

Raw Data Capture for XWR6843 Device Using DCA1000 Board and mmWave Studio

Scope of the training

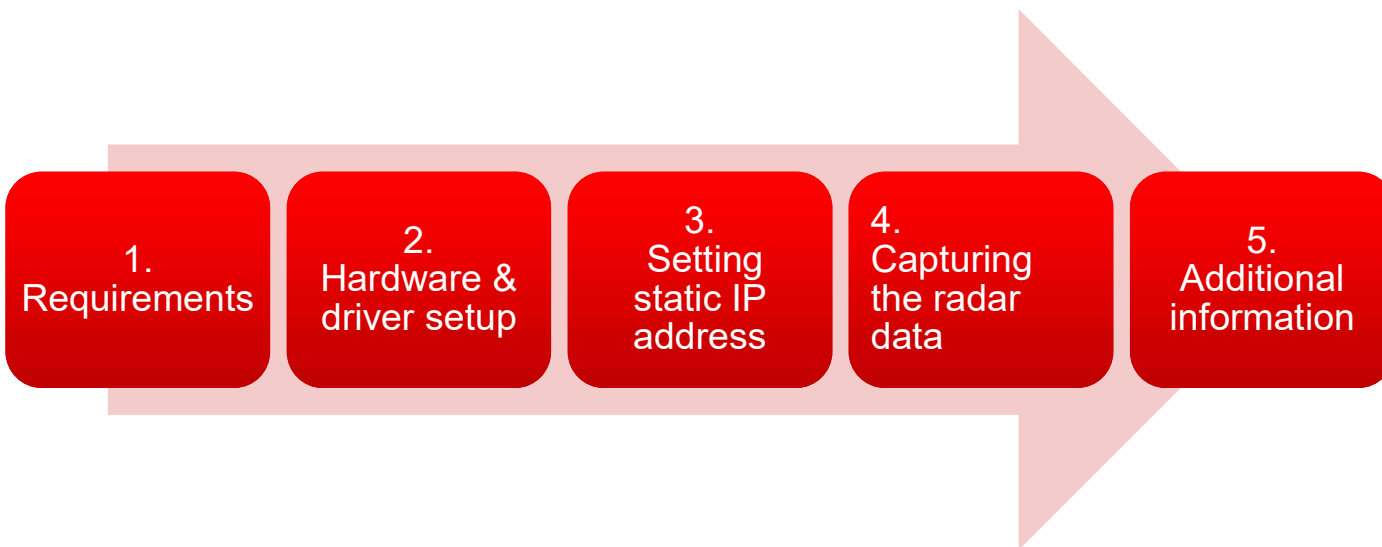
This training will help you getting started on capture raw ADC data from TI's mmWave sensor devices using the DCA1000 capture card and mmWave studio tool used to configure the mmWave front end.

Once you get started you can refer to the mmWave studio user guide

(http://software-dl.ti.com/ra-processors/esd/MMWAVE-STUDIO/latest/exports/mmwave_studio_user_guide.pdf)

and DCA1000 user guide (<http://www.ti.com/lit/pdf/spruij4>) for more advanced options.

Steps



Requirements

1.
Requirements

2

3

4

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- Hardware

- [xWR6843](#) / [Carrier board](#), 5 V / >2.5 A [power supply](#), micro USB cable (cables are part of the kit)
- [DCA1000 EVM](#), 5 V / >2.5 A [power supply](#), micro USB cable, RJ45 Ethernet cable, 60pin Samtec cable (cables are part of the kit)

- Software

- [mmWave Studio](#)
- [MatLab Runtime Engine v8.5.1](#)
- If you do not have Code Composer Studio v7.1 or higher installed:
 - [XDS Emulation Software Package](#) v6.0.579.0 or higher

Hardware Setup (1) - Configure Antenna Module

1

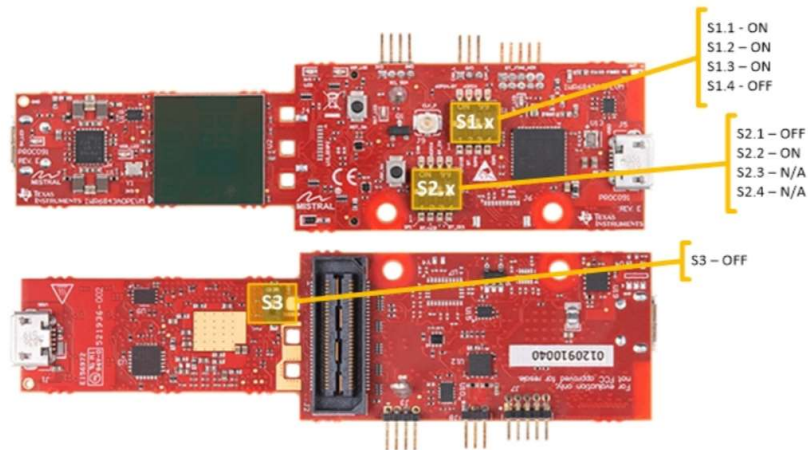
2.
Hardware setup

3

4

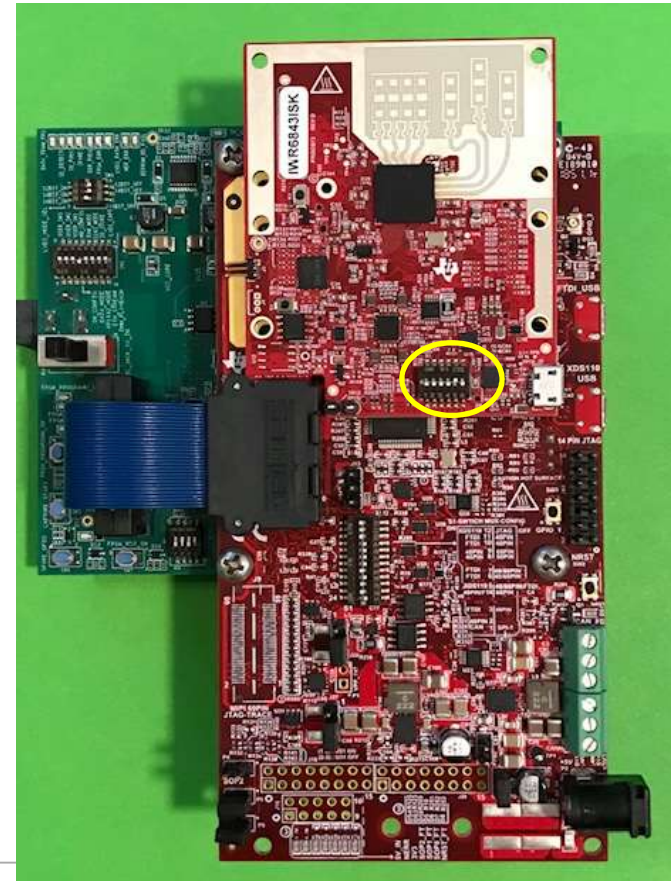
5

- This step only applies if using the AOPEVM antenna module.
- This information can be found in the ICBOOST users guide at:
<https://www.ti.com/lit/ug/swru546c/swru546c.pdf>
- To use the AOPEVM as an antenna module in conjunction with the ICBOOST carrier card the switches need to be set as shown to route signals from the carrier card through the 60Pin header.



Hardware Setup (1) - Configure xwr6843ISKEVM Rev D

- This step only applies when using the xwr6843ISKEVM RevD antenna module or xwr6843ISK-ODSEVM RevD **with ICBOOST carrier board**.
- This information can be found in the ICBOOST users guide at:
<https://www.ti.com/lit/ug/swru546c/swru546c.pdf>
- To use RevD EVM as an antenna module in conjunction with the ICBOOST carrier card, the switches (highlighted in yellow cycle) need to be set as shown to route signals from the carrier card through the 60Pin header.

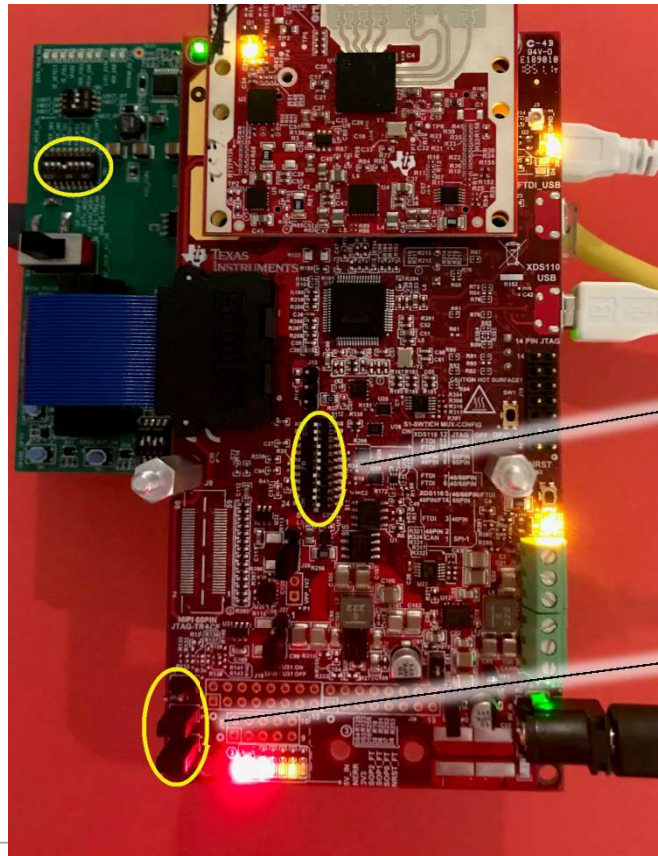


Hardware setup (2) - Mount Antenna Module

- If using the xwr6843ISK or wr6843ISK-ODS antenna module, both 60Pin connectors will be used.
- If using the standalone module like xwr6843ISK RevD or xwr6843ISK-ODS RevD or AOPEVM module, only the right connector closer to the micro-usb connectors will be connected.
- The mounted modules should appear as shown below.



Hardware setup (3) – switch setting



Please use the left figure to match

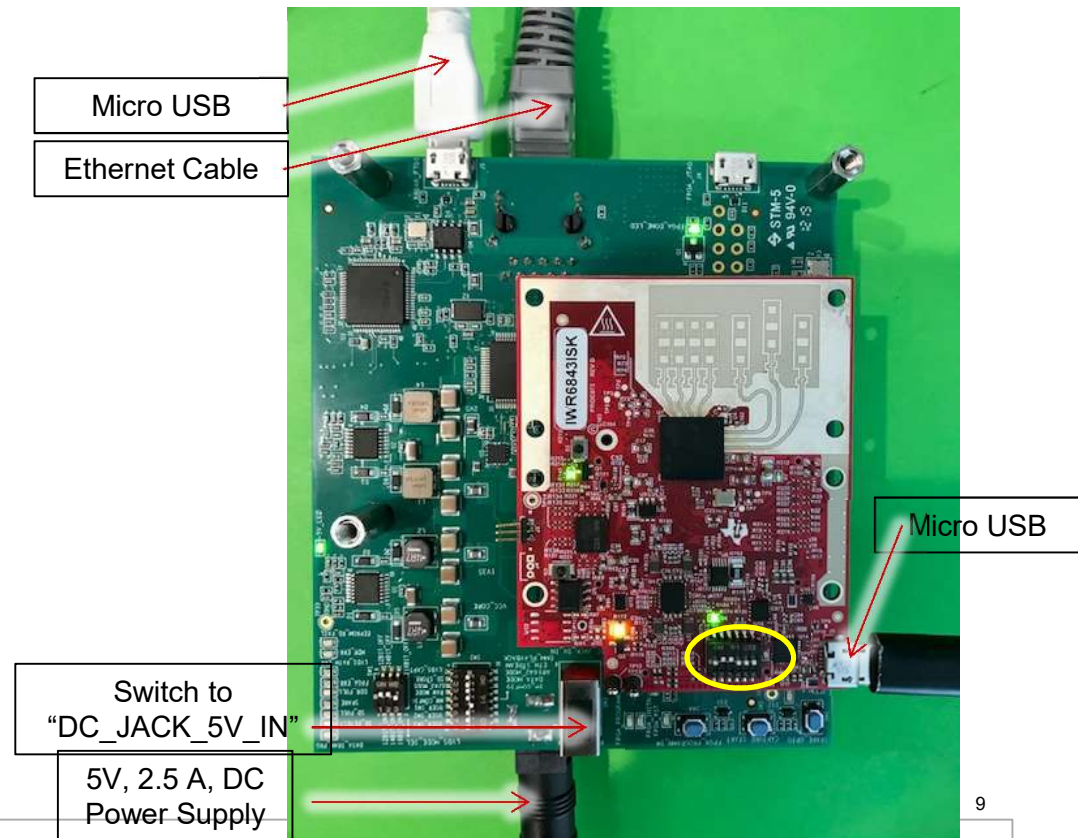
- SW2 setting on the DCA1000 board
- Switch S1 setting on the ICBOOST
- SOP setting on the ICBOOST

SOP name	Setting
SOP2	OFF
SOP1	ON
SOP0	ON

Switch name	Setting when connect with DCA
S1.12	ON
S1.11	ON
S1.10	ON
S1.9	OFF
S1.8	OFF
S1.7	OFF
S1.6	OFF
S1.5	ON
S1.4	OFF
S1.3	ON
S1.2	ON
S1.1	OFF

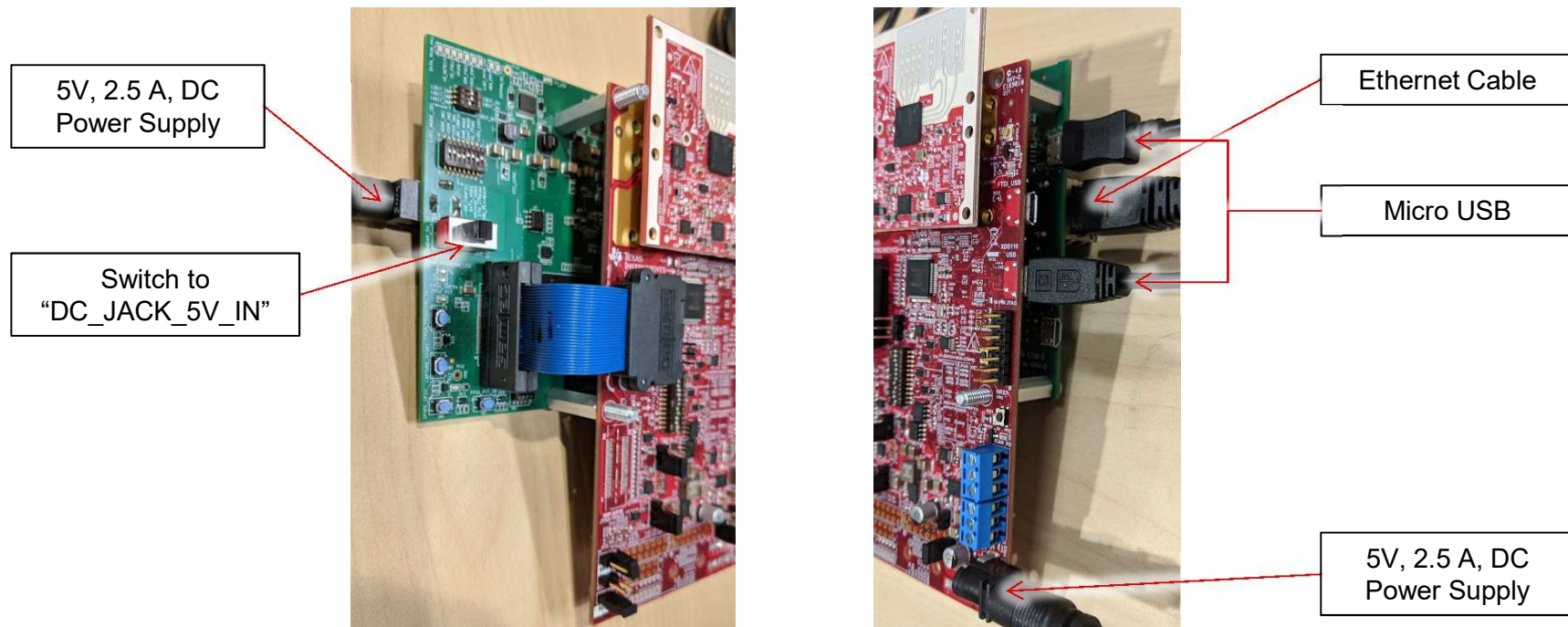
Hardware Setup (4) – xwr6843EVM RevD + DCA1000

- This step only applies when using the xwr6843ISKEVM RevD antenna module or xwr6843ISK-ODSEVM RevD **without ICBOOST carrier board**.
- This information can be found in the ICBOOST users guide at:
<https://www.ti.com/lit/ug/swru546c/swru546c.pdf>
- To use RevD EVM as an antenna module directly with DCA1000, the switches (highlighted in yellow circle) need to be set as shown.
- Note that on RevD board, power is supply via USB connector.



Hardware setup (4)

The DCA1000 and the xWR EVM are powered with 5 V, 2.5 A supplies. Micro USB cable and Ethernet cables are connected for PC interface.



FTDI and XDS driver

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2.
Driver setup

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- If you do not have Code Composer Studio v7.1 or higher installed:
 - Install the XDS Emulation Software Package.
- Connect the DCA1000 and the EVM to your PC through USB cables and power.
- In the Windows Device Manager, the COM ports should appear as this when their drivers are installed:
- The FTDI device ports of the DCA1000 board will appear with a yellow label when the driver is not installed.
 - In this case, right-click on this symbol, select “Update Driver Software”, “Browse my computer for driver software”, select the below directory, and tick “Include subfolders”.
~\mmwave_studio_xx_xx_xx_xx\ftdi
 - This needs to be done for each of the 4 ports. In some cases you might need to do it twice for the 1st port or each of the 4 ports.



Setting static IP address

1

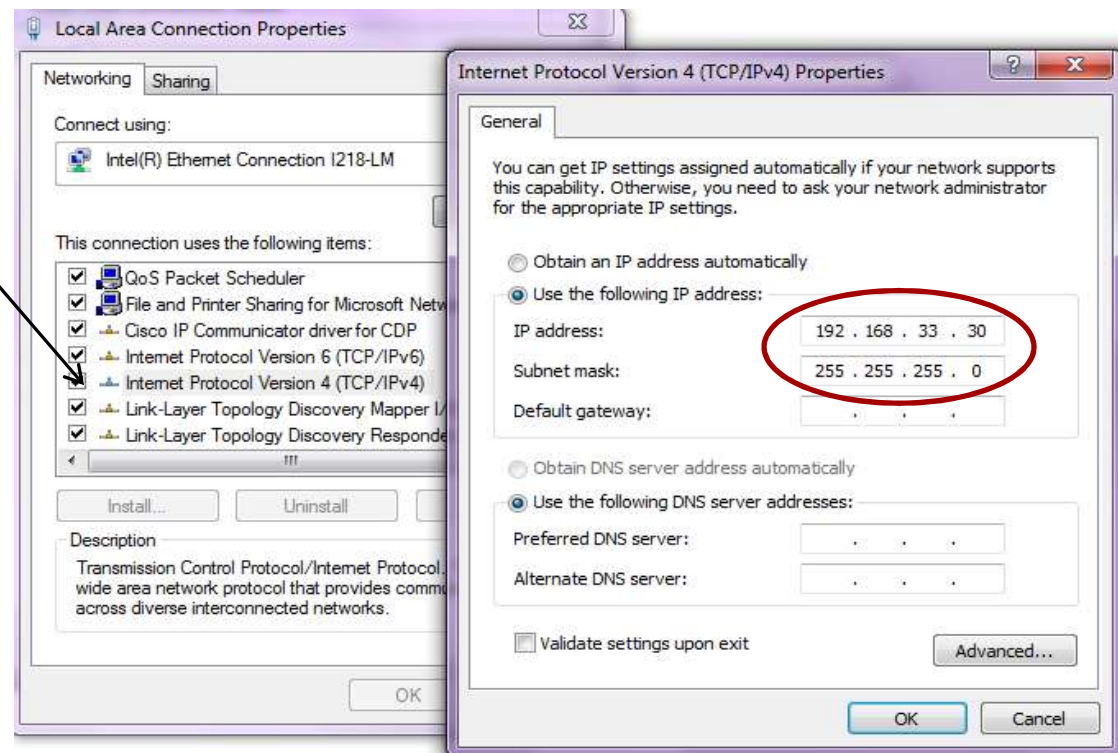
2

3.
Setting static IP address

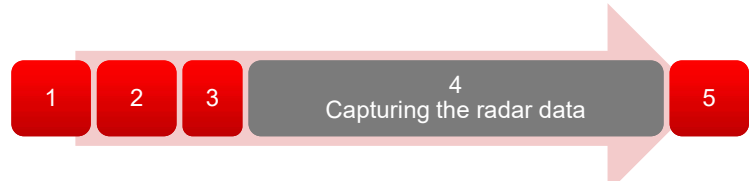
4

5

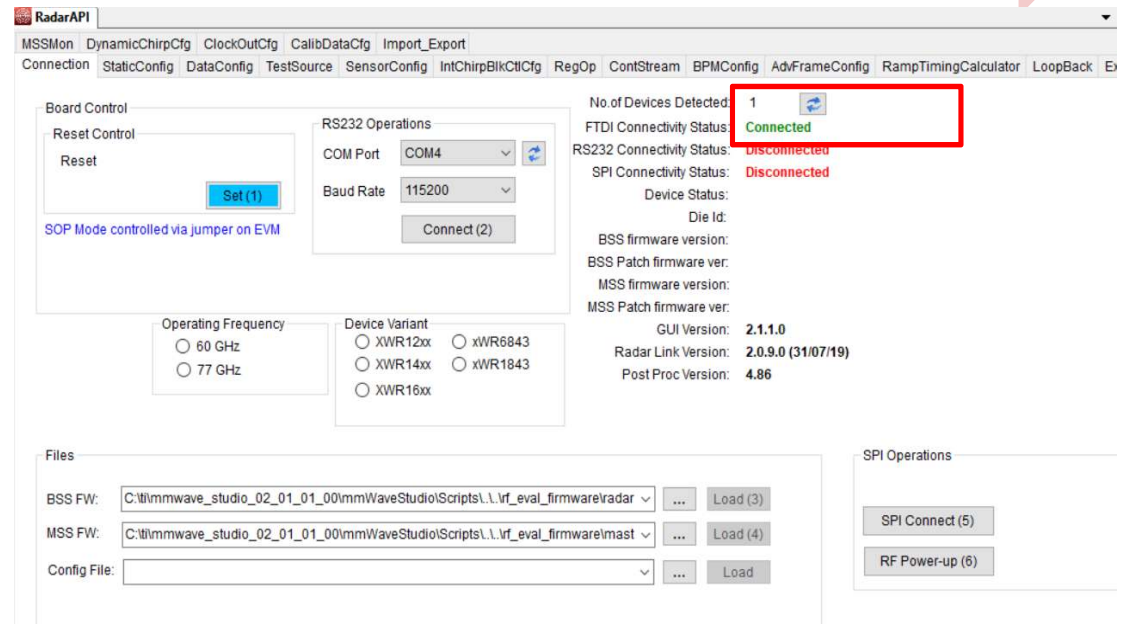
- Connect the Ethernet cable between the DCA1000 and the PC.
- In the PC local area network properties select TCP/IPv4.
- Set static IP address of 192.168.33.30.
- Subnet mask as 255.255.255.0



Capturing the radar data (4.1)



1. Run mmWave Studio from the installation location (~\mmwave_studio_<ver>\mmWaveStudio\RunTime\mmWaveStudio.exe). You can also create a short for easy access.
2. The Connection window should show up with FTDI Connectivity highlighted in green. If in red, install the FTDI drivers (see section 2).



Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.2)

1

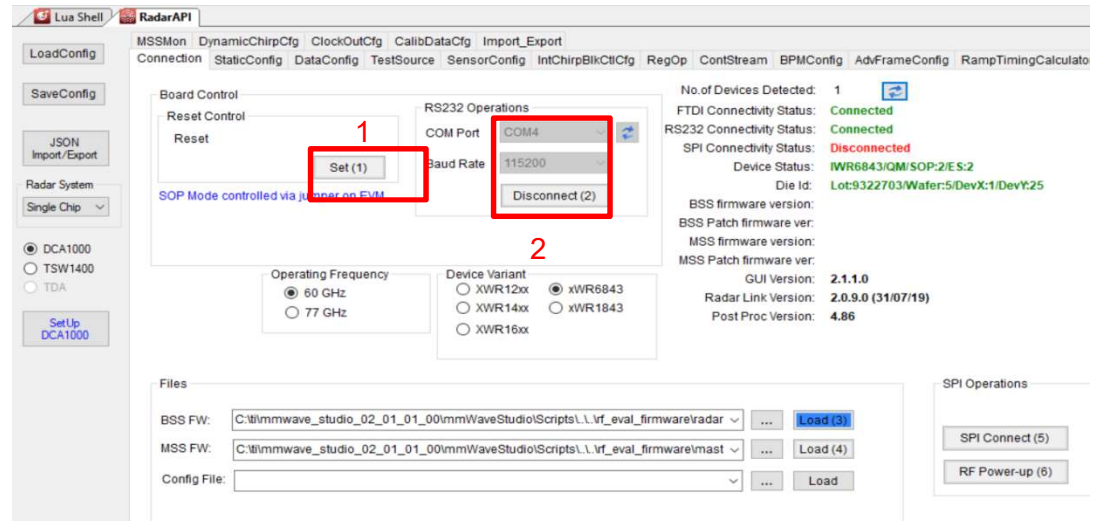
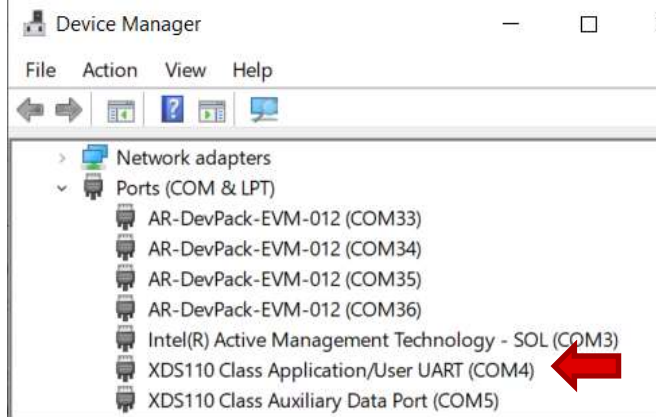
2

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4
Capturing the radar data

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1. “Reset Control” click ‘Set(1)’
2. “RS232 Operations” Select the COM port listed in device manager as Application/User port number, Baud rate 115200.
3. Click ‘Connect’. The RS232 Connectivity should turn to ‘Disconnect’. The Device status should show based on the radar device used.



Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.2.2)

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Capturing the radar data

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1. This page only applied to the AOP device.
2. In the case of AOP device, after reset and RS232 connection, the device name is not automatically detected. User has to program the “operation frequency” and “device variant” manually. And the order matters.

The screenshot shows the RadarAPI software interface. The top menu bar includes: Lua Shell, RadarAPI, MSSMon, DynamicChirpCfg, ClockOutCfg, CalibDataCfg, Import_Export, Connection, StaticConfig, DataConfig, TestSource, SensorConfig, IntChirpBlkCtlCfg, RegOp, ContStream, BPMConfig, AdvFrameConfig, and RampTimingCalculator. The main panel is divided into several sections:

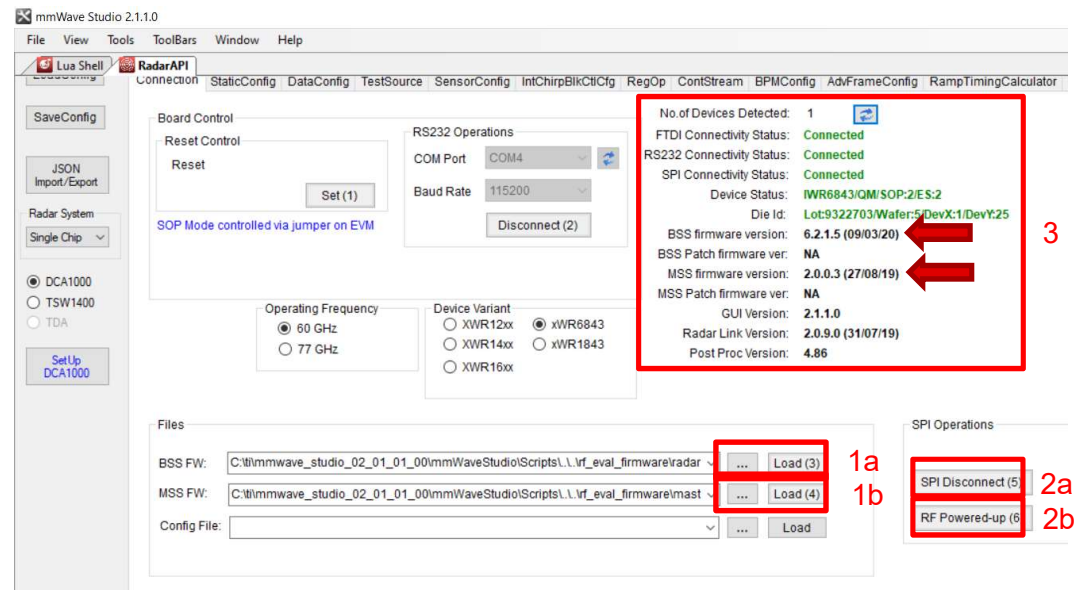
- Board Control:** Includes a 'Reset Control' section with a 'Reset' button and a 'Set (1)' button. Below it, a note says 'SOP Mode controlled via jumper on EVM'.
- RS232 Operations:** Includes a 'COM Port' dropdown set to 'COM4', a 'Baud Rate' dropdown set to '115200', and a 'Disconnect (2)' button.
- Operating Frequency:** A section with two radio buttons: '60 GHz' and '77 GHz'. This section is highlighted with a red box and labeled '1'.
- Device Variant:** A section with four radio buttons: 'XWR12xx', 'XWR14xx', 'XWR16xx', and 'xWR6843'. This section is highlighted with a red box and labeled '2'.
- Device Information:** A section on the right showing various status and version information:
 - No. of Devices Detected: 1
 - FTDI Connectivity Status: Connected
 - RS232 Connectivity Status: Connected
 - SPI Connectivity Status: Disconnected
 - Device Status: UnDetDe/QM/SOP:2/ES:2 (highlighted with a red box)
 - Die Id: Lot:3929529/Wafer:19/DevX:6/DevY:11
 - BSS firmware version:
 - BSS Patch firmware ver:
 - MSS firmware version:
 - MSS Patch firmware ver:
 - GUI Version: 2.1.1.0
 - Radar Link Version: 2.0.9.0 (31/07/19)
 - Post Proc Version: 4.86

Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.3)

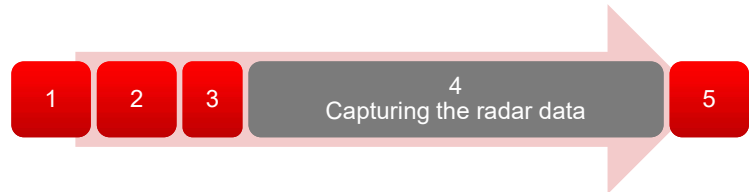


1. **“Files”** load the appropriate BSS (radarss.bin) , then MSS firmware (Masterss.bin) from the “~\mmwave_studio_<ver>\rf_eval_firmware” folder. The binary is based on the device variant being used (1243/1443/1642/6843)
2. The silicon PG version being (ES1.0, ES2.0, ES3.0) supported by the firmware is listed in the radar studio release notes. The firmware for an older PG version can be found in the older version of the radar studio.
3. **“SPI Operations”** Click ‘SPI Connect(5)’ then ‘RF Power-up(6)’
4. Once the firmware is loaded, the firmware and patch versions are displayed.



Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.4)



- StaticConfig tab:

1. Select the desired TX and RX channels that you would want to use. In ADC Config, select desired ADC configuration and click SET
2. If board is provided 1V RF supply Enable the RF LDO Bypass, if its 1.3V leave it unchecked. Click the Advanced Configuration Set button.
3. LP mode select 'Regular ADC' mode
4. Click the RF Init Done button.

The screenshot shows the 'Static Configuration' window with three main sections: Basic Configuration, Advanced Configuration, and ADC Config. Red boxes and numbers highlight specific actions:

- 1**: A red box labeled '1' is around the 'Set' button at the bottom of the ADC Config section.
- 2**: A red box labeled '2' is around the 'Set' button at the bottom of the Advanced Configuration section.
- 3**: A red box labeled '3' is around the 'RF Init Done' button in the Radar Miscellaneous Control section.

Capturing the radar data (4.5)



- In the DataConfig tab,
 1. select the data path config (ADC_ONLY) and click Set button.
 2. Select the clock rate and click set.
 3. Select the LVDS lanes and click set.

Data Configuration

Data Path Configuration

Data Path	LVDS	Virtual Channel No	0	CQ Cfg	16 Bit
Packet 0	ADC_ONLY			CQ0TransSize (16bit)	132
Packet 1	Suppress Pac			CQ1TransSize (16bit)	132
				CQ2TransSize (16bit)	72

Set 1

Clock Configuration

Lane Clock	DDR Clock
Data Rate	600 Mbps

Set 2

LVDS Lane Configuration

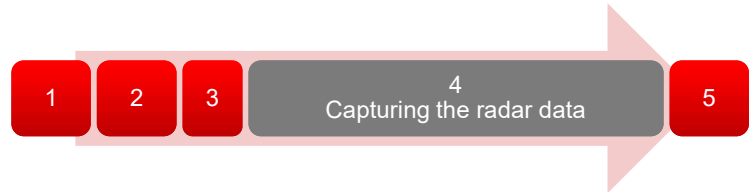
Lane Format	Format 0
Lane Config	<input checked="" type="checkbox"/> Lane1 <input checked="" type="checkbox"/> Lane2 <input type="checkbox"/> Lane3 <input type="checkbox"/> Lane4
	<input checked="" type="checkbox"/> MSB First <input type="checkbox"/> CRC
	<input type="checkbox"/> Packet End Pulse

CSI2 Lane Configuration

Lane0 Position	Lane0 Polarity	Lane1 Position	Lane1 Polarity
1	<input type="checkbox"/> +/- Pin Order	2	<input type="checkbox"/> +/- Pin Order
Lane2 Position	Lane2 Polarity	Lane3 Position	Lane3 Polarity
4	<input type="checkbox"/> +/- Pin Order	5	<input type="checkbox"/> +/- Pin Order
Clock Position	Clock Polarity		
3	<input type="checkbox"/> +/- Pin Order		

Set 3

Capturing the radar data (4.6)



• SensorConfig tab

1. select the required Profile configuration. These define the FMCW chirp profile.
2. Select the chirp configuration.
3. Select the frame configuration.
4. Select the Dump file path name.

For more details on selecting the values for profile , chirp and frame configuration refer to the app note [“Programming Chirp Parameters in TI Radar Devices”](#)

Capturing the radar data (4.7)

1

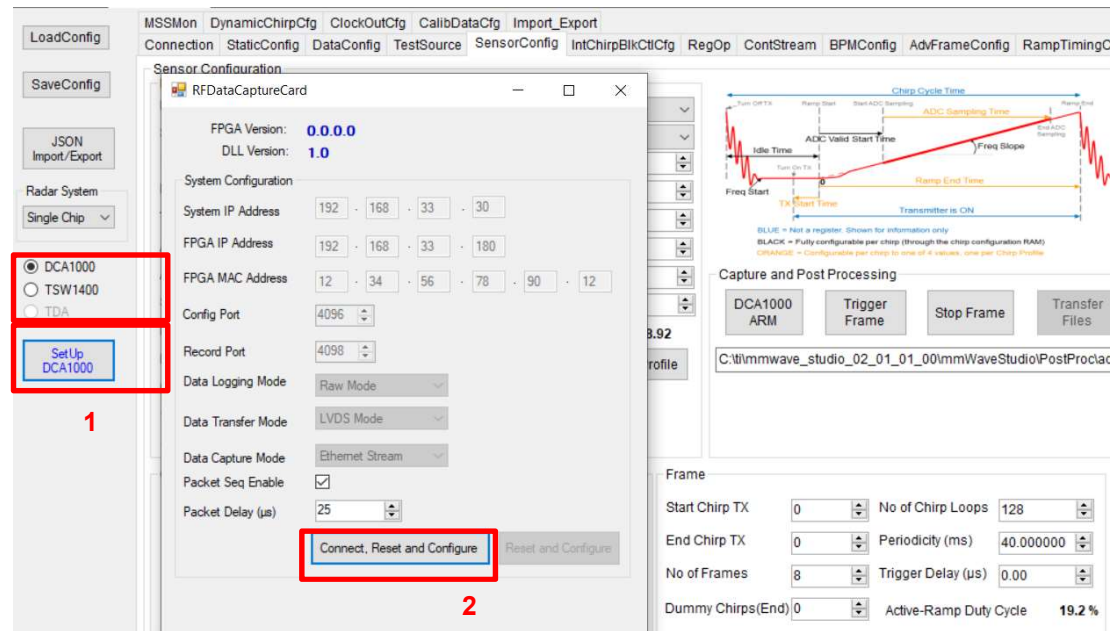
2

3

4
Capturing the radar data

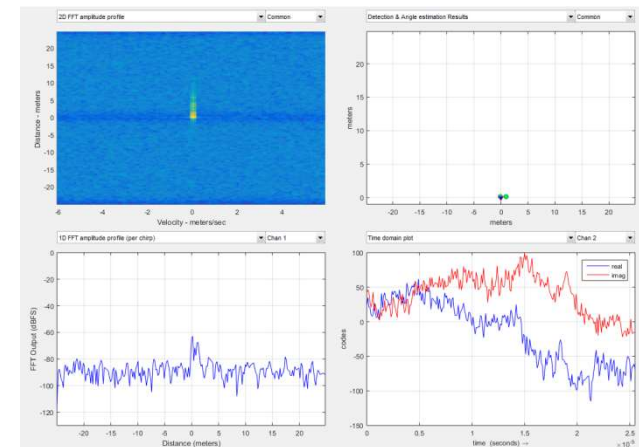
5

- Select 'DCA1000' and click on 'SetUp DCA1000'
- Click on "Connect, Reset and configure". This would establish the Ethernet connection and display the FPGA versions. Verify that the FPGA version is correct.
- Note that in case the connection fails make sure the static IP is set correctly, Ethernet cable is plugged in correctly, WIFI is disabled and the ports 4096 and 4098 are accessible in the PC used, i.e. there is no firewall blocking the ports.

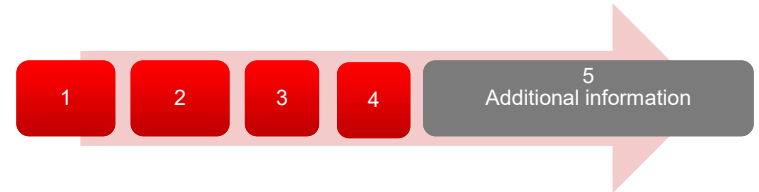


Capturing the radar data (4.8)

- Click on DCA1000 ARM and then Trigger Frame. At this point the radar starts sending out ADC data and DCA1000 starts capturing it.
- Once the capture is complete , click on 'Post Proc'.
- At this point the .bin file specified in the “Dump File” dialog box is created and the captured data is processed.
- The post processing utility displays the FFT, time domain and other analyses plots
- For details on the post processing analyses options and file formats refer the mmWave studio user guide.
- Below are some of the Post Proc plots available:
 - Range-Angle plot
 - Time domain plot
 - 2D FFT amplitude profile
 - 1D FFT amplitude profile
 - Phase stability across Chirps
 - Amplitude stability across Chirps
 - Noise Cloud plots

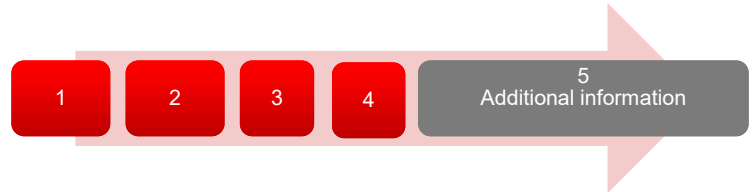


Data file format (1)



- Configuration:
 - n LVDS Lanes, complex data, n channels, chirping/continuous streaming mode
- Notation:
 - Rx k In: The n^{th} in-phase sample corresponding to k^{th} RX channel.
 - Rx k Qn: The n^{th} quadrature-phase sample corresponding to k^{th} RX channel.
 - N: The number of samples per chirp.
- Note that since the data is captured using a UDP protocol over Ethernet interface , there could be occasional packets drops. The data from the dropped packets is filled with zeros in the file and can be ignored for analyses.

Data file format (2)



Sample binary file produced by mmWave

```

1  95ff 80ff e3ff e0ff 7bff 60ff f1ff f4ff
2  75ff 79ff e2ff fdff 72ff 6eff 1b00 3d00
3  48ff 19ff 3d00 4300 e2fe cafe 0900 f9ff
4  b1fe 90fe d7ff a8ff 9ffe bcfe 77ff 4bff
5  b7fe d2fe 38ff 1fff e3fe 11ff 1eff 2cff
6  47ff 34ff 41ff 5cff 4cff 54ff 7cff 6aff
7  44ff 2fff 6bff 5cff 0cff 29ff 20ff 20ff
8  2aff 3aff fdfe effe 68ff 74ff 11ff 26ff
9  87ff 73ff 45ff 35ff 6fff 78ff 3aff 4fff
10 4bff 47ff 29ff 3dff 64ff 5eff 45ff 48ff
11 4aff 4cff 4dff 3aff 4dff 47ff 37ff 37ff
12 38ff 47ff 28ff 38ff 58ff 8cff 2eff 43ff
13 acff 97ff 80ff 9bff 8cff 88ff 9aff b9ff
14 78ff 5eff b0ff 99ff 52ff 40ff 98ff 8dff
15 30ff 23ff 85ff 64ff 33ff 40ff 3eff 32ff
16 5cff 77ff 5cff 74ff 57ff 64ff 78ff 89ff
17 62ff 6aff 8fff 83ff 50ff 6aff 68ff 62ff
18 76ff 66ff 75ff 8dff 77ff 52ff 99ff 8eff
19 55ff 43ff 7bff 6cff 37ff 5bff 3fff 3cff
20 7fff adff 48ff 71ff cdff d2ff 9bff c3ff
    
```

6843 non- interleaved format- complex 4 channel

Chirp 1	Rx0I0	Rx0I1	Rx0Q0	Rx0Q1	Rx0I2	Rx0I3	Rx0Q2	Rx0Q3
	Rx0I4	Rx0I5	Rx0Q4	Rx0Q5	Rx0I6	Rx0I7	Rx0Q6	Rx0Q7

	Rx3IN-4	Rx3IN-3	Rx3QN-4	Rx3QN-3	Rx3IN-2	Rx3IN-1	Rx3QN-2	Rx3QN-1
Chirp 2	Rx0I0	Rx0I1	Rx0Q0	Rx0Q1	Rx0I2	Rx0I3	Rx0Q1	Rx0Q3
	Rx0I4	Rx0I5	Rx0Q4	Rx0Q5	Rx0I6	Rx0I7	Rx0Q6	Rx0Q7

	Rx3IN-4	Rx3IN-3	Rx3QN-4	Rx3QN-3	Rx3IN-2	Rx3IN-1	Rx3QN-2	Rx3QN-1

- From mmWave studio the raw ADC data (without any headers) is stored in the file name provided sensor config window.
- The data format remains unchanged in the 'continuous streaming' mode where one can think of the data collected as belonging to a single large chirp.
- For more details on file format refer to the mmWave studio user guide and the [Mmwave Radar Device ADC Raw Data Capture](#) app note.

Useful links

1

2

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4

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Additional information

- Online support https://e2e.ti.com/support/sensor/mmwave_sensors
- mmWave Studio <http://www.ti.com/tool/MMWAVE-STUDIO>
- ICBOOSTER users guide <https://www.ti.com/lit/ug/swru546c/swru546c.pdf>
- DCA1000 <http://www.ti.com/tool/DCA1000EVM>
- XDS Emulation Software http://processors.wiki.ti.com/index.php/XDS_Emulation_Software_Package
- MatLab runtime https://www.mathworks.com/supportfiles/downloads/R2015a/deployment_files/R2015aSP1/installers/win32/MCR_R2015aSP1_win32_installer.exe
- Example power supply <https://www.digikey.com/product-detail/en/cuiinc/SMI36-5-V-P5/102-3589-ND/5415060>
- DCA1000 Debug handbook <https://e2e.ti.com/support/sensors/f/1023/t/872161>