User's Guide

AWR1843AoP EVM User's Guide

ABSTRACT

The AWR1843AOPEVM from Texas Instruments is an easy-to-use evaluation board for the AWR1843AOP mmWave sensing device, with direct connectivity to the MMWAVEICBOOST and DCA1000EVM development kits. This EVM contains everything required to start developing software for on-chip C67x DSP core and low-power ARM® Cortex®-R4F controllers.

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Trademarks

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1 Getting Started

1.1 Key Features

- Breakaway section for smaller form factor
- Serial port for onboard QSPI flash programming
- Back-channel UART through USB-to-PC for logging purposes
- On package antenna
- 60-pin, high-density (HD) connectors for raw analog-to-digital converter (ADC) data over LVDS and trace-data capability
- Two onboard CAN-FD transceivers
- On board Bluetooth with CC2642R2 wireless MCU
- One button and two LEDs for basic user interface
- 5-V power jack to power the board

1.2 Kit Contents

The following items are included with the AWR1843AOPEVM kit.

- AWR1843AOP evaluation board
- Heat sink
- Mounting stand
- Micro USB cable

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.

1.2.1 mmWave Out of Box Demo

TI provides sample demo codes to easily get started with the AWR1843AOP evaluation module (EVM) and to experience the functionality of the AWR1843AOP radar sensor. For details on getting started with these demos, see www.ti.com/tool/mmwave-sdk.

2 Hardware

CAUTION HOT SURFACE
CONTACT MAY CAUSE BURN
DO NOT TOUCH

Note

RECOMMENDED DUTY CYCLE: The AWR1843AOPEVM operates at a maximum duty cycle of 50%: running at a higher duty cycle increases the risk of damaging the EVM by exceeding the maximum operating junction temperature (T_j) of 125°C.

The AWR1843AOPEVM includes four receivers and three transmitter wide field of antennas on the package of the device. The AWR1843AOP operates at a 4-Ghz bandwidth from 77 to 81 GHz; the AWR1843AOPEVM has an antenna gain of ~5 dBi.

Note

During operation, a minimum separation distance of 5 centimeters should be maintained between the user and the EVM.

Note

Refer to the *Thermal Design Guide for Antenna on Package mmWave Sensor* application note for details of thermal dissipation options for AWR1843AOP devices, particularly for small form factor designs such as the mission side of the EVM.

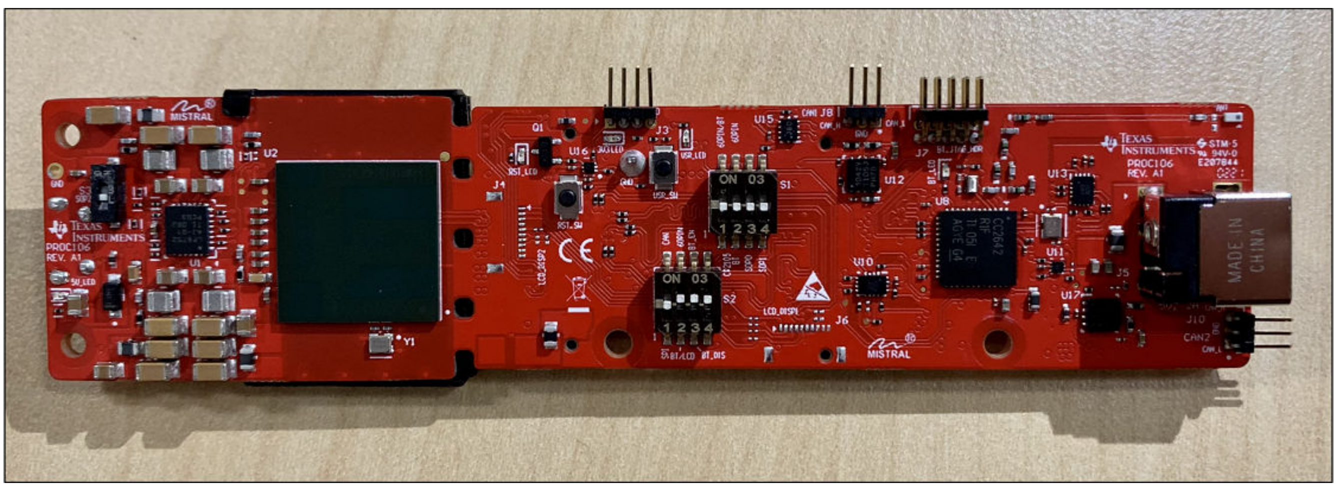

Figure 2-1. AWR1843AOPEVM Top View

When split, the following features are available:

- 77 to 81 GHz mmWave sensing for form-factor deployment and testing
- Functional and flashing SOP Mode
- Emulator USB port for user UART and Data COM ports

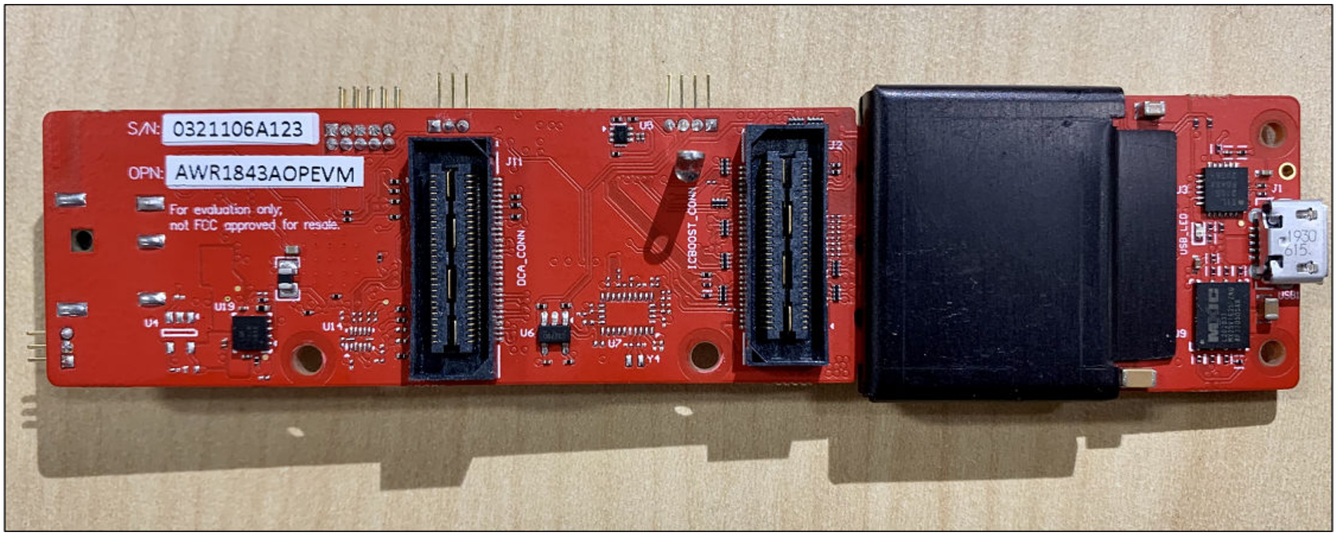

Figure 2-2. AWR1843AOPEVM Bottom View

> **CAUTION**
>
> There is a possibility of damage and lose of function to the mission board when it is split. When split, the board cannot be put back together and many features are lost. Raw data capture, JTAG debug and other features requiring the 60 pin SAMTEC connectors are permanently lost.

2.1 Block Diagram

Figure 2-3 shows the functional block diagram. The mission board side contains the essential components for the TI radar system, PMIC, SFLASH, SOP configuration, Filter, TI mmWave Radar chip, and a USB to UART converter. The Breakaway board sections contain the 60-pin Samtec connector for interfacing with the DCA1000 and MMWAVEICBOOST.

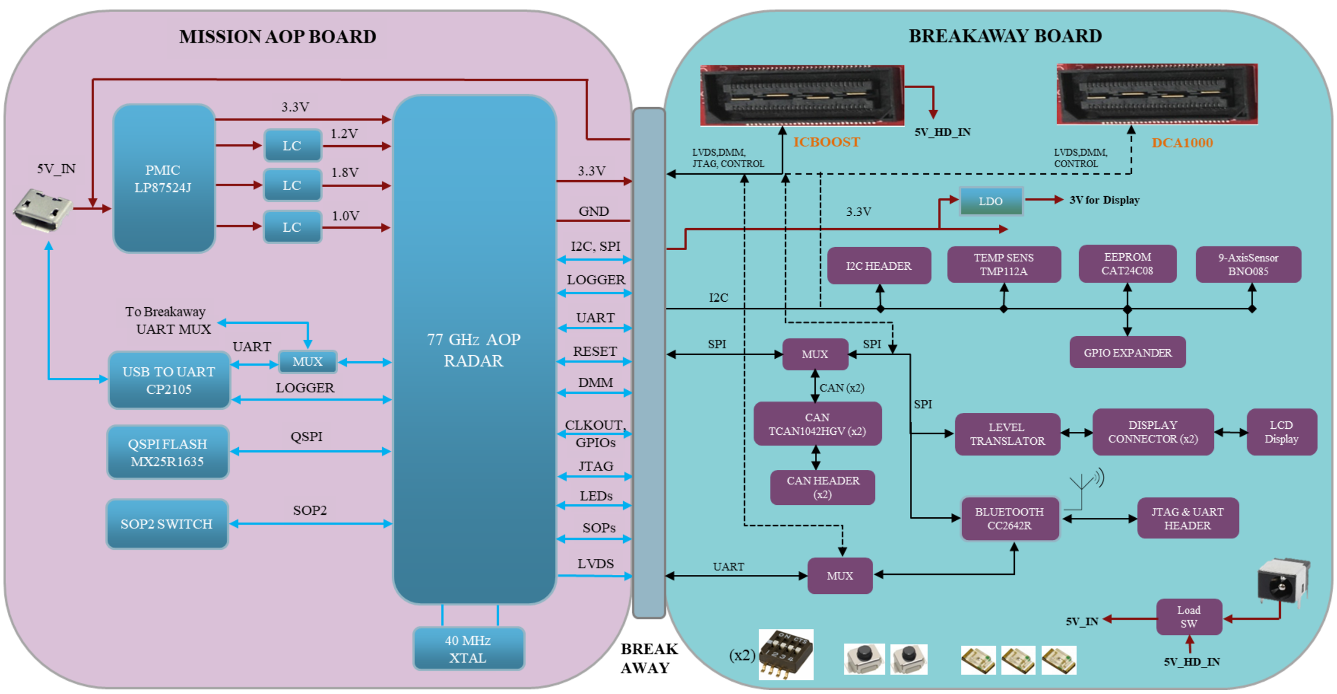

Figure 2-3. Block Diagram of the AWR1843AOPEVM

2.2 PCB Storage and Handling Recommendations

This EVM contains components that can potentially be damaged by electrostatic discharge. Always transport and store the EVM in its supplied ESD bag when not in use. Handle using an antistatic wristband. Operate on an antistatic work surface. For more information on proper handling, refer to SSYA010A.

2.3 Heat Sink and Temperature

Users are strongly encouraged to use the AWR1843AOPEVM with the heat sink installed. Due to the smaller size of the AWR1843AOPEVM, it is likely to get warmer than other larger sized EVMs on the mmWave Radar portfolioso care must be taken to ensure the junction temperature does not exceed 125°C. Figure 2-4 shows measurement of junction temperature versus duty cycle taken with and without the heat sink. As seen in the plot, the EVM can safely operate up to 50% duty cycle with or without the heat sink. Although the heatsink is not absolutely required, usage of the heat sink provides protection against exceeding the junction temperature at higher duty cyles.

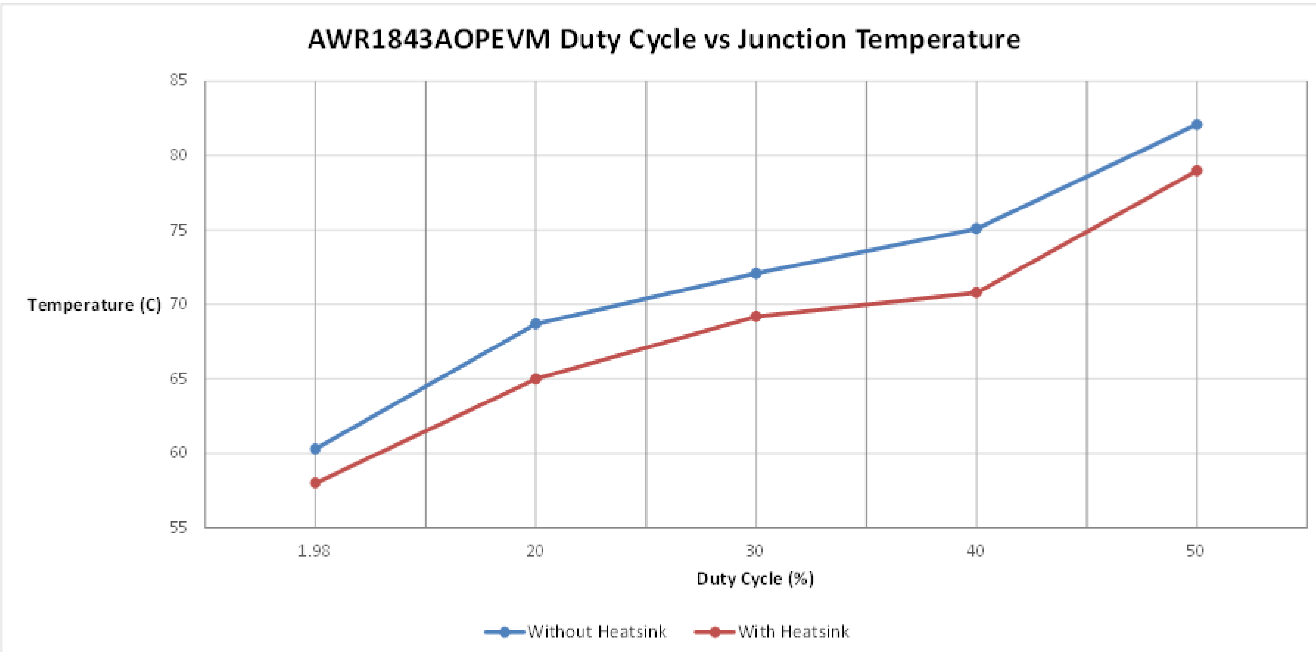

Figure 2-4. Duty Cycle versus Junction Temperature

When using the EVM for custom applications, the duty cycle can be adjusted as needed, the heat sink provided with the kit can be used, customers can also design their own heat sink using better heat disipating materials or one with more surface area such as addition of fins. The CAD drawing for the heat sink is shown in Figure 2-5.

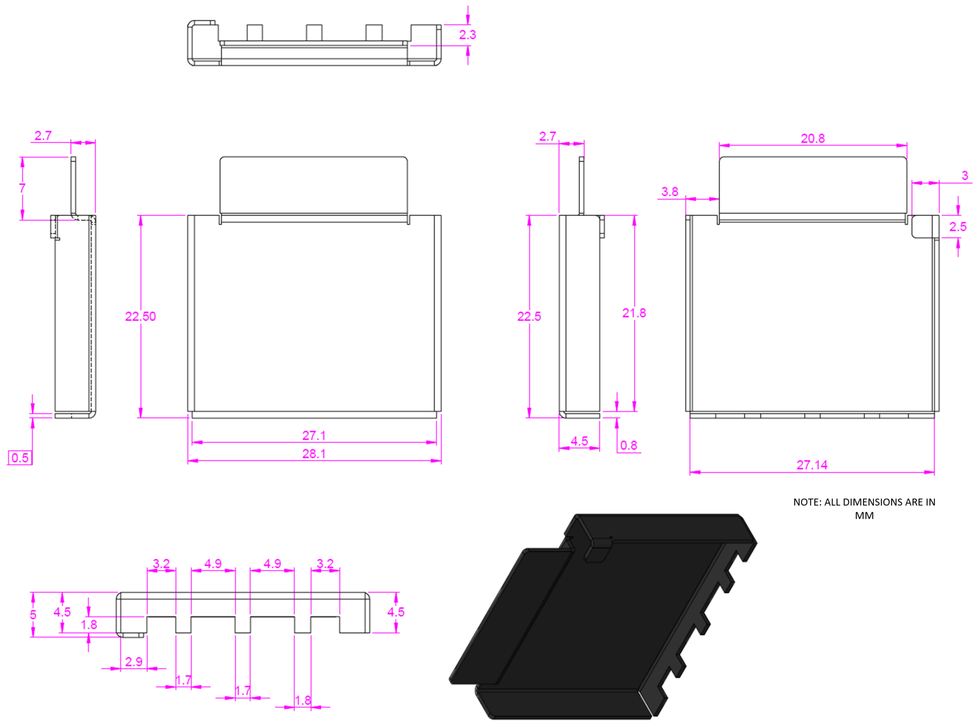

Figure 2-5. Heat Sink CAD Drawing

Application of the heat sink is shown in Figure 2-6.

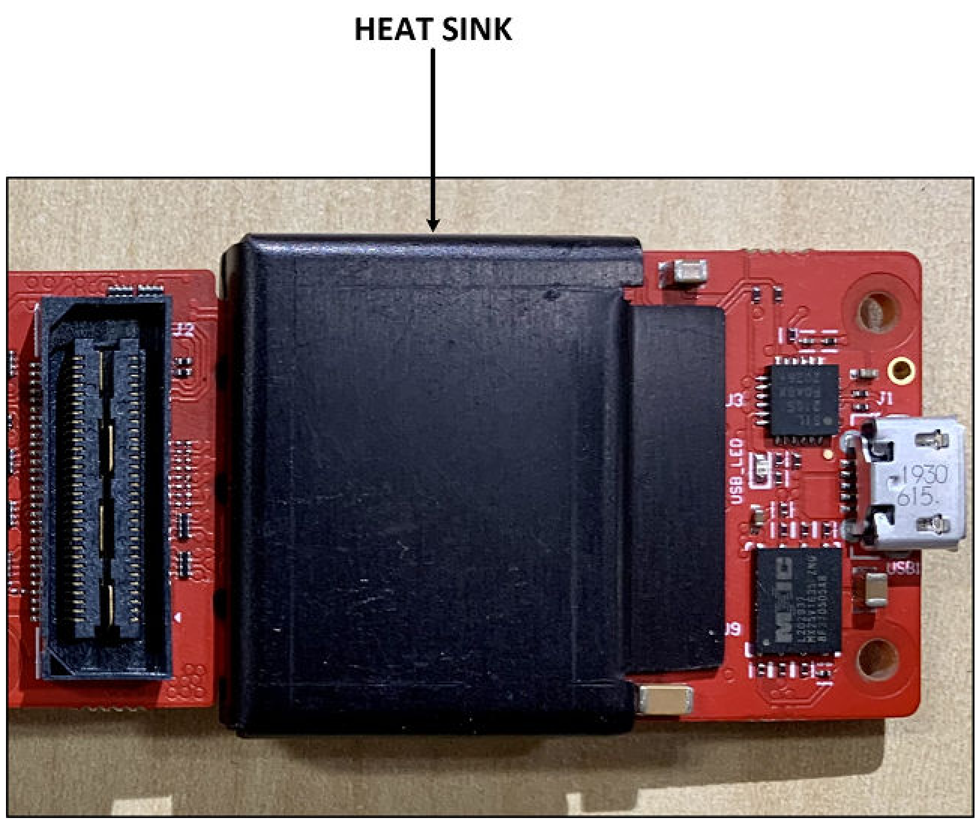

Figure 2-6. Heat Sink Placement

2.4 AWR1843AOPEVM Antenna

The AWR1843AOPEVM includes four receiver and three transmitter short range antennas on the package of the chip. Figure 2-7 shows the antenna on package.

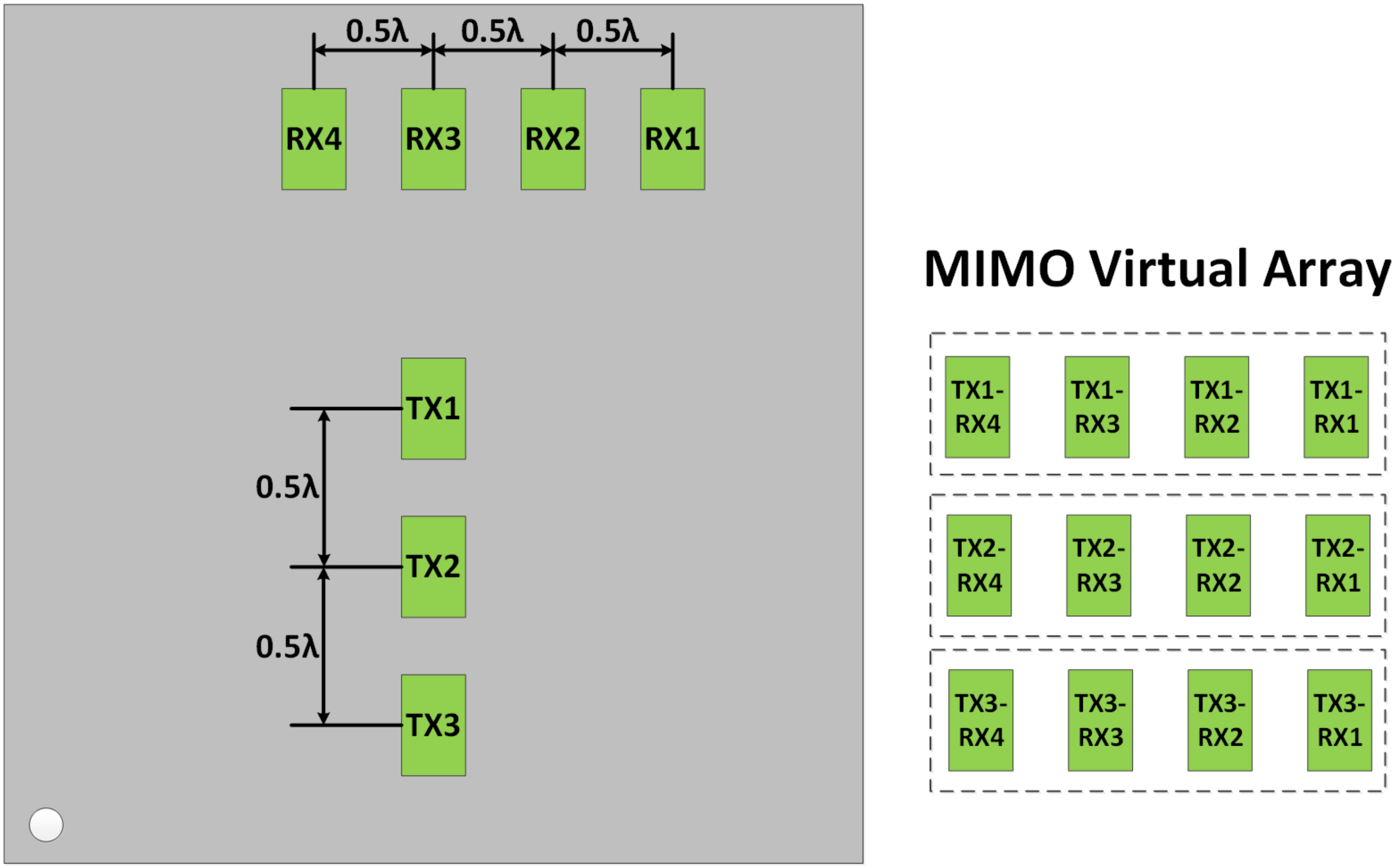

Figure 2-7. AWR1843AOP Antenna Placement MIMO Array

Figure 2-8 shows the orientation of the AWR1843AOP relative to the PCB. This orientation shows that when the EVM is mounted on the provided mounting stand, the antenna is in the elevation orientation relative to the scene.

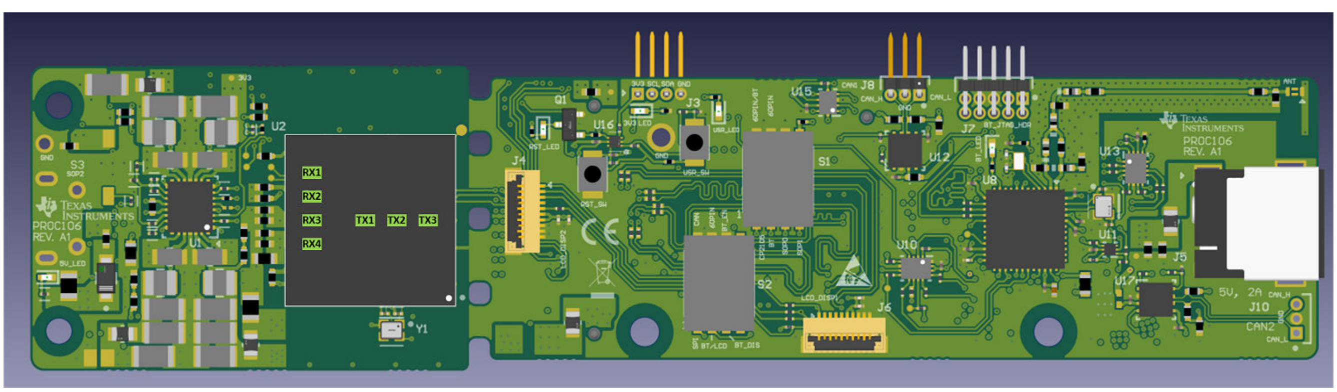

Figure 2-8. Orientation of the AWR1843AOP Relative to the PCB

Figure 2-9 shows the antenna radiation pattern with regard to azimuth. Figure 2-10 shows the antenna radiation pattern with regard to elevation for TX1, TX2, and TX3. Both show the radiation pattern for TX1, TX2, and TX3 and RX1, RX2, RX3, and RX4 together.

Note

Lambda is computed based on a frequency of 78.5 GHz.

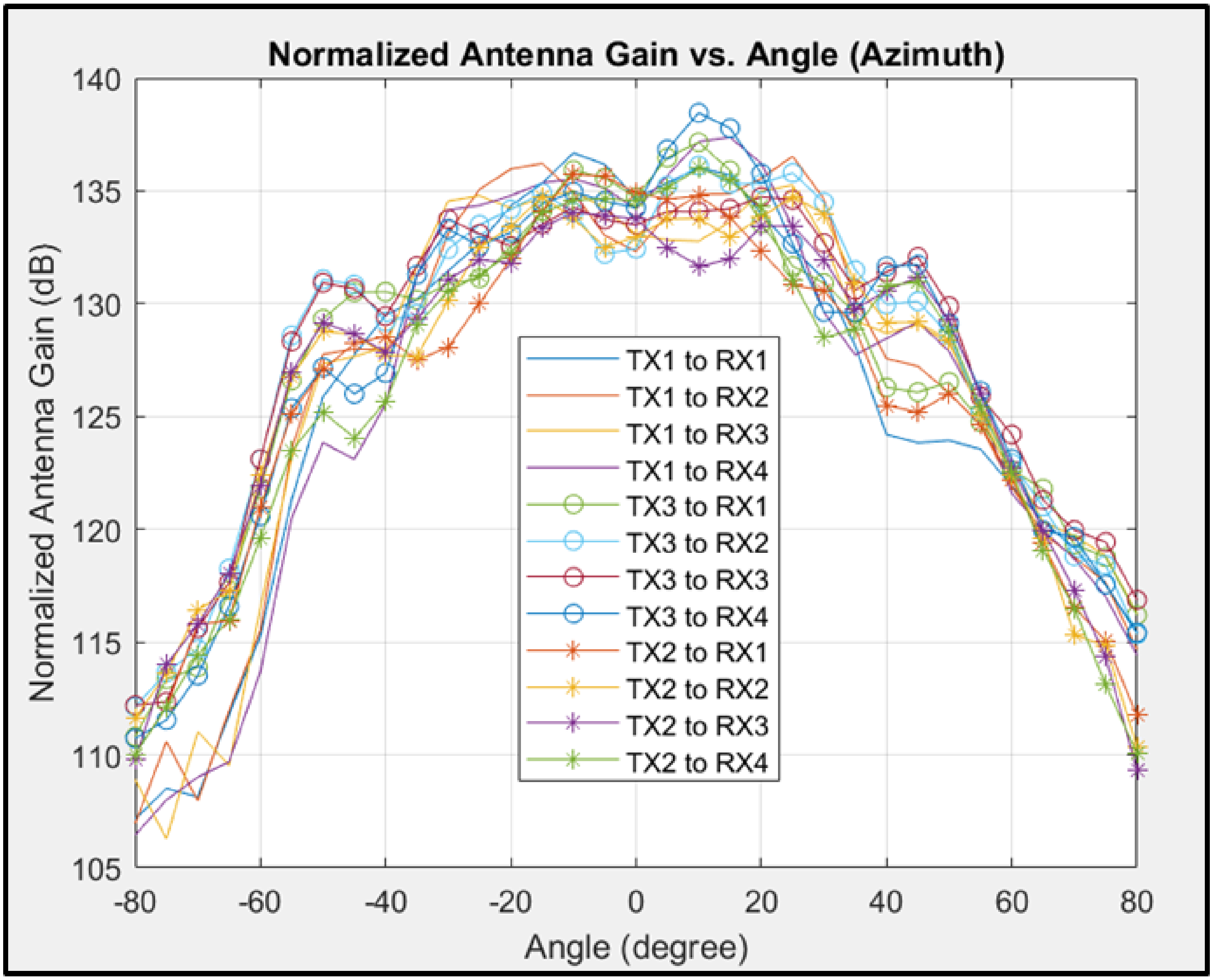

Figure 2-9. Measured Azimuthal Radiation Pattern for All Tx to Rx Pairs (Corner Reflector Placed at 4.5 Meters with a 1.75-GHz Bandwidth Chirp Starting at 77.75 GHz)

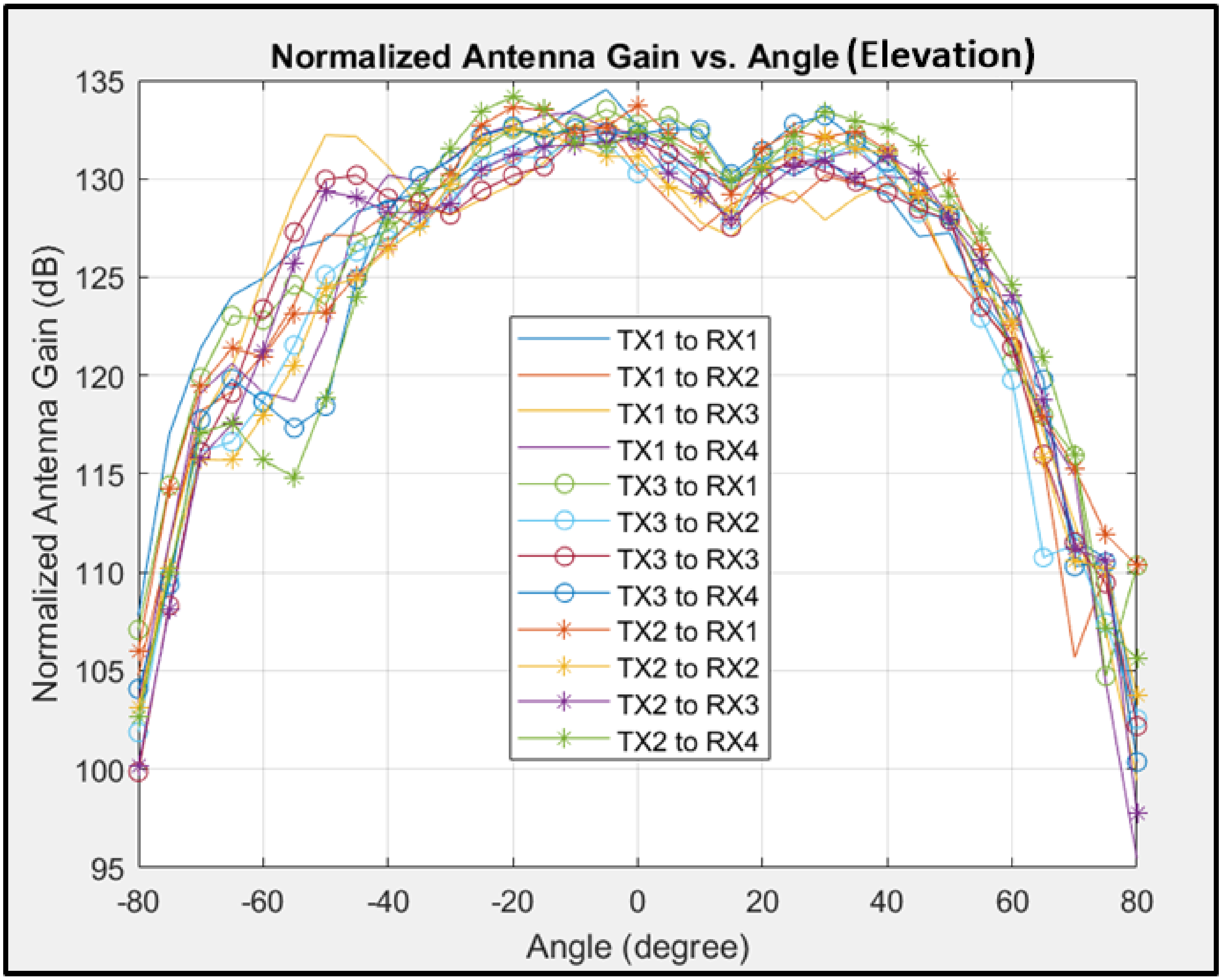

Figure 2-10. Measured Elevation Radiation Pattern for All Tx to Rx Pairs (Corner Reflector Placed at 4.5 Meters with a 1.75-GHz Bandwidth Chirp Starting at 77.75 GHz)

2.5 Switch Settings

Figure 2-11 shows the part designators and positions of the switches on the AWR1843AOPEVM.

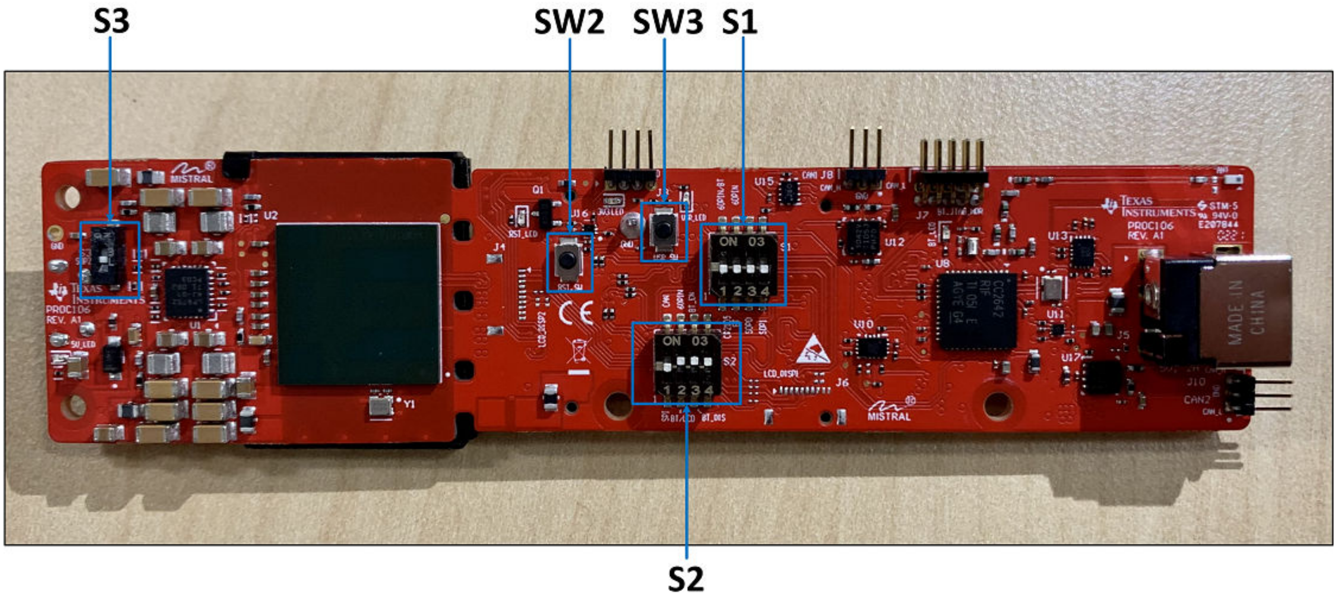

Figure 2-11. AWR1843AOPEVM Switches

Table 2-1. Switches

Reference Designator	Switch ON	Switch OFF
S1.1	UART routed to 60-pin connector / Bluetooth	UART routed to CP2105 UART
S1.2	UART routed to 60-pin connector	UART routed to Bluetooth
S1.3	SOP0 pulled down	SOP0 pulled up
S1.4	SOP1 pulled up	SOP1 pulled down
S2.1	SPI MISO/MOSI routed to CAN Transceiver	SPI MISO/MOSI routed to DCA1000/ MMWAVCEICBOOST / BT/ LCD
S2.2	SPI CS routed to 60-pin connector	SPI CS routed to BT/ LCD
S2.3	Bluetooth Enable	Bluetooth Disable
S2.4	Not Connected	Not Connected
S3	SOP2 Pulled up	SOP2 Pulled down
SW2	Reset switch	
SW3	User switch	

2.6 LEDs

Table 2-2 contains the list of LEDs on the AWR1843AOPEVM.

Table 2-2. List of LEDs

Reference Designator	Usage
LD1	5V indication LED
LD2	3.3V breakaway indication LED
LD3	GPIO2 LED, illuminates when GPIO2 is logic-1
LD4	USB to UART enumeration LED
LD5	NRST LED, illuminates when NRST is pulled low
LD6	CC2642R GPIO6 LED, illuminates when GPIO6 is logic-1

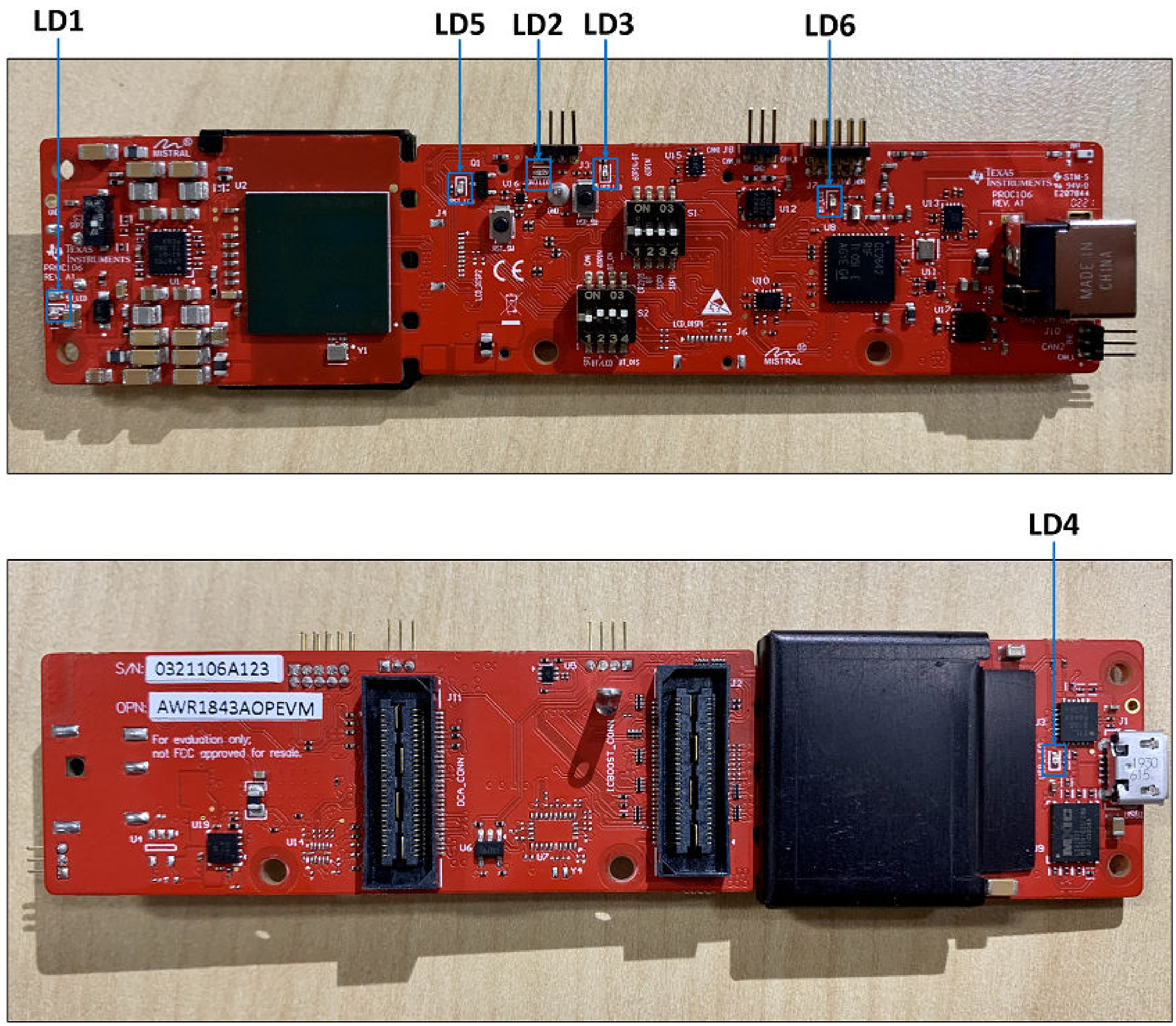

Figure 2-12. Location of LEDs on PCB

2.7 Connectors

2.7.1 Power Connector (J5)

The EVM can be powered by the 5-V power jack (2.5-A current limit), shown in Figure 2-13. When the power is provided, the NRST and 5-V LEDs should glow, indicating that the board is powered on.

The J5 connector is intended to be used when using the EVM with the DCA1000 or in stand alone (modular) mode. When using the EVM with the MMWAVEICBOOST, the 5-V supply is provided by the MMWAVEICBOOST board, so power over the J5 connector is not required.

When the breakaway section is removed, power should come from the USB connector (J1). See more details about this connector in Section 2.7.2.

Note

After the 5-V power supply is provided to the EVM, TI recommends pressing the NRST switch (SW2) one time to ensure a reliable boot-up state.

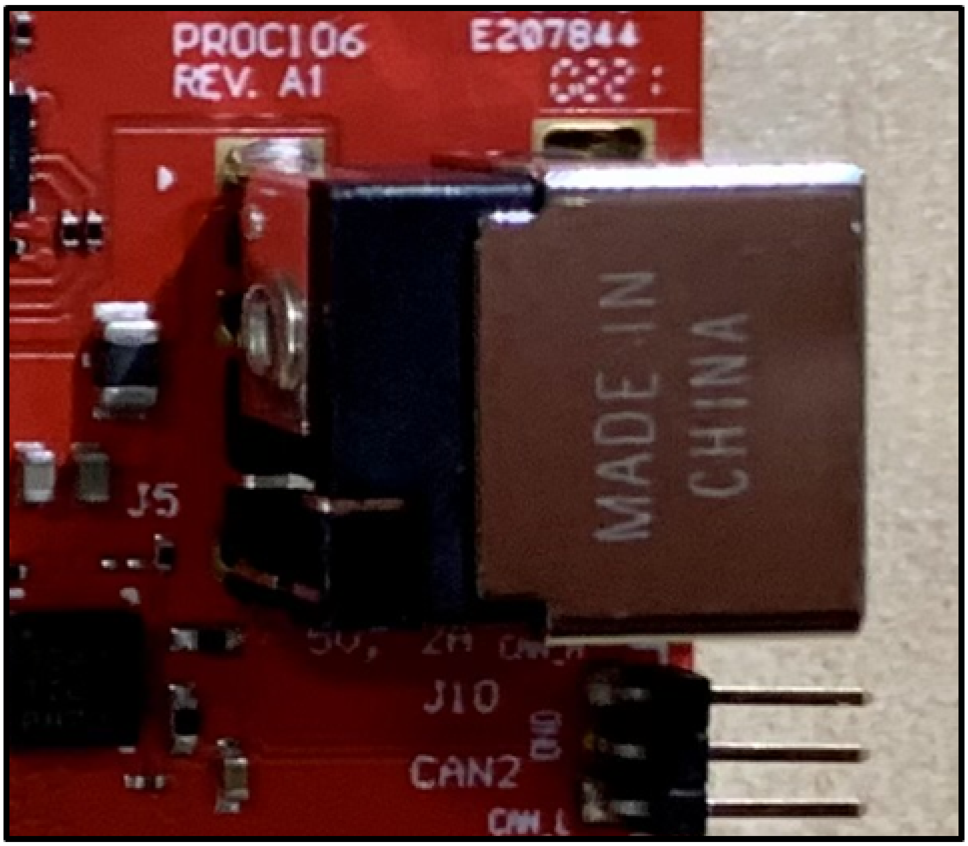

Figure 2-13. 5-V Power Connector (J5)

2.7.2 USB Connector (J1)

The USB connector provides an alternative 5-V supply input to power the device if the breakaway section is removed. 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
- MSS logger UART (can be used to get MSS code logs on the PC)

Figure 2-14. USB Connector (J1)

2.7.3 DCA1000 HD Connector (J11)

The 60-pin HD connector shown in Figure 2-15 provides the high-speed CSI/LVDS data, and controls signals (SPI, UART, I2C, NRST, NERR, and SOPs) to the DCA1000. The Trace and DMM interface lines are also available through this connector.

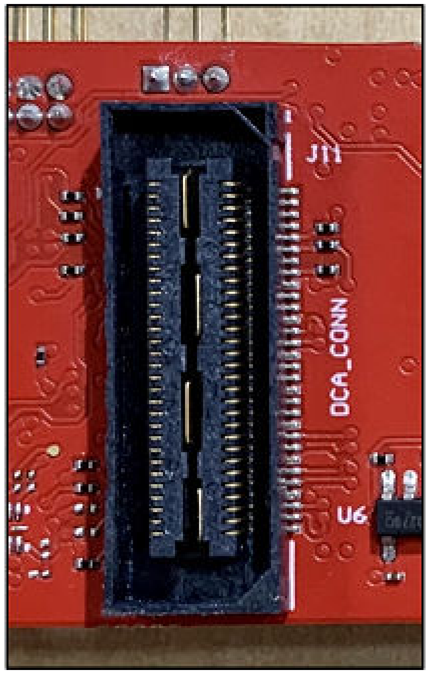

Figure 2-15. DCA1000 HD Connector (J11)

Table 2-3. J11 Pin Assignment

Pin Number	Description	Pin Number	Description
1	No Connection	2	No Connection
3	No Connection	4	No Connection
5	No Connection	6	No Connection
7	SPI_CS	8	No Connection
9	SPI_CLK	10	SPI_HOSTINTR
11	SPI_MOSI	12	SPI_MISO
13	DCA1000_PGOOD	14	No Connection
15	DMM_CLK	16	AR_SYNC_IN
17	DMM_SYNC	18	GND
19	DMM_DP0	20	No Connection
21	DMM_DP1	22	No Connection
23	DMM_DP2	24	GND
25	DMM_DP3	26	LVDS_FRCLKP
27	DMM_DP4	28	LVDS_FRCLKN
29	DMM_DP5	30	GND
31	DMM_DP6	32	No Connection
33	DMM_DP7	34	No Connection
35	No Connection	36	GND
37	No Connection	38	No Connection
39	No Connection	40	No Connection
41	No Connection	42	GND
43	No Connection	44	LVDS_CLKP

Table 2-3. J11 Pin Assignment (continued)

Pin Number	Description	Pin Number	Description
45	No Connection	46	LVDS_CLKN
47	No Connection	48	GND
49	No Connection	50	LVDS_1P
51	I2C_SDA	52	LVDS_1N
53	I2C_SCL	54	GND
55	RS232RX (NC by default)	56	LVDS_0P
57	RS323TX (NC by default)	58	LVDS_0N
59	AR_NRESET	60	GND

2.7.4 MMWAVEICBOOST HD Connector (J2)

The 60-pin HD connector shown in Figure 2-16 provides the high-speed CSI/LVDS data, controls signals (SPI, UART, I2C, NRST, NERR, and SOPs) and JTAG debug signals to the MMWAVEICBOOST. The Trace and DMM interface lines are also available through this connector (not connected by default).

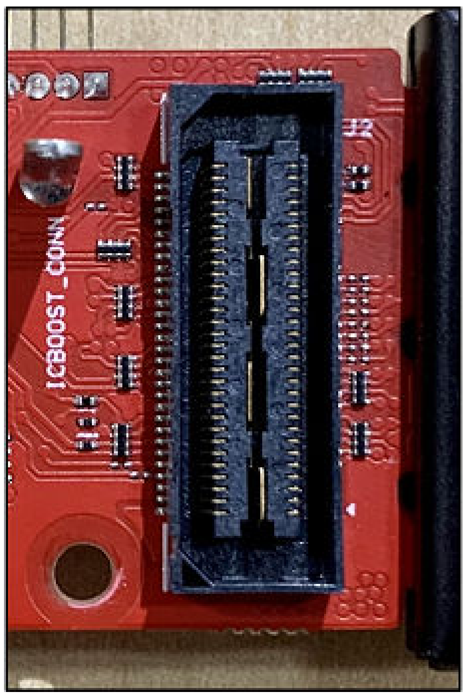

Figure 2-16. MMWAVEICBOOST HD Connector (J2)

Table 2-4. J2 Pin Assignment

Pin Number	Description	Pin Number	Description
1	No Connection	2	5V
3	No Connection	4	No Connection
5	No Connection	6	No Connection
7	No Connection	8	DMM_SYNC
9	No Connection	10	DMM_CLK
11	TDI	12	AR_NRESET
13	TMS	14	MMWAVEICBOOST PGOOD
15	TCK	16	SPI_HOSTINTR
17	TDO_SOP0	18	MSS_LOGGER
19	SPI_CS1	20	GND
21	SPI_CLK	22	AR_SYNC_IN

Table 2-4. J2 Pin Assignment (continued)

Pin Number	Description	Pin Number	Description
23	SPI_MOSI	24	AR_SYNC_OUT_SOP1
25	SPI_MISO	26	GND
27	DMM_DP0	28	LVDS_FRCLKP
29	DMM_DP1	30	LVDS_FRCLKN
31	DMM_DP2	32	GND
33	DMM_DP3	34	LVDS_CLKP
35	DMM_DP4	36	LVDS_CLKN
37	DMM_DP5	38	GND
39	DMM_DP6	40	LVDS_1P
41	DMM_DP7	42	LVDS_1N
43	BSS_LOGGER	44	GND
45	OSC_CLKOUT	46	LVDS_0P
47	MCU_CLKOUT	48	LVDS_0N
49	PMIC_CLKOUT_SOP2	50	GND
51	AR_WRMRST	52	AR_NERROR_IN
53	I2C_SDA	54	AR_NERROR_OUT
55	I2C_SCL	56	AR_GPIO_0
57	RS232RX	58	AR_GPIO_1
59	RS232TX	60	AR_GPIO_2

2.7.5 I2C Connector (J3)

The I2C bus along with the 3.3-V supply and GND are brought out on the I2C connector (J3).

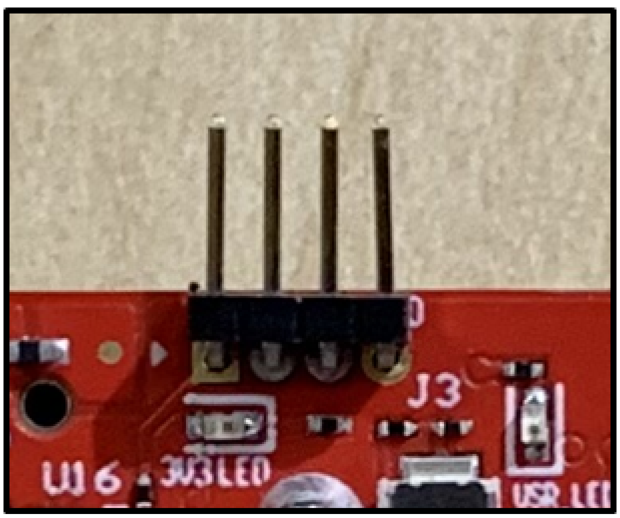

Figure 2-17. I2C Connector (J3)

Table 2-5. J3 Pin Assignment

Pin Number	Description
1	3.3 V
2	I2C_SCL
3	I2C_SDA
4	GND

2.7.6 BT/JTAG Connector (J7)

The Bluetooth control signals (UART, NRESET) and the JTAG debug signals are brought out on connector J7.

Figure 2-18. BT/JTAG Connector (J7)

Table 2-6. J7 Pin Assignment

Pin Number	Description
1	Bluetooth UART_RX
2	Bluetooth UART_TX
3	Bluetooth NRESET
4	JTAG_TDI
5	GND
6	JTAG_TDO
7	GND
8	JTAG_TCK
9	3.3V
10	JTAG_TMS

2.7.7 CAN Connectors (J8, J10)

The CAN connector provides access to the two CAN_FD interfaces (CAN_L and CAN_H signals) from the onboard CAND-FD transceivers (TCAN1042HGVDRQ1). These signals can be directly wired to the CAN bus.

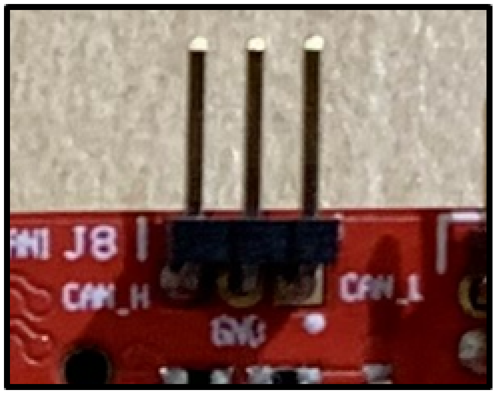

Figure 2-19. CAN Connectors (J8, J10)

Table 2-7. J8, J10 Pin Assignment

Pin Number	Description
1	CAN_L
2	GND
3	CAN_H

2.8 AWR1843AOPEVM Muxing Scheme

The AWR1843AOPEVM UART RX/TX can be routed to the Samtec 60-pin connector, USB to UART (SICP2105), and bluetooth (BT) device (CC2640R2F), as detailed in Table 2-8.

Table 2-8. Pin Mux Settings

Modes	S1.1	S1.2	S1.3	S1.4	S2.1	S2.2	S2.3	S2.4	S3
Modular (USB)SICP2015	OFF	NA	OFF	OFF	OFF	N/A	N/A	N/A	OFF (Functional AOP IC Mode) ON (Flashing AOP IC Mode)
Modular - (Bluetooth)CC2642R2F	ON	OFF (Functional Bluetooth Mode) ON (Programming Bluetooth Mode)	OFF	OFF	OFF	OFF	OFF (Functional Bluetooth Mode) ON (Programming Bluetooth Mode)	N/A	OFF
MMWAVEICBOOST	ON	ON	OFF	OFF	OFF	ON	N/A	N/A	OFF (Functional AOP IC Mode) ON (Flashing AOP IC Mode)
DCA1000 (mmWave Studio)	OFF	N/A	OFF	ON	OFF	ON	N/A	N/A	OFF
DCA1000 (SDK)	OFF	N/A	OFF	OFF	OFF	ON	N/A	N/A	OFF

2.8.1 SOP Configuration

Table 2-9. SOP Switch Settings

	SOP0(S1.3)	SOP1(S1.4)	SOP2(S3)
Flashing	OFF	OFF	ON
Functional	OFF	OFF	OFF
MMWAVEICBOOST Mode (JTAG, and so forth)	OFF	OFF	OFF
DCA1000 (mmWave Studio)	OFF	ON	OFF
DCA1000 (SDK)	OFF	OFF	OFF

Note

SOP0 is pulled high when switch is on the OFF position and low when the switch is the ON position. SOP 1 and 2 are pulled low when the switch is OFF and high when the switch is ON.

In MMWAVEICBOOST mode, the AWR1843AOPEVM is mounted on the MMWAVEICBOOST and the SOP mode is set by the MMWAVEICBOOST.

2.9 Modular, MMWAVEICBOOST, and DCA1000 Mode

The AWR1843AOP can be used in modular mode or mounted on the DCA1000 or MMWAVEICBOOST for debugging.

Modular mode is primarily used when running application code or the SDK mmWave Demo. In this mode the user will have access to the UART and Logger ports via the USB connector (J1) as well as the on-board CAN trancievers (J8, J10) and the Bluetooth/JTAG header (J7).

Additional debug interfaces (DMM, LVDS, SPI) and tools (mmWaveStudio) can be accessed by connecting to the MMWAVEICBOOST on the J2 connector. For more details about the MMWAVEICBOOST features and uses, refer to the MMWAVEICBOOST User's Guide.

Raw data capture over the LVDS interface with mmWaveStudio can be accomplished by directly connecting the EVM to the DCA1000 EVM on the J11 connector. For more details about the DCA1000 EVM and its features, refer to the DCA1000 EVM User's Guide.

2.9.1 Modular Mode

When used in Modular mode, the UART can either be routed to the SICP2015, which displays the data on the mmWave visualizer, or to other devices connected to the USB interface. The UART data can also be routed to the CC2642R2F, which transmits data to a wireless device through Bluetooth. Figure 2-20 shows the setup for SICP2015. Figure 2-21 shows the setup for CC2642R2F. [1]

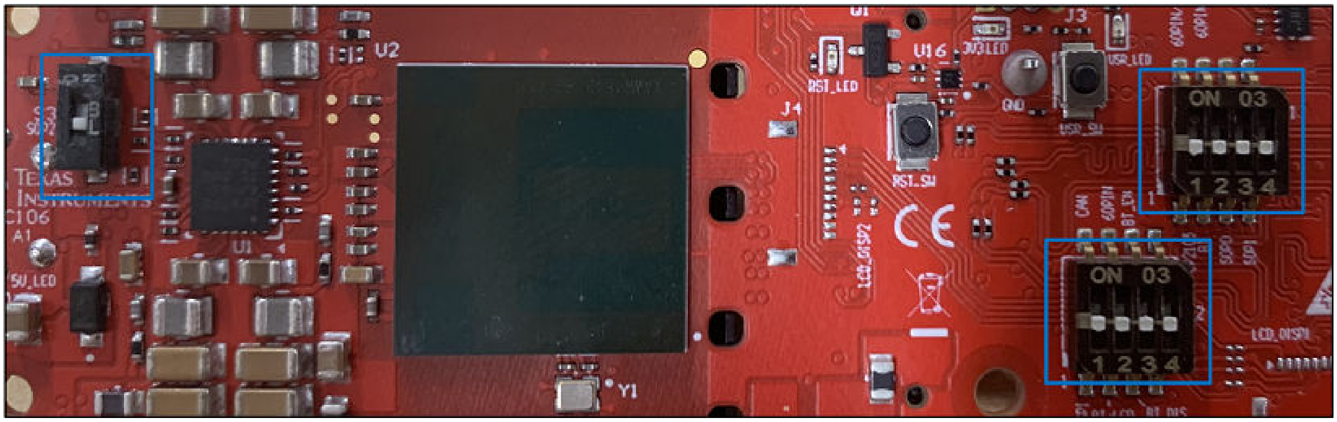

Figure 2-20. Switch Configuration for Modular Mode (Functional)

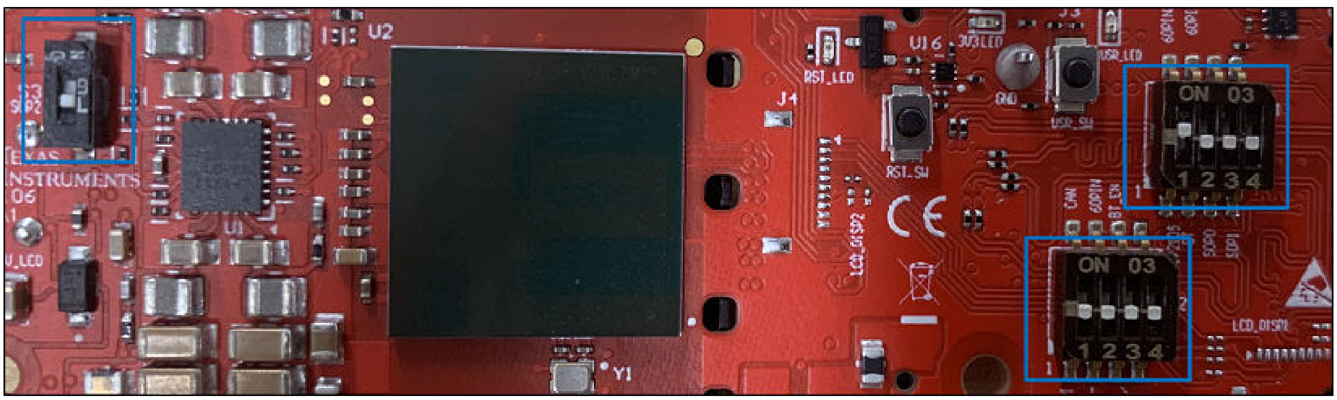

Figure 2-21. Switch Configuration for Bluetooth Mode (Functional)

[1] For higher power application ensure the USB J1 is connected before connecting USB J5.

2.9.2 MMWAVEICBOOST Mode

This mode enables access to debugging tools available on the MMWAVEICBOOST such as the JTAG, ADC capture, CAN, LaunchPad connector, and so forth.

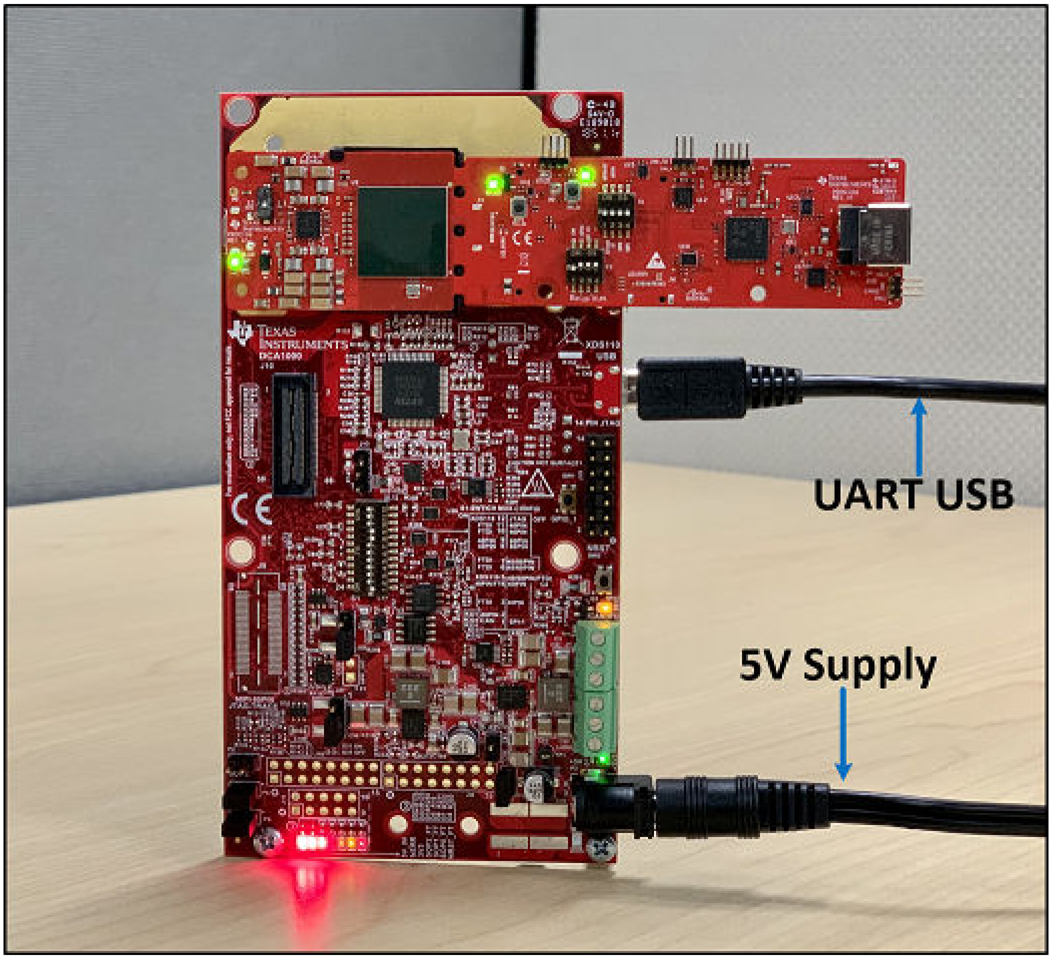

Figure 2-22. AWR1843AOPEVM Mounted on MMWAVEICBOOST

For mounted mode, the UART should be routed to the 60-pin connector. Set up the device as shown in Figure 2-23. When mounted as shown, the SOP mode is overridden by the MMWAVEICBOOST SOP configuration.

Note

The EVM shown in Figure 2-22 is mounted in the elevation orientation. Refer to Section 2.4 for more details.

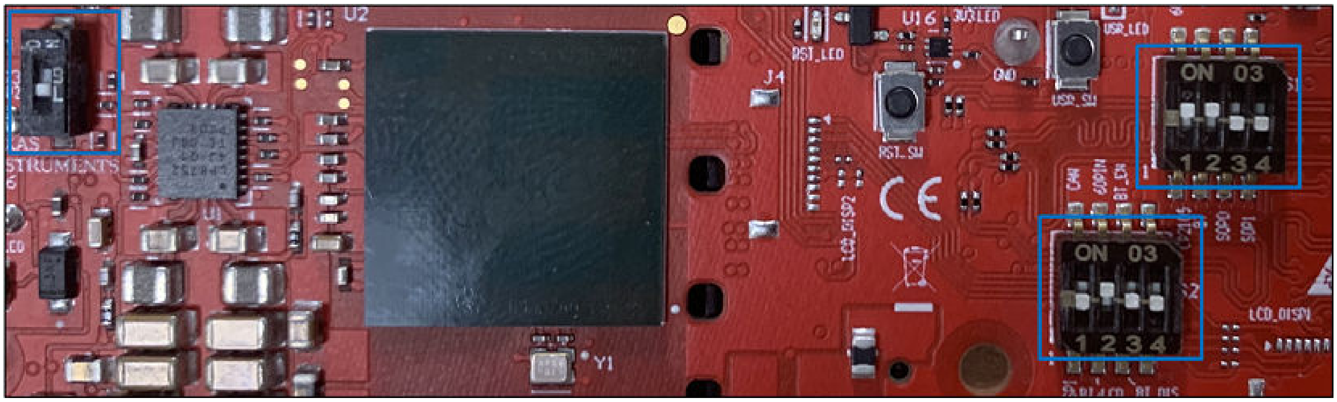

Figure 2-23. Switch Configuration for MMWAVEICBOOST Mode (Functional)

2.9.3 DCA1000 Mode

This mode enables raw data capture using the DCA1000 EVM.

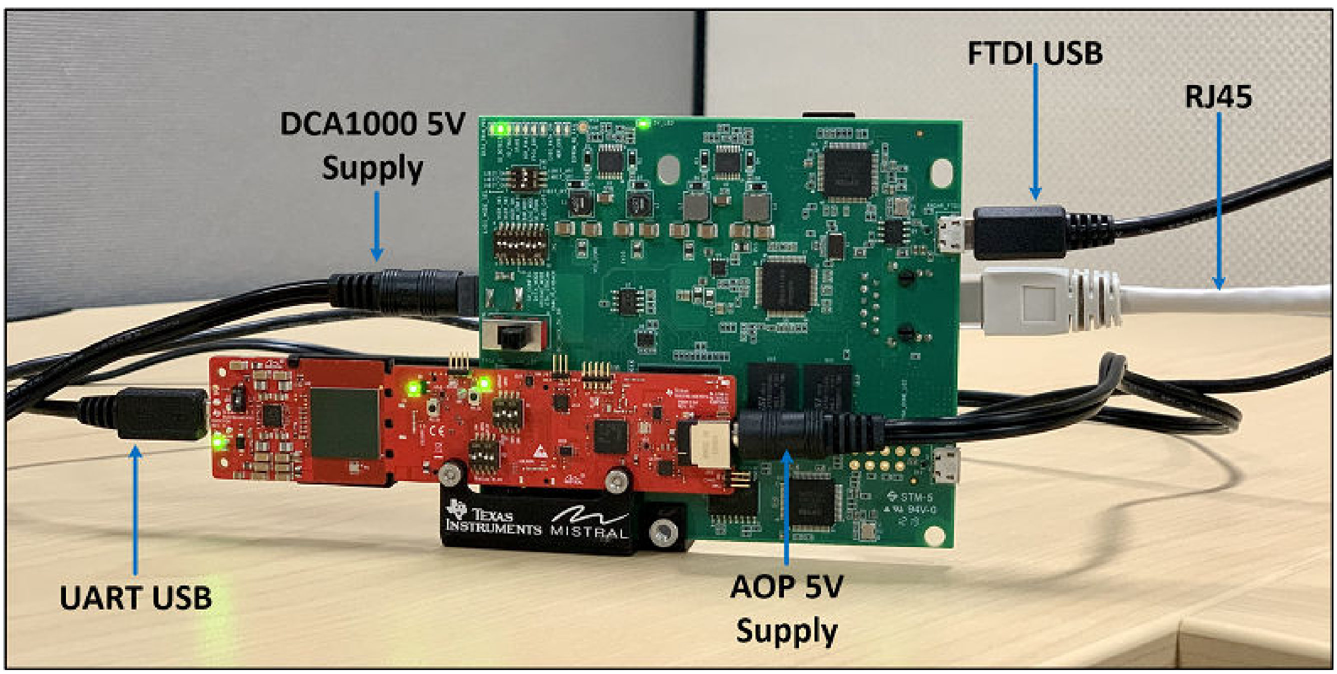

Figure 2-24. AWR1843AOPEVM Mounted on the DCA1000

Note

The EVM shown in Figure 2-24 is mounted in the elevation orientation. Refer to Section 2.4 for more details.

For mounted mode, the UART should be routed to the 60-pin connector. The SOP settings are controlled by the SOP switches on the AWR1843AOPEVM. Set up the device as shown in Figure 2-25.

Figure 2-25. Switch Configuration for DCA1000 Mode (mmWave Studio)

2.10 PC Connection

2.10.1 Installing the Drivers

The SICP2105 drivers must be installed to access the UART port. Download and install the drivers here.

When installed correctly, the COM port should be enumerated as shown in .

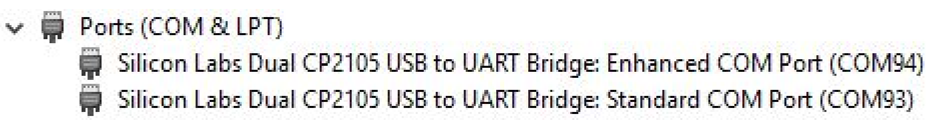

Figure 2-26. SICP2015 COM Ports

The enhanced COM port is the application/user UART and the standard COM port is the data port.

2.10.2 Flashing the Board

1. Ensure the drivers have been successfully installed and COM ports enumerated.
2. Configure the SOP to flashing mode.
3. Run the UniFlash tool.
4. Press the reset switch to ensure that the board boots up in the right mode.
5. Enter the Enhanced COM Port in UniFlash interface.
6. Load image to serial flash.

2.11 Power Supply Optimization

For best transient supply settling at the start of the chirp, the [idle time + TX start time] can be set to a value < 10 µsec. In this configuration, the firmware keeps some of the RF blocks ON between the chirps. For idle time + Tx start time > 10 µsec, the blocks are turned off for power saving. In cases where all transmitters and receivers are enabled and the idle time is > 10us, the transient caused by the dynamic power save disabling and enabling the blocks can produce a ringing behavior on the output of the secondary LC filter. If this ringing is impacting the RX sampled data, the ADC start time can be increased to a point where the supply is settled within 5%, or the inductance value can be reduced to reduce the ringing (which may come at the expense or poorer 4-Mhz filtering). Typically, setting issues will show up as a transient in the start of the time domain plot as shown below.

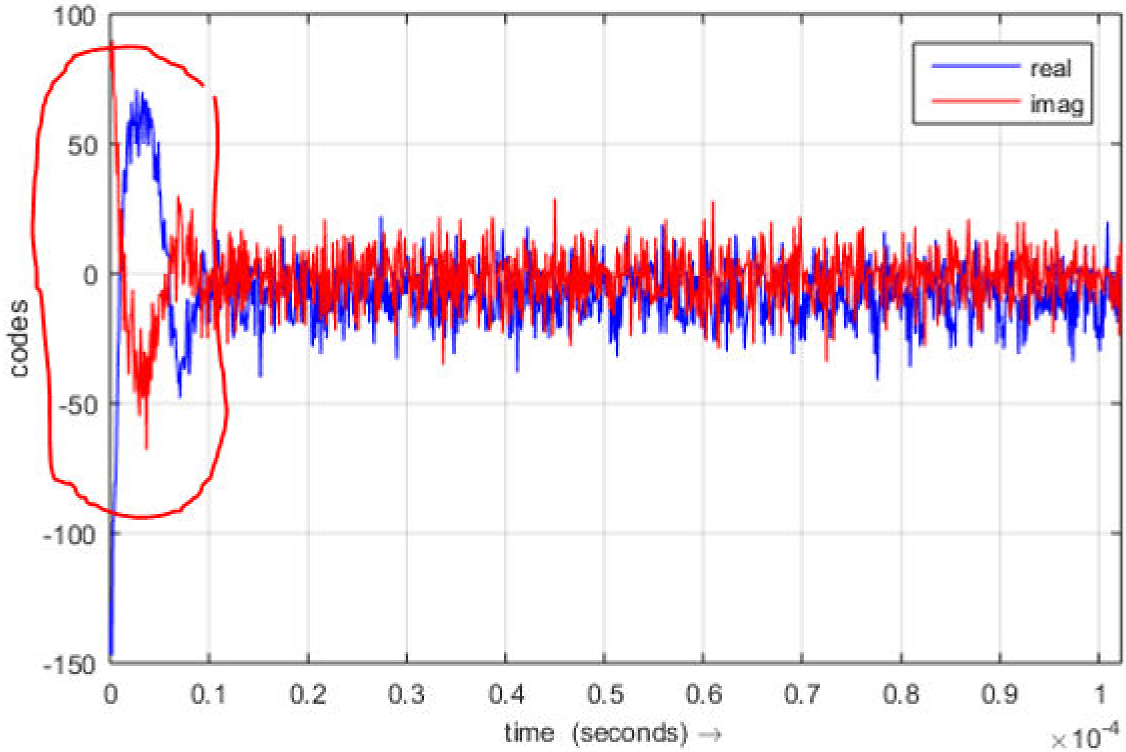

Figure 2-27. Time Domain Plot with Transient Ringing on 1.0-V Supply

In the Rev A1 version of the EVM, the LC filter on the 1.0-V supplies consists of an MPZ2012S101ATD25 ferrite bead, a 22-uF capacitor (GCM31CR71A226KE02L), and a 10-uF capacitor (GCM21BR71A106KE22L). Testing has shown that this filter can be optimized for better transient performance by replacing L12 and L14 with the BLM18KG121TH1D part. Further optimizations can be made by replacing C75, and C111 with the GCM21BD70J226ME36L part and C113 and C121 with the GCM21BR71A106KE22L part.

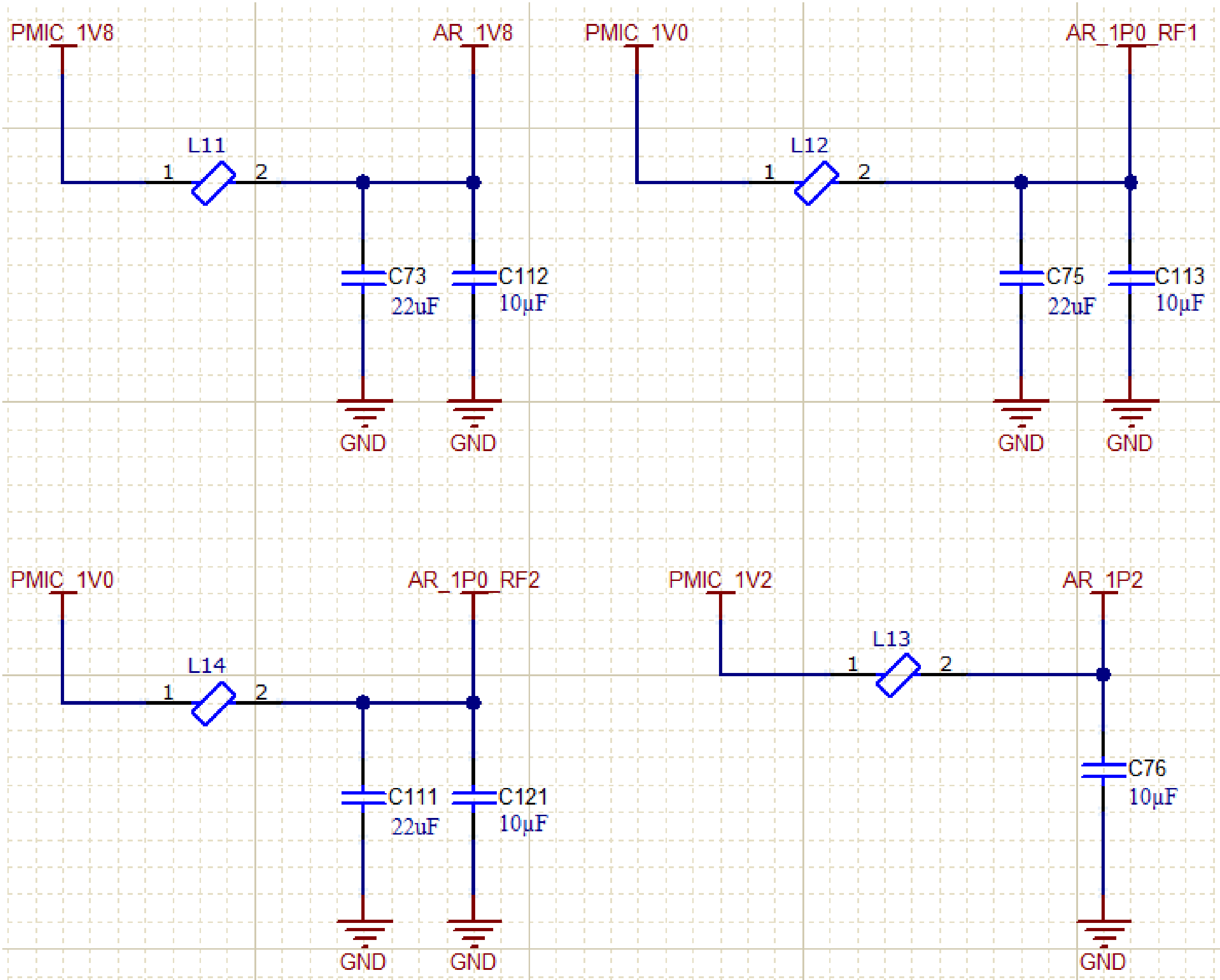

Figure 2-28. Secondary LC Filter on the AWR1843AOPEVM

3 Design Files and Software Tools

3.1 Hardware

To view the schematics, assembly drawings, and BOM, see AWR1843AOPEVM Schematic, Assembly Files, and BOM.

To view the design database and layout details, see AWR1843AOPEVM Hardware Files.

3.2 Software, Development Tools, and Example Code

To enable quick development of end applications on the C67x DSP and ARM® Cortex® R4F core in the AWR1843AOP, 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.

3.3 LDO Bypass Requirement

The AWR1843AOPEVM utilizes a 1.0-V supply on the RF1 and RF2 power rails. To support the third transmitter, the VOUT_PA output is connected to the RF2 power rail. For best performance and to prevent damage to the device, select the 'RF LDO Bypass Enable' and 'PA LDO I/P Disable' options in the Static Configuration when using mmWave Studio. Additionally, the LDO bypass can be configured using the AWR_RF_LDO_BYPASS_SB API. To enable the RF LDO Bypass and PA LDO I/P Disable through the API, issue an ar1.RfLdoBypassConfig(0x3) command.

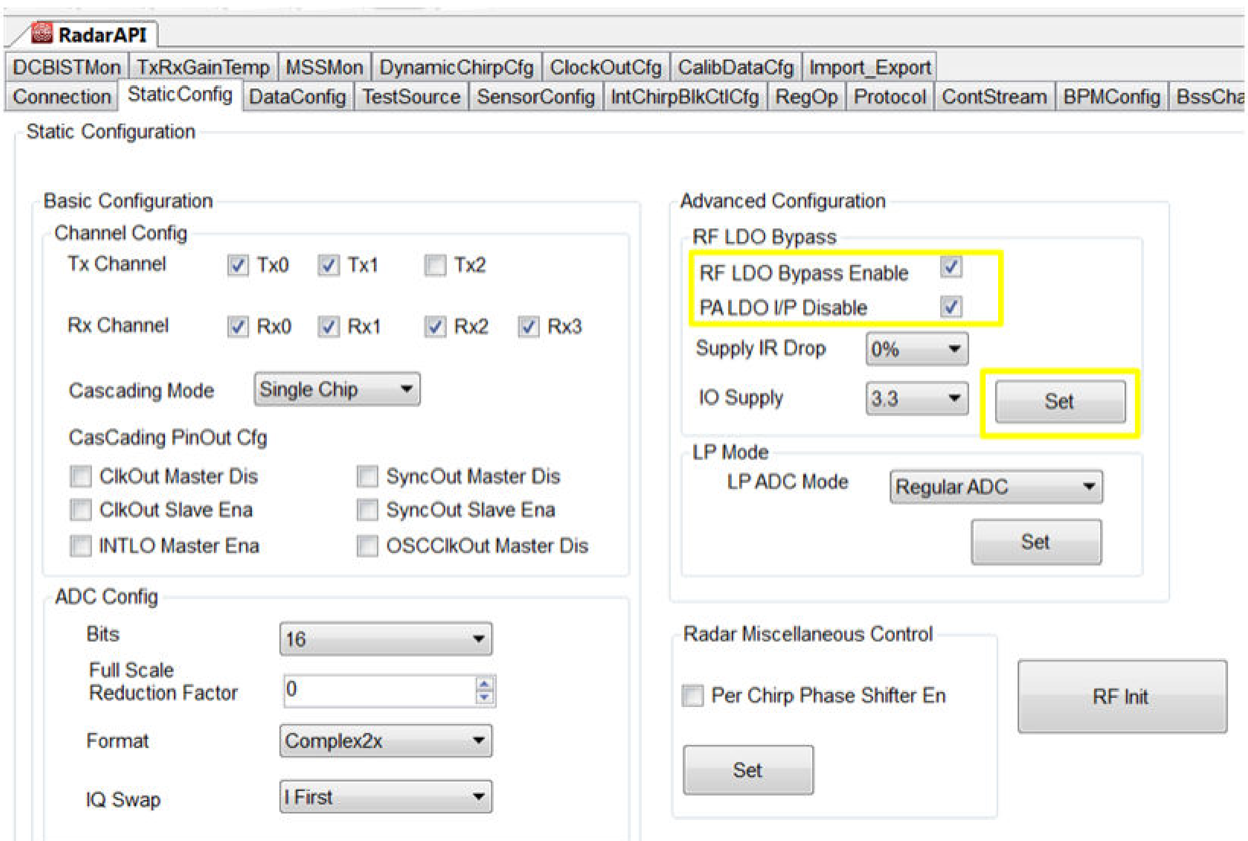

Figure 3-1. LDO Bypass Enable

4 References

DCA1000EVM Data Capture Card User's Guide

MMWAVEICBOOST User's Guide