TI mmWave Training

xWR16xx mmWave Demo



Contents

- Overview
- Requirements
- Software setup
 - Pre-requisites
 - Downloading the Lab Project
 - Building the project
- Hardware setup
 - Preparing the EVM
 - Connecting the EVM
- Running the Demo



2

Lab Overview

- Configurable visualization tool for processed radar data
- The following plots are available:
 - Scatter Plot
 - Range Profile
 - Noise Profile
 - Range Azimuth Heat Map
 - Range Doppler Heat Map
 - Statistics





1. Requirements

- Software
 - Pre-requisites
 - Latest TI mmWave SDK and all related dependencies installed as mentioned in the mmWave SDK release notes.
 - Google Chrome with TI Cloud Agent Extension
 - For running the mmWave Demo Visualizer
 - Download from <u>TI Cloud Agent</u> or install when accessing the <u>demo</u>
 - mmWave SDK Demo
 - Download from <u>TI Resource Explorer</u>
 - UniFlash
 - For flashing firmware images onto
 - Download from <u>TI.com/tool/uniflash</u>
 - XDS110 Drivers
 - For EVM XDS device support
 - Included with CCS Installation, or standalone through <u>TI</u> <u>XDS Emulation Software</u>

- Hardware
 - xWR16xx EVM
 - Micro USB cable (included in the EVM package)
 - 5V/2.5A Power Supply
 - Purchase from Digikey



Steps





1. Pre-requisites

- It is assumed that you have the latest TI mmWave SDK and all the related tools installed as mentioned in the mmWave SDK release notes.
 - The mmWave SDK release notes include the links for downloading the required versions of the above tools.
 - Helpful Tips
 - Please make sure that any existing PERL installations are removed from the PC before installing the version of PERL listed in the SDK release notes
 - After you've downloaded and saved **CRC.pm**, locate the saved file and remove the .txt extension if it is there. Please ensure that the file has a **.pm** extension and not a .txt extension at the end
 - XDC tools are provided as a zip file which needs to be extracted in the TI install directory (typically C:\ti)
 - Note: For this video, we used mmWave SDK 1.0.0.5 and the snapshot shown here corresponds to mmWave SDK 1.0.0.5
- If you have already installed the mmWave SDK and all the required tools, you can move on to the next step i.e. downloading the lab on to your machine.

Version	Download link

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1001	Version	Download link
ccs	7.1 or later	download link Please note that CCS v7.1 or later is mandatory. CCSv6.x cannot be used
TI SYS/BIOS	6.50.1.12 or later	download link
TI ARM compiler	16.9.1.LTS or later	Included in CCS v7.1
TI CGT compiler	8.1.3 or later	Included in CCS v7.1
XDC	3.50.00.10 or later	download link Use the installer that has no mention of JRE which by default has JRE (this installer will be bigger than the one without JRE). Also it is recommended that this be installed separately even if CCS has this version installed since the CCS version is without JRE.
C64x+ DSPLIB	3.4.0.0	Please download the installer for C64x+. download link
C674x MATHLIB (little-endian, elf/coff format)	3.1.2.1	Please download the installer for C674x. download link
Perl	5.20.2 or later	download link
CRC.pm	0.21	download link This is an add-on to the Perl installation. This file needs to be copied to <perl installation folder>\per\lib\Digest folder.</perl
Mono JIT compiler	3.2.8	Only for Linux builds
mmwave device support packages	1.5.3 or later	Upgrade to the latest using CCS update process
TI Emulators package	6.0.0576.0 or later	Upgrade to the latest using CCS update process
		6

1. Install Pre-requisites



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5

Steps





2. Download the Lab project

- The mmWave projects are available under mmWave Training in CCS Resource Explorer.
- To download the xWR16xxmmWave demo, start CCS v7.1 (or later) and select View ► Resource Explorer to open the Resource Explorer.
- In the Resource Explorer Window, select Software ► mmWave Training ► Demos.





Resource Explorer 🖾 Search Q 🛆 🏫 💿 🚍 << xWR16xx mmWave SDK Demo - CCS Project Spee 4 😂 Software 4 🙈 mmWave Training - v:1.0.2 Run this TI xWR16xx EVM out-of-box demo to view processed TI mmWave sensor data in configurable plots 🕨 🗁 Labs 🔺 📴 Demos 👂 🤐 Drone Altitude xWR16xx mmWave SDK E Contraffic Monitoring * * Demo - CCS Project Spec Intelligent Lighting and Factory Automation , Setup Guide xWR16xx mmWave SDK Demo - CCS Project S WR14xx mmWave SDK Demo - CCS Project S , Release Notes CCS Project MSS 📇 CCS Project DSS Click here to download the project on to your PC

Download Demo project

- Select the xWR16xx mmWave SDK demo in the left view.
- The right view shows the contents of the Lab which contains the CCS Project and the PC GUI.
- Click on the Download and Install button **I** in the top right corner as shown.
- Select the Make Available Offline option from the drop down to start downloading the Lab.



3

5

2. Download - continued

2. Download - continued

- The xWR16xx mmWave Demo consists of two CCS projects, one for the R4F core and one for the C674x DSP core
- The projects will be downloaded in C:\ti\mmwave_training
- Select the CCS Project MSS file in the left view
- Click on the **Import to IDE** button which should be visible in the right side view after a successful download.
- This copies the project in the user's workspace and imports it into the CCS project explorer.
 - It is important to note that the copy created in the workspace is the one that gets imported in CCS. The original project downloaded in mmwave_training is not touched.
- Repeat with the CCS Project DSS file

Ø Resource Explorer ⊠		- 5
Q. Select a Device or Board		Search Q 🛆 🔒 🔍 🚍
Software Software Software Contract Training - v:1.0.2	CCS Project MSS	€ © ₫
 Class Control Control Contro		Click here to import the project

Download Demo project



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2. Download - continued

- After successfully completing the Import to IDE operation, the both projects should be visible in CCS Project Explorer as shown here.
- At this point, we have successfully downloaded the mmWave demo and imported it in CCS.
- We are ready to move on to the next step i.e. Building the projects.

1 2 Download Demo project	3	4	5
Project Explorer	🗆 🔄	~ - 8	
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🗁 Debug			
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r4f_linker.cmd			
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mmw_dss [Active - Debug]			
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Is dss_config_edma_util.c			
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Image: Second			
M dss_mmw.n			
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gen_twiddle_hts2x52.c			
i uss_mmw.crg			



11

Steps





3. Build the Lab

- With the mmw_dss project selected in Project Explorer, right click on the project and select Rebuild Project.
 - Selecting Rebuild instead of Build ensures that the project is always re-compiled. This is especially important in case the previous build failed with errors.
- On successful completion of the build, you should see the output in CCS console as shown here and the following two files should be produced in the project debug directory
 - xwr16xx_mmw_dss.xe674
 - xwr16xx_mmw_dss.bin
- If the build fails with errors, please ensure that all the pre-requisites are installed as mentioned in the mmWave SDK release notes.







3. Build the Lab

- The mmw_dss project must be built BEFORE the mmw project is built.
- With the mmw project selected in Project Explorer, right click on the project and select Rebuild Project.
- On successful completion of the build, you should see the output in CCS console as shown here and the following three files should be produced in the project debug directory
 - xwr16xx_mmw_mss.xer4f
 - xwr16xx_mmw_mss.bin
 - xwr16xx_mmw.bin

CDT Build Console [mmw] C:/ti/mmwave_sdk_01_00_00_05/packages/scripts/ImageCreator/xwr16xx/crc_multicore_image/crc_multicore_image.exe xwr16xx_mmw.bin xwr16xx_mmw.bin.tmp size of App Image is 412096 bytes cur_crc_read_addr 128 cur_crc_read_addr 103040 cur_crc_read_addr 239232 Failed to remove CRC temp file

• If the build fails with errors, please ensure that all the pre-requisites are installed as mentioned with errors and the mmWave SDK release notes.

E Console 🛛

**** Build Finished ****





Steps





4.1 Preparing the EVM



- There are two ways to execute the compiled code on the EVM:
 - Deployment mode: Flashing the binary (.bin image) on to the EVM serial flash
 - In this mode, the EVM boots autonomously from flash and starts running the bin image.
 - Debug mode: Downloading and running the executable (.xer4f image and .xe674) from CCS.
 - You will need to flash a small CCS debug firmware on the EVM (one time) to allow connecting with CCS. This debug firmware image is provided with the mmWave SDK.
 - As a recap, the build process in Step 3 produces the .bin .xer4f and .xe674 images.
- This presentation explains the second method i.e. Debug mode (CCS).
 - To prepare the EVM for debug mode, we start with flashing the CCS debug firmware image.
 - Please note that the same flashing process can be used to flash the Lab binary to run it in deployment mode.



4.2 Connecting to the EVM

- Power on the EVM using a 5V/2.5A power supply.
- Connect the EVM to your PC and check the COM ports in Windows Device Manager
- The EVM exports two virtual COM ports as shown below:
 - XDS110 Class Application/User UART (COM_{UART}):
 - Used for passing configuration data and firmware to the EVM
 - XDS110 Class Auxiliary Data Port (COM_{AUX})
 - Used to send processed radar data output
- Note the COM_{UART} and COM_{AUX} port numbers, as they will be used later for flashing and running the Lab.



 The actual port numbers on your machine may be different



17

4. Preparing

4.3 Flashing CCS debug firmware

- 1. Put the EVM in flashing mode by connecting jumpers on SOP0 and SOP2 as shown in the image.
- 2. Open the UniFlash tool
- 3. In the **New Configuration** section, locate and select the appropriate device (xWR14xx)
- 4. Click Start to proceed



2



4. Preparing the EVM

4.3 Flashing CCS debug firmware

- 1 2 3 4. Preparing the EVM
- 5. In the **Program** tab, browse and locate the CCS debug image shown below:

Flash Image(s)		Image	Location
Meta Image 1 xwr16xx_ccsdebug.bin Size: 23	32.75 KB	Meta Image 1	C:\ti\mmwave_sdk_ <ver>\packages\ti\utils\ccsdebug</ver>
Meta Image 2 Leave this empty	Erowse		
Meta Image 3 Leave this empty	E Browse		
Meta Image 4 Leave this empty	🔔 Browse		

6. In the **Settings & Utilities** tab, fill the **COM Port** text box with the Application/User UART COM port number (**COM_{UART}**) noted earlier

Note: Example - COM1 (Windows) /dev/	ttyACM0 (Linux)
Note: Example - CONT (Windows), / dev/	(LINUX)

- 7. Return to the **Program** tab, power cycle the device and click on **Load Images**
- 8. When the flash procedure completes, UniFlash's console should indicate: [SUCCESS] Program Load completed successfully
- 9. Power off the board and remove the jumper from only header **SOP2.** Power the board back on (this puts the board back in functional mode)



19

Steps





5.1 Connecting EVM to CCS

- It is assumed that you were able to download and build the Lab in CCS (completed steps 1, 2 and 3)
- To connect the Radar EVM to CCS, we need to create a target configuration
 - Go to File ► New ► New Target Configuration File
 - Name the target configuration accordingly and check the "Use shared location" checkbox.
 Press Finish
 - In the configuration editor window:
 - Select "Texas Instruments XDS110 USB Debug Probe" for **Connection**
 - Select IWR1642 or AWR1642 in the Board or Device list
 - Press the **Save** button to save the target configuration.
 - You can press the **Test Connection** button to check the connection with the board.

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				_			7/
🖓 New Target Config	uration					X	
Target Configurat	ion Configuration file						
Eile name: IWR1642	.ccxml						
Location: C:/Users/	/ti/CCSTa	argetConfigurations		Eile System	<u>W</u> orksp	ace	
asic							
General Setup	the general confi	guration about the	target				
Connection Te	as Instruments XD	S110 USB Debug Pro	be			•	
Board or Device iwi							
	IWR1443 IWR1642						
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5.1 Connecting - continued

- Go to View ► Target Configurations to open the target configuration window.
- You should see your target configuration under **User Defined** configurations.
- With the board powered on, right click on the target configuration and select Launch Select Configuration.
- This will launch the target configuration in the debug window.
- Select the Texas Instruments XDS110 USB Debug probe/C674X_0 and press the Connect Target button
- Select the Texas Instruments XDS110 USB Debug probe/Cortex_R4_0and press the Connect Target button



to the target CPU



5.2 Loading the binary

- Once both targets are connected, select the C674X_0 target, and click on the Load button in the toolbar.
- In the Load Program dialog, press the Browse Project button.
- Select the lab executable (.xe674) found in the mmw_dss project as shown, and press OK.
- Press OK again in the Load Program dialog.



5.2 Loading the binary

- Now select the Cortex_R4_0 target, and click on the **Load** button in the toolbar.
- In the Load Program dialog, press the Browse Project button.
- Select the lab executable (.xer4f) found in the mmw project as shown, and press OK.
- Press OK again in the Load Program dialog.

1 2 3 4	5. Running the Demo
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Debug %	
WRIOXXCCXIII [Code Composer Studio - Device Debugging] we Texas Instruments XDS110 USB Debug Probe_0/C674X_0 (Suspended - SW Breakpoint)	
main() at dss_main.c:1,975 0x20004520 _c_int00() at boot.c:180 0x007FD5BC (the entry poin was reached)	
 Texas Instruments XDS110 USB Debug Probe_0/Cortex_R4_0 (Suspended) 0x00004EE4 (no symbols are defined for 0x00004EE4) 	
Load Program	
😵 Load Program	
Program file C:\Users\a027265 space_v7\water_ground_lab\Deb Browse Browse project Code offset Data offset	
OK Cancel	
Select a program	
⊿ [™] mmw	
▲ ➢ Debug ➢ xwr16xx_mmw_mss.xer4f	
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5.3 Running the binary

- With both executables loaded, select mss_main.c, as shown, and press the Run/Resume button
- The program should start executing and generate console output as shown.
- If everything goes fine, you should see the "MMWDemoMSS mmWave Control Initialization was successful" message which indicates that the program is waiting for the DSS to be started



Debug: Launching the Millimeter Wave Demo

Debug: MMWDemoMSS Launched the Initialization Task Debug: MMWDemoMSS mmWave Control Initialization was successful



5.3 Running the binary

- Select dss_main.c, as shown, and press the Run/Resume button
- Further console output should be generated as shown.
- You should see the "CLI is operational" message which indicates that the program is ready and waiting for the sensor configuration
- The sensor configuration is sent using the web GUI

	1 2 3 4	5. Running the Demo
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	Console ⋈ cds_main.c WR16xx.ccxml:ClO [Cortex_R4_0] ************************************	
im	<pre>************************************</pre>	



5.4 Running the Lab GUI



- 1. Using Google Chrome, navigate to the following URL: https://dev.ti.com/mmWaveDemoVisualizer
 - Alternatively, go to <u>https://dev.ti.com/gallery</u> and search for "mmWave Demo Visualizer"
- 2. If prompted, follow the on-screen instructions for installing TI Cloud Agent
- 3. Once the demo is loaded, go to **Options** \rightarrow **Serial Port**
- 4. In the serial port window, enter the appropriate port in each of the drop down menus based on your port numbers from Step 2





5.4 Running GUI - continued

- 5. Click on **Configure** and the demo will automatically connect to the EVM
 - Not connected: Connected: Connected:
 - If the connection fails, try clicking on the connection icon in the bottom left corner
- 6. Select the appropriate mmWave device from the **Platform** dropdown menu
- 7. Use the available options to create the desired configuration
 - Additional details about the configuration parameters can be found in the <u>mmWave</u> <u>Demo Visualizer User Guide</u>
- 8. When ready to send the configuration, click on **Send Config To mmWave Device**
- 9. Click on the **Plots** tab to view the plots that were selected to be shown
- 10. Move a highly reflective object in front of the EVM and see how the demo responds



5. Running the

Demo

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5.4 Running GUI - continued

mmWave Demo Visualizer Options Help Configure Plots Range Depth X-Y Scatter Plot Range Profile Range Width Range Profile Y max 2e6 2M Range Profile Log Scale 0.8 axis (me 1.5M Display Parameters Profiling • gitudinal 0.6 Platform 0xa1443 SDK Version 1.0.0.4 along lor Number of Detected Objects 6 InterChirpProcessingMargin (usec) 0 Distance 0.5M 0.3 InterFrameProcessingMargin (usec) 65685 InterFrameProcessingTime (usec) 2018 TransmitOutputTime (usec) 7536 -0.5 Distance along lateral axis (meters) Range (meters) Doppler-Range Plot Active and Interframe CPU (R4F) load ----- Active frame ----- Interframe Doppler (m/s) CPU Load * -0.4 50 Powered By GUI Compos COM43:115200, COM42:921600 Hardware Connected. TEXAS INSTRUMENTS 9



29

5. Running the Demo

Learn more about TI mmWave Sensors

- Learn more about xWR1x devices, please visit the product pages
 - IWR1443: <u>http://www.ti.com/product/IWR1443</u>
 - IWR1642: <u>http://www.ti.com/product/IWR1642</u>
 - AWR1443: <u>http://www.ti.com/product/AWR1443</u>
 - AWR1642: <u>http://www.ti.com/product/AWR1642</u>
- Get started evaluating the platform with xWR1x EVMs, purchase EVM at
 - IWR1443 EVM: http://www.ti.com/tool/IWR1443BOOST
 - IWR1642 EVM: <u>http://www.ti.com/tool/IWR1642BOOST</u>
 - AWR1443 EVM: <u>http://www.ti.com/tool/AWR1443BOOST</u>
 - AWR1642 EVM: <u>http://www.ti.com/tool/AWR1642BOOST</u>
- Download mmWave SDK @ <u>http://www.ti.com/tool/MMWAVE-SDK</u>
- Ask question on TI's E2E forum mmWave Sensors forum @ https://<u>e2e.ti.com/support/sensor/mmwave_sensors</u>/





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