IWR1642 Evaluation Module (IWR1642BOOST) Single-Chip mmWave Sensing Solution

The IWR1642 BoosterPack™ from Texas Instruments™ is an easy-to-use evaluation board for the IWR1642 mmWave sensing device, with direct connectivity to the microcontroller (MCU) LaunchPad™ Development Kit. The BoosterPack contains everything required to start developing software for on-chip C67x DSP core and low-power Arm® R4F controllers, including onboard emulation for programming and debugging as well as onboard buttons and LEDs for quick integration of a simple user interface.

Contents

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1 Getting Started

1.1 Introduction

The IWR1642 BoosterPack from Texas Instruments is an easy-to-use evaluation board for the IWR1642 mmWave sensing device, with direct connectivity to the microcontroller (MCU) LaunchPad Development Kit. The BoosterPack contains everything required to start developing software for on-chip C67x DSP core and low-power ARM R4F controllers, including onboard emulation for programming and debugging as well as onboard buttons and LEDs for quick integration of a simple user interface.

The standard 20-pin BoosterPack headers make the device compatible with a wide variety of TI MCU LaunchPads and enables easy prototyping.

1.2 Key Features

- Two 20-pin LaundPad connectors that leverages the ecosystem of the TI LaunchPad
- XDS110 based JTAG emulation with a serial port for onboard QSPI flash programming
- Back-channel UART through USB-to-PC for logging purposes
- Onboard antenna
- 60-pin, high-density (HD) connector for raw analog-to-digital converter (ADC) data over LVDS and trace-data capability
- Onboard CAN transceiver
- One button and two LEDs for basic user interface
- 5-V power jack to power the board

1.3 Kit Contents

- IWR1642BOOST evaluation board
- Mounting brackets, screws, and nuts to place the printed-circuit board (PCB) vertical
- Micro USB cable to connect to PC

NOTE: A 5-V, > 2.5-A supply brick with a 2.1-mm barrel jack (center positive) is not included. TI recommends using an external power supply that complies with applicable regional safety standards, such as UL, CSA, VDE, CCC, PSE, and more. The length of the power cable should be < 3 m.

1.3.1 mmWave Demo

TI provides sample demo codes to easily get started with the IWR1642 evaluation module (EVM) and to experience the functionality of the IWR1642 radar sensor. For details on getting started with these demos, see www.ti.com/tool/mmwave-sdk.

2 Hardware

Figure 1 and Figure 2 show the front and rear view of the EVM, respectively.

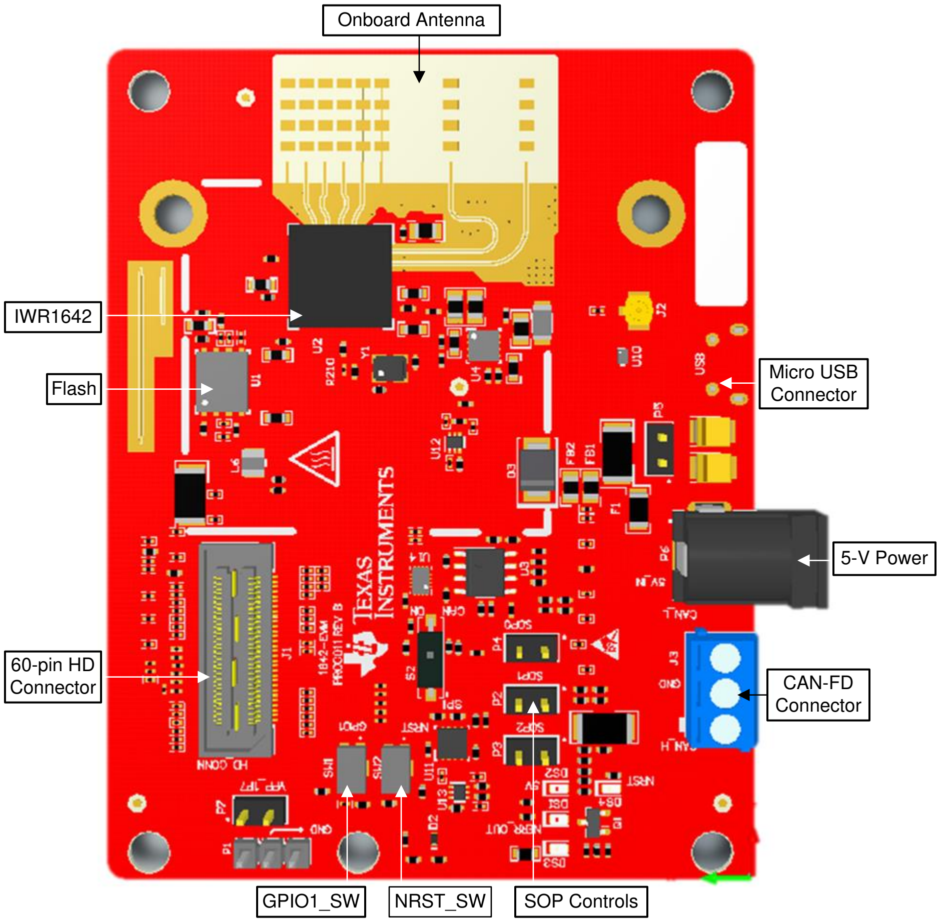


Figure 1. EVM (Front)

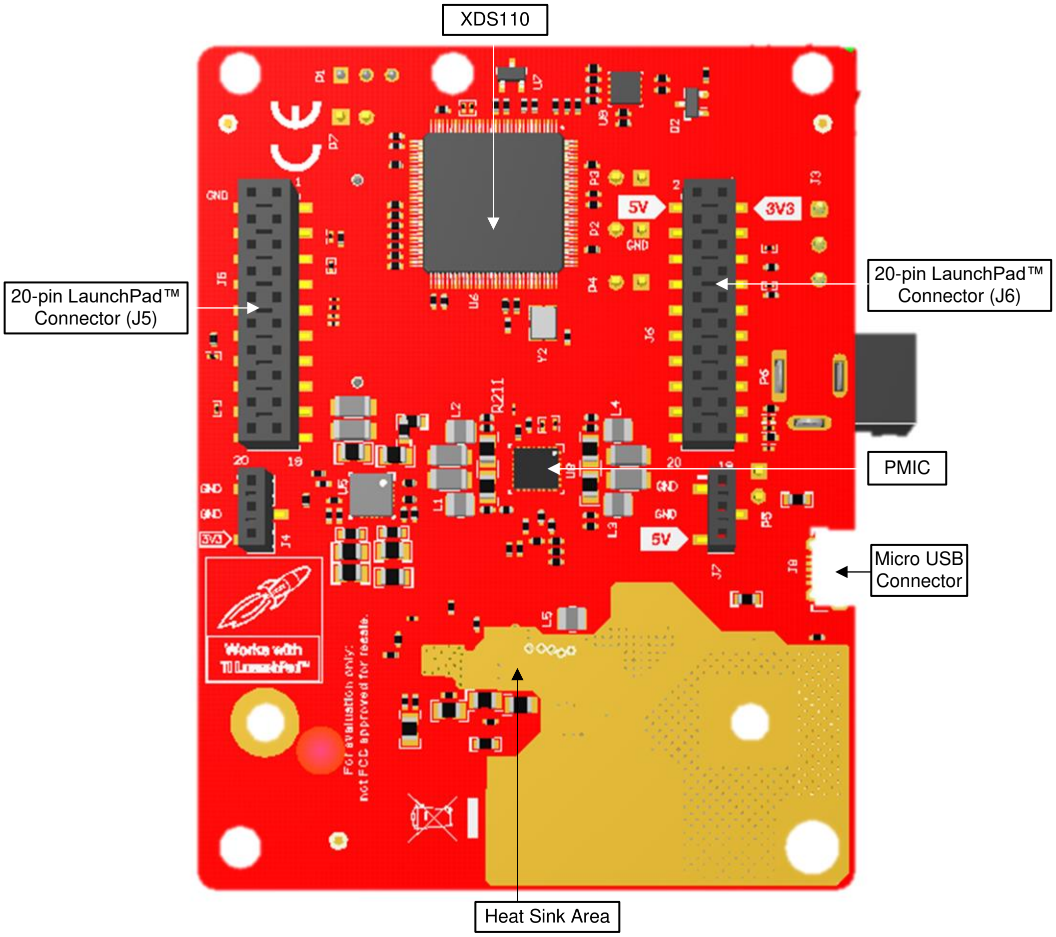


Figure 2. EVM (Rear)

2.1 Block Diagram

Figure 3 shows the block diagram.

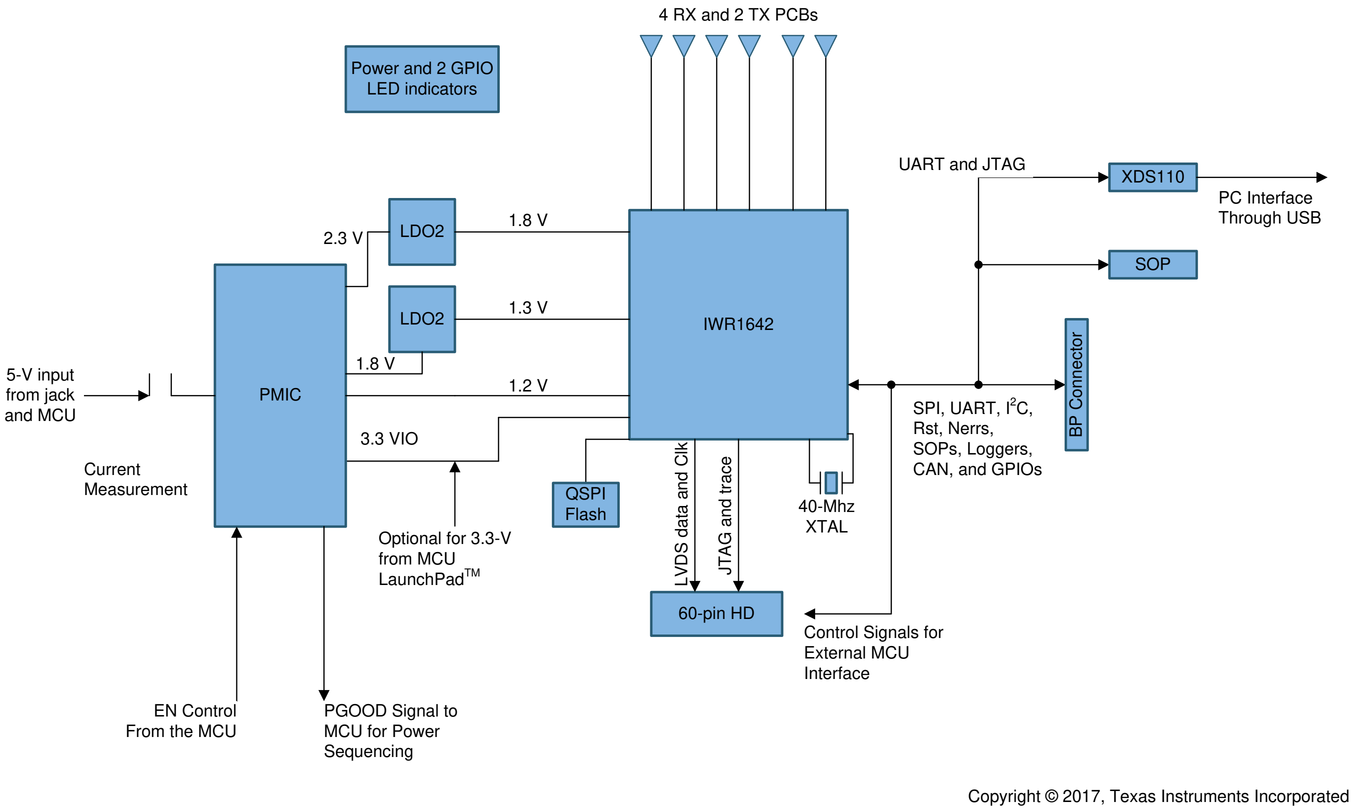


Figure 3. Block Diagram

2.2 Power Connections

The BoosterPack is powered by the 5-V power jack (5-A current limit), shown in Figure 4. As soon as the power is provided, the NRST and 5-V LEDs should glow, indicating that the board is powered on.

NOTE: After the 5-V power supply is provided to the EVM, it is recommended to press the NRST switch (SW2) one time to ensure a reliable boot-up state.

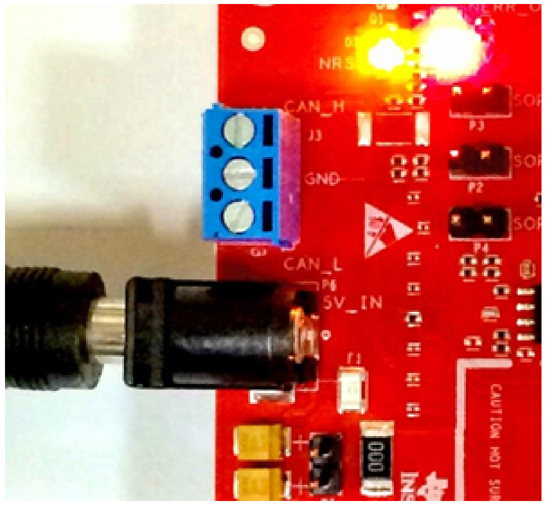


Figure 4. Power Connector

2.3 Connectors

2.3.1 20-Pin BoosterPack Connectors

The BoosterPack has the standard LaunchPad connectors (J5 and J6, shown in Figure 5) that enable it to be directly connected to all TI MCU LaunchPads. While connecting the BoosterPack to other LaunchPads, ensure the pin-1 orientation is correct by matching the 3V3 and 5-V signal marking on the boards.

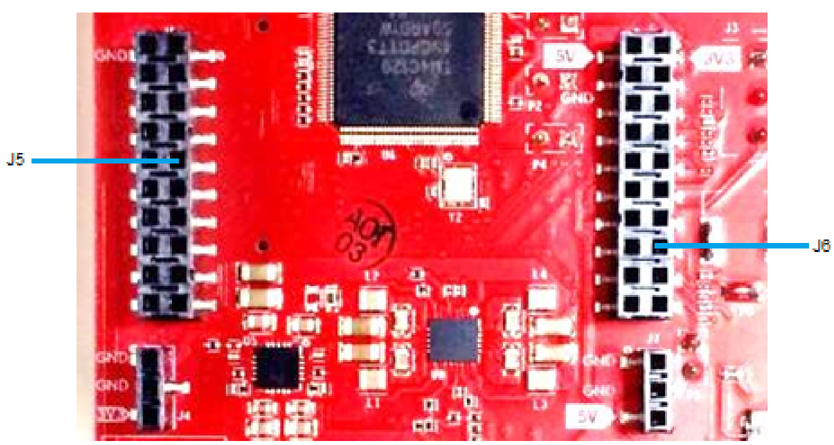


Figure 5. 20-Pin BoosterPack Connectors

Table 1 and Table 2 provide the connector-pin information.

Table 1. J5 Connector Pin

Pin Number	Description	Pin Number	Description
1	AR_NERR_OUT	2	GND
3	AR_NERRIN	4	DSS_LOGGER (AR_DP7)
5	AR_MCUCLKOUT	6	AR_CS1
7	NC	8	AR_GPIO_1
9	AR_MSS_LOGGER	10	AR_NRST_MCU
11	AR_WARMRST	12	AR_MOSI1
13	AR_BSS_LOGGER	14	AR_MISO1
15	MCU_SOP2	16	AR_HOSTINTR1
17	MCU_SOP1	18	AR_GPIO_2
19	MCU_SOP0	20	NC

Table 2. J6 Connector Pin

Pin Number	Description	Pin Number	Description
1	3V3	2	MCU_5v (5V_IN)
3	NC	4	GND
5	AR_RS232TX	6	AR_ANATEST1 (1)
7	AR_RS232RX	8	AR_ANATEST2 (1)
9	AR_SYNC_IN	10	AR_ANATEST3 (1)
11	NC	12	AR_ANATEST4 (1)
13	AR_SPICLK1	14	PGOOD (onboard VIO) (2)
15	AR_GPIO_0	16	PMIC_EN1 (3)
17	AR_SCL	18	AR_SYNC_OUT_SOP1
19	AR_SDA	20	AR_PMIC_CLKOUT_SOP2

(1) Voltage input to the GPADC available on the IWR1642.

(2) Indicates the state of the onboard VIO supply for the IWR device coming from the onboard PMIC. A HIGH on the PGOOD signal (3.3 V) indicates the supply is stable. Because the I/Os are not failsafe, the MCU must not drive any I/O signals to the IWR device before this I/O supply is stable to avoid leakage current into the I/Os.

(3) Controls the onboard PMIC enable. The MCU can use this to shut down the PMIC and IWR device during the periods it does not use the IWR device and save power. The power up of the PMIC takes approximately 5 ms once the enable signal is made high.

2.3.2 60-Pin HD Connector

The 60-pin HD connector provides the high speed LVDS data, control signals (SPI, UART, I^{2}C, NRST, NERR, SOPs) and JTAG debug signals. The connector can be connected to the MMWAVE-DEVPACK board to further get to the standard TSW1400 EVM. Figure 6 shows the HD connector, and Table 3 provides the connector information.

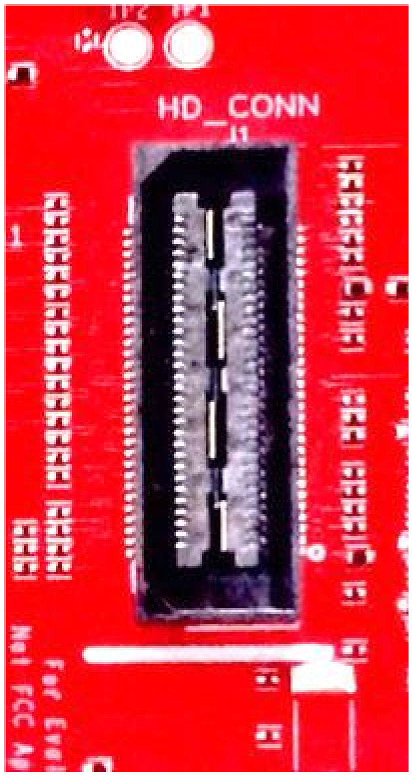


Figure 6. HD Connector

Table 3. J1 Connector Pin

Pin Number	Description	Pin Number	Description
1	5V	2	5V_IN
3	5V	4	AR_TDO_SOP0
5	AR_TDI	6	AR_TCK
7	AR_CS1	8	AR_TMS
9	AR_SPICLK1	10	AR_HOSTINTR1
11	AR_MOSI1	12	AR_MISO1
13	PGOOD (onboard VIO)[(1)]	14	AR_NERR_OUT
15	AR_DMM_CLK	16	AR_SYNC_IN
17	AR_DMM_SYNC	18	GND
19	AR_DP0	20	NC
21	AR_DP1	22	NC
23	AR_DP2	24	GND
25	AR_DP3	26	AR_LVDS_FRCLKP
27	AR_DP4	28	AR_LCDS_FRCLKM
29	AR_DP5	30	GND
31	AR_DP6	32	NC
33	AR_DP7	34	NC
35	AR_DP8	36	GND
37	AR_DP9	38	NC
39	AR_DP10	40	NC
41	AR_DP11	42	GND
43	AR_DP12	44	AR_LVDS_CLKP
45	AR_DP13	46	AR_LVDS_CLKM
47	AR_DP14	48	GND
49	AR_DP15	50	AR_LVDS_1P
51	AR_SDA	52	AR_LVDS_1M
53	AR_SCL	54	GND
55	AR_RS232RX	56	AR_LVDS_0P
57	AR_RS232TX	58	AR_LVDS_0M
59	AR_NRST_MCU	60	GND

(1) Indicates the state of the onboard VIO supply for the IWR device coming from the onboard PMIC. A HIGH on the PGOOD signal (3.3 V) indicates the supply is stable. Because the I/Os are not failsafe, the MCU must not drive any I/O signals to the IWR device before this I/O supply is stable to avoid leakage current into the I/Os.

2.3.3 CAN Interface Connector

The J3 connector provides the CAN_L and CAN_H signals from the onboard CAND transceiver (TCAN1042HGVDRQ1). These signals can be directly wired to the CAN bus.

Because the digital CAN signals (Tx and Rx) are muxed with the SPI interface signals on the IWR device, one of the two paths must be selected. In the Rev A of the board, to enable the CAN interface, R11 and R12 resisters must be populated with 0 Ω; R4, R6, R28, and R63 resistors must be removed to disconnect the SPI path. In the Rev B board, this is done by placing the switch S2 on the "CAN" position.

NOTE: For CAN use, a modification is needed along with the S2 position:

- Remove R11
- Connect U3-1 to U14-12 CAN_Tx
- Remove R12
- Connect U3-4 to U14-9 CAN_Rx

Figure 7 shows the CAN connector.

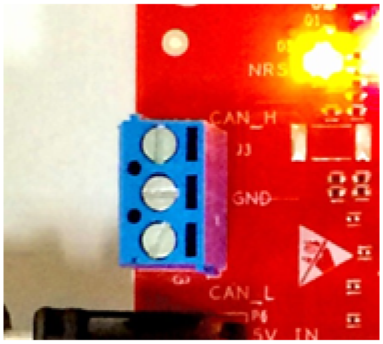


Figure 7. CAN Connector

2.4 PC Connection

The connectivity is provided through the micro USB connector over the onboard XDS110 (TM4C1294NCPDT) emulator. This connection provides the following interfaces to the PC:

- JTAG for Code Composer Studio™ (CCS) connectivity
- UART1 for flashing the onboard serial flash, downloading FW through Radar Studio, and getting application data sent through the UART
- MSS logger UART (can be used to get MSS code logs on the PC)

When the USB is connected to the PC, the device manager should recognize the following COM ports, shown in Figure 8:

- XDS110 Class Application/User UART – UART1 port
- XDS110 Class Auxiliary Data Port – MSS logger port

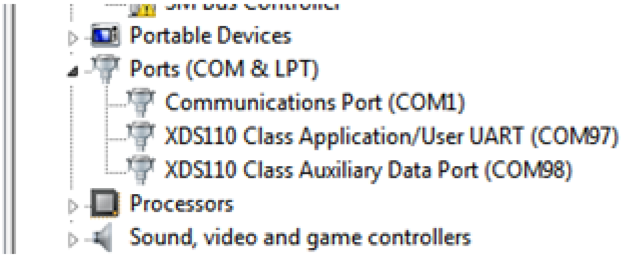


Figure 8. COM Ports

If Windows® is unable to recognize the COM ports, users must install the EMU pack available at *XDS Emulation Software Package*.

2.5 Connecting the BoosterPack to the LaunchPad or the MMWAVE-DEVPACK

The development pack may be required with the BoosterPack for the following use cases:

- Connecting to Radar Studio

  Radar Studio TSW1400+Devpack, mmwave Studio TSW1400+Devpack/DCA1000 tool is a tool that provides capability to configure the mmWave front end from the PC. This tool is available in the DFP package and refers to single dfp landing page for both pieces of software.
- Capturing high-speed LVDS data using the TSW1400 or DCA1000 FPGA platform from TI (see *High Speed Data Capture and Pattern Generation Platform*).

  The TSW1400 EVM and Devpack or DCA1000 EVM platform allows users to capture the raw ADC data over the high-speed debug interface and post process it in the PC.
- Getting DSP trace data through the MIPI 60-pin interface
- Use the DMM interface

This BoosterPack can be stacked on top of the Launchpad or the MMWAVE-DEVPACK by using the two 20-pin connectors. The connectors do not have a key to prevent the misalignment of the pins or reverse connection. Hence, care must be taken to ensure reverse mounting does not take place.

On the IWR1642 BoosterPack, TI has provided 3V3 markings near pin 1, shown in Figure 9. The same marking is provided on compatible LaunchPads (must be aligned before powering up the boards).

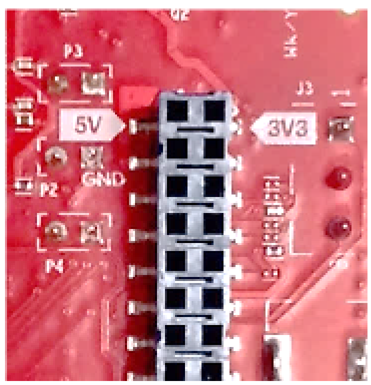


Figure 9. 3V3 and 5V Marking on BoosterPack

For details on these use cases, see the *MMWAVE-DEVPACK User's Guide*.

NOTE: The DCA1000 EVM has internal DEVPACK functionality. For more information, see the *DCA1000EVM Data Capture Card User's Guide*.

2.6 Antenna

The BoosterPack includes onboard-etched antennas for the four receivers and two transmitters that enable tracking multiple objects with their distance and angle information. This antenna design enables estimation of distance and elevation angle that enables object detection in a two-dimensional plane. Figure 10 shows the PCB antennas.

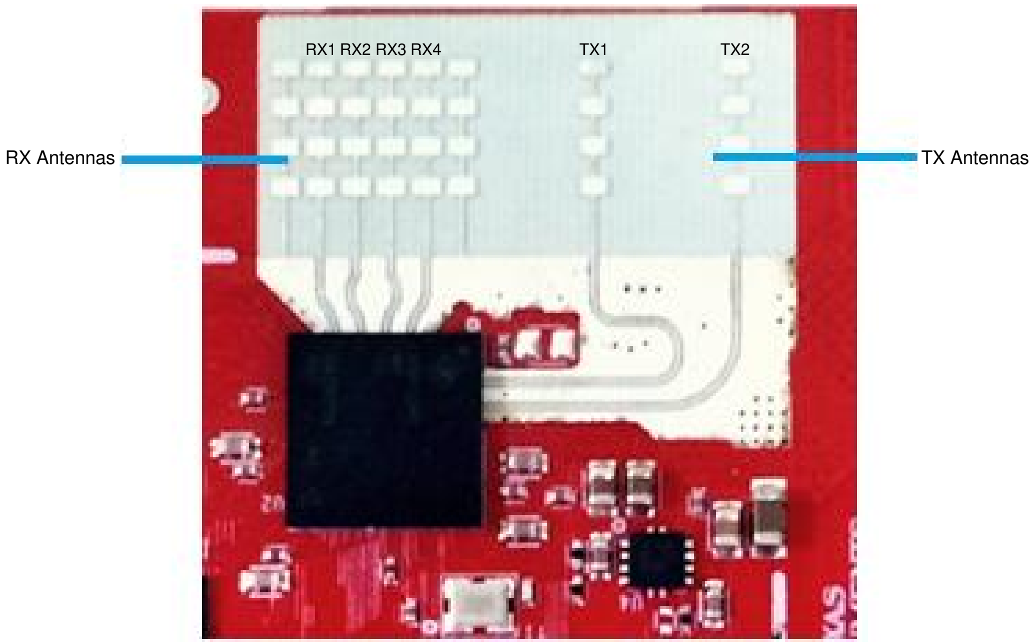


Figure 10. RX and TX Antennas

The antenna peak gain is > 9 dBi across the operating frequency band of 76 to 81 GHz. The peak output power with the antenna gain is < 55 dBm EIRP, as required by the European regulations. The radiation pattern of the antenna in the horizontal plane (H-plane Phi = 0 degrees) and elevation plane (E-plane Phi = 90 degrees) is shown by Figure 10.

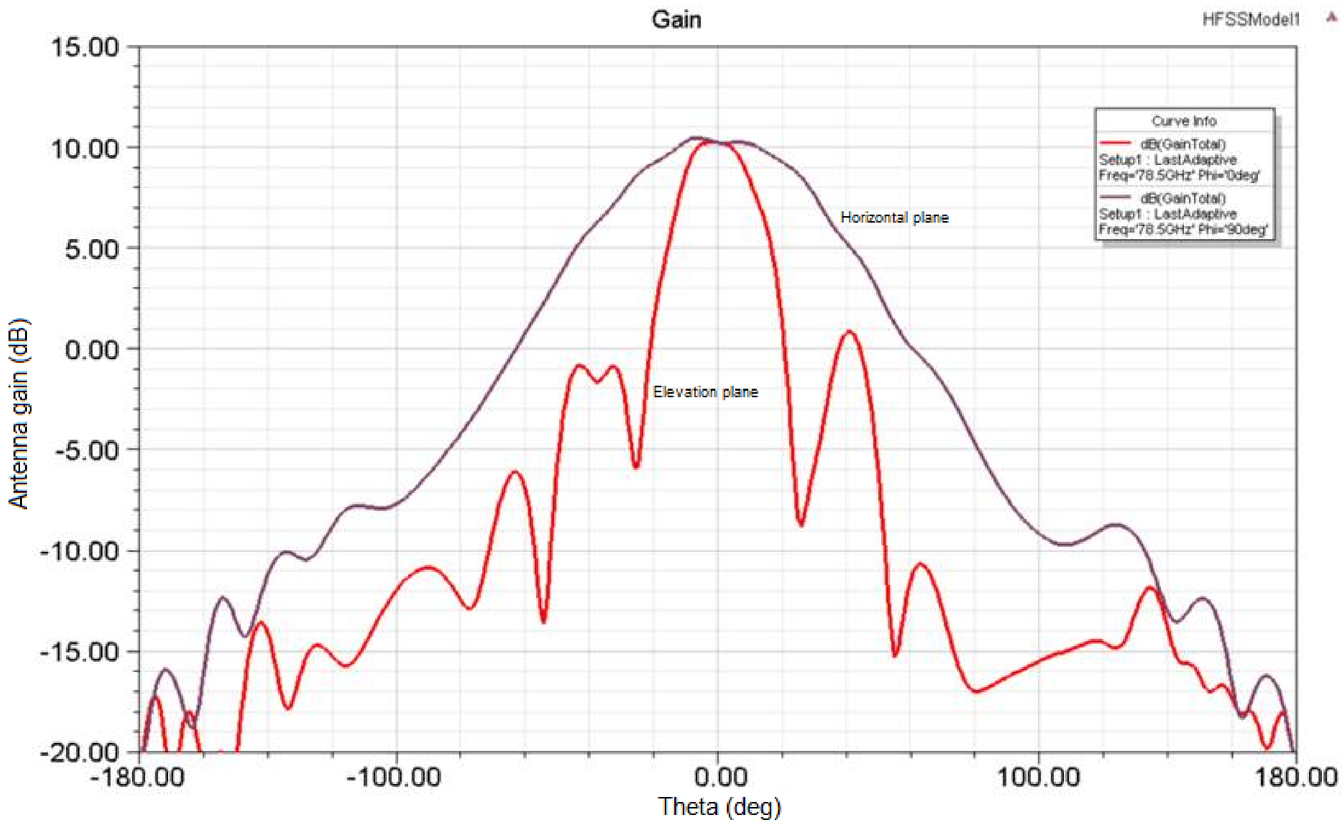
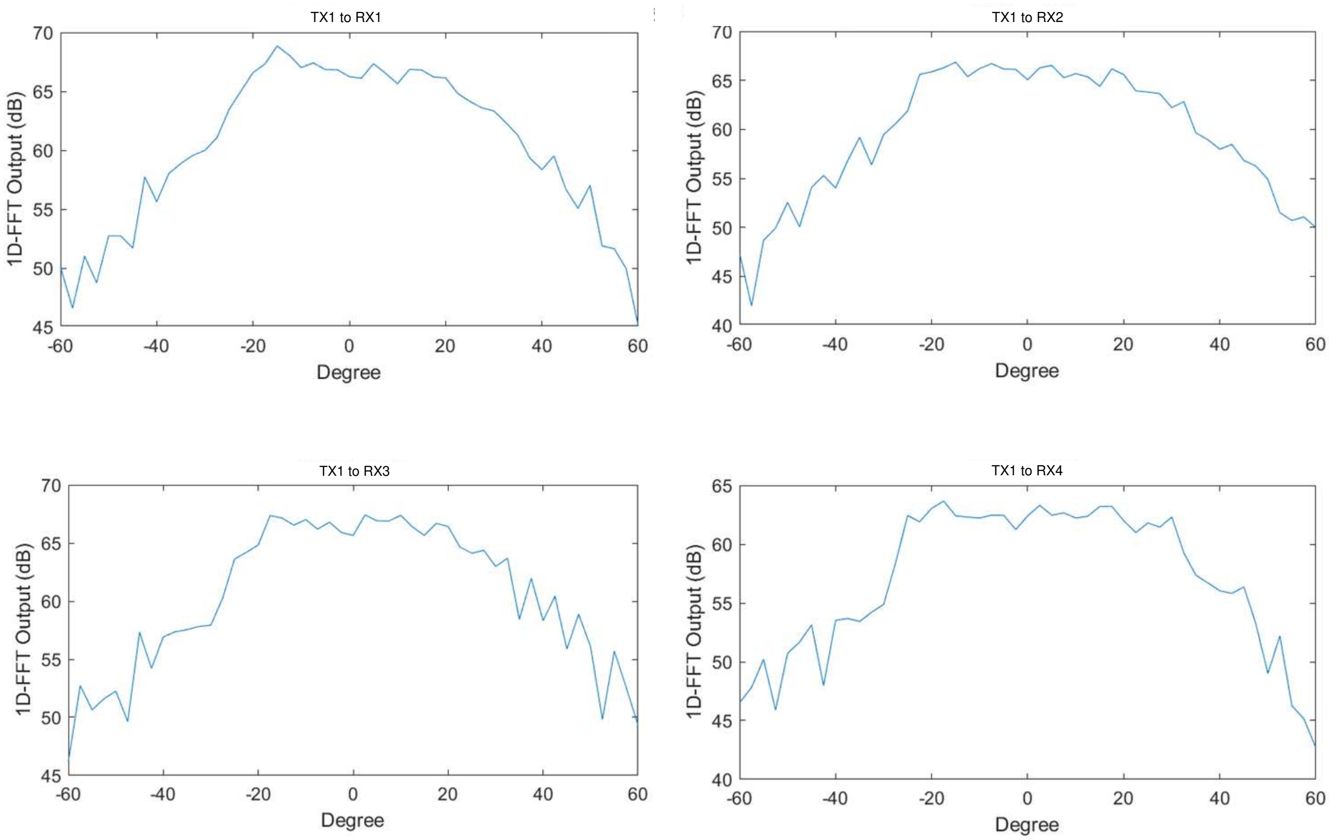
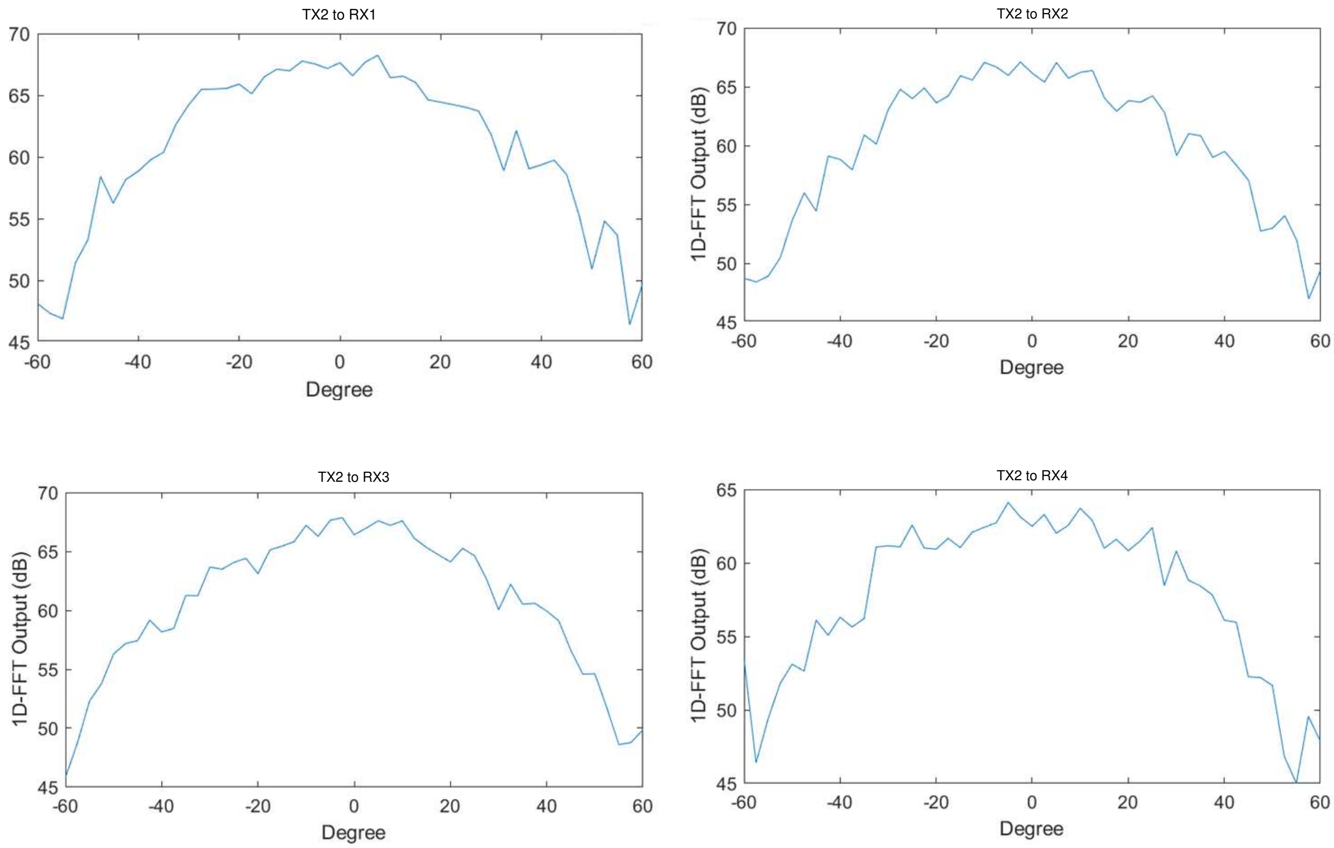


Figure 11. Antenna Pattern

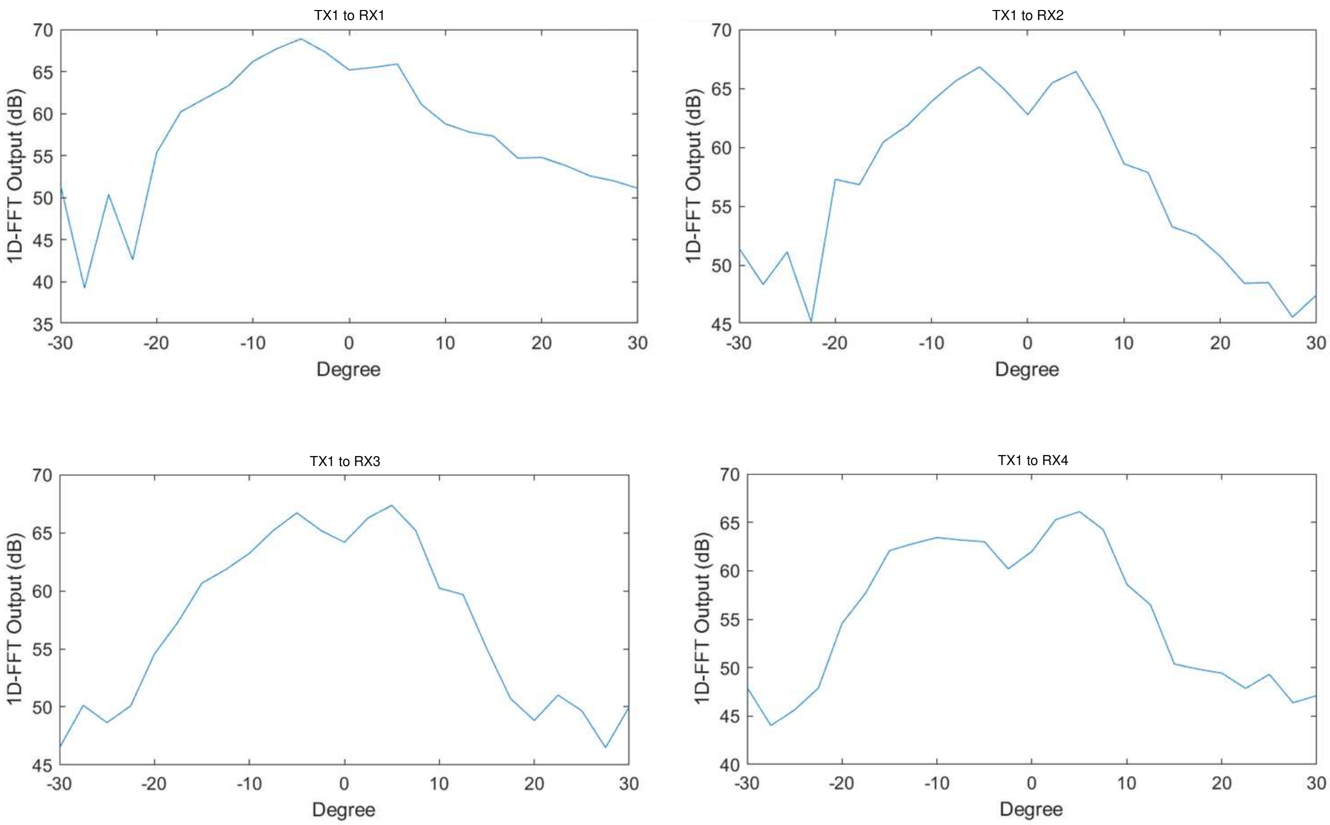
Azimuth Antenna Pattern TX1



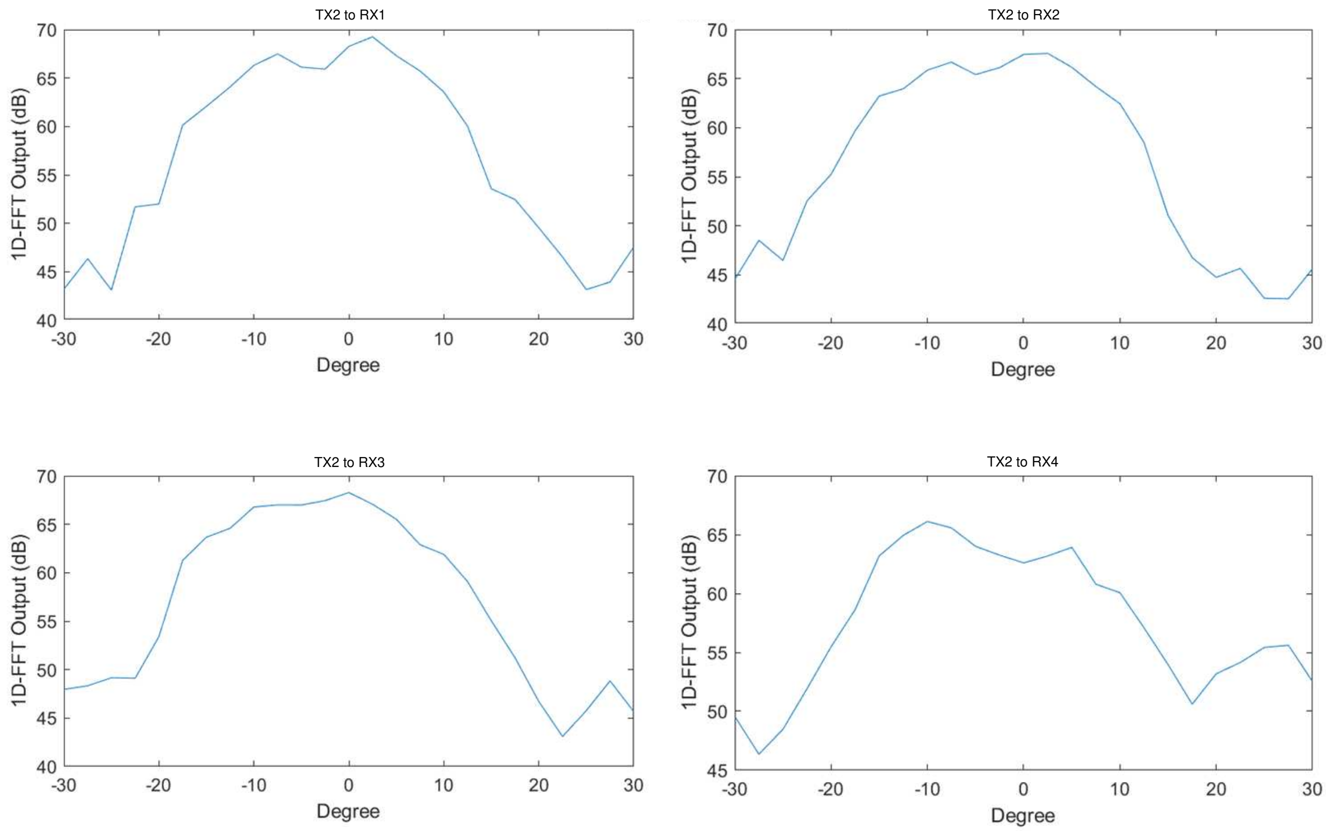
Azimuth Antenna Pattern TX2



Elevation Antenna Pattern TX1



Elevation Antenna Pattern TX2



2.7 Jumpers, Switches, and LEDs

2.7.1 Sense-on-Power (SOP) Jumpers

The IWR1642 device can be set to operate in three different modes based on the state of the SOP lines. These lines are sensed only during boot up of the IWR device. The state of the device is detailed by Table 4.

A closed jumpers refers to a 1, and an open jumper refers to a 0 state of the SOP signal going to the IWR device.

Table 4. SOP Jumper Information

Reference		Usage	Comments
P3	SOP 2	SOP[2:0]	101 (SOP mode 5) = flash programming
P2	SOP 1		001 (SOP mode 4) = functional mode
P4	SOP 0		011 (SOP mode 2) = debug mode

Figure 12 shows the SOP jumpers.

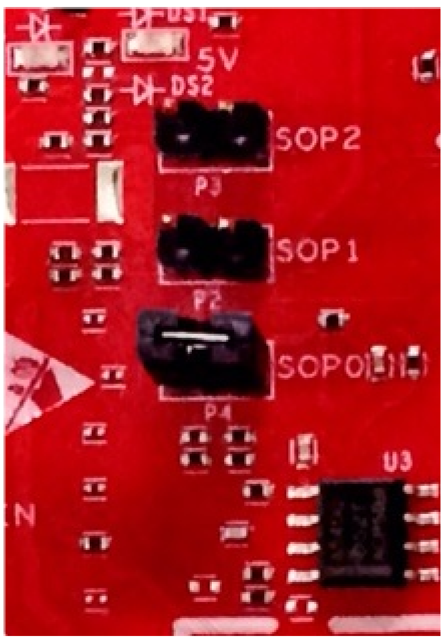


Figure 12. SOP Jumpers

2.7.2 Current Measurement

The P5 jumper enables the measurement of the current being consumed by the reference design (IWR device, PMIC, and LDOs) at a 5-V level.

To measure the current, resistor R118 must be removed and a series ammeter can be put across the P5 pins (shown in Figure 13).

Figure 13. P5 Pins

2.7.3 Push Buttons and LEDs

Table 5 provides the switch and LED information.

Table 5. Switch and LED Information

Reference	Usage	Comments
SW2	RESET	Used to RESET the IWR1642 device. This signal is also brought out on the 20-pin connector and 60-pin HD connector so an external processor can control the IWR device. The onboard XDS110 can also use this reset.
SW1	GPIO_1	When pushed, the GPIO_1 is pulled to V_{CC}.
DS2	5-V supply indication	This LED indicates the presence of the 5-V supply.
DS4	nRESET	This LED is used to indicate the state of nRESET pin. If this LED is glowing, the device is out of reset. This LED will glow only after the 5-V supply is provided.
DS1	Nerr_OUT	Glows if there is any HW error in the IWR device
DS3	GPIO_1	Glows when the GPIO is logic-1

Figure 14 through Figure 19 show the location of switches and LEDs.

Figure 14. SW1

Figure 15. SW2

Figure 16. DS2

Figure 17. DS4

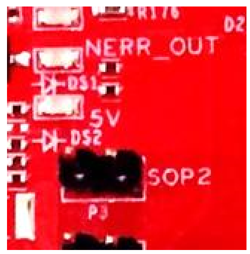


Figure 18. DS1

Figure 19. DS3

2.7.4 Selection Between SPI and CAN Interface

The SPI and CAN interface are muxed on the same lines on the IWR1642 device. Based on the configuration, the user can select if the pins E14 and D13 must be connected to the 20-pin/BP/LP connectors to provide the SPI interface OR to the onboard CANFD PHY (U3). This selection is done by the S2 switch. This switch is available on the board from Rev B onwards.

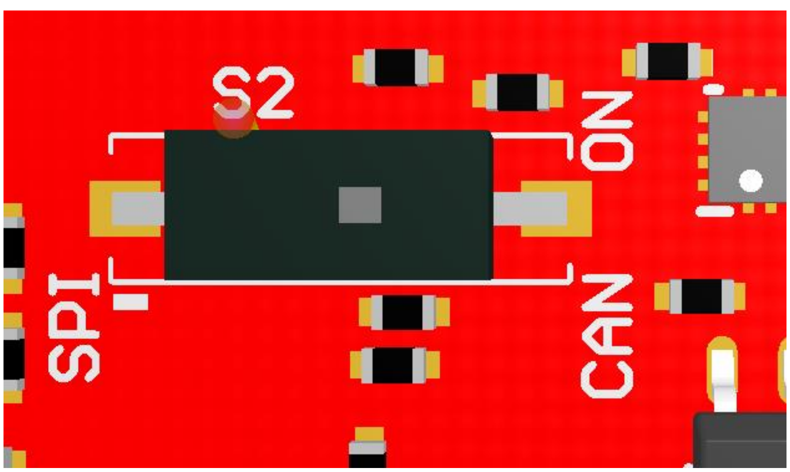


Figure 20. S2 Switch to Select Between SPI or CAN Interface

3 Design Files and Software Tools

3.1 Hardware

To view the schematics, assembly drawings, and BOM, see *IWR16xx BoosterPack and DevPack Layout Files*.

To view the design and layout files, see *IWR16xx BoosterPack and DevPack Board Assembly Files*.

NOTE: Boards with a Rev 'C' sticker have had capacitor C56 (VBGAP decoupling capacitor) changed from 0.22 µF to 0.047 µF (part number CGA2B3X7R1H473K050BB). TI recommends that customers incorporate this change with an equivalent capacitor in their designs.

3.2 Software, Development Tools, and Example Code

To enable quick development of end applications on the C67x DSP and R4F core in the IWR1642, TI provides a software development kit (SDK) that includes demo codes, software drivers, emulation packages for debug, and more. These can be found at *mmwave-sdk*.

4 Mechanical Mounting of PCB

The field of view of the radar sensor is orthogonal to the PCB. To enable easy measurements on the sensing objects on the horizontal plane, the PCB can be mounted vertically. The L-brackets provided with the IWR1642 EVM kit, along with the screws and nuts help in the vertical mounting of the EVM. Figure 21 shows how the L-brackets can be assembled.

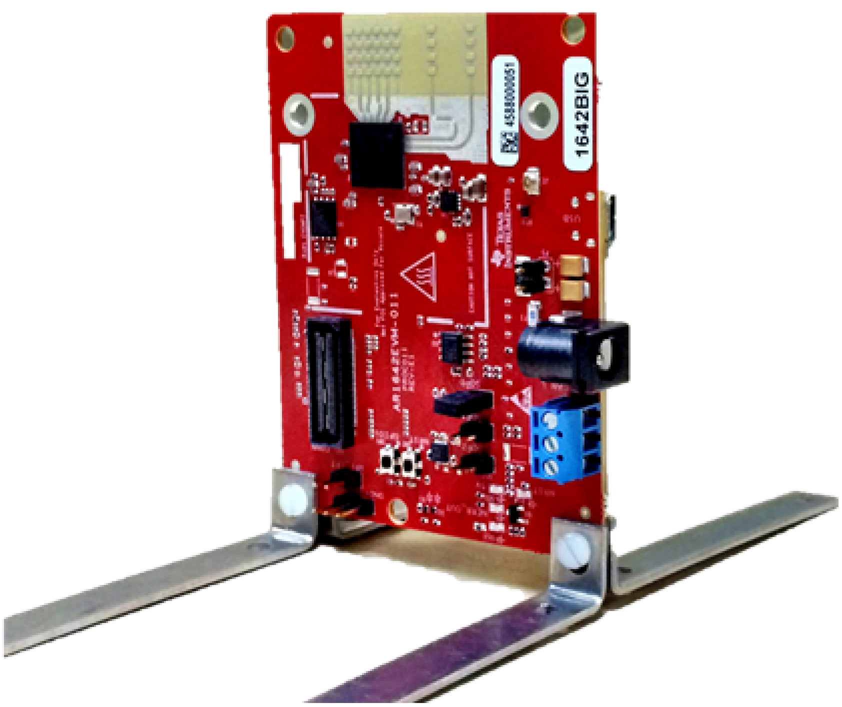


Figure 21. Vertical Assembly of EVM

5 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 environments. This oxidation causes the surface around the antenna region to blacken. To avoid oxidation, the PCB should 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.

6 Regulatory Information

The IWR1642 evaluation module (IWR1642BOOST) is in compliance with Directive 2014/53/EU. The full text of TI's EU Declaration of Conformity is available at the following link: http://www.ti.com/tool/iwr1642boost. The compliance has been verified in the operating bands of 76- to 77-GHz and 77- to 81-GHz. Should the user choose to configure the IWR1642BOOST to operate outside of the test conditions it should be operated inside a protected and controlled environment, such as a shielded chamber. This evaluation board is intended only for development and not as an end product or part of an end product. Developers and integrators that incorporate the chipset in any end products are responsible for obtaining applicable regulatory approvals for such end product.

The European RF exposure radiation limit is fulfilled if a minimum distance of 5 cm between the user and the radio transmitter is respected.

NOTE: The IWR1642BOOST has been tested in the 76- to 77-GHz band (2 Tx at a time) at a maximum peak power of 26 dBm EIRP, and in the 77- to 81-GHz band (1 Tx at a time) with maximum peak power of 21 dBm EIRP across the temperature range of –20°C to +60°C.

7 Troubleshooting

EVM Board Power-up Failure

See Section 2.2 for desired power connections. Please ensure NRST and 5-V LEDs glow brightly. When a nonfunctional or insufficient current capacity power supply is used with the EVM, the EVM LEDs will not turn on. See Section 2.7.3 for LED information.

8 References

DCA1000EVM Data Capture Card User's Guide

Revision History

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

Changes from B Revision (August 2018) to C Revision	Page
• Added Note.	21