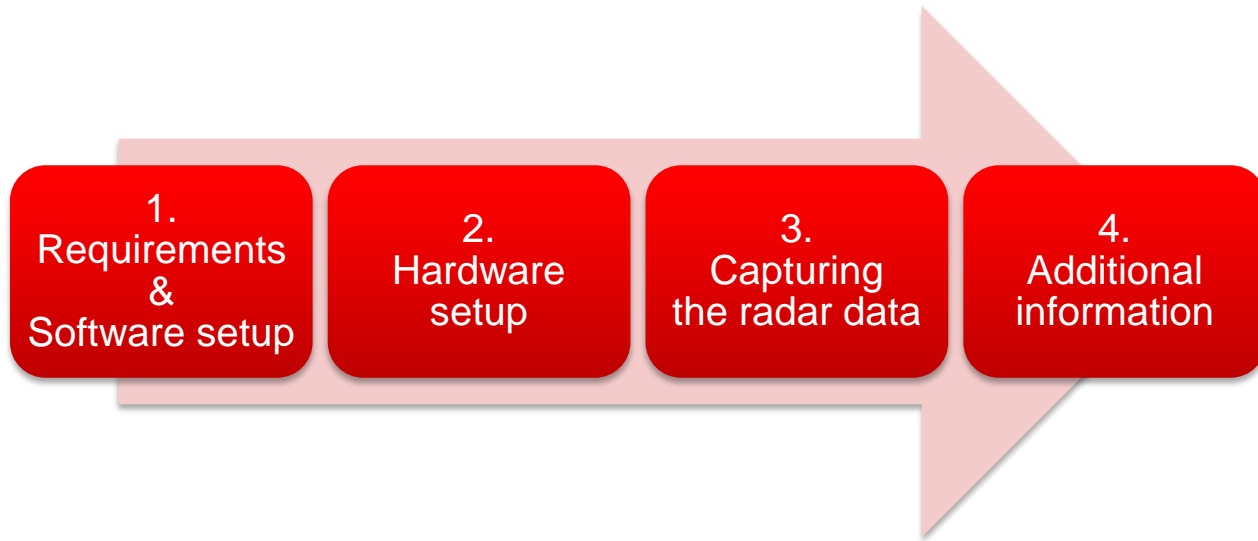


mmWave Sensor Raw Data Capture Using the TSW1400 Board

Steps



Requirements

- Hardware
 - [xWR1443 EVM](#), 5 V / >2.5 A [power supply](#), micro USB cable
 - [TSW1400 EVM](#), 5 V / 4 A [power supply](#), mini USB cable
 - [mmWave DevPack](#), micro USB cable
- Software
 - [mmWave DFP](#) (Device Firmware Package)
 - For an EVM with ES1.0 silicon (prior to 16-May-2017): use DFP 00.06.00.05
 - For an EVM with ES2.0 silicon (post 16-May-2017): use DFP 00.07.00.04 or above
 - [High Speed Data Converter Pro](#) (HSDC Pro) 4.50 or above
 - [UniFlash](#) 4.1 or above
 - [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
- The above links are in clear at the end of this presentation.



Software installation (1)

1.
Requirements & Software 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 DevPack and the EVM to your PC through USB cables. Connect a power supply to the EVM and power it up.
- In the Windows Device Manager, the COM ports should appear as this when their drivers are installed: 
- The FTDI device ports of the DevPack 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”.
C:\ti\mmwave_dfp_00_07_00_04\rf_eval\ftdi
 - This needs to be done for each of the 4 ports.

Software installation (2)

1.
Requirements & Software setup

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- Install the Matlab v8.5.1 runtime.
 - If you already have a more recent of the full Matlab installed, the path to the above runtime should come first in the PATH system variable.
In Windows, go into Control Panel > System > Advanced system settings > Environment variables > System variables, then edit PATH so this pathname comes first: c:\Program Files (x86)\MATLAB\MATLAB Runtime\v851\runtime\win32
- Install the UniFlash software.
- Install the HSDC Pro software.
- Patch the HSDC Pro software as described in the file:
C:\ti\mmwave_dfp_00_07_00_04\rf_eval\radarstudio\HSDCProFiles\ReadMe.txt
- The RadarStudio runtime is located here:
C:\ti\mmwave_dfp_00_07_00_04\rf_eval\radarstudio\RunTime\Radar Studio.exe
For convenience, install a shortcut of this file on your Windows Desktop.

Erasing the EVM flash

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2.
Hardware setup

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- The xWR1443 EVM flash memory should be blank in this setup.
- Using the standalone EVM, put the SOP2 jumper in place.
- Connect the xWR1443 EVM to the PC and power it.
- The EVM appears as 2 COM ports.
Note the Application/User port number.
- Run UniFlash, then do the following in it:
 - Select the relevant device, e.g., IWR1443.
 - Select the Serial Connection, then click the Start button.
 - In Settings & Utilities, enter the Application/User port number and click on Format SFLASH.
- Close UniFlash, power off the EVM and remove the SOP2 jumper.

SOP2 jumper



- Ports (COM & LPT)
- ECP Printer Port (LPT1)
- XDS110 Class Application/User UART (COM4)
- XDS110 Class Auxiliary Data Port (COM3)

Hardware setup (1)

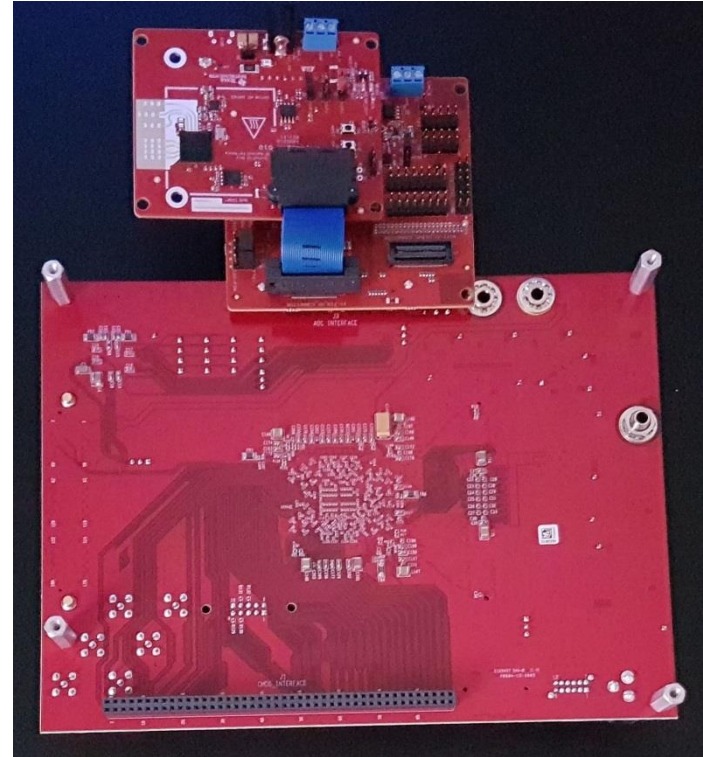
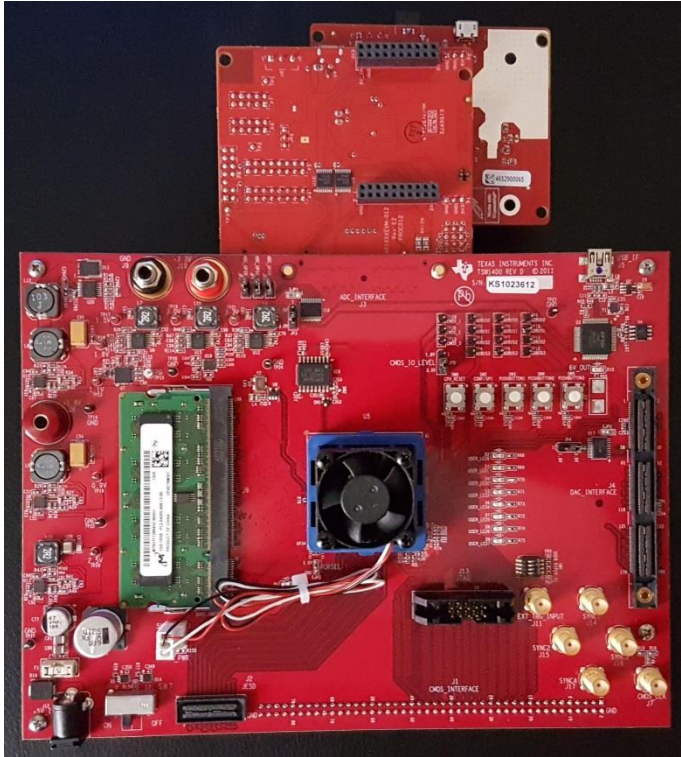
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2.
Hardware setup

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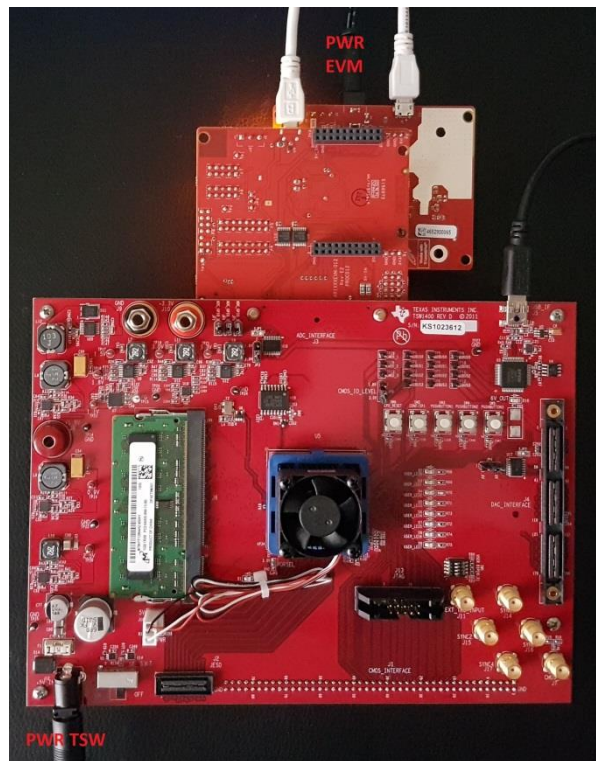
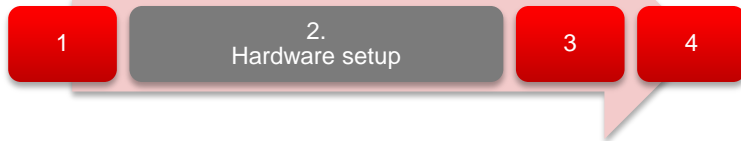
4

- Connect the board stack. This is what it should look like:

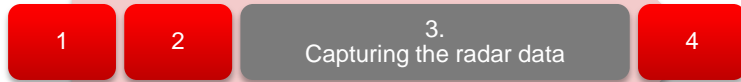


Hardware setup (2)

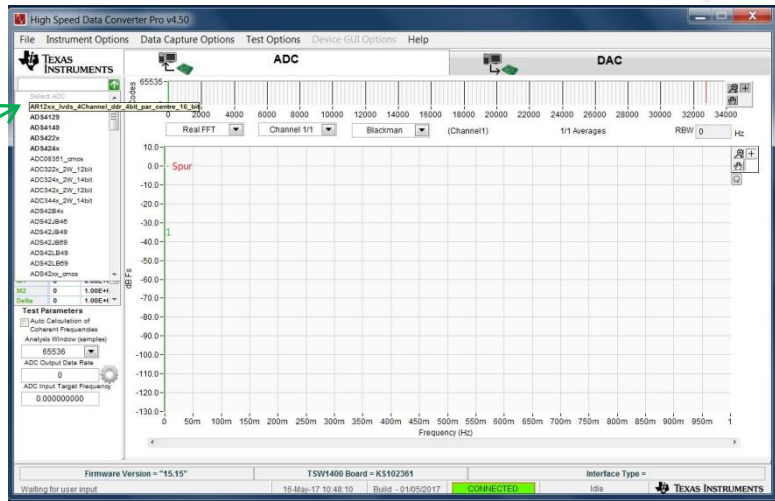
- Connect the 3 USB cables to the same PC.
- Connect the 2 power supplies to the xWR1443 EVM and the TSW1400 EVM.

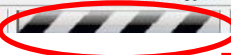


Capturing the radar data (1)



- Run HSDC Pro.
- Select the TSW1400 board.
- In the firmware drop down menu, select AWR12xx_lvds_4Channel_dds_4bit_par_centre_16_bit
- Wait for the firmware to be downloaded.
- For the future, note the difference between a busy and a ready HSDC Pro window:



Firmware Version = "15.15"	TSW1400 Board = KS102361	Interface Type =
Download Firmware Version	16-May-17 10:48:29 Build - 01/05/2017	CONNECTED 

Anything else than "Waiting for user input" indicates busy.

These bars indicate busy.

Firmware Version = "0.2"	TSW1400 Board = KS102361	Interface Type = ADC_FIRMWARE
Waiting for user input	16-May-17 10:59:27 Build - 01/05/2017	TRIGGER ARMED Idle

Ready

Ready

Capturing the radar data (2)

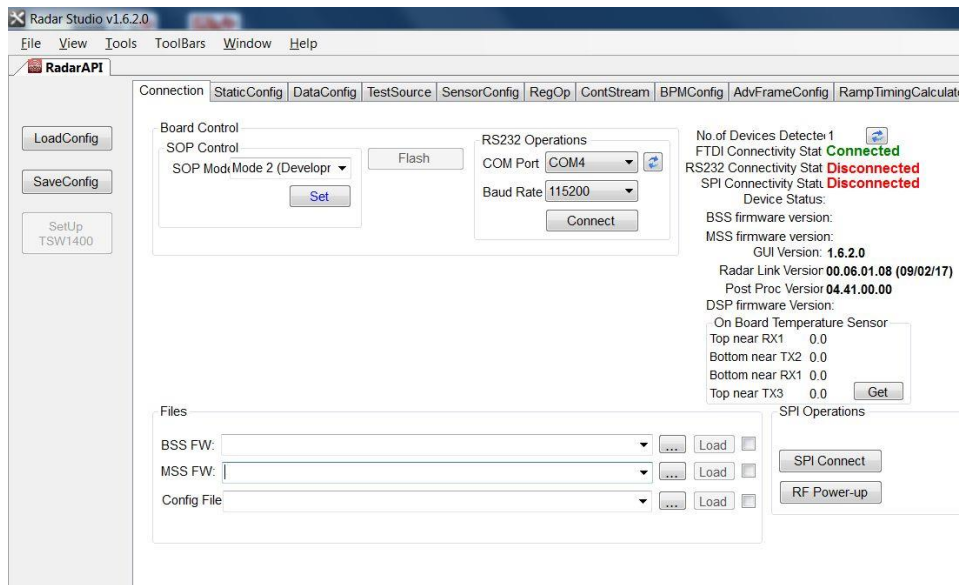
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3.
Capturing the radar data

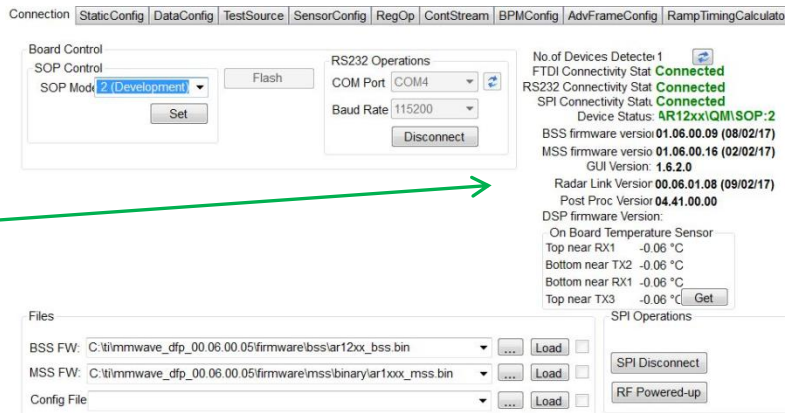
4

- Run Radar Studio.
- The Connection window should show up with FTDI Connectivity highlighted in green. If in red, install the FTDI drivers (see section 2).
- Select SOP Mode 2. Click Set.
- Select the Application/User port number, Baud rate 115200.
- Click Set. If the RS232 Connectivity stays red, make sure you erased the xWR1443 EVM flash memory. If Device Status stays blank, you may have a mismatch between the DFP version and the silicon revision.



Capturing the radar data (3)

- Still in the Radar Studio Connection tab, load the BSS, then MSS firmware.
 - For ES2.0 silicon, use these files:
BSS: c:\ti\mmwave_dfp_00_07_00_04\rf_eval\rf_eval_firmware\radarss\xwr12xx_xwr14xx_radarss.bin
MSS: c:\ti\mmwave_dfp_00_07_00_04\rf_eval\rf_eval_firmware\masterss\xwr12xx_masterss.bin
 - For ES1.0 silicon, use these files:
BSS: c:\ti\mmwave_dfp_00.06.00.05\firmware\bss\ar12xx_bss.bin
MSS: c:\ti\mmwave_dfp_00.06.00.05\firmware\mss\binary\ar1xxx_mss.bin
- Click the SPI Connect button.
If SPI Connectivity stays red, see Common issues in section 4.
- The Connection tab should now look like this:



Capturing the radar data (4)

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3.
Capturing the radar data

4

- In the Radar Studio Static Config tab, do the below:
 - Select the desired TX and RX channels. A maximum of 2 TX channels may be enabled at once.
 - In ADC Config, select 16 bits / Complex2x, I First.
 - Click the Set button.
 - Click the Advanced Configuration Set button.
 - Click the RF Init Done button.
- In the DataConfig tab, select the values as shown on the right and click each Set button.
- Note the number of LVDS channels should be:
 - 1 if 1 RX antenna was selected above.
 - 4 if more than 1 RX antenna were selected.

The screenshot shows the 'Data Configuration' tab in Radar Studio. It is divided into several sections:

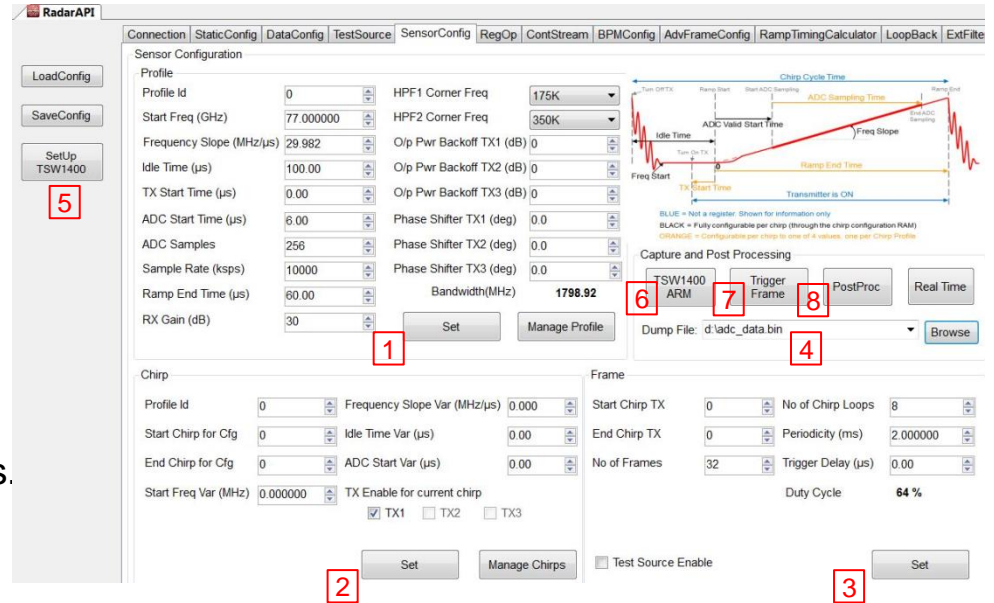
- Data Path Configuration:** Data Path is set to 'LVDS'. Packet 0 is 'ADC_ONLY' and Packet 1 is 'Suppress Packet'. Virtual Channel No. is 0. A 'Set' button is present.
- Clock Configuration:** Lane Clock is 'DDR Clock' and Data Rate is '600 Mbps'. A 'Set' button is present.
- LVDS Lane Configuration:** Lane Format is 'Format 0'. Lane1 and MSB First are checked. Lane2, Lane3, Lane4, CRC, and Packet End Pulse are unchecked.
- CS12 Lane Configuration:** Lane0 Position is 1, Lane0 Polarity is '+/- Pin Order'. Lane1 Position is 2, Lane1 Polarity is '+/- Pin Order'. Lane2 Position is 4, Lane2 Polarity is '+/- Pin Order'. Lane3 Position is 5, Lane3 Polarity is '+/- Pin Order'. Clock Position is 3, Clock Polarity is '+/- Pin Order'. A 'Set' button is present at the bottom right.

Capturing the radar data (5)

- In the SensorConfig tab, configure the Profile, Chirp and Frame and click the corresponding Set buttons. Select the Dump file pathname.
- Then click in sequence the following buttons: SetUp TSW1400, TSW1400 ARM, Trigger Frame.

Before to click on these buttons, make sure the HSDC Pro window is in ready state.

- Then retrieve the dump file for further processing or click the PostProc button for viewing.
 - The Radar Studio documentation describes the post-processing capabilities.
- It is possible to repeat the 6-7-8 steps multiple times.



Additional information

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2

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4.
Additional information

- xWR12xx/14xx file format
- Common issues
- Useful links
- Radar Studio documentation (post-processing options...):
 - ES1.0 silicon: C:\ti\mmwave_dfp_00.06.00.05\docs\RadarStudio User's Guide.pdf
 - ES2.0 silicon: C:\ti\mmwave_dfp_00_07_00_04\rf_eval\docs\RadarStudio_User's_Guide.pdf
- This file
 - <https://training.ti.com/mmwave-sensor-raw-data-capture-using-tsw1400-board>

xWR12xx/14xx file format (1)

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4.
Additional information

- Configuration:
 - n LVDS Lanes, complex data, n channels, chirping/continuous streaming mode
- Notation:
 - RxkIn: The n^{th} in-phase sample corresponding to k^{th} RX channel.
 - RxkQn: The n^{th} quadrature-phase sample corresponding to k^{th} RX channel.
 - N: The number of samples per chirp.
- Sample format:
 - 2 bytes long, 2's complement with an 2^{15} offset
 - 2's complement value = HSDC Pro value – 2^{15}

xWR12xx/14xx file format (2)

Chirp 1	Rx0I0	Rx0Q0	Rx1I0	Rx1Q0	Rx2I0	Rx2Q0	Rx3I0	Rx3Q0
	Rx0I1	Rx0Q1	Rx1I1	Rx1Q1	Rx2I1	Rx2Q1	Rx3I1	Rx3Q1

	Rx0IN-1	Rx0QN-1	Rx1IN-1	Rx1QN-1	Rx2IN-1	Rx2QN-1	Rx3IN-1	Rx3QN-1
Chirp 2	Rx0I0	Rx0Q0	Rx1I0	Rx1Q0	Rx2I0	Rx2Q0	Rx3I0	Rx3Q0
	Rx0I1	Rx0Q1	Rx1I1	Rx1Q1	Rx2I1	Rx2Q1	Rx3I1	Rx3Q1

	Rx0IN-1	Rx0QN-1	Rx1IN-1	Rx1QN-1	Rx2IN-1	Rx2QN-1	Rx3IN-1	Rx3QN-1

- Data is arranged in row-major-order.
- 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. There is no sync packet at the start of an LVDS packet, as there is one lane for each channel, so one always knows which lane has which channel.
- If the number of enabled channels is less than 4, then the columns corresponding to the disabled channels will have zeroes in it. For example, if only channels 1 and 3 are enabled, then the data format will look as follows.

Chirp 1	0	0	Rx1I0	Rx1Q0	0	0	Rx3I0	Rx3Q0
	0	0	Rx1I1	Rx1Q1	0	0	Rx3I1	Rx3Q1

	0	0	Rx1IN-1	Rx1QN-1	0	0	Rx3IN-1	Rx3QN-1

Common issues

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4.
Additional information

- Insufficient power supplies
 - Most user LEDs of the TSW1400 board should be on after the FPGA programming. If they are not, please use another power supply.
 - The ERROR LED of the xWR1443 EVM may be on after power up. If pressing the NTRST button does not switch it off, please use another power supply.
- Need to use a cable between the TSW1400 EVM and the DevPack
 - Refer to this e2e post: https://e2e.ti.com/support/sensor/mmwave_sensors/f/1023/t/595100
- Matlab initialization issue
 - Possible conflict with an existing Matlab installation. Refer to section 2.
- SPI is not connected after having clicked on the SPI Connect button.
 - Make sure the DevPack board has a JP5 jumper fitted as shown.
- Sometimes the data file is empty after having clicked the Trigger Frame button.
 - Clicking on the TSW1400 ARM button should resolve the issue.
- The PostProc window shows no data.
 - Enable 1 LVDS lane only for 1 RX antenna, or 4 lanes for 4 RX.
- For other issues, please use the mmWave e2e forum:
http://e2e.ti.com/support/sensor/mmwave_sensors



Useful links

1

2

3

4.
Additional information

- Online support https://e2e.ti.com/support/sensor/mmwave_sensors
- xWR1443 EVM <https://www.ti.com/tool/iwr1443boost>
- mmWave DevPack <https://www.ti.com/tool/mmwave-devpack>
- TSW1400 EVM <https://www.ti.com/tool/tsw1400evm>
- mmWave DFP <https://www.ti.com/tool/mmwave-dfp>
- HSDC Pro <https://www.ti.com/tool/dataconverterpro-sw>
- UniFlash <https://www.ti.com/tool/uniflash>
- 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>