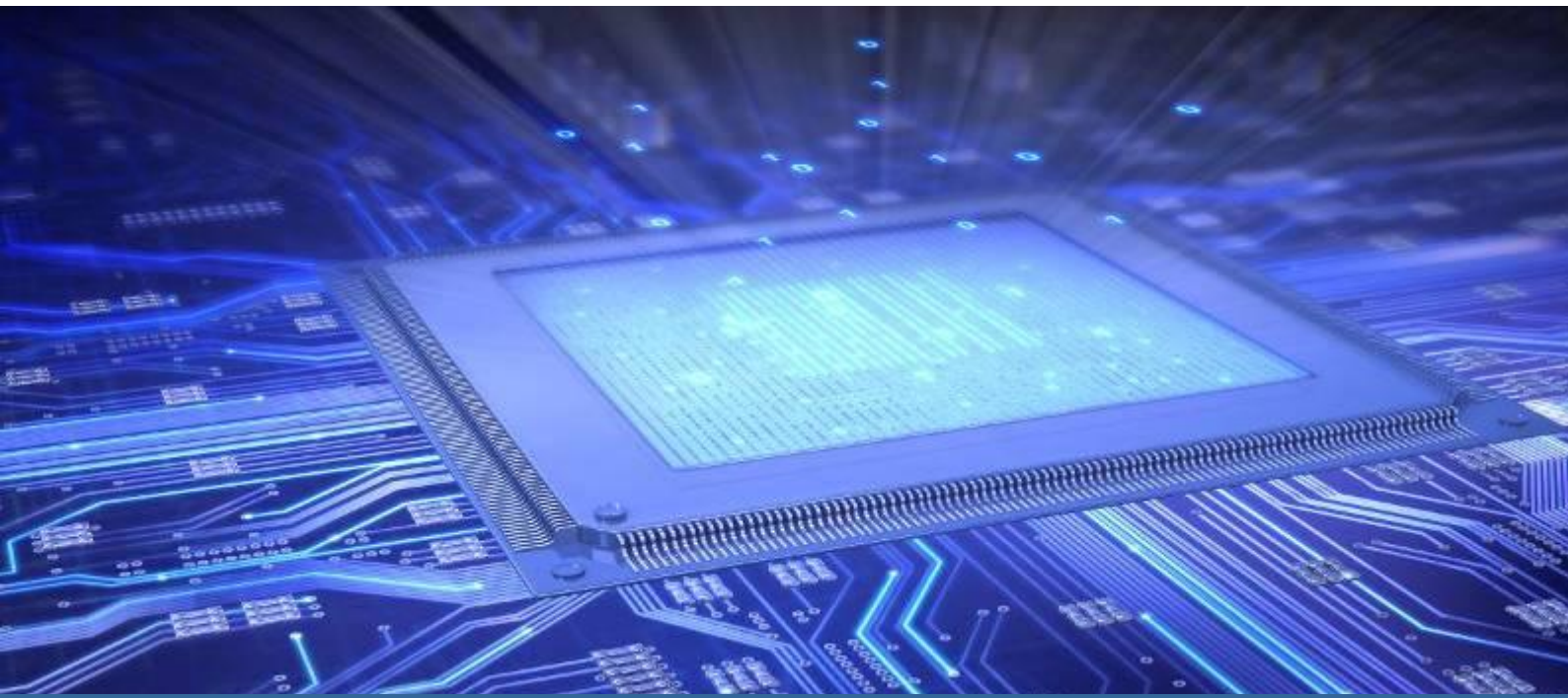
60GHz ODS AoPCB Radar Module
User Manual



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1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to provide instructions to use Mistral's mmWave Industrial 60GHz ODS RADAR on Module (RoM) with Antenna on PCB (AoPCB), RevA.

1.2 Audience

This document is intended for Mistral's 60GHz ODS RADAR on Module with Antenna on PCB (IWR6843 AoPCB) Radar Module users.

1.3 About 60GHz ODS AoPCB Radar Module

The mmWave IWR6843 ODS AoPCB from Mistral is an easy to use, compact, light-weight RADAR providing high functionality for Industrial and automotive applications.

The AoPCB is built around IWR6843 from Texas Instruments assuring long lifecycle and support.

1.3.1 Key Features

- Small, optimized, and ready to use module.
- USB Powered
- Standalone boot up and programming support
- Built-in Calibration and Self-test
- On board QSPI flash and PMIC
- Antenna Pattern: Single element ODS
- UART communication for Configuration and RADAR Data
- UART channels over USB or directly on header
- Flexible Connectivity: CAN, UART, SPI, I2C, GPIOs, JTAG and LVDS
- Remote firmware upgrade
- Supports TI's SDK 3.05
- Supports 60-pin high-speed connector for host-controlling interface
- Supports raw data capture through DCA1000 EVM
- Board Dimension (L x W x H): 54 x 53 x 18 mm
- Industrial Operating Temperature: -40°C to 85°C

1.3.2 Kit Contents

- 60GHz ODS AoPCB Board
- Mechanical Clamp
- M2x6 Philip Pan Head Screw.
- M2 Hex Nut.

2 GENERAL SAFETY PRECAUTIONS

2.1 ESD Precautions

The boards contain devices, which are sensitive to Electro-Static Discharge. Improper handling may lead to performance degradation of the devices or even permanent damage.

3 HARDWARE

3.1 60GHz ODS AoPCB Radar Module Description

Figure 1 60GHz ODS AoPCB Module Top Side and **Figure 2 60GHz ODS AoPCB Module Bottom Side** shows the Top and Bottom View of AoPCB Module.

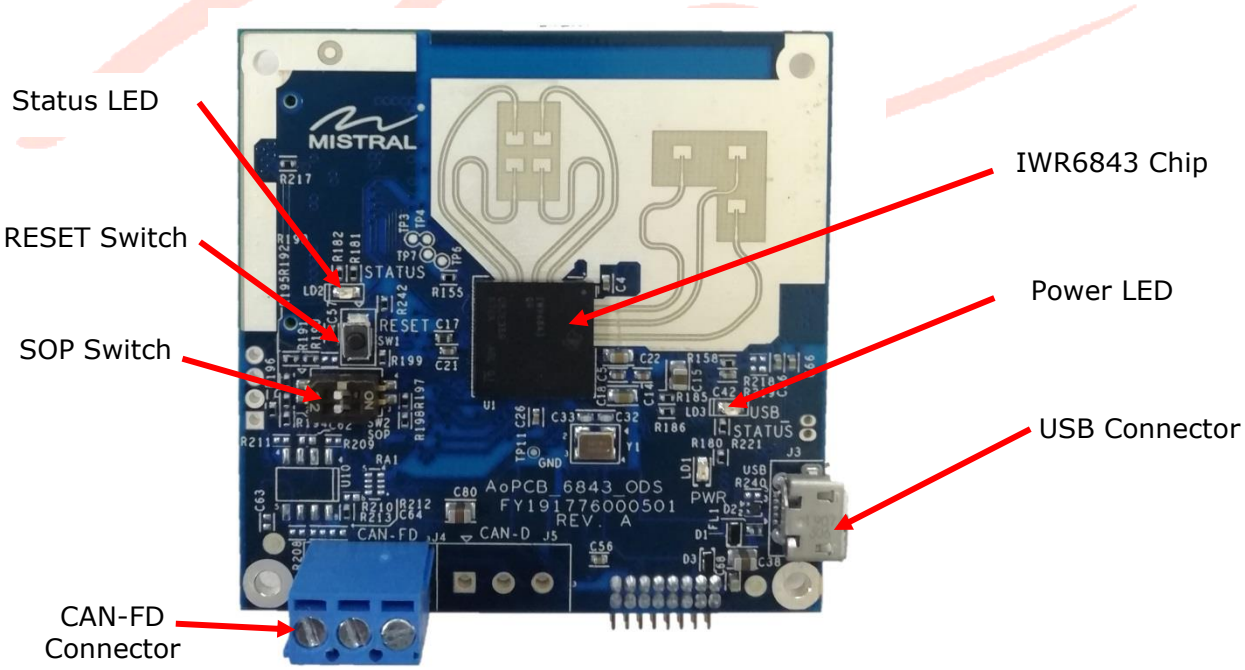


Figure 1 60GHz ODS AoPCB Module Top Side

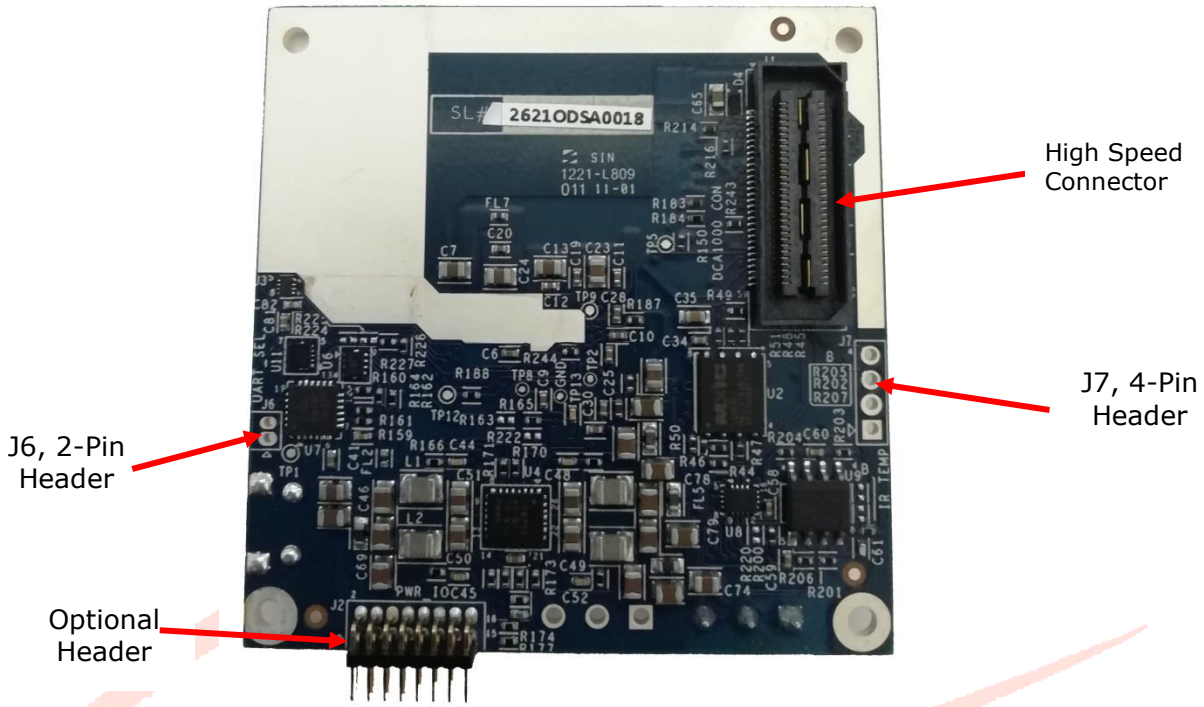


Figure 2 60GHz ODS AoPCB Module Bottom Side

3.2 Accessories required

60GHz ODS AoPCB Module requires a USB Type A to Micro-B Cable connected to the Host PC for Power and Data.

3.3 AoPCB Mechanical Assembly

For correct functionality of the radar, the orientation of the radar must be as depicted in figure below. AoPCB board fixed with mechanical clamp with the help of M2 Pan Head screw and M2 Hex nut.

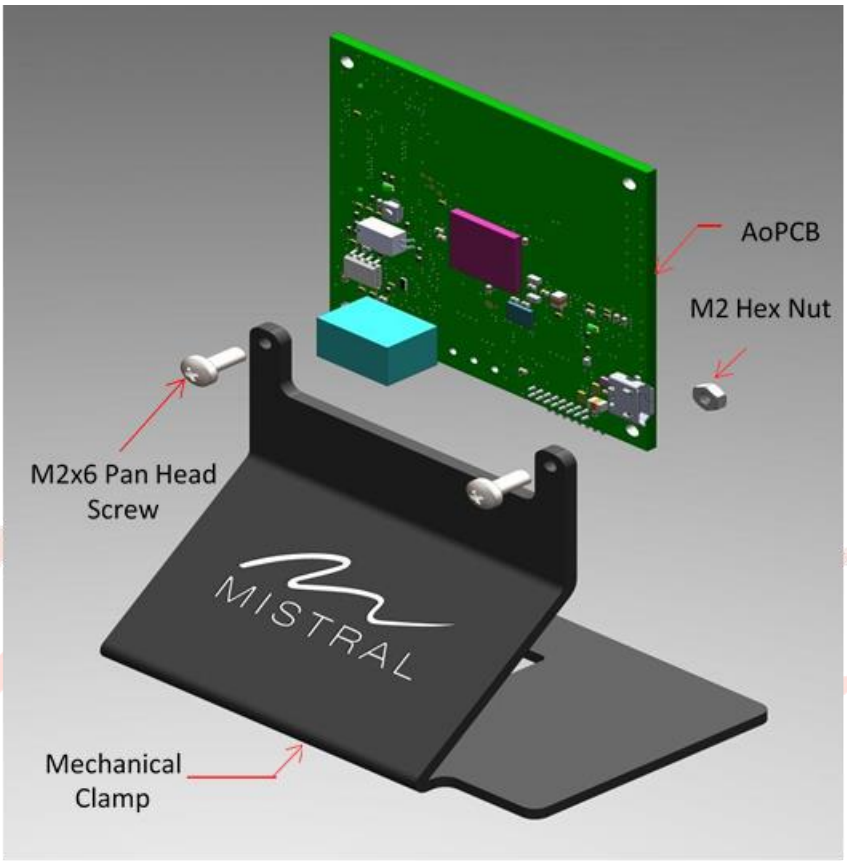


Figure 3 Mechanical Assembly

Mounting holes are provided on the mechanical fixture. Contact Mistral for any custom mount / heat sink requirements.

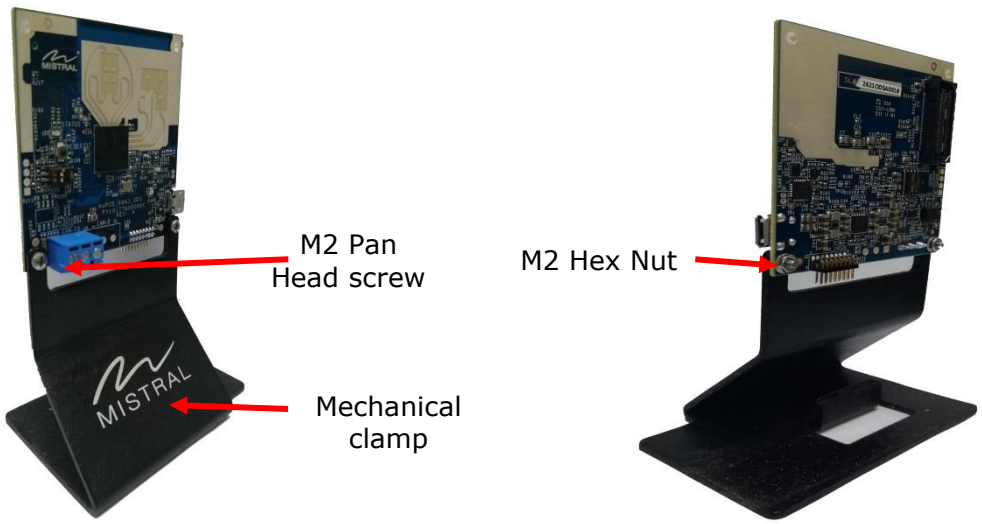


Figure 4 Mounting Orientation

3.4 SOP Switch Setting

The SOP Switch (SW2) setting determines the mode of operation of AoPCB. The following table details its function.

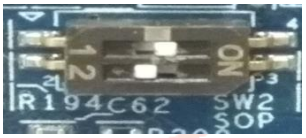
SOP Setting	Mode of Operation	Image
SW2-1 position -> OFF SW2-2 position -> OFF	Functional Mode	
SW2-1 position -> ON SW2-2 position -> OFF	Flash Programming Mode	
SW2-1 position -> OFF SW2-2 position -> ON	Development /Raw Data Capture mode	

Table 1 SOP Switch Setting

3.5 LED's Indication

Reference Designator	Usage	Comments	Image
LD1	Power	This LED indicates the presence of the 5V Supply	
LD2	NERROUT	Glows if there is any HW error in the IWR6843 sensor module	
LD3	USB	Glows if the USB enumerates	

Table 2 LED's Indication

3.6 Reset switch

Reference Designator	Usage	Comments	Image
SW1	RESET	This is used to RESET the mmWave Sensor. This signals also output on the 60-pin connector so an external processor can control the mmWave sensor Device.	

Table 3 Reset Switch

4 RUNNING THE OUT OF BOX DEMO

4.1 Quick Host PC Setup

1. If a Windows Host PC is used, Install the CP2105 Drivers from

   https://www.silabs.com/documents/public/software/CP210x_Windows_Drivers.zip

2. Open the mmWave Demo Visualizer from
   https://dev.ti.com/mmWaveDemoVisualizer

   If prompted to install browse extensions, install the extensions.

4.2 Identifying the COM Ports

When the 60GHz ODS AoPCB Module is powered on and connected to a Windows PC, the following COM ports appear in the Host PC's Device Manager.

AoPCB Port	Host PC COM Ports	Port Function
CFG_Port	Port: CP2105-Enhanced COM Port, Baud Rate: 115200	AoP Programming & Configuration
DATA_Port	Port: CP2105-Standard COM Port, Baud Rate: 921600	AoP MSS Logger Output (Point Cloud Data)

Table 4 UART Port Mapping

4.3 Running the Demos

For Running Out-of Box Demo, Follow the Procedure given below:

1. Ensure that the SOP switch (S3) is set to Functional Mode.
2. Connect AoP Module to Host PC via USB cable
3. Ensure PWR LED (LD1) glows (it indicates that the module gets correct power).
4. USB LED (LD3) glows and stays off, after successful USB enumeration.
5. Open mmWave Demo Visualizer in a browser.
6. In Options->Serial Port, configure the COM ports as mentioned in Table 4 UART Port Mapping.
7. Under the Plots tab, click 'LOAD CONFIG FROM PC AND SEND'. Select profile_2d.cfg file from the Profiles folder present in the zip package provided by Mistral.
8. Demo starts running and the detected object plot can be seen.

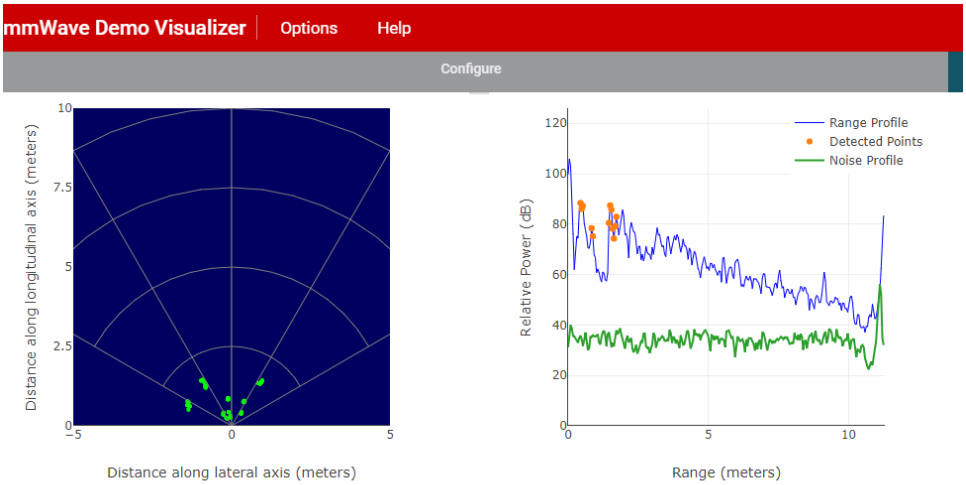


Figure 5 Out of Box Demo Output

If demo is not working, Check Status in "Console Messages" under "Configure" Tab.

5 OUT OF BOX DEMO DATA PACKET STRUCTURE

5.1 Packet Structure

A TLV (Type-Length-Value) encoding scheme is used with Little Endian Order. For Every Frame, Packet consists of a fixed Size Frame Header and then a Variable Number of TLV's depending on what was detected in that scene. The number of TLV's are depending based on the selection.

Figure 6 Packet Structure

5.2 Frame Header Structure

Size of Frame Header Structure is 40 Bytes.

Name	Type	Length (Bytes)	Comments
magicWord	uint16	8	Magic Word in Hex: 02 01 04 03 06 05 08 07
version	uint32	4	mmWave SDK Version
totalPacketLen	uint32	4	Including Header (in Bytes)
Platform	uint32	4	Platform Type
frameNumber	uint32	4	Frame Number (Starts from "1")
timeCpuCycles	uint32	4	Time in CPU Cycles when the Message was created
numDetectedObj	uint32	4	Number of Detected objects
numTLVs	uint32	4	Number of TLV's
subframeNumber	uint32	4	Sub-Frame Number

Table 5 Frame Header Structure

5.3 TLV Structure

Size of TLV Structure is 8 Bytes.

Name	Type	Length (Bytes)	Comments
type	uint32	4	TLV Type
length	uint32	4	TLV Length including TLV Header

Table 6 TLV Structure

5.4 Types of TLVs

1. Detected Points
2. Range Profile
3. Noise Floor Profile
4. Azimuth Static Heat Map
5. Range Doppler Heat Map
6. Statistics
7. Detected Points Side Info
8. Azimuth Elevation Static Heat Map
9. Temperature Statistics

Type	Length	Value
Detected Points	Number of Detected Objects * 16 Bytes	X, Y, Z and Velocity
Range Profile	Range FFT Size * 2 Bytes	Range Bins
Detected Points Side Info	Number of Detected Objects * 4 Bytes	SNR and Noise

Table 7 TLV Type Structure

For details on all TLV's, refer "`mmwave_sdk_03_05_00_04/packages/ti/demo/xwr68xx/mmw/docs/doxygen/html/index.html`"

6 60GHz ODS AoPCB Module Flash Programming

The AoPCB Boards are shipped with the default out of box demo software pre-programmed.
To program a custom software, follow the below given procedure.

6.1 Host PC Tool Dependency

The following tool versions are to be installed on Windows Host PC.

Tool	Version	Download Link
UniFlash	4.2 or later	http://software-dl.ti.com/ccs/esd/uniflash/uniflash_sl.4.2.1435.exe

Table 8 Tool Dependency

6.2 Programming 60GHz ODS AoPCB Module

1. Ensure that the SOP Switch (SW2) is set to Flash Programming Mode
2. Connect AoPCB Module to Host PC via USB cable
3. Open Uniflash tool, for older version select IWR1642, for newer versions select IWR6843 and click 'Start'

   Note: We have tested with Uniflash v4.2 by selecting IWR1443 as device and with Latest Version by selecting I/IWR6843
4. Under the Settings and Utilities tab, choose CFG_Port as the COM port. Refer Table 4 UART Port Mapping for correct identification of the COM ports
5. Under the 'Program' tab, browse to the binary file to be programmed for 'Meta Image 1'. In the release zip package provided by Mistral, the binary file is 'MS_IWR6843_ODS_AoPCB_v2_0.bin'
6. Click 'Load Image'
7. Check logs in the Console window to verify flashing status. After successful flashing, disconnect the board from the PC
8. Power OFF the Board
9. Set SOP Switches (SW2) back to Function Mode for Normal Radar Function

7 60GHZ ODS AoPCB Raw Data capture with DCA1000 EVM

60 GHz ODS AoPCB can be directly integrated with DCA1000 EVM which enables users to capture High-Speed LVDS data from the radar device and stream it over Ethernet.

60 pin High speed connector J1 of AoPCB is used to connect to the J3 input connector on the DCA1000 EVM. AoPCB supports 2 LVDS data lanes for capturing ADC data.

Follow the below given procedure for AoPCB Data Capture with DCA1000 EVM.

1. Mount ODS AoPCB on DCA1000 EVM as shown in Figure 9 AoPCB Data Capture with DCA1000 EVM demo setup.
2. Ensure that the SOP Switches (SW2) are set to Development Mode, refer SOP Switch Setting to set the radar module in development mode
3. On DCA100 EVM make sure power selection switch (SW3) position pointing towards DC_JACK_5V_IN as shown in below Figure 7 Switch 3 Positions.

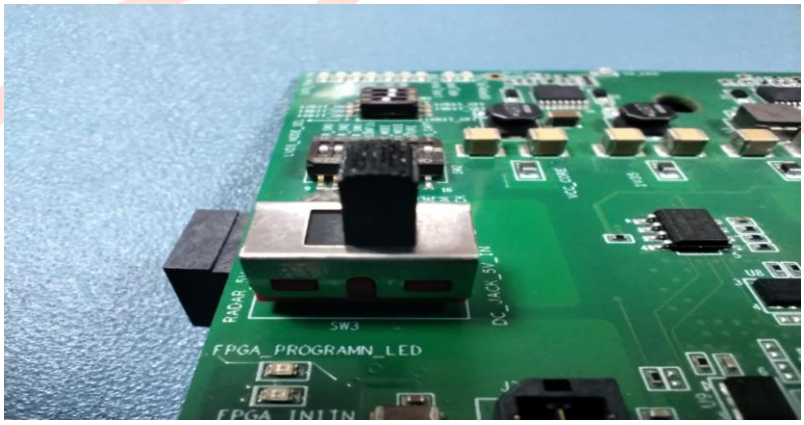


Figure 7 Switch 3 Positions

4. Power on DCA1000 EVM using 5V adaptor.
5. Connect AoPCB board to Host PC using Mirco USB cable (J3 on AoPCB) it will power ON the Radar module
6. Choose third COM port (COM199) from the listed COM Ports as similar shown in below image this will provide access to UART Enhanced COM port of AoPCB radar module.

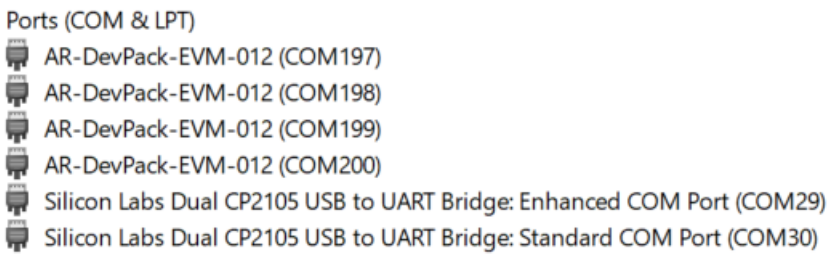


Figure 8 DCA1000 UART Ports

Note: To access the UART Enhanced COM port via USB of radar module, Unmount R243 on mmwave radar.

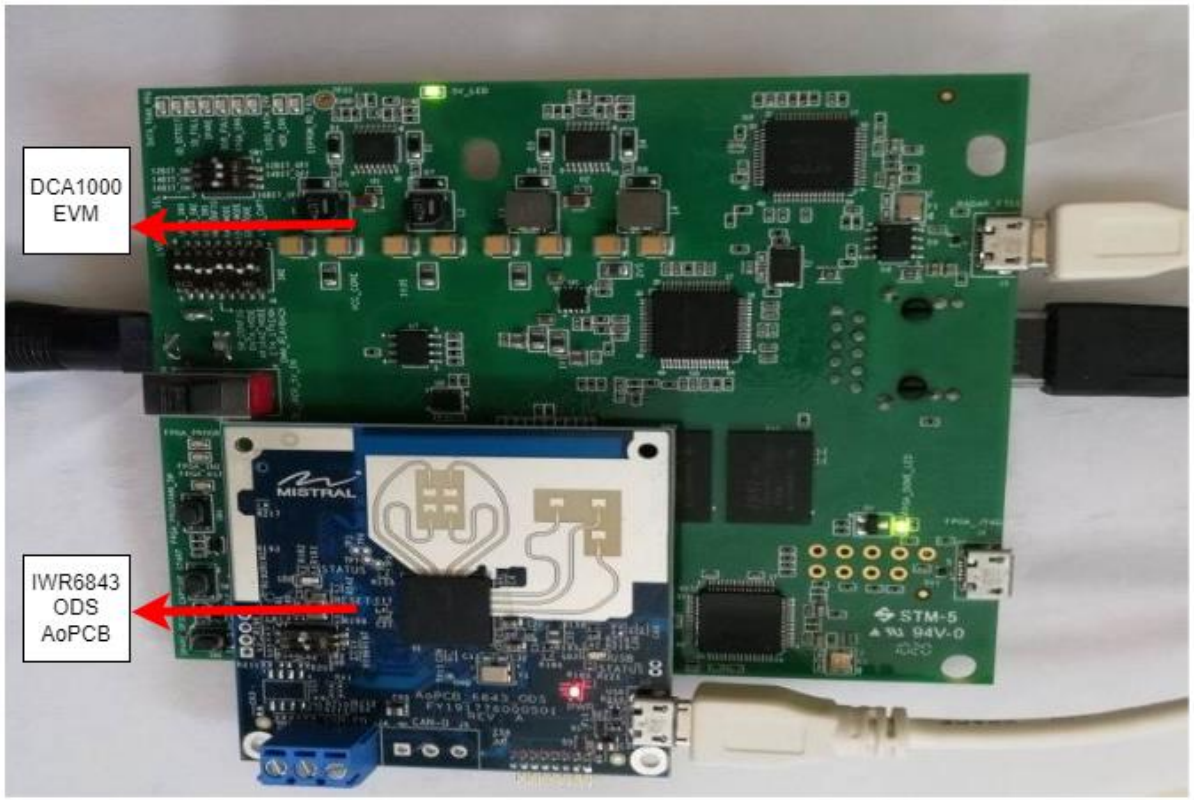


Figure 9 AoPCB Data Capture with DCA1000 EVM demo setup

8 External Connector Options

The ODS AoPCB RoM has the following connector provisions:

1. CAN-FD Connector Terminal Block (3x1,3.5mm Pitch)
2. Optional Header-double Row 16 pin right angle (8x2, 1.27mm pitch)
3. High Speed Connector (60 POS, 0.5mm pitch)
4. 2-pin Header for UART MUX select
5. 4-Pin I2C interface with power header (4x1,1.27mm pitch)

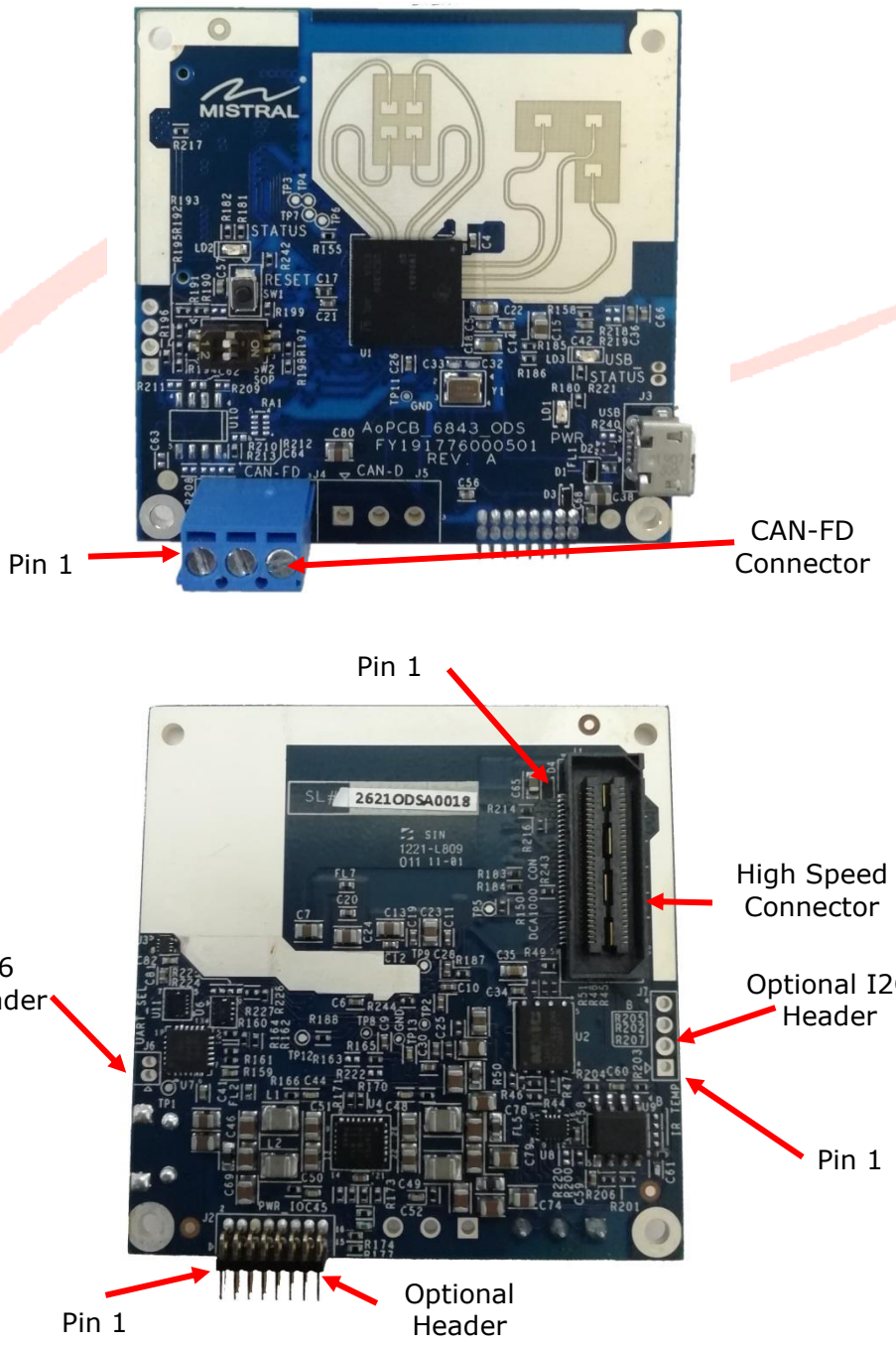


Figure 10 AoPCB Connector Options

8.1 CAN-FD Connector 3x1(J4)

Pin #	Pin Name	Description
1	CAN_FD_H	High level CAN bus input/output line
2	GND	Ground
3	CAN_FD_L	Low level CAN bus input/output line

Table 9 CAN-FD Connector

8.2 Optional Header 8x2(J2)

Mating Part**:** LPPB082CFFN-RC

Pin #	Pin Name	Description	Hardware Requirement
1	GND	Ground	
2	VIN_5V0	External 5V DC input, max of 1A current	
3	GND	Ground	
4	VIN_5V0	External 5V DC input, max of 1A current	
5	NERROR_OUT	Open drain fail safe output signal from Radar	
6	EXT_GPIO0	Can be used as GPIO_0/ Can be used as NRESET (Power on reset for Radar chip)	**To use as GPIO_0, R227 to be unpopulated.** **By default, R227 (0E) is populated to enable NRESET**
7	SYNC_IN_C	Radar Synchronization signal input	
8	MUX Control 1	MUX control (Default: high) from IWR6843 for SPI/CAN bus select	MUX control 1 - **High** for SPI Interface MUX control 1 - **Low** for CAN Interface
		Can be used as GPIO_1. If SPI/CAN is not used	To use GPIO, it requires Resistor **R225 (0E)** to be mounted. By default, it's unpopulated.
		Can be used as SOP2 to switch the Radar operation from functional mode to Flash	To use SOP2, it requires Resistor **R224 (0E)** to be mounted. By default, it's unpopulated.

		mode.	MUX control 1 - **High** for FLASHING Mode MUX control 1 - **Low** for FUNCTIONAL Mode
9	SPI_CS	SPI interface CS by default/ Can be used as GPIO_30	
10	MUX Control 2	Can be used as GPIO_2	
		1. MUX Control 2(GPIO_2) selects mux control either to route UART signals to USB or External header. Refer to Figure 8.	It requires Resistor **R218 (0E)** to be mounted. By default, it's unpopulated. MUX control 2 - **High** for UART over USB MUX control 2 – **Low** for EXT_UART via Header. In the firmware add code to set GPIO_2 accordingly.
		2. Can have manual mux control for USB_UART/EXT_UART selection with Resistor option	USB_UART → Default state (R158-10K populated, R219 -10K is unpopulated) EXT_UART → Unpopulate R158, populate R219.
		3. Can have manual mux control for USB_UART/EXT_UART selection by having jumper on J6 header.	To enable this option mount **J6** (1x2) header on AoPCB board. (By default, R158 populated, R219 is unpopulated) USB_UART → without Jumper EXT_UART → Insert Jumper (Part# M50-1900005) on **J6** header.
11	SPI_CLK	SPI interface Clock by default/ Can be used as GPIO_3	
12	EXT_LOGGER	UART Data Logger Output from AoPCB	
13	EXT_UART_TXD	UART Command TXD from AoPCB	
14	SPI_MISO	SPI interface MISO by default/ Can be used as GPIO_20	
15	EXT_UART_RXD	UART Command RXD to AoPCB	

16	SPI_MOSI	SPI interface MOSI by default/ Can be used as GPIO_19	

Table 10 Optional Header 8x2

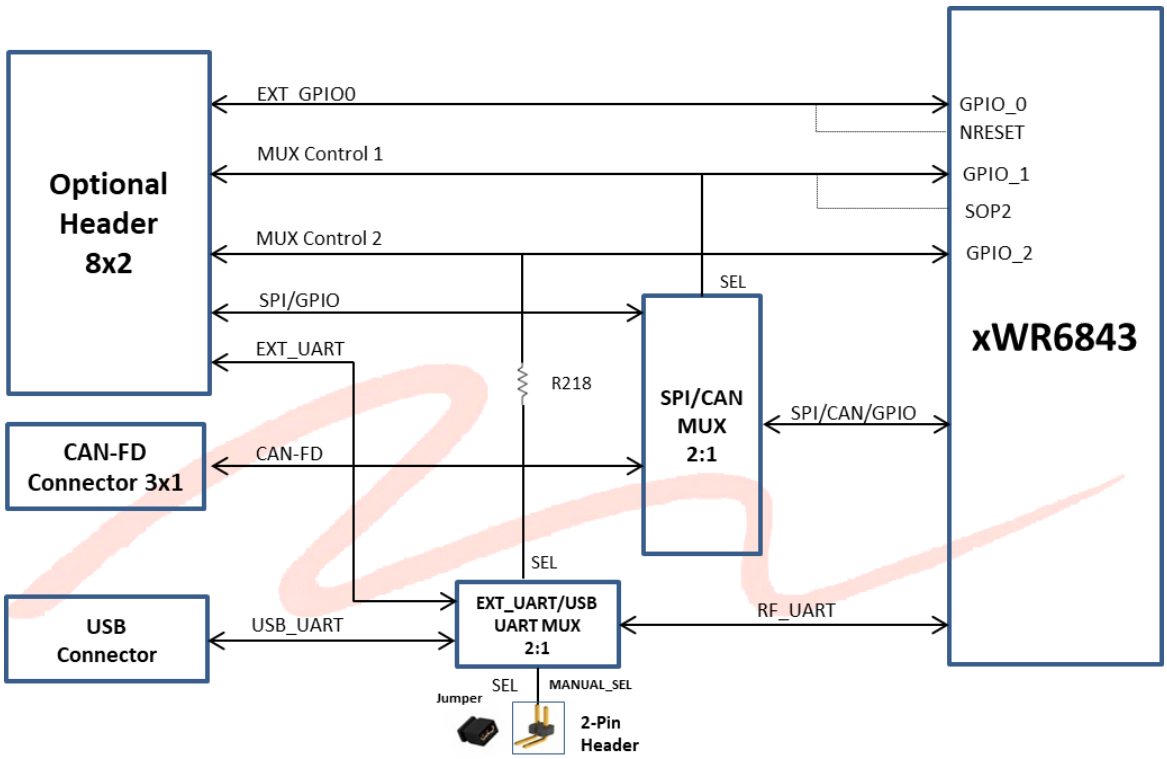


Figure 11 Optional Header interface Block Diagram

8.3 2 - Pin Header (J6)

By default, this connector is not populated on AoPCB board. Connector shall be mounted based on the customer requirement.
Connector Part: GRPB021VWCN-RC
Mating Part: NPB02SVAN-RC (Shunt Connector)

Pin #	Pin Name	Description
1	GND	Ground
2	UART_MUX_EN	Mux control either to route UART signals to USB or High-speed connector

Table 11 2 - Pin Header

8.4 4-Pin I2C with Power Header (J7)

By default, this connector is not populated on AoPCB board. Connector shall be mounted based on the customer requirement.
Connector Part: TMM-104-01-T-S
Mating Part: MMS-104-01-T-SV

Pin #	Pin Name	Description
1	VCC_3V3	3.3V supply.
2	GND	Ground
3	I2C_SCL	SCL signal
4	I2C_SDA	SDA signal

Table 12 4 - Pin Header

8.5 High Speed Connector 60 Pin (J1)

Mating Part: QTH-030-01-L-D-A (5mm Stack Height)
QTH-030-02-L-D-A-K-TR (8mm Stack Height)
QTH-030-03-L-D-A-K-TR (11mm Stack Height)

Pin #	Pin Name	Description	Pin #	Pin Name	Description
1	VCC_FR_5V0	5V Input to AoPCB	2	VCC_FR_5V0	5V Input to AoPCB
3	VCC_FR_5V0	5V Input to AoPCB	4	JTAG_TDO	JTAG TDO Signal
5	JTAG_TDI	JTAG TDI Signal	6	JTAG_TCK	JTAG TCK Signal
7	SPI_CS	SPI interface CS	8	JTAG_TMS	JTAG TMS Signal
9	SPI_CLK	SPI interface Clock	10	SPI_HOST_INT	O/P Interrupt to an Ext- host communicating over SPI
11	SPI_MOSI	SPI interface MOSI	12	SPI_MISO	SPI interface MISO
13	PMIC_PGOOD	PGOOD o/p from AoPCB	14	NERROR_OUT	NERROR output from xWR AoPCB
15	RADAR_DMM_CLK	DMM clock	16	SYNC_IN	Frame Synchronization Input to AoPCB
17	RADAR_DMM_SYNC	DMM sync	18	GND	Ground
19	RADAR_DP0	DMM Data0	20	NC	No Connect
21	RADAR_DP1	DMM Data1	22	NC	No Connect
23	RADAR_DP2	DMM Data2	24	GND	Ground
25	RADAR_DP3	DMM Data3	26	LVDS_FRCLK_P	LVDS Frame Clock +
27	RADAR_DP4	DMM Data4	28	LVDS_FRCLK_N	LVDS Frame Clock -
29	RADAR_DP5	DMM Data5	30	GND	Ground
31	RADAR_DP6	DMM Data6	32	NC	No Connect
33	RADAR_DP7	DMM Data7	34	NC	No Connect
35	NC	No Connect	36	GND	Ground
37	NC	No Connect	38	NC	No Connect

39	UART_MUX_EN	To access UART MUX control signal through High-Speed connecter, mount the R243 resister on AoPCB radar module. (By default, R243 resister is mounted) To access the UART signals from AoPCB radar module, unmount the R243 resister on AoPCB radar module.	40	NC	No Connect
41	NC	No Connect	42	GND	Ground
43	NC	No Connect	44	LVDS_CLK_P	LVDS Clock pair +
45	NC	No Connect	46	LVDS_CLK_P	LVDS Clock pair -
47	EXT_SOP2	SOP2 control to switch the Radar operation from Functional mode to Flash mode. To enables this Resistor **R224 (0E)** to be mounted.	48	GND	Ground
49	LOGGER_60PIN	DATA LOGGER output from AoPCB. To enable this, Resistor **R222 (0E)** to be mounted.	50	LVDS_TX1_P	LVDS data pair 1 +
51	I2C_SDA	I2C Data	52	LVDS_TX1_N	LVDS data pair 1 +
53	I2C_SCL	I2C Clock	54	GND	Ground
55	UART_RX	UART RXD to AoPCB	56	LVDS_TX0_P	LVDS data pair 0 +
57	UART_TX	UART TXD from AoPCB	58	LVDS_TX0_N	LVDS data pair 0 -
59	NRESET	Reset Input to AoPCB	60	GND	Ground

Table 13 60 - Pin Connector

9 AoPCB Mechanical Drawing

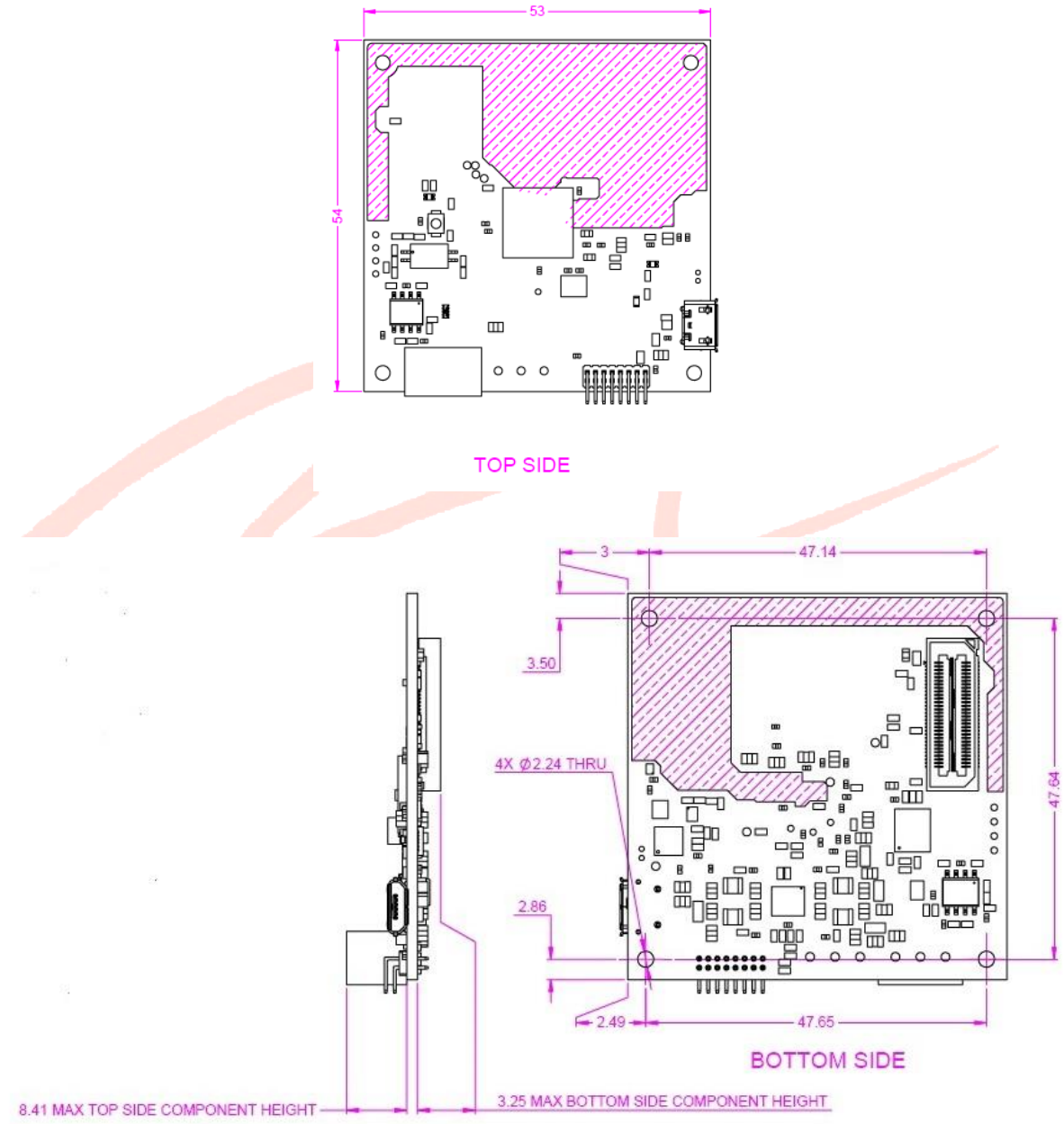


Figure 12 Mechanical Drawing

10 ADDITIONAL INFORMATION

Please refer the following links:

- MMW SDK Latest Page: http://software-dl.ti.com/ra-processors/esd/MMWAVE-SDK/latest/index_FDS.html
- MMW SDK Release Note: http://software-dl.ti.com/ra-processors/esd/MMWAVE-SDK/latest/exports/mmwave_sdk_release_notes.pdf
- MMW SDK User Guide: http://software-dl.ti.com/ra-processors/esd/MMWAVE-SDK/latest/exports/mmwave_sdk_user_guide.pdf

11 SUPPORT INFORMATION

11.1 Contact

In case of questions contact Mistral Solutions Pvt Ltd.

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