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

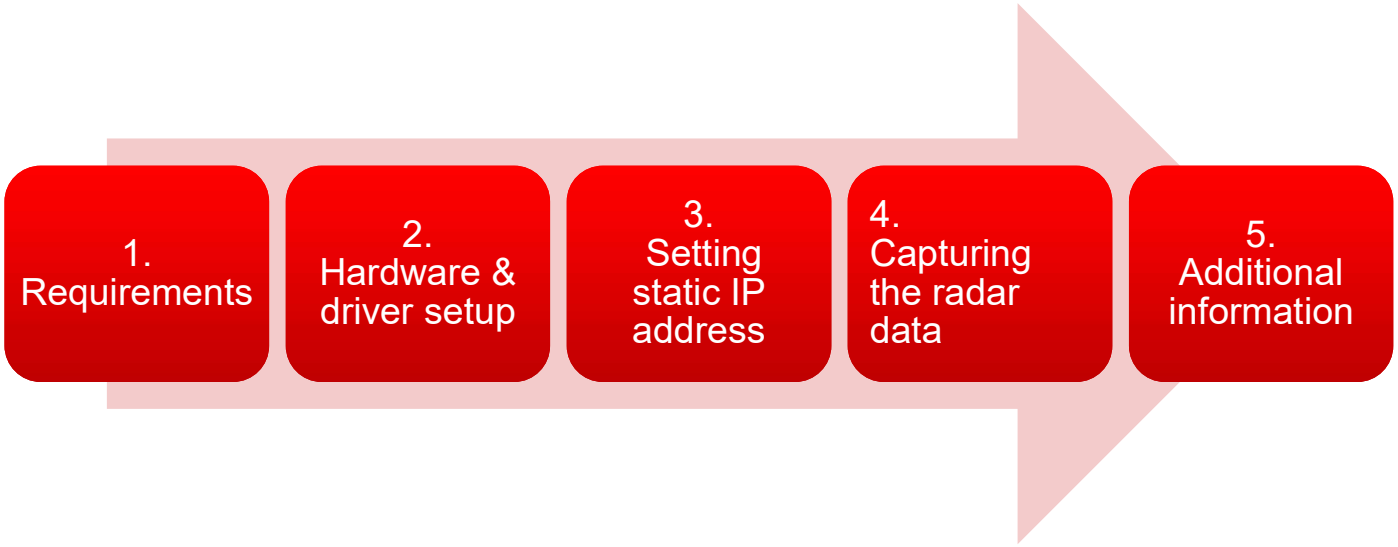
Scope of the training

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

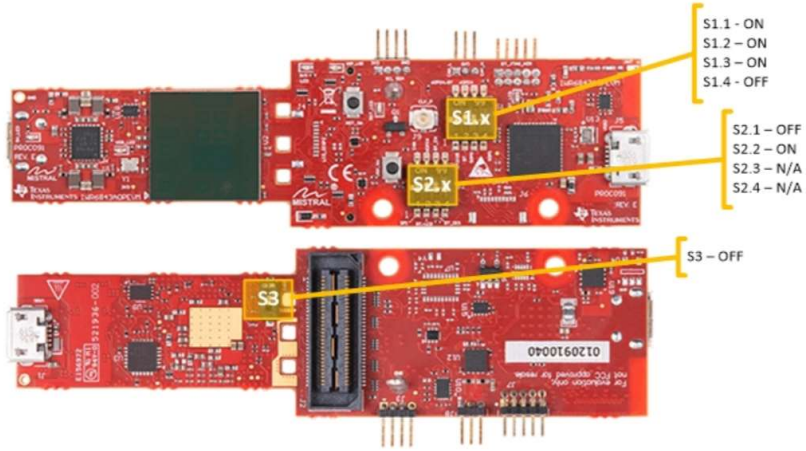

1. Requirements
2. Hardware & driver setup
3. Setting static IP address
4. Capturing the radar data
5. Additional information

Requirements

- 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

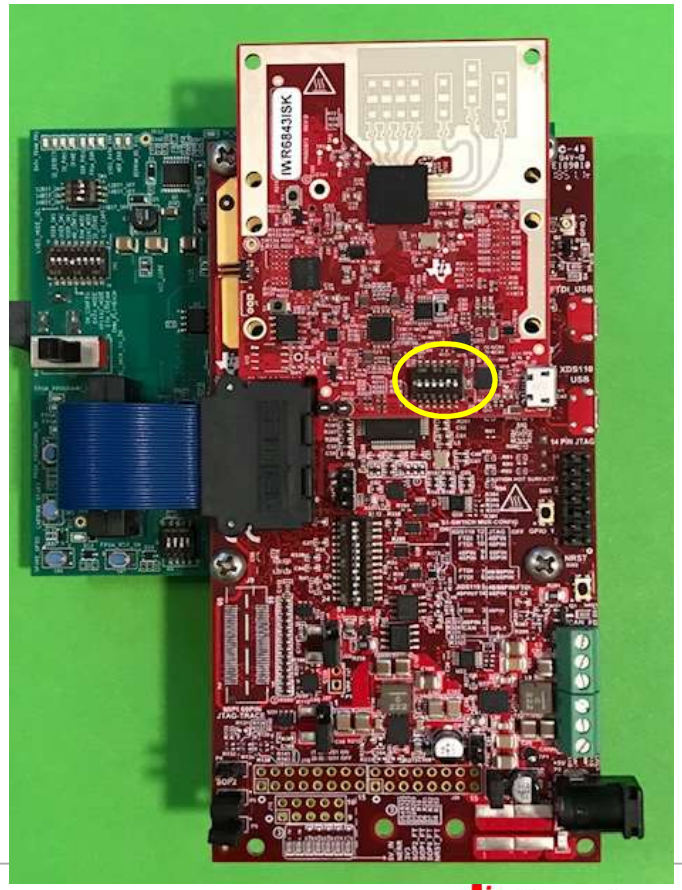
Hardware Setup (1) - Configure Antenna Module

- 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.



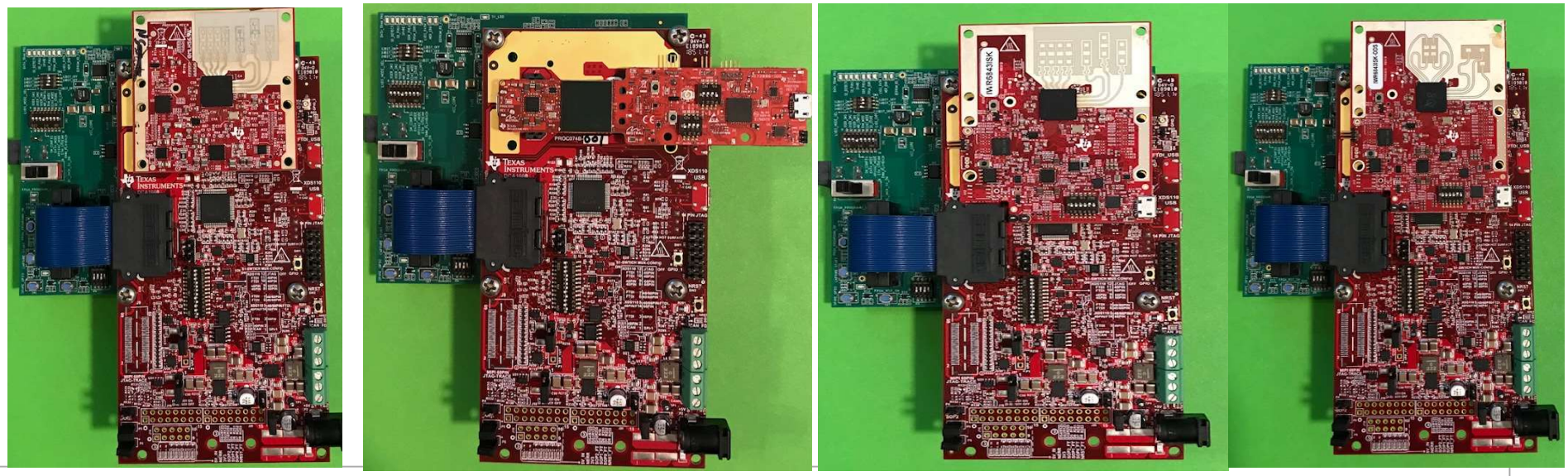
Hardware Setup (1) - Configure xwr6843ISKEVM Rev D

- 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.

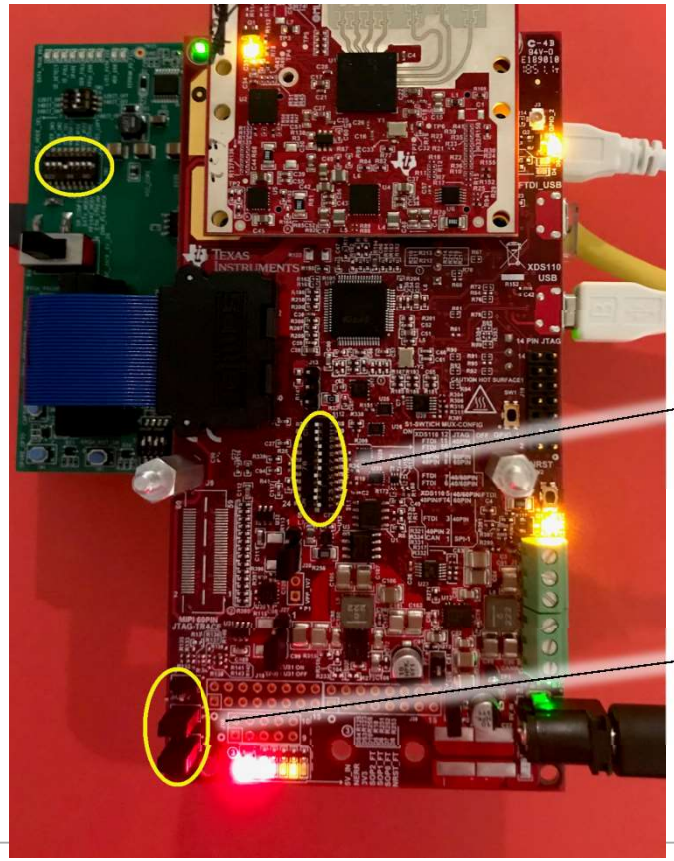


Hardware setup (2) - Mount Antenna Module

- 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

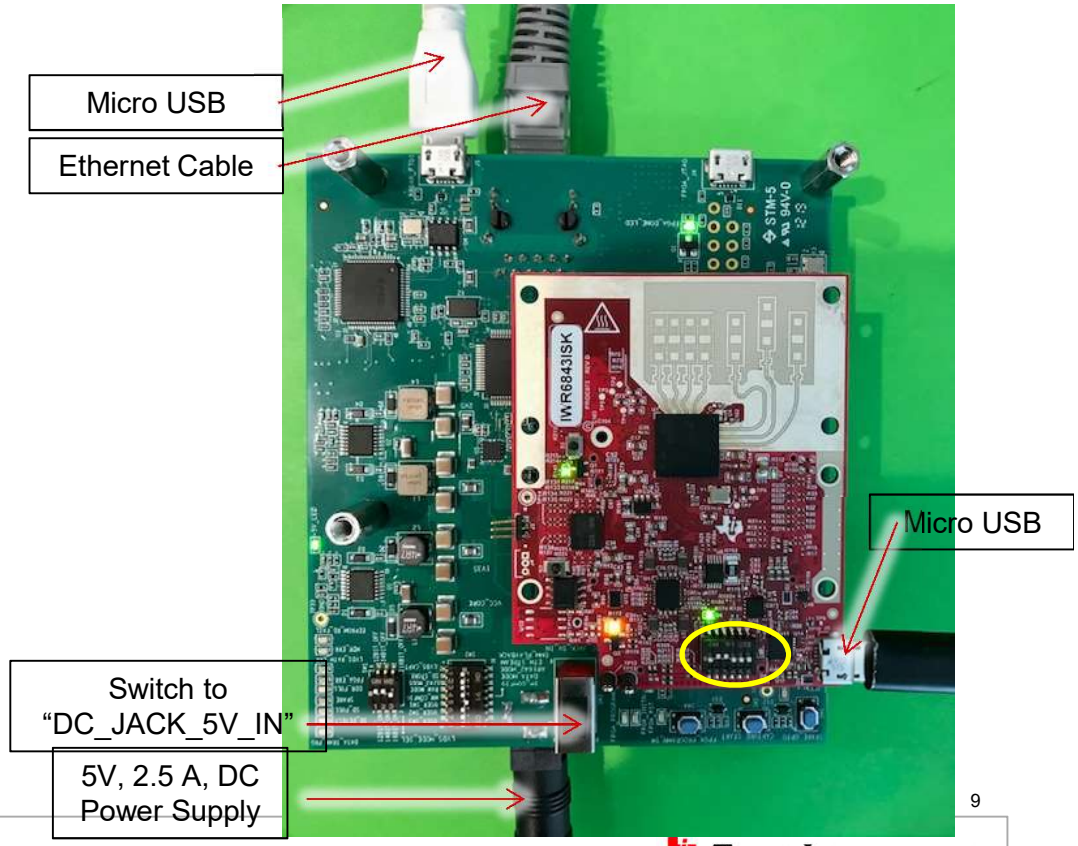
- SW2 setting on the DCA1000 board
- Switch S1 setting on the ICBOOST
- SOP setting on the ICBOOST

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

SOP name	Setting
SOP2	OFF
SOP1	ON
SOP0	ON

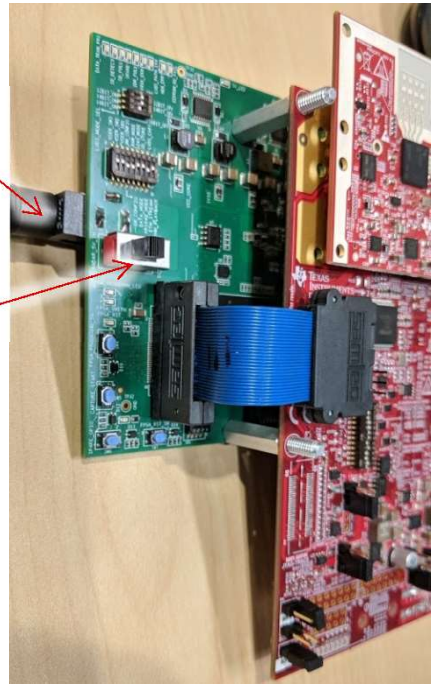
Hardware Setup (4) – xwr6843EVM RevD + DCA1000

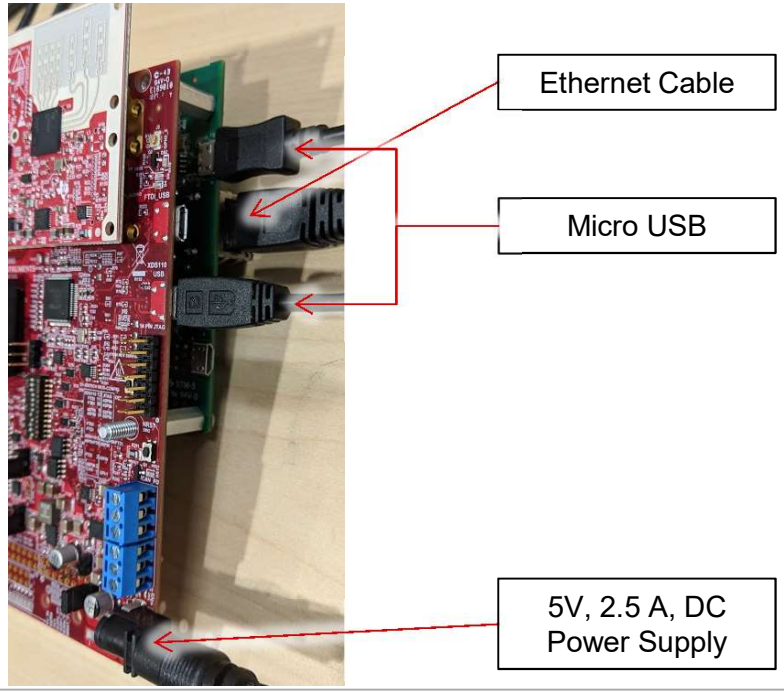
- This step only applies when using the xwr6843ISKEVM RevD antenna module or xwr6843ISK-ODSEVM RevD **without ICBOOST carrier board.**
- This information can be found in the ICBOOST users guide at: https://www.ti.com/lit/ug/swru546c/swru546c.pdf
- To use RevD EVM as an antenna module directly with DCA1000, the switches (highlighted in yellow cycle) 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 an Ethernet cables are connected for PC interface.





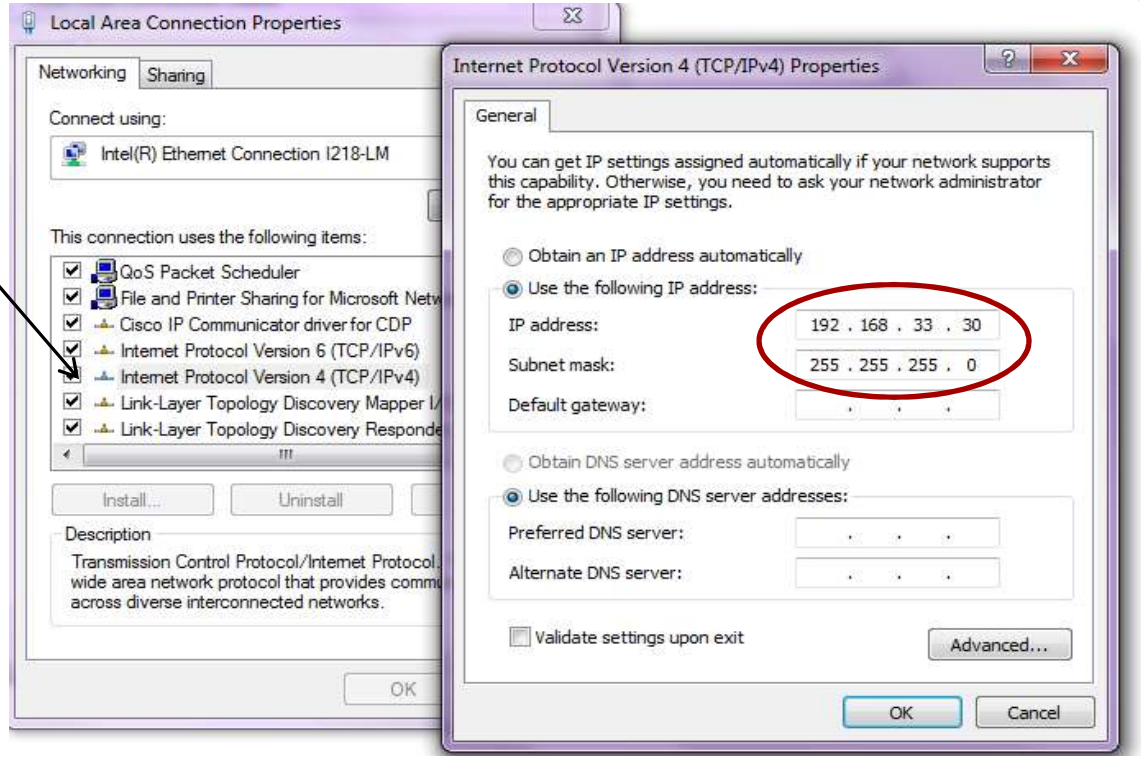
FTDI and XDS driver

- 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.

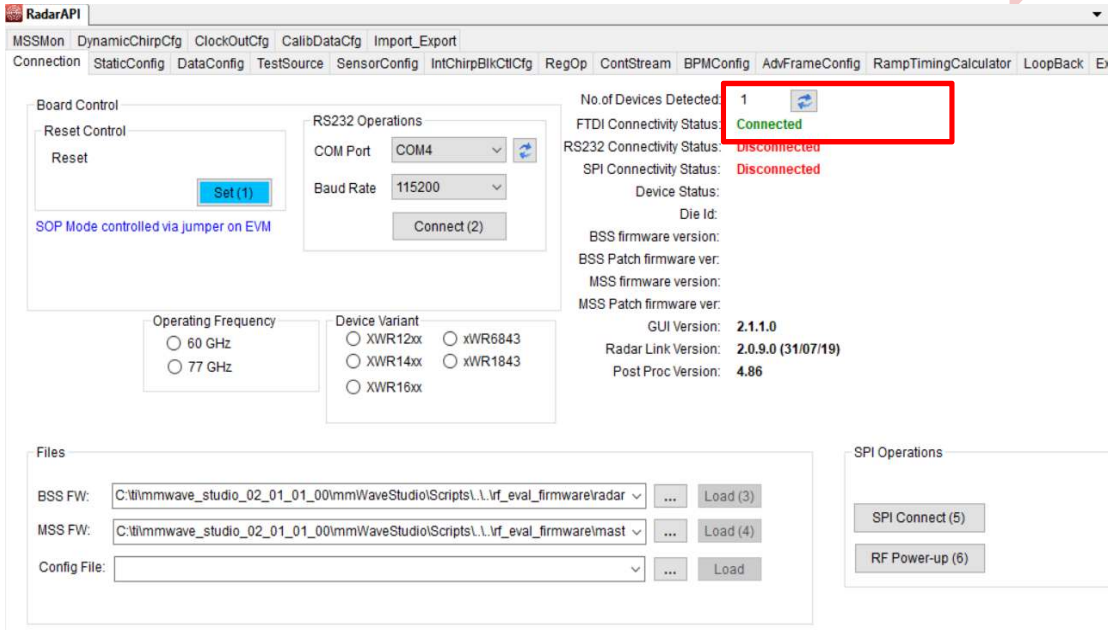
Setting static IP address

- 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 2555.255.255.0



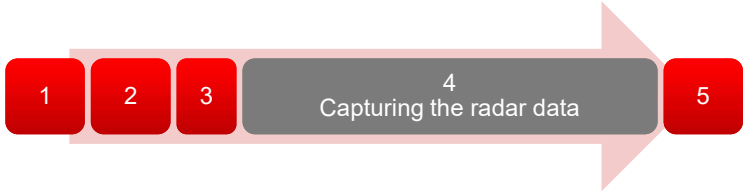
Capturing the radar data (4.1)

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).

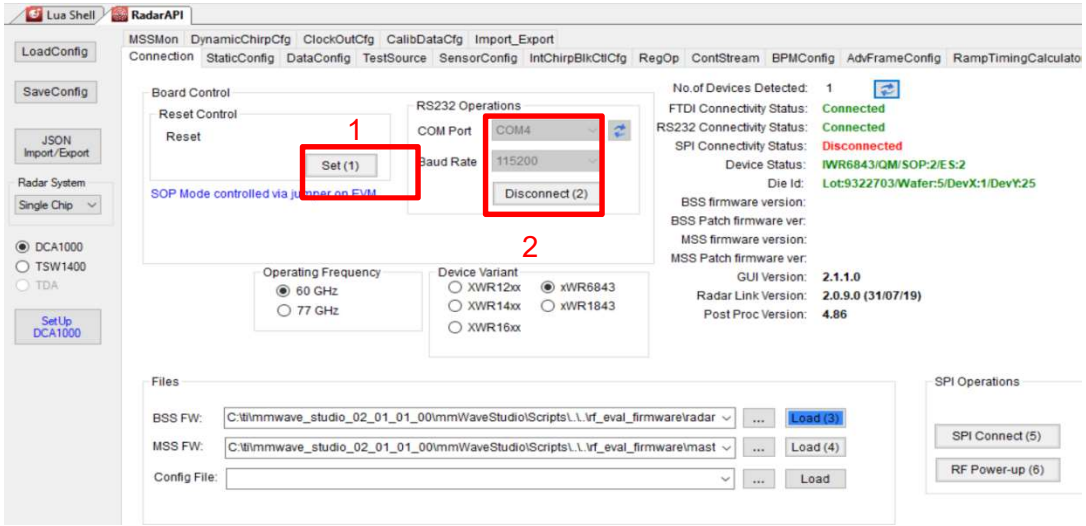


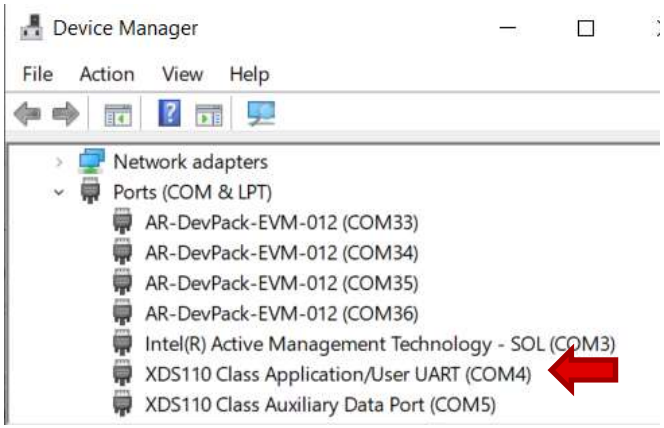
Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.2)



1. "**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.

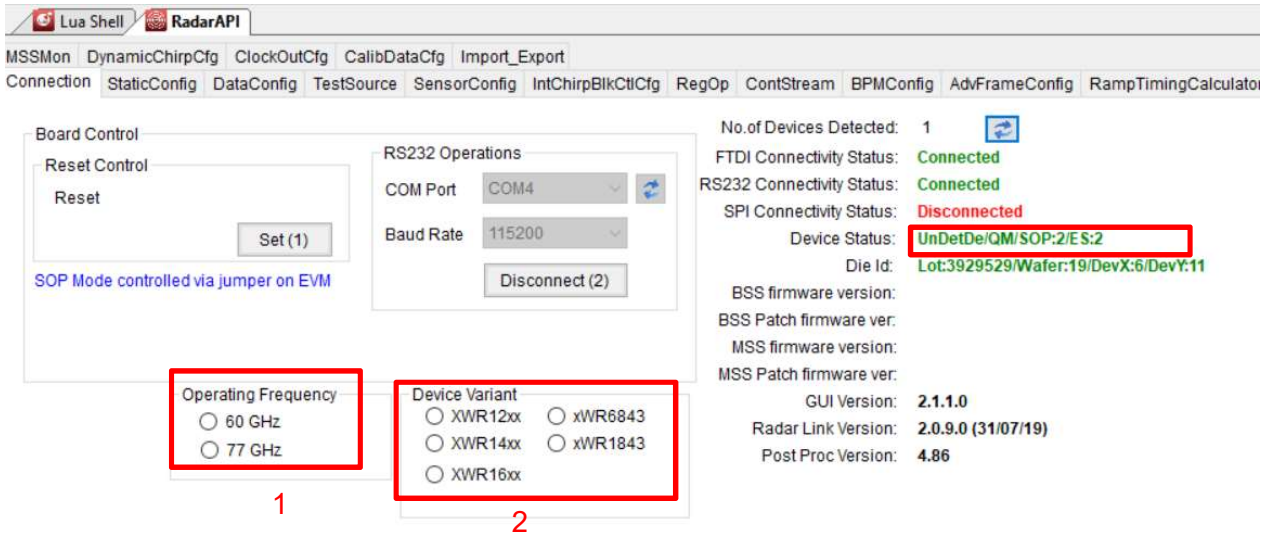




Note that the tool guides you with the button sequence by highlighting it in BLUE

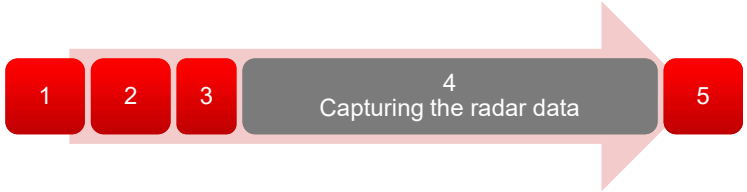
Capturing the radar data (4.2.2)

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.

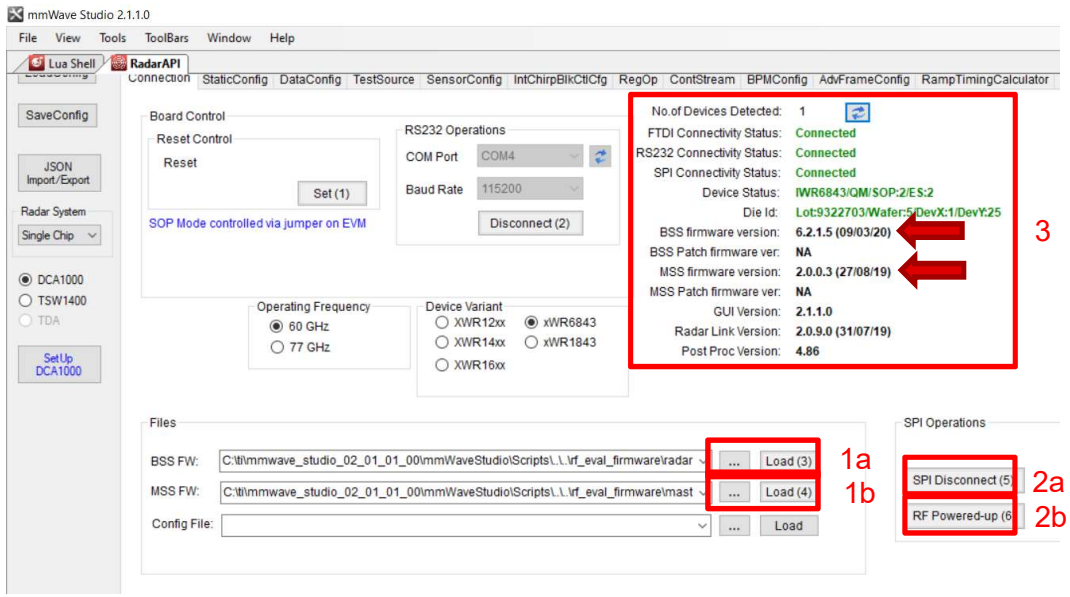


Note that the tool guides you with the button sequence by highlighting it in BLUE

Capturing the radar data (4.3)

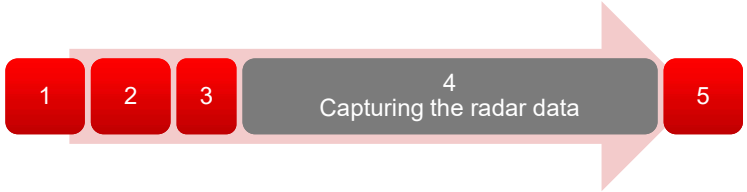


1. "**Files**" load the appropriate BSS (radarss.bin) , then MSS firmware (Masterss.bin) from the "~\mmwave_studio_<ver>\rf_eval_firmware" folder. The binary is based on the device variant being used (1243/1443/1642/6843)
2. The silicon PG version being (ES1.0, ES2.0, ES3.0) supported by the firmware 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.

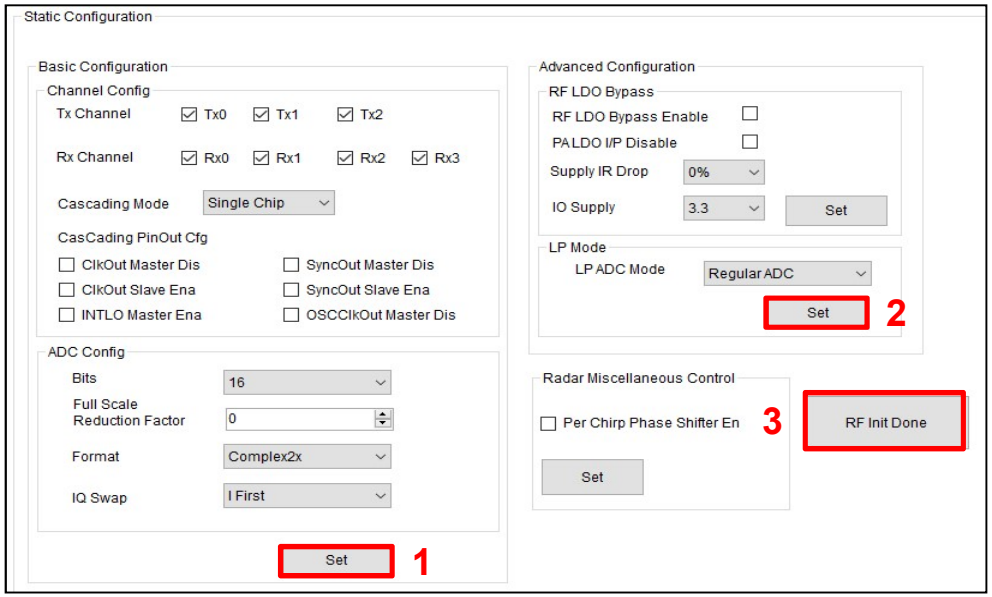


Note that the tool guides you with the button sequence by highlighting it in BLUE

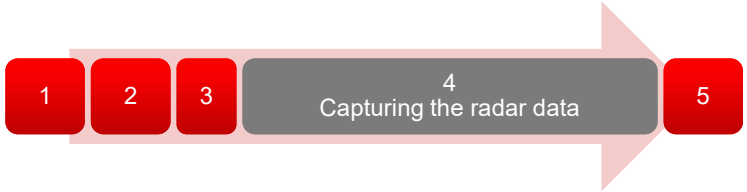
Capturing the radar data (4.4)



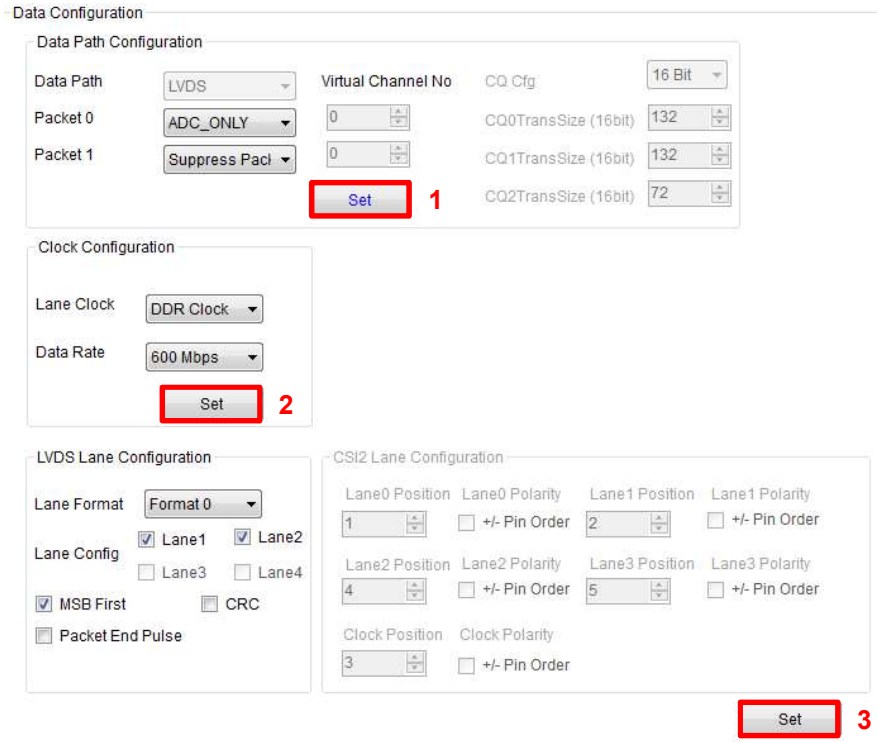
- StaticConfig tab:
  1. Select the desired TX and RX channels that you would want to use. In ADC Config, select desired ADC configuration and click SET
  2. If board is provided 1V RF supply Enable the RF LDO Bypass, if its 1.3V leave it unchecked. Click the Advanced Configuration Set button.
  3. LP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



Capturing the radar data (4.5)



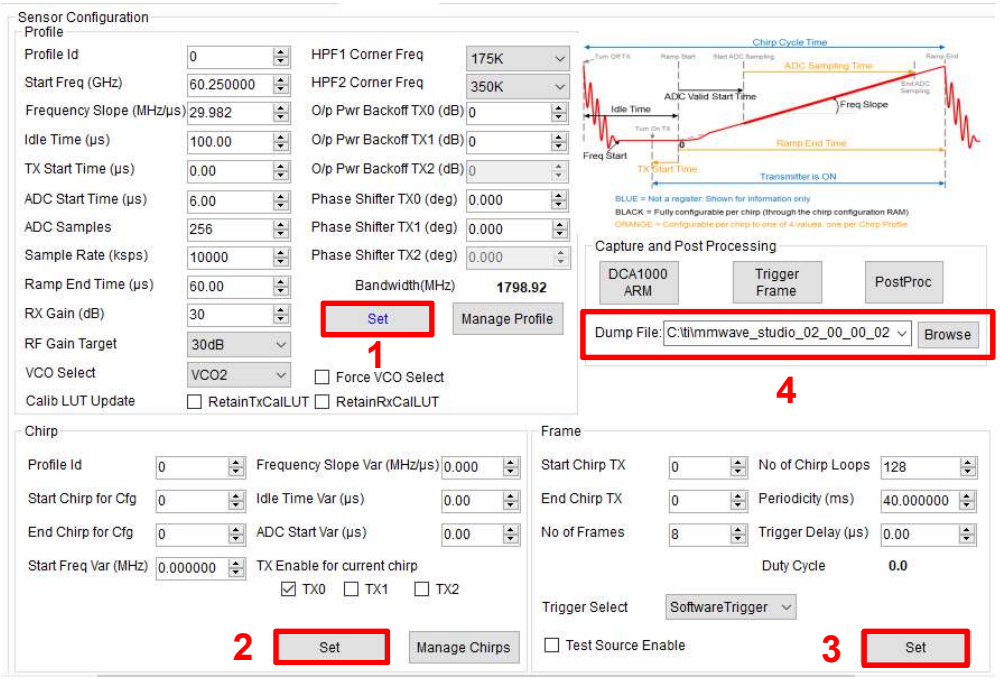
- In the DataConfig tab,
  1. select the data path config (ADC_ONLY) and click Set button.
  2. Select the clock rate and click set.
  3. Select the LVDS lanes and click set.



Capturing the radar data (4.6)

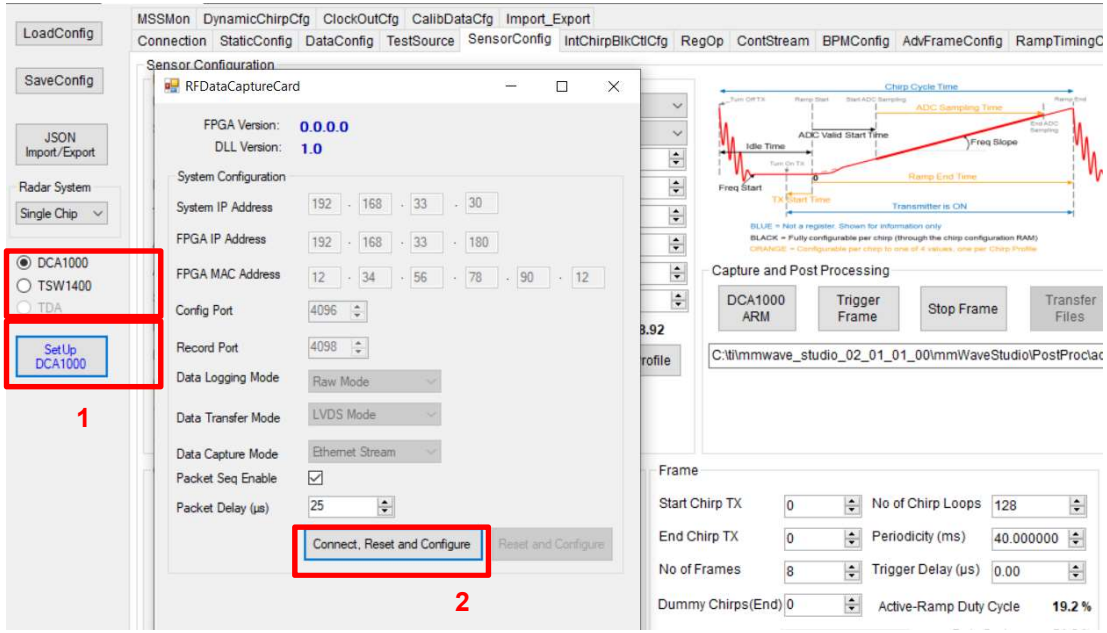
- SensorConfig tab
  1. select the required Profile configuration. These define the FMCW chirp profile.
  2. Select the chirp configuration.
  3. Select the frame configuration.
  4. Select the Dump file path name.

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)

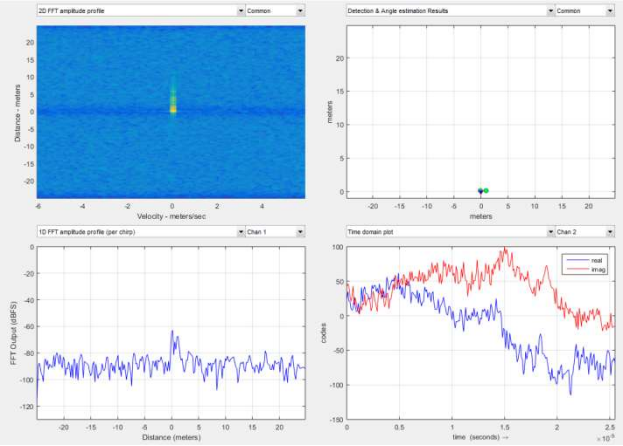
- Select ‘DCA1000’ and click on ‘SetUp DCA1000’
- Click on “Connect, Reset and configure”. This would establish the Ethernet connection and display the FPGA versions. Verify that the FPGA version is correct.
- Note that in case the connection fails make sure the static IP is set correctly, Ethernet cable 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.



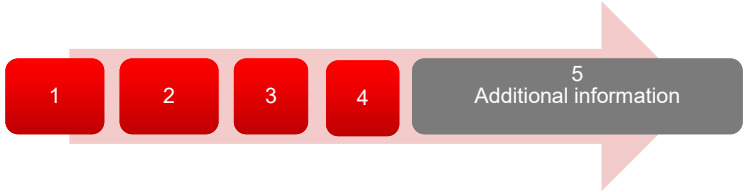
Capturing the radar data (4.8)

- Click on DCA1000 ARM and then Trigger Frame. At this point the radar starts sending out ADC data and DCA1000 stars 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.
- Bellow 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:
  - RxkIn: The nth in-phase sample corresponding to k^{th} RX channel.
  - RxkQn: The nth 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

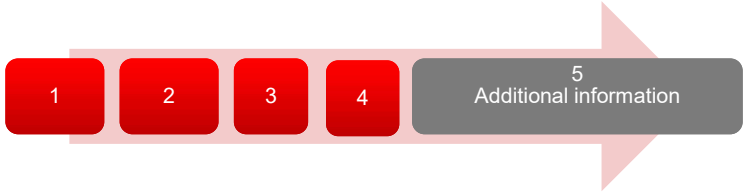
```
95ff 80ff e3ff e0ff 7bff 60ff f1ff f4ff
75ff 79ff e2ff fdff 72ff 6eff 1b00 3d00
48ff 19ff 3d00 4300 e2fe cafe 0900 f9ff
b1fe 90fe d7ff a8ff 9ffe bcfe 77ff 4bff
b7fe d2fe 38ff 1fff e3fe 11ff 1eff 2cff
47ff 34ff 41ff 5cff 4cff 54ff 7cff 6aff
44ff 2fff 6bff 5cff 0cff 29ff 20ff 20ff
2aff 3aff fdfe effe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



- 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