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

User's Guide

Literature Number: SWRU521
May 2017

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

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
- 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.

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.

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2 Hardware

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

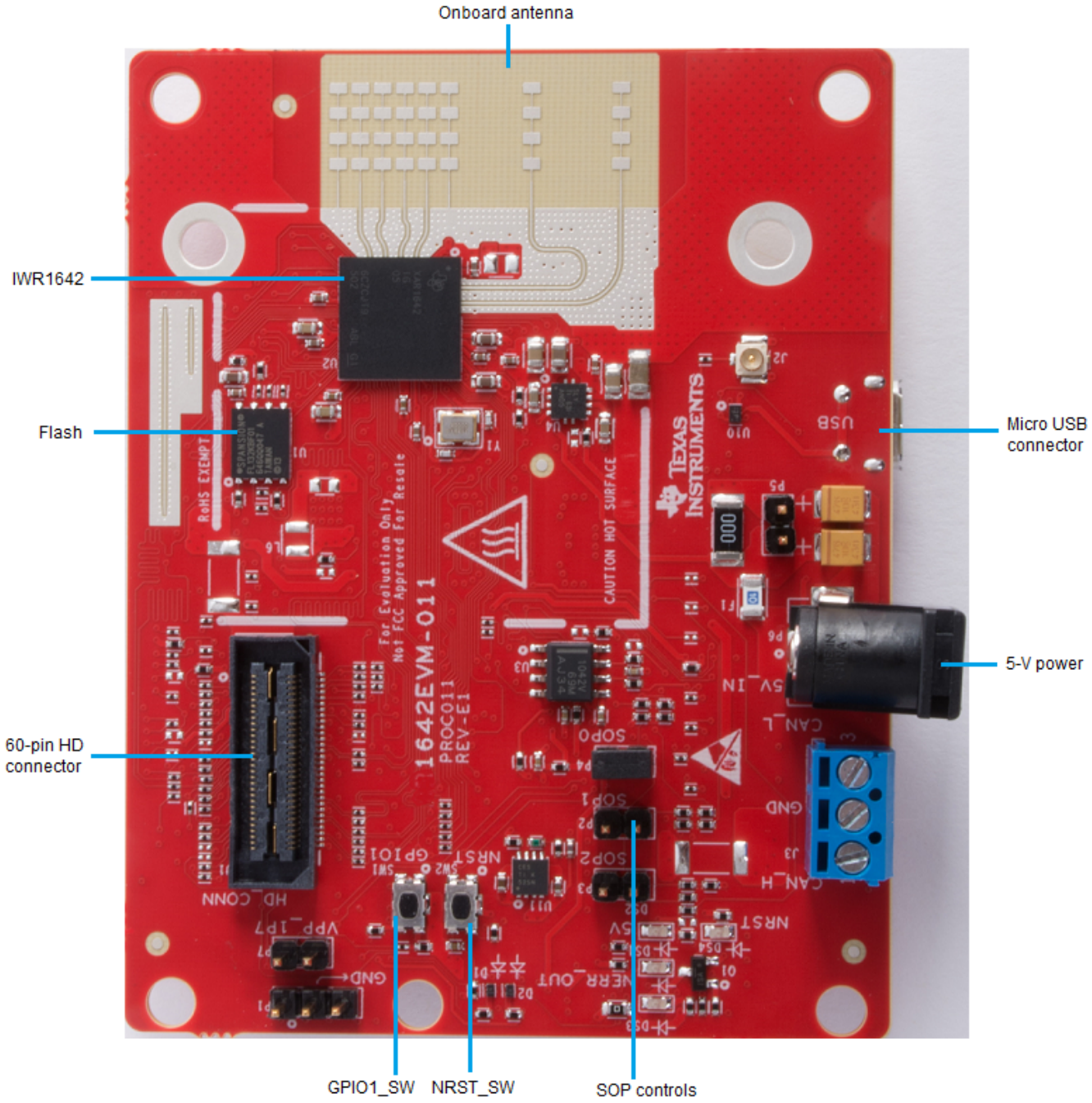

Figure 1. EVM (Front)

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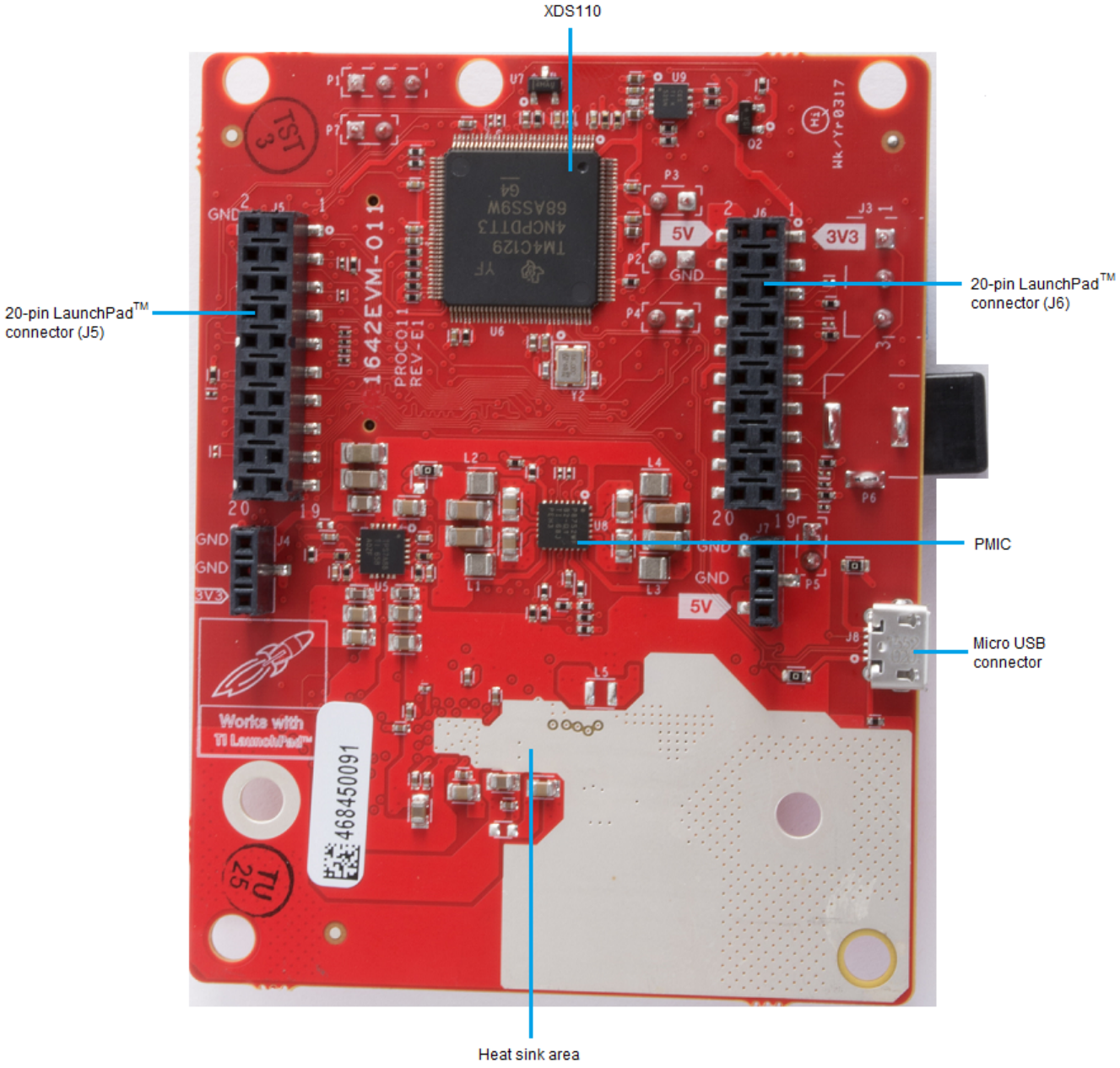

Figure 2. EVM (Rear)

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2.1 Block Diagram

Figure 3 shows the block diagram.

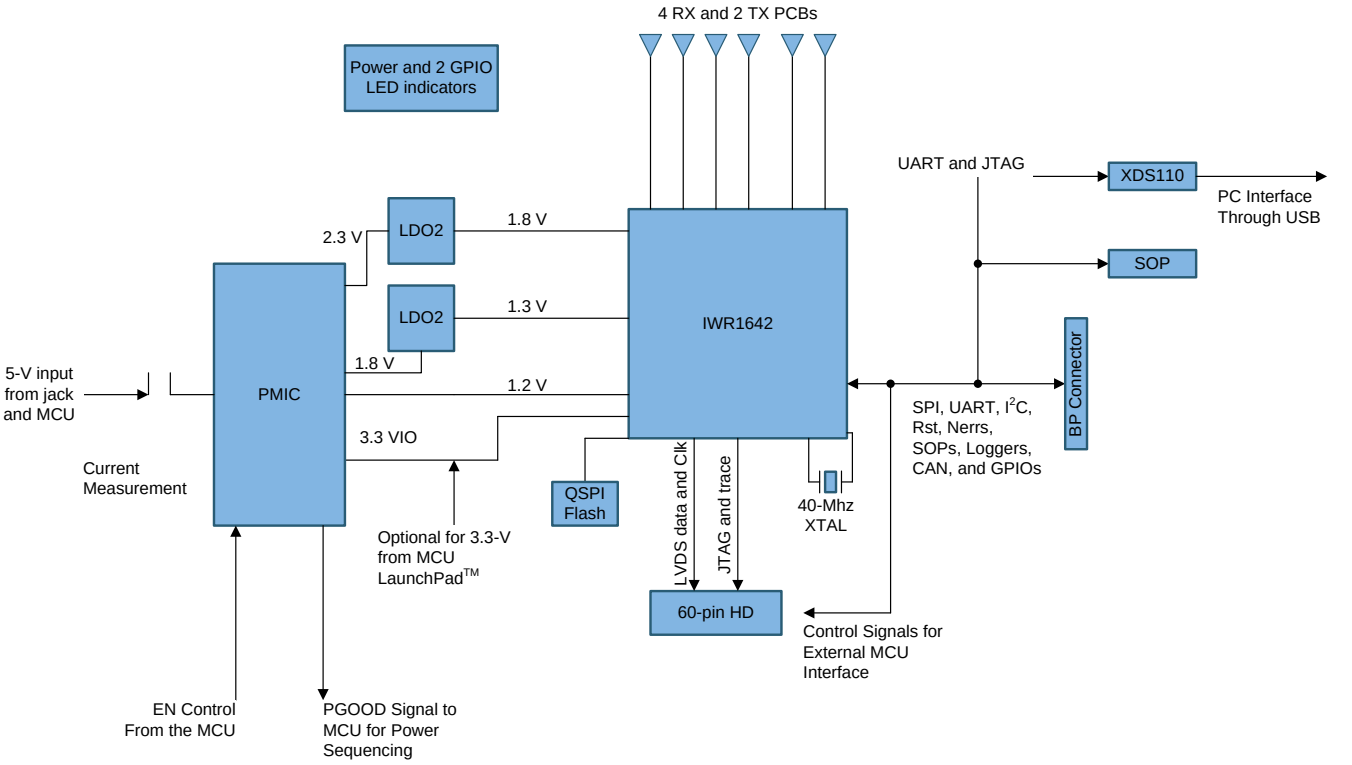

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Figure 3. Block Diagram

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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.

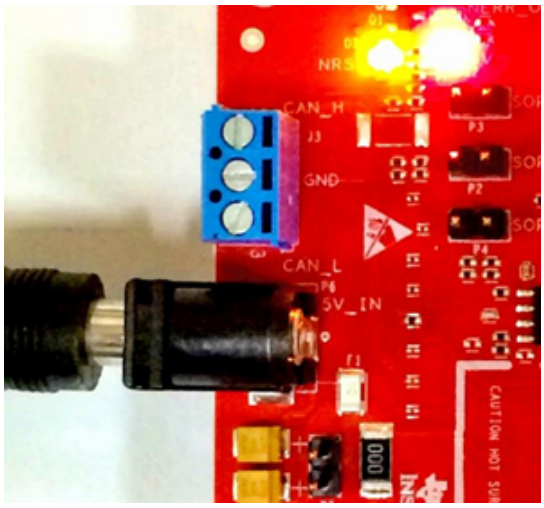

Figure 4. Power Connector

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

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

Table 1. J5 Connector Pin

Pin Number	Description	Pin Number	Description
1	NERROUT	2	GND
3	NERRIN	4	DSS LOGGER
5	MCUCLK OUT	6	SPI_CS
7	NC	8	GPIO01
9	MSS LOGGEr	10	nRESET
11	WARMRST	12	SPI_MOSI
13	BSS LOGGER	14	SPI_MISO
15	SOP2	16	HOSTINT
17	SOP1	18	GPIO02
19	SOP0	20	NC

Table 2. J6 Connector Pin

Pin Number	Description	Pin Number	Description
1	3V3	2	5V
3	NC	4	GND
5	RS232RX (Tx from IWR device)	6	ANA1(1)
7	RS232RX (Rx into IWR device)	8	ANA2(1)
9	SYNC_IN	10	ANA3(1)
11	NC	12	ANA4(1)
13	SPI_CLK	14	PGOOD (onboard VIO)(2)
15	GPIO0	16	PMIC Enable(3)
17	SCL	18	SYNC_OUT
19	SDA	20	PMIC CLK OUT

(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.

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2.3.2 60-Pin HD Connector

The 60-pin HD connector provides the high speed LVDS data, control signals (SPI, UART, I^2C, 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

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Table 3. J1 Connector Pin

Pin Number	Description	Pin Number	Description
1	5V	2	5V
3	5V	4	TDO
5	TDI	6	TCK
7	SPI_CS	8	TMS
9	SPI_CLK	10	HOSTINT
11	SPI_MOSI	12	SPI_MISO
13	PGOOD (onboard VIO)(1)	14	NERROUT
15	DMM_CLK	16	SYNC_IN
17	DMM_SYNC	18	GND
19	TRACE_DATA0	20	NC
21	TRACE_DATA1	22	NC
23	TRACE_DATA2	24	GND
25	TRACE_DATA3	26	LVDS_FRCLKP
27	TRACE_DATA4	28	LVDS_FRCLKM
29	TRACE_DATA5	30	GND
31	TRACE_DATA6	32	NC
33	TRACE_DATA7	34	NC
35	TRACE_DATA8	36	GND
37	TRACE_DATA9	38	NC
39	TRACE_DATA10	40	NC
41	TRACE_DATA11	42	GND
43	TRACE_DATA12	44	LVDS_CLKP
45	TRACE_DATA13	46	LVDS_CLKM
47	TRACE_DATA14	48	GND
49	TRACE_DATA15	50	LVDS_1P
51	I2C_SDA	52	LVDS_1M
53	I2C_SCL	54	GND
55	RS232RX (Rx into IWR device)	56	LVDS_0P
57	RS232TX (Tx from IWR device)	58	LVDS_0M
59	nRESET	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.

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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 7:

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

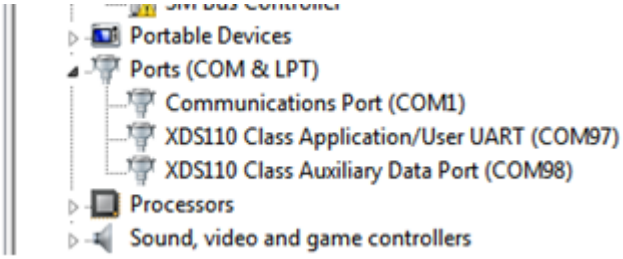

Figure 7. COM Ports

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

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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 is a tool that provides capability to configure the mmWave front end from the PC. This tool is available in the DFP package.
- Capturing high-speed LVDS data using the SW1400 FPGA platform from TI (see *High Speed Data Capture and Pattern Generation Platform*).

  The TSW1400 FPGA 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 8. The same marking is provided on compatible LaunchPads (must be aligned before powering up the boards).

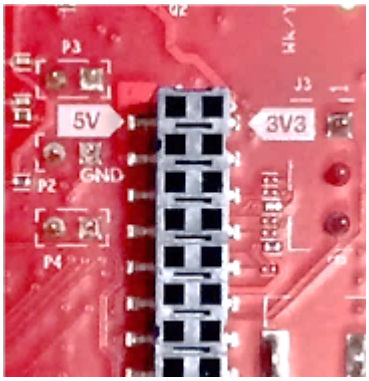

Figure 8. 3V3 and 5V Marking on BoosterPack

For details on these use cases, see the *MMWAVE-DEVPACK 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 9 shows the PCB antennas.

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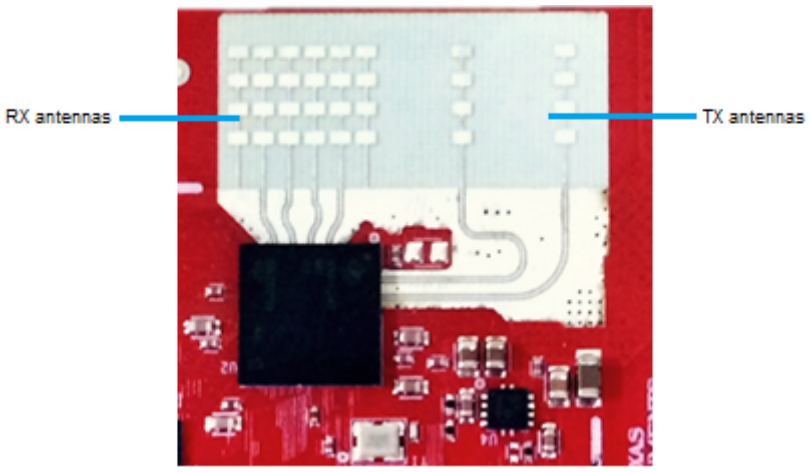

Figure 9. PCB Antennas

The antenna peak gain is > 9 dBi across the frequency band of 76 to 81 GHz. 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.

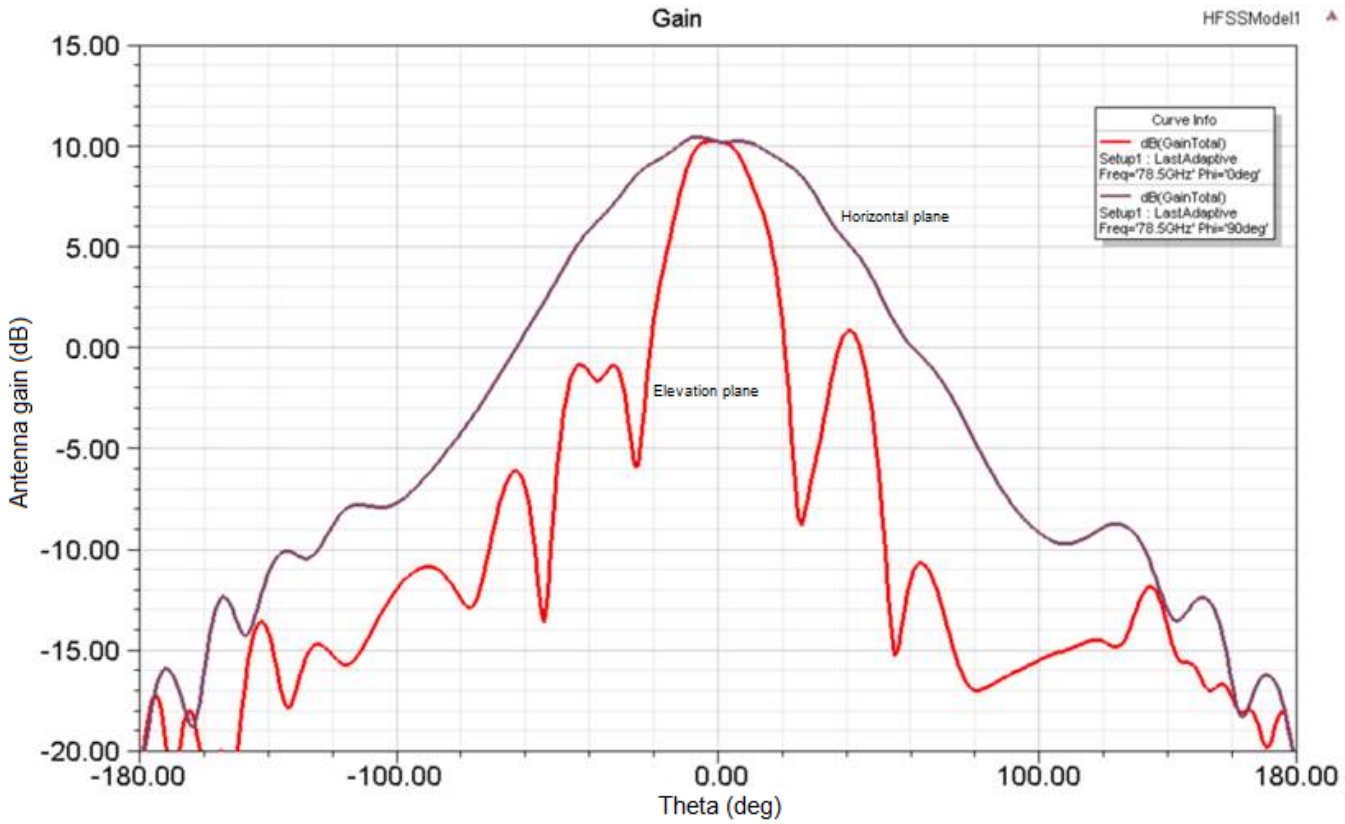

Figure 10. Antenna Pattern

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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) = dev mode

Figure 11 shows the SOP jumpers.

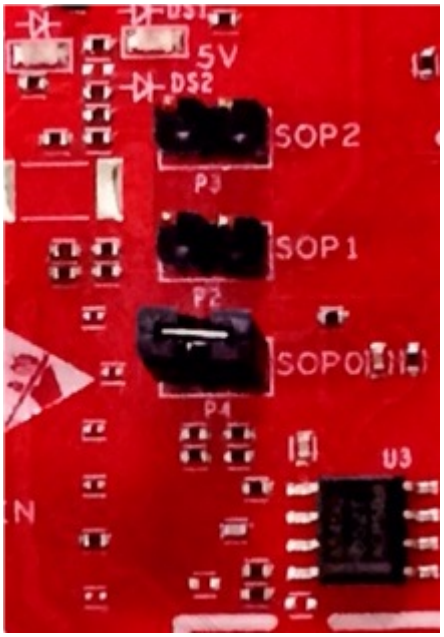

Figure 11. SOP Jumpers

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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 12).

Figure 12. 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

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Figure 13 through Figure 18 show the location of switches and LEDs.

Figure 13. SW1

Figure 14. SW2

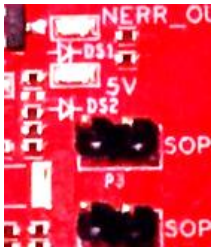

Figure 15. DS2

Figure 16. DS4

Figure 17. DS1

Figure 18. DS3

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*.

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*.

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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 19 shows how the L-brackets can be assembled.

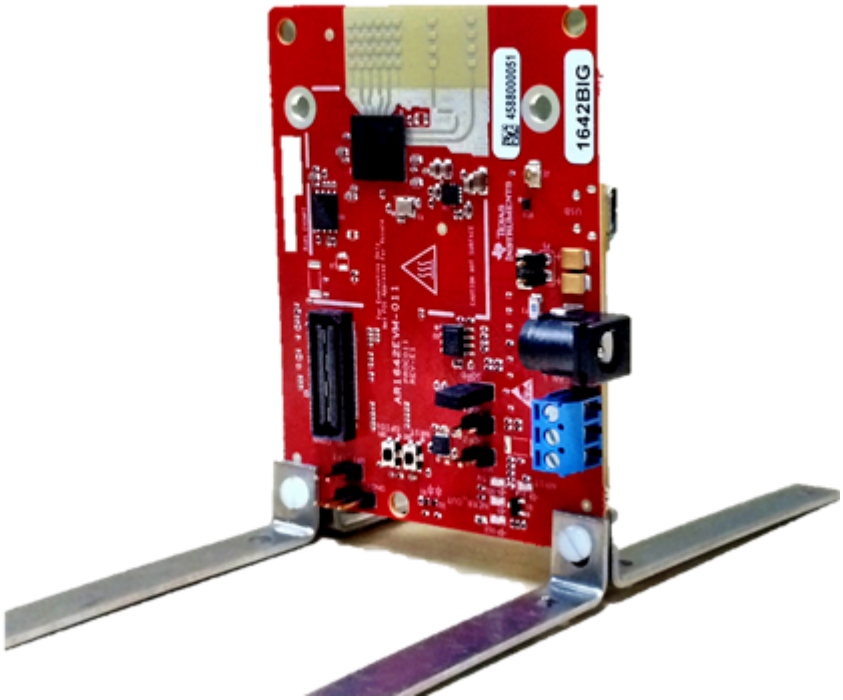

Figure 19. Vertical Assembly of EVM

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 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.

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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.

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.

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FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

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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.

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STANDARD TERMS FOR EVALUATION MODULES (continued)

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