 Transmitter and Receiver Virtual Array

The transmitter and receiver antenna positions shown in Figure 2-6 form a virtual array of sixteen transmitter and receiver pairs. This allows finer object detections in both azimuth and Elevation planes with an angular resolution of 29°. Receiver antennas are spaced at distance D (λ/2) apart in both azimuth and elevation plane. The transmitter antennas are spaced at distance D (λ) apart in both azimuth and elevation plane.
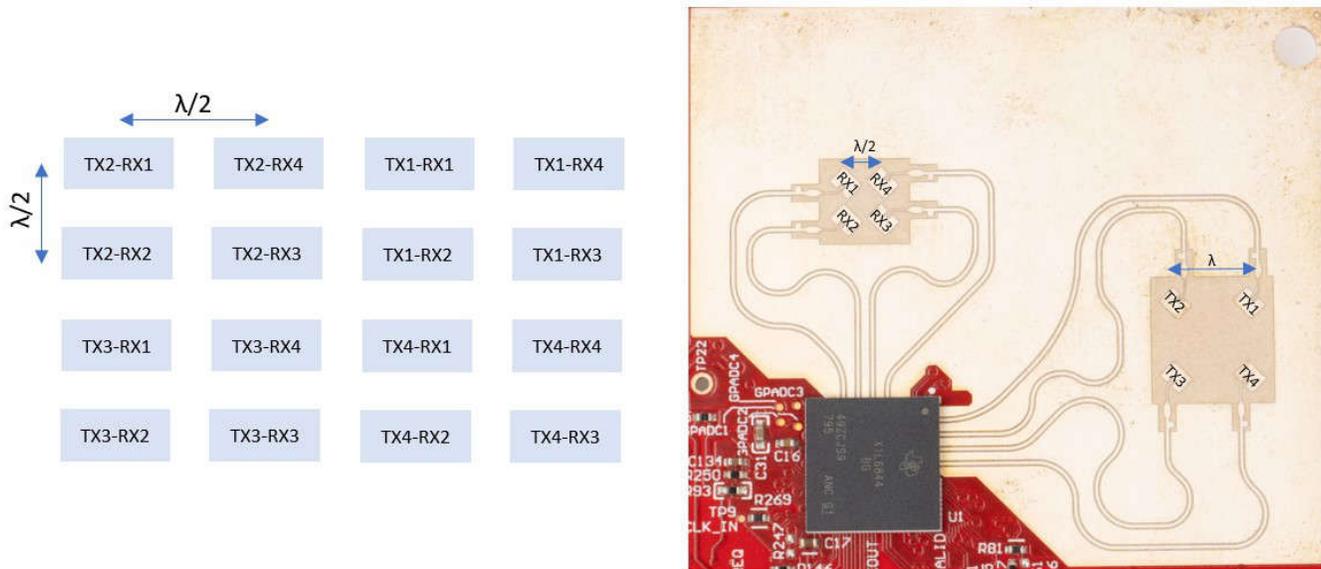

Figure 2-6. Antenna Virtual array with respect to TXs and RXs

Figure 2-7 and Figure 2-8 below show the antenna radiation pattern with regard to azimuth and elevation planes. Both figures show the radiation pattern for TX1, TX2, TX3, TX4 and RX1, RX2, RX3 and RX4 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 59GHz. Antenna placements were made according to this frequency.
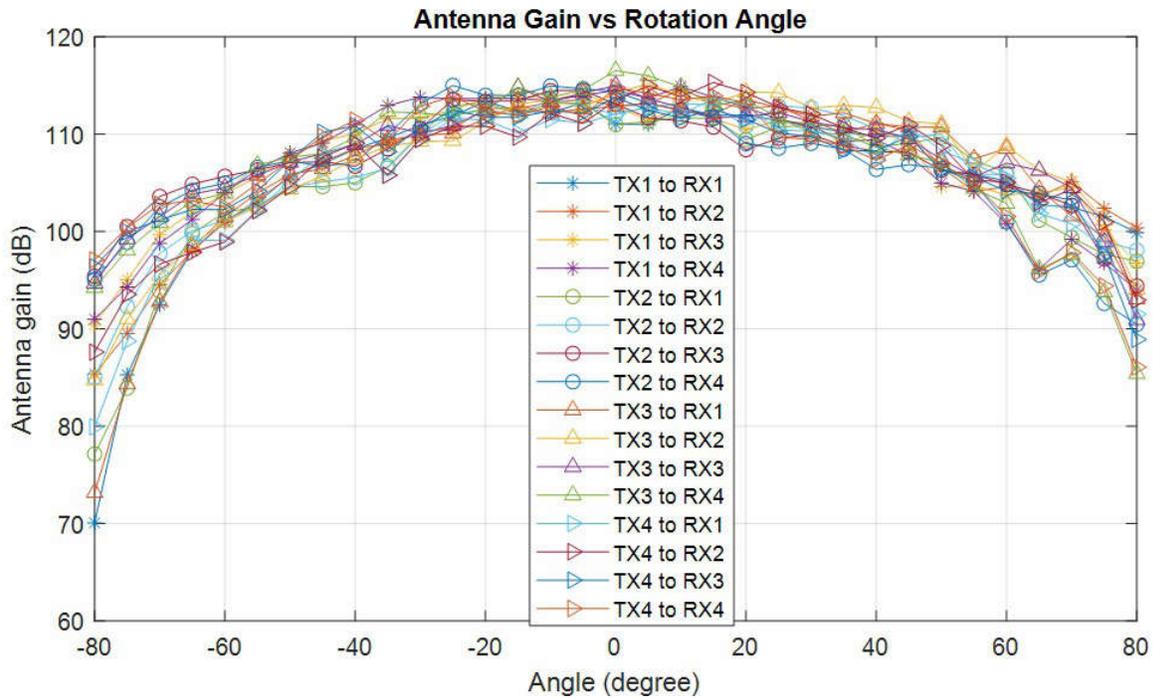

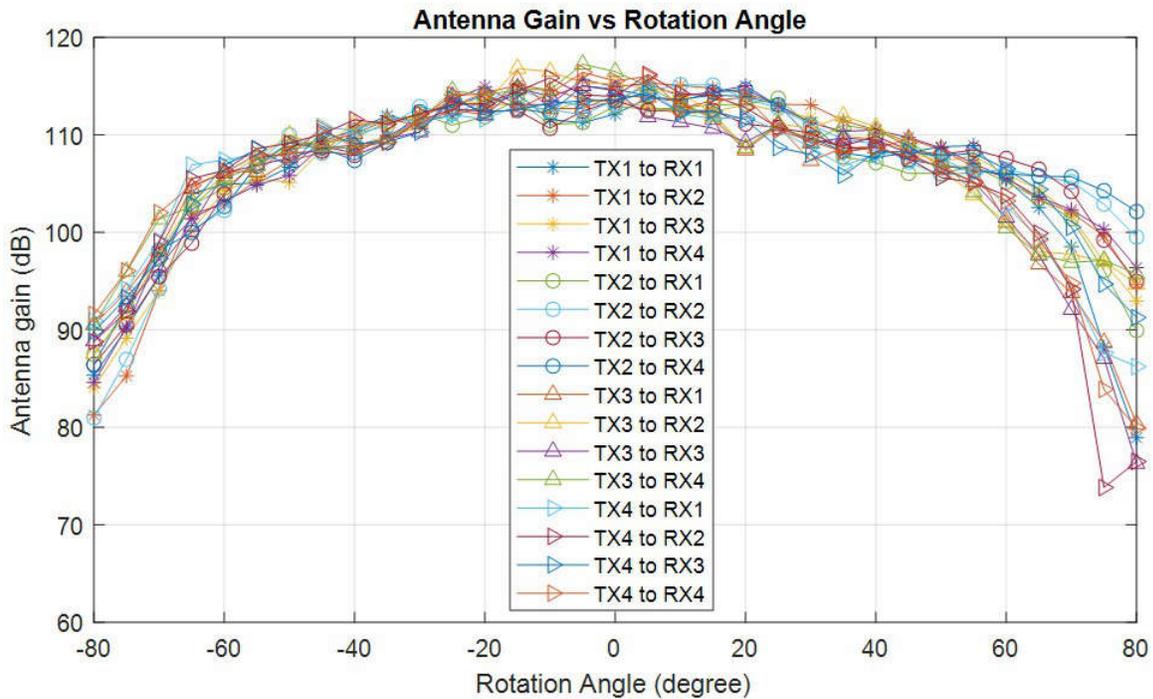**Figure 2-7. xWRL6844EVM Azimuth Antenna Radiation Pattern**

Figure 2-8. xWRL6844EVM Elevation Antenna Radiation Pattern

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 functionality muxing options for digital signals. The xWRL6844 contains multiple internal IPs and features. The EVM provides de-muxing options using various analog muxes and switches to improve the user experience. Switch Settings section shows different switch and mux configurations to enable connection to different peripherals.
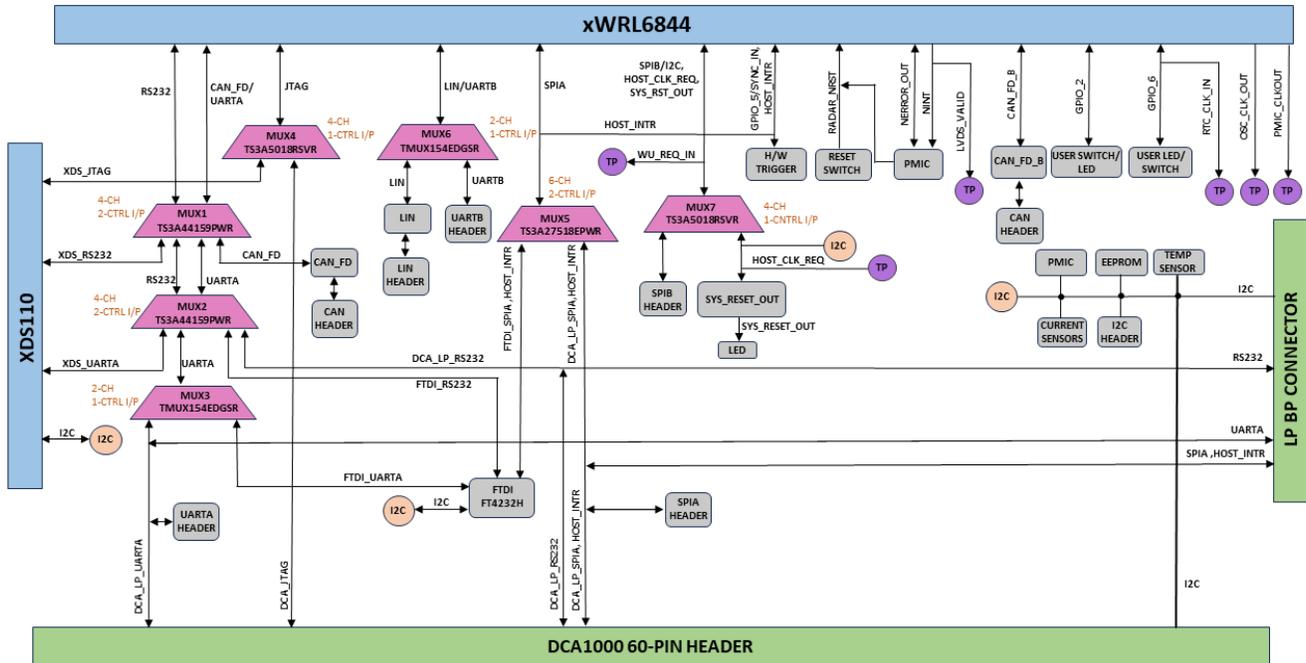
Figure 2-9. Functionality Muxing Options in the EVM

2.3 Switch Settings

The Figure 2-10 shows the part designators and positions of the switches on xWRL6844EVM for different SOP mode settings. Table 2-1 shows the different boot mode configurations for the device. xWRL6844 supports Application mode/ Functional mode, Device management mode/ QSPI flashing mode, and Debug modes. The mode (SOP) configurations shown below Table 2-1 must be exercised first. After the correct SOP mode is set, an nRESET must be issued to register the SOP setting. In the Figure 2-10 the current SOP mode shown is Debug mode.
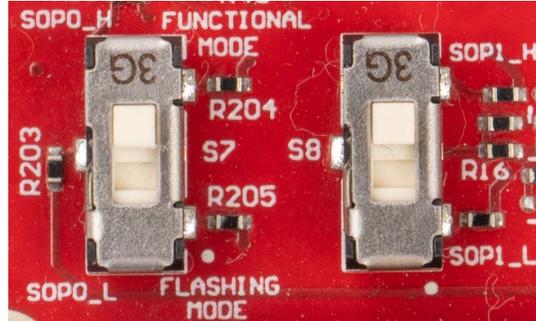
Figure 2-10. SOP switches (S7, S8)

Table 2-1. SOP settings

SOP Mode	PMIC_CLK_OUT, TDO	Combinations SOP1(S8), SOP0(S7)
SOP_MODE1	Device Management Mode/ QSPI Flashing Mode	00
SOP_MODE2	Application mode/ Functional Mode	01
SOP_MODE4	Debug Mode/ Development Mode	11

The S1 and S4 slide switches allows user connect to the digital interfaces from different peripherals
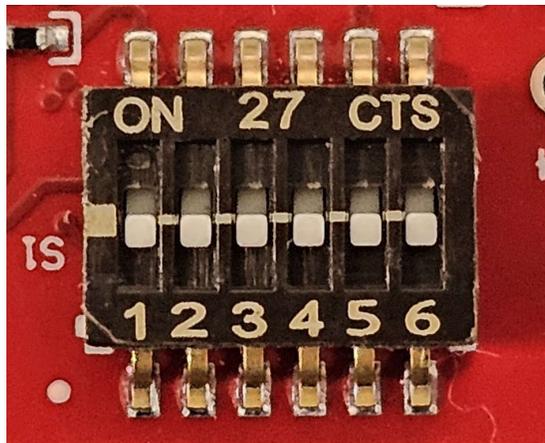

Figure 2-11. Slide Switch (S1)

Table 2-2. S1 Switch Settings

| Reference Designator	Switch OFF	Switch ON
S1.1	CAN PHY B: Stand by Mode Disable	CAN PHY B: Stand by Mode Enable
S1.2	XDS_RS232	FTDI_DCA_LP/BP_RS232
S1.3	FTDI_RS232	DCA_LP/BP_RS232
S1.4	CAN_FD_A	XDS_DCA_LP/BP_FTDI_UARTA
S1.5	DCA_LP/BP_FTDI_UARTA	XDS_UARTA
S1.6	FTDI_UARTA	DCA_LP/BP_UARTA
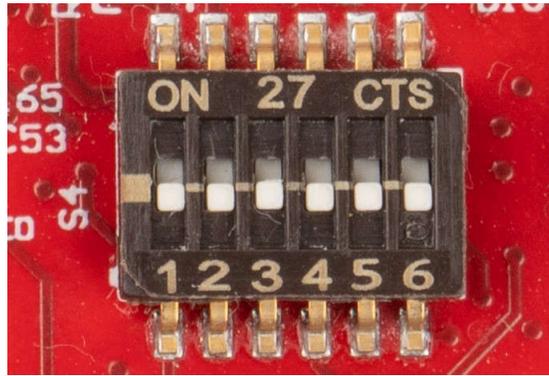
Figure 2-12. Slide Switch (S4)

Table 2-3. S4 Switch Settings

Reference Designator	Switch OFF	Switch ON
S4.1	CAN PHY A: Stand by Mode Disable	CAN PHY A: Stand by Mode Enable
S4.2	LIN PHY: Enable	LIN PHY: Disable
S4.3	FTDI_SPI	DCA_SPI
S4.4	XDS_JTAG	DCA_JTAG
S4.5	UARTB	LIN
S4.6	SPIB	I2C/HOST_CLK_REQ/SYS_RST_OUT

2.4 Push Button Switches

Table 2-4 contains list of Push Button Switches on the xWRL6844EVM. The User switches are connected to GPIO and can be used for quick integration of a simple interface

Table 2-4. List of Push Button Switches

| Switch reference designators	Usage	Comments	Image
S2	Reset Switch	This Switch can be used to reset the xWRL6844 device	
S3	User Switch 1	When pushed, GPIO_2 logic is pulled high	
S6	User Switch 2	When pushed, GPIO_6 logic is pulled high	
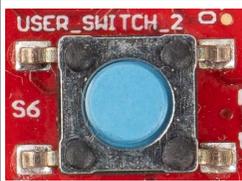
2.5 LEDs

Table 2-5 contains list of LEDs present on the xWRL6844EVM. The User LEDs are provided for integration and can be controlled using the GPIO's of xWRL6844.

Table 2-5. List of LEDs

LED reference designators	Usage	Comments	Image
D3	PGOOD LED	Glows once all the power supplies are stable from PMIC	
D6	Power ON LED	5V or 12V Power indication	
D5	Reset LED	This LED Indicates the state of Reset pin on xWRL6844 device. LED glowing indicates the device is out of reset.	
D7	User LED: Customer programmable	Glows when GPIO_2 is logic-1	
D9	SYS_RST_OUT LED	Glows in presence of any System reset from xWRL6844 device	
D10	FTDI suspend LED	Glows when FTDI is in suspend state	
D11	User LED: Customer programmable	Glows when GPIO_6 is logic-1	
D13	nERROR LED	Glows in presence of any HW error in xWRL6844 device	

2.6 DC Input Jack

The xWRL6844EVM can be powered-up using the 5V to 12V DC Jack. When DC Jack is connected, the Priority switchover is given to DC-jack's Voltage at the power mux(TPS2121).
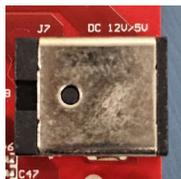
Note

After the 5V-12V 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.

2.7 USB Connector

The xWRL6844EVM has two micro USB connectors. These connectors are for xds110 and FTDI interface connectivity. These connectors can also be used to provide 5V power supply input to the EVM.

FTDI Interface: Micro USB Connector J10 provides access to the xWL6844 device's UART-A, SPI, I2C, RS232/ UART-B, SOP and Reset signals

Figure 2-13. FTDI USB (J10)

XDS Interface: Micro USB connector J5 provides access to the xWL6844 device's I2C, JTAG, UART_A, RS232/ UART-B signals. This is the UART interface used to flash the binary to the onboard serial flash and for running Out-of-box (OOB) demo.

Figure 2-14. XDS USB (J5)

2.8 DCA1000 HD Connector

The 60-pin HD connector shown in Figure 2-15 provides access to the xWRL6844 device's high-speed data and controls signals (I2C, LVDS, NRST, RS232/UART-B, SPI, UART-A) through the DCA1000.
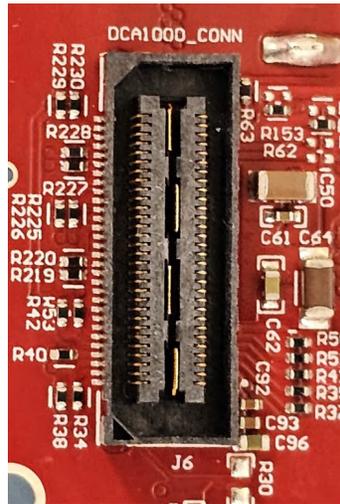

Figure 2-15. DCA1000 HD Connector

The Figure 2-16 further details on the xWRL6844 device's signals being brought out at the DCA1000 direct mating connector.
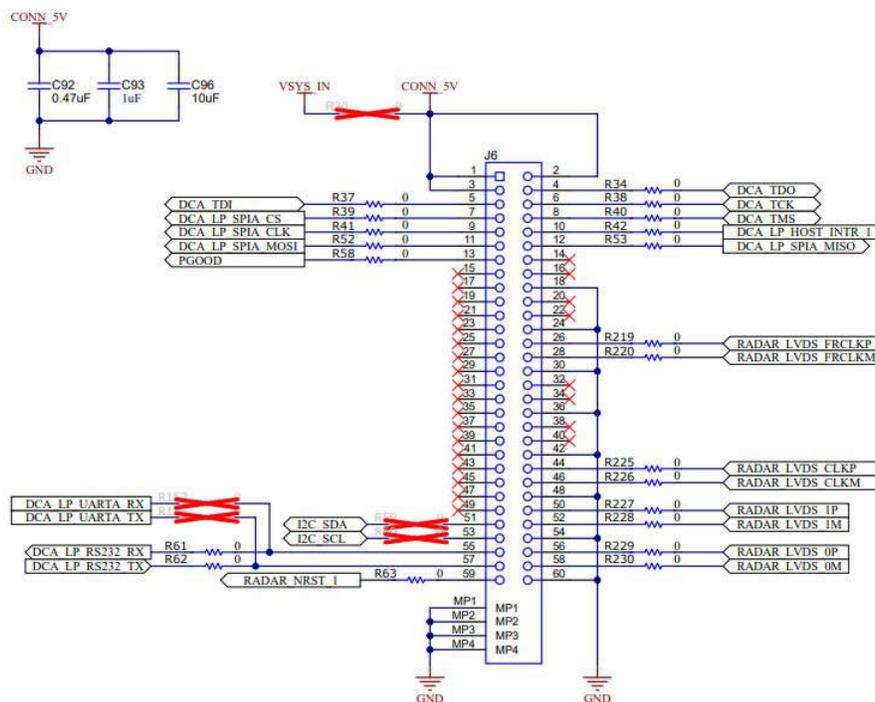

Figure 2-16. DCA1000 HD Connector Pins

2.9 BoosterPack Connector for LaunchPad Connectivity

J11/J2 are the booster pack connectors provided on the EVM. The user can populate the LP-BP connector to connect with other TI launchpad kits.

Figure 2-17. Booster Pack Connector

The Figure 2-18 shows the various signals that have been brought-out on the LP-BP connector.

Figure 2-18. LP-BP connector Pins

2.10 CAN-FD_B Connector

The CAN connector provides access to the CAN_FD_B interface (CAN_L and CAN_H signals) from the onboard CAN-FD transceiver. These signals can be directly wired to the CAN bus.

The J8 connector shown in provides the CAN_L and CAN_H signals from the onboard CAN-FD transceiver (TCAN3403DRQ1). CAN standby input can be controlled by toggling S1.1 switch
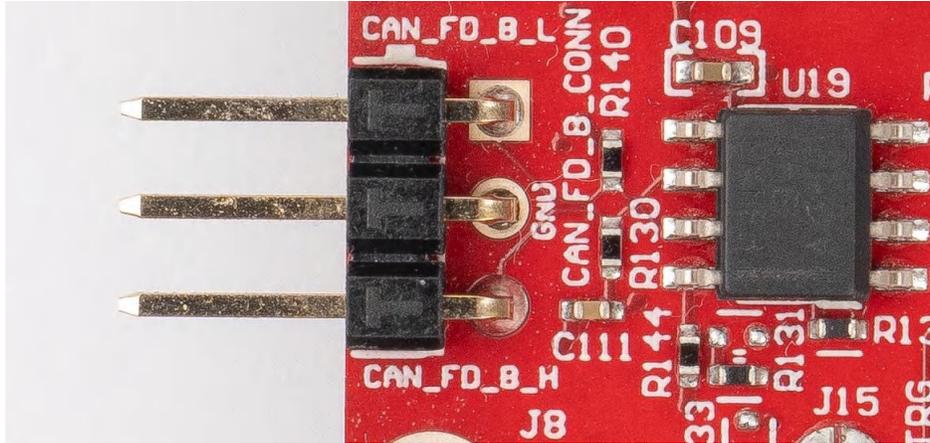
Figure 2-19. CAN-FD B Connector
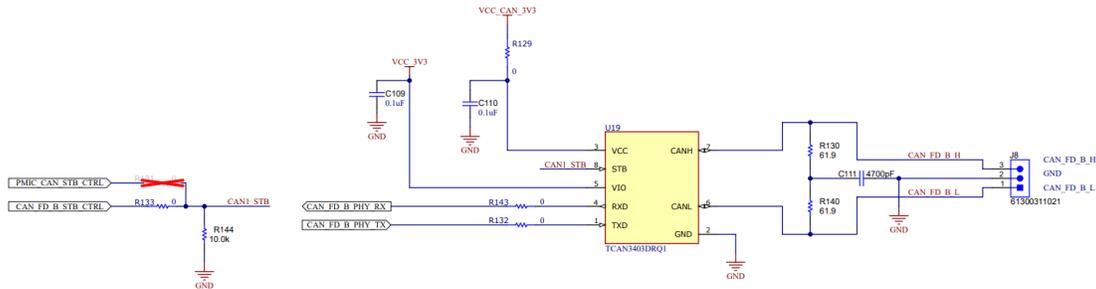
Figure 2-20. CAN-FD PHY Used in the EVM

2.11 CAN-FD_A Connector

The J3 connector shown in Figure 2-21 provides the CAN_L and CAN_H signals from the onboard CAN-FD transceiver (TCAN3403DRQ1). These signals are wired to the CAN bus after muxing with the UART-A signals; one of the two paths must be selected. CAN signal paths get connected to PHY by changing the switch S1.4 to off position. CAN standby input can be controlled by toggling S4.1 switch.

Figure 2-21. CAN-FD A Connector

Figure 2-22. Analog Mux for the CAN PHY Switch

Figure 2-23. CAN-FD PHY Used in the EVM

2.12 LIN-PHY Connector

Figure 2-24 shows the LIN PHY (TLIN1039DDFRQ1) interface to the device. 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 VSYS_IN supply is provided for J4 connector.
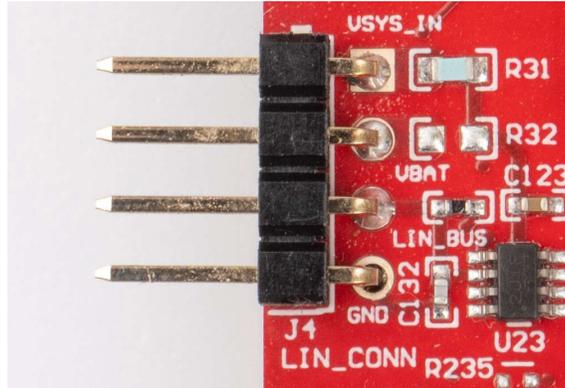
Figure 2-24. LIN Connector
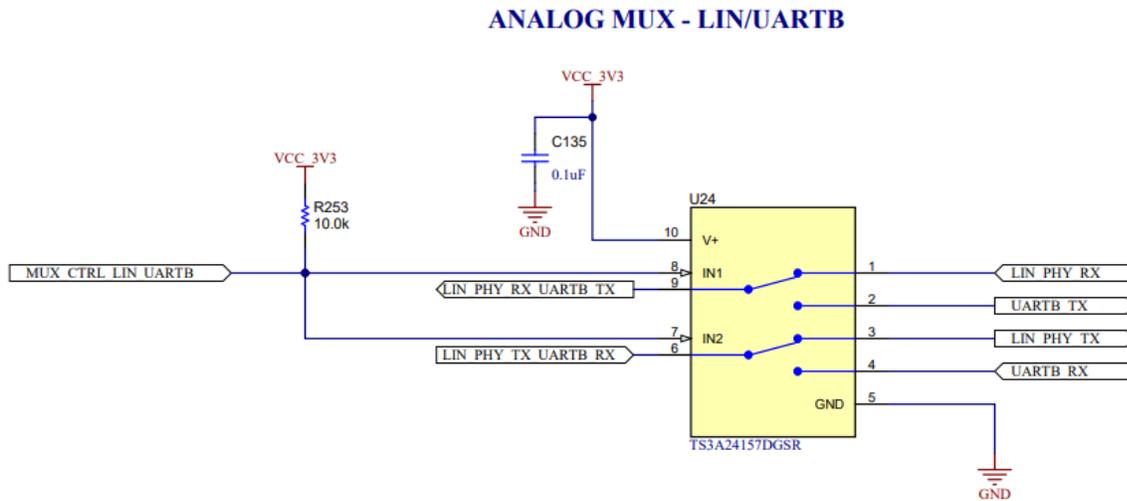
Figure 2-25. Analog Mux for the LIN PHY Switch
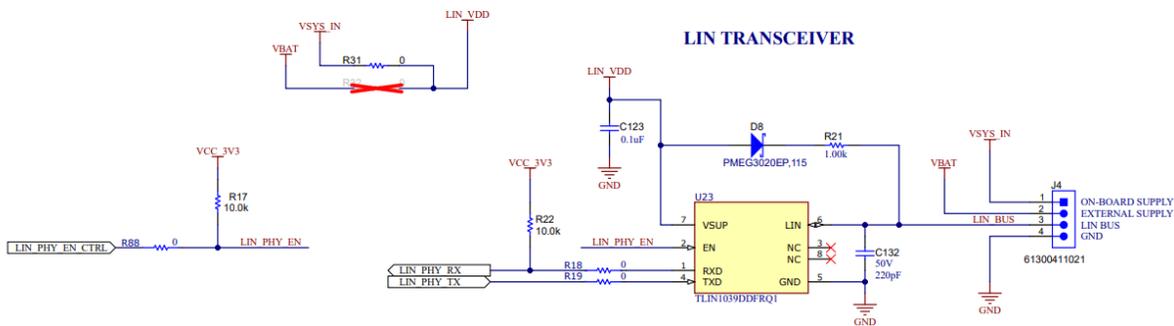
Figure 2-26. LIN PHY Interface

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

2.13 I2C Connections

The xWRL6844EVM board features a temperature sensor for measuring on-board temperature, current sensors for current measurement on 3.3V, 1.8V, 1.2VDigital, 1.2VRF power supply rails for xWRL6844 device and EEPROM for storing board ID. These are connected to TPS65036501 and xWRL6844 through I2C bus. In addition to this, header J1 is also provided for easy interface to I2C bus. Please refer to xWRL6844EVM's schematics for the I2C addresses.
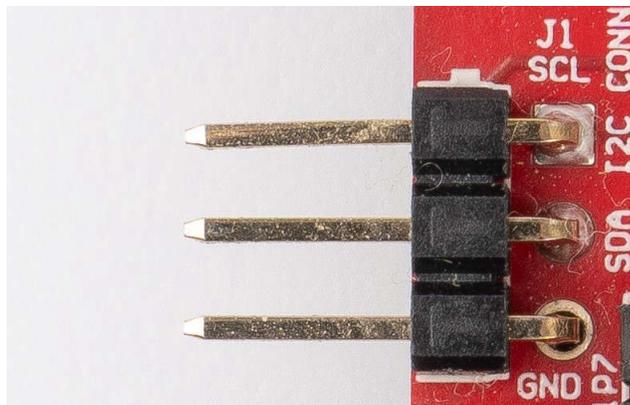
Figure 2-27. I2C Connector

2.13.1 EEPROM

The board features an EEPROM for storing the board specific IDs (for the identification of the EVM through the XDS110 interface).

2.14 XDS110 Interface

J5 connector 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, the power is supplied through a single USB connector. Connector J5 is also used for configuration and data transfer through the user UART mounted on PC by XDS110 interface. When enumerated correctly, the two UART ports from the XDS110 are displayed on the device manager as a virtual COM Port, similar to that shown in Figure 2-28.
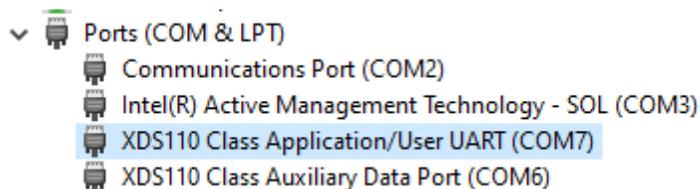
Figure 2-28. Virtual COM Port

If the PC is unable to recognize the above COM ports, install the latest EMUpack.

2.15 FTDI Interface

J10 connector provides access to the onboard FTDI ports. This provides the following Interfaces to PC:

- FTDI Port A : SPI
- FTDI Port B : I2C, HOST_INTERRUPT
- FTDI Port C : UARTA, nRESET
- FTDI Port D : RS232, SOP control

When xWRL6844EVM's FTDI USB is connected for the first time to PC, Windows® may not be able to recognize the device. This is indicated and confirmed in the device manager with yellow exclamation marks, as shown in Figure 2-29.
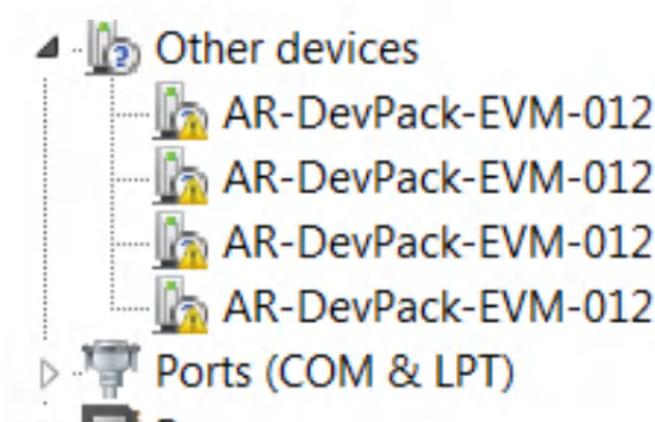

Figure 2-29. Uninstalled FTDI Drivers

In order to correctly detect these ports on the PC please download and install the latest FTDI drivers available in the (C:\ti\mmwave_sdk_\tools\ftdi). This must be done for all four COM ports. When all four COM ports are installed, the device manager recognizes these devices and indicates the COM port numbers, as shown in Figure 2-30.
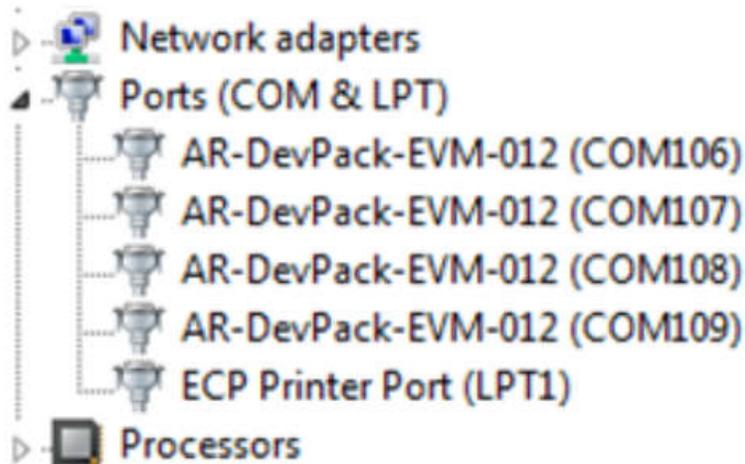
Figure 2-30. Installed FTDI Drivers

2.16 DCA1000EVM Mode

The setup for raw data capture using DCA1000EVM is shown in Figure 2-31. For more details on raw ADC data capture, refer to SWRU636 .
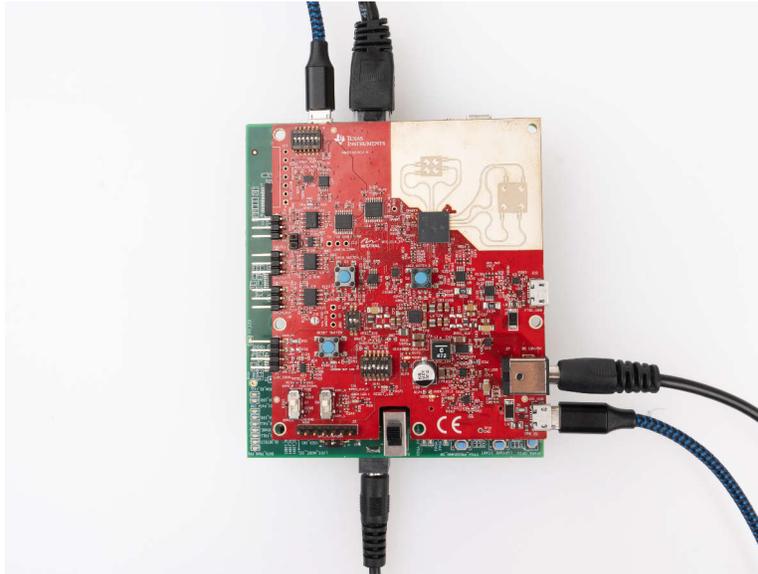
Figure 2-31. AWRL6844EVM for Raw Data Capture

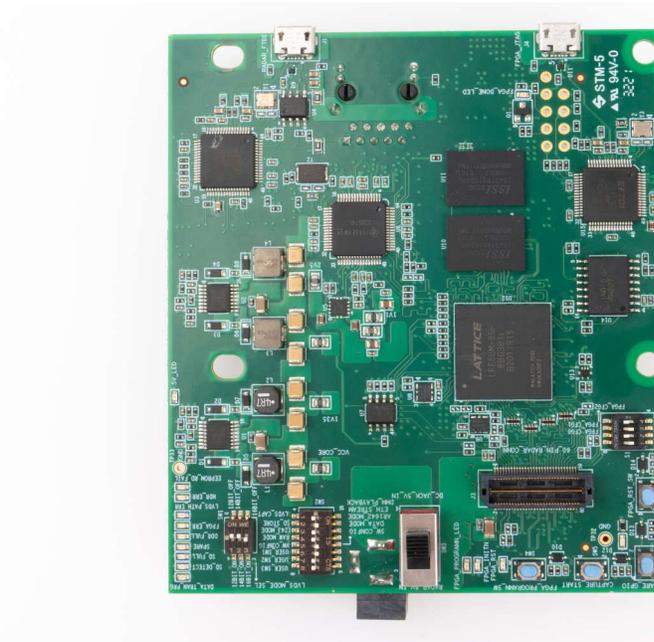The DCA Switch settings which needs to be followed for Raw Data capture are shown in Figure 2-32.

Figure 2-32. DCA1000 switch settings

Note

When EVM is directly mated with DCA1000 board, kindly use spacers which are included in the kit and ensure no physical happens between DCA1000 and the xWRL6844EVM as it can damage the boards.

2.17 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.

2.17.1 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.

2.17.2 Higher Power Demanding Applications

Most of the EVM can be operated with a single 5V USB cable. For higher power consumption applications where a single 5V USB supply cannot provide the power needed, use an external 5V or 12V power adapter.

3 Software, Development Tools, and Example Code

To enable quick development of end applications on the ARM Cortex-R5F core in xWRL6844, 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 and getting started guide SWRU636.

4 Hardware Design Files

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

xWRL6844EVM Schematic, Assembly, Bill of Materials can be found on SWRC394.

4.2 EVM Design Database

xWRL6844EVM Design Database containing Altium Project Source files can be found on SWRR198.

4.3 Hardware Design Checklist

xWRL6844 Hardware Design Checklist containing schematic, layout recommendations can be found on SPRADL0.

5 Additional Information

5.1 Trademarks

- ARM® and Cortex® are registered trademarks of Arm Limited.
- Code Composer Studio™ and LaunchPad™ are trademarks of Texas Instruments.
- Windows® is a registered trademark of Microsoft.

All trademarks are the property of their respective owners.

6 References

1. DCA1000EVM Data Capture Card User's Guide
2. MMWAVE-L-SDK
3. Code Composer Studio

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.

DATE	REVISION	NOTES
December 2024	*	Initial Release

IMPORTANT NOTICE AND DISCLAIMER