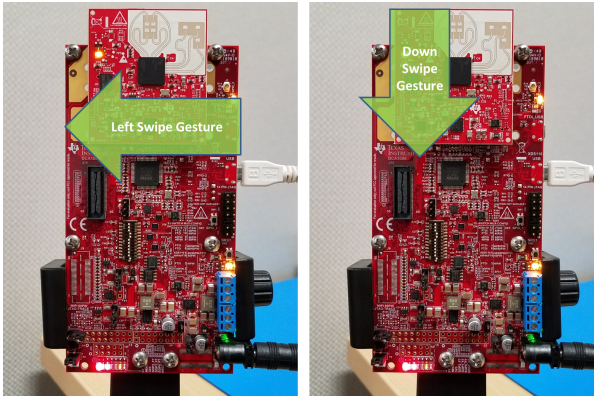


Multiple Gesture and Motion Detection Overview

This lab demonstrates the use of TI single-chip millimeter-wave (mmwave) technology for detection and classification of natural gestures. The example provided in this demo can recognize two different hand gestures: Left swipe and Down swipe. In addition, the lab also demonstrates Person detection (through motion) at various ranges up to about 3.5 meters.

Such a system can be used to implement gesture based Human Machine Interfaces (HMI) which switch to a low power mode for motion/presence detection when someone is not around and switch to gesture detection mode when motion is detected near the sensor.

The lab provides full source code with CCS projects and runs on the TI IWR6843 60GHz mmWave sensor Evaluation Platform.



Quickstart

Please follow the instructions in this Quickstart section only to flash the EVM with the pre-compiled binary provided here. After flashing the EVM, please follow the instructions provided in the Testing and Results section of the Gesture-controlled HMI with mmWave Sensors and Sitara Processors Reference Design (<http://www.ti.com/tool/TIDEP-01013>) user guide to continue with the rest of the setup and instructions for running the demo.

1. Hardware and Software Requirements

Hardware

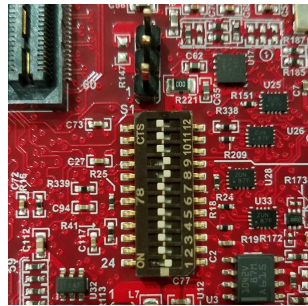
Item	Details
Device	Industrial mmWave Carrier Board (http://www.ti.com/tool/MMWAVEICBOOST) and IWR6843ISK-ODS Antenna Module (http://www.ti.com/tool/IWR6843ISK-ODS)
	Note: The rest of this document will refer to the above board combination as EVM .
Computer	Windows 7 or 10 PC with TeraTerm (https://ttssh2.osdn.jp/index.html.en) or another terminal emulator installed.
Micro USB Cable	Provided with the Industrial Radar Carrier Board (http://www.ti.com/tool/MMWAVEICBOOST)
Power Supply	5V, 3A with 2.1-mm barrel jack (center positive). The power supply can be wall adapter style or a battery pack with a USB to barrel jack cable.

Software

Tool	Version	Details	Download Link
Software provided with TIDEP-01013 (http://www.ti.com/tool/TIDEP-01013)	Latest	Contains pre-compiled binaries and source code for the lab	Gesture-controlled HMI with mmWave Sensors and Sitara Processors Reference Design (http://www.ti.com/tool/TIDEP-01013)
			Download and install the software provided at the above location. You should have the following directory structure on your PC after installation: <Install_dir>\lab0023_multi_gesture_and_motion_det_68xx
Uniflash	Latest	Uniflash tool is used for flashing TI mmWave Radar devices.	Download offline tool (http://www.ti.com/tool/UNIFLASH) or use the Cloud version (https://dev.ti.com/uniflash/#/)

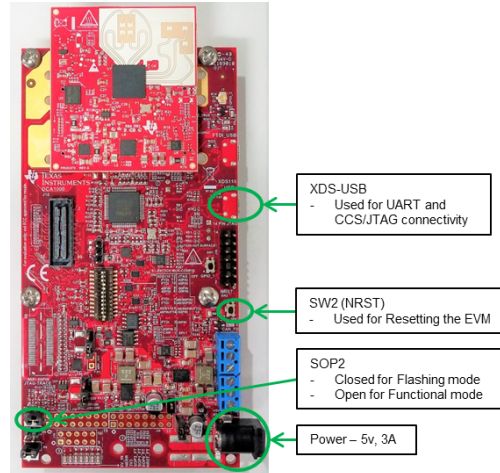
2. Physical Setup

1. Setup the Carrier Board in standalone mode using the S1 switch combination as shown below.



Switch ID	Position for Standalone Mode
S1.12	ON
S1.11	ON
S1.10	ON
S1.9	OFF
S1.8	OFF
S1.7	ON
S1.6	ON
S1.5	ON
S1.4	ON
S1.3	ON
S1.2	ON
S1.1	OFF

2. Connect the IWR6843ODS antenna board to the MMWAVEICBOOST board and mount the EVM vertically as shown below. The EVM should be positioned with antenna oriented on the top side and facing gesturing hand. The lab is configured to detect gestures within 0.3m of the EVM.



3. Plug in micro-usb and power supply to EVM using the connectors shown above.

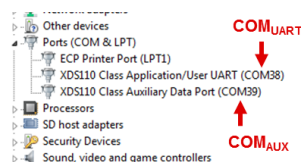
3. Flash the EVM

- Power on the EVM using a 5V/3A power supply.
- Flash the following image using **Uniflash**

Image	Location
Meta Image 1	<Install_dir>\lab0023_multi_gesture_and_motion_det_68xx\prebuilt_binaries\multi_gesture_demo_68xx.bin

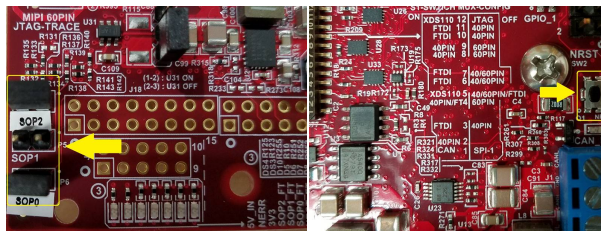
Expand for help using Uniflash

- 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

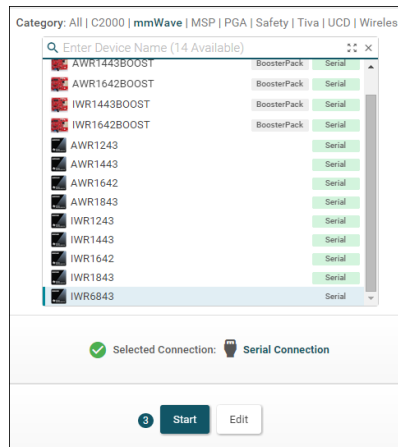


Note the COM UART and COM AUX port numbers, as they will be used later for flashing and running the lab.

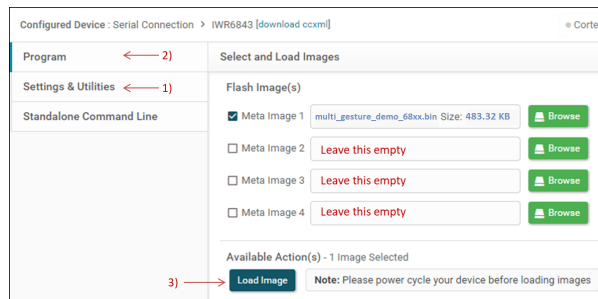
- Put the EVM in flashing mode by connecting jumpers on **SOP0** and **SOP2** as shown in the image. Then power cycle the EVM with **SW2** (NRST).



- Open the **UniFlash tool** (Download offline tool (<http://www.ti.com/tool/UNIFLASH>) or use the Cloud version (<https://dev.ti.com/uniflash/#/>))
 - In the New Configuration section, locate and select the appropriate device (IWR6843)
 - Click Start to proceed



- Click the **Settings & Utilities** tab. Under setup, fill the **COM Port** text box with the Application/User UART COM port number (COM UART) noted earlier.
- In the **Program** tab, browse and locate the images (.bin file) as specified above.



- **Power cycle** the device and click on **Load Images**



Successful Flash Procedure

UniFlash's console should indicate: [SUCCESS] Program Load completed successfully

- Power off the board and **remove only SOP2 jumper**

SOP2 Removed?

Ensure that the jumper has been removed and the EVM power cycled. This puts the board back in functional mode.

4. Run the Lab

- Please follow the instructions provided in the Testing and Results section of the Gesture-controlled HMI with mmWave Sensors and Sitara Processors Reference Design (<http://www.ti.com/tool/TIDEP-01013>) user guide.
- This concludes the Quick Start Section

Developer's Guide

Build the Firmware from Source Code

1. Software Requirements

Tool	Version	Download Link
TI mmWave SDK	3.1.1.2	TI mmWave SDK 3.1.1.2 (http://software-dl.ti.com/ra-processors/esd/MMWAVE-SDK/03_01_01_02/index_FDS.html) and all the related tools are required to be installed as specified in the mmWave SDK release notes
Code Composer Studio	8.1.0	Code Composer Studio v8 (http://processors.wiki.ti.com/index.php/Download_CCS#Code_Composer_Studio_Version_8_Downloads)
TI SYS/BIOS	6.73.01.01	Included in mmWave SDK installer
TI ARM Compiler	16.9.6.LTS	Included in mmWave SDK installer
TI CGT Compiler	8.1.3	Included in mmWave SDK installer
XDC	3.50.08.24	Included in mmWave SDK installer
C64x+ DSPLIB	3.4.0.0	Included in mmWave SDK installer
C674x DSPLIB	3.4.0.0	Included in mmWave SDK installer
C674x MATHLIB (little-endian, elf/coff format)	3.1.2.1	Included in mmWave SDK installer
mmWave Radar Device Support Package	1.6.1 or later	Upgrade to the latest using CCS update process (see SDK user guide for more details)
TI Emulators Package	7.0.188.0 or later	Upgrade to the latest using CCS update process (see SDK user guide for more details)
Uniflash	Latest	Uniflash tool is used for flashing TI mmWave Radar devices. Download offline tool (http://www.ti.com/tool/UNIFLASH) or use the Cloud version (https://dev.ti.com/uniflash/#1/)


2. Import Lab Project

For the Multiple Gesture and Motion Detection lab, there are two projects, the DSS for the C674x DSP core and the MSS project for the R4F core, that need to be imported to CCS and compiled to generate firmware for the xWR6843. You can import the project in your CCS workspace using TI Resource Explorer in CCS or using a browser. Both methods of importing projects are defined in the Expand boxes below.

- Start CCS and setup workspace as desired.
- Import the projects below to CCS using either TI Resource Explorer in CCS or CCS Import Projects specs method:
 - **multi_gesture_68xx_dss**
 - **multi_gesture_68xx_mss**

Expand for details on importing via TI Resource Explorer in CCS



- In the top toolbar, navigate to **View** → **Resource Explorer**
- In the **Resource Explorer** side panel (not the main panel with "Welcome to.."), navigate to **Software** → **mmWave Sensors** → **Industrial Toolbox - <ver>** → **Labs** → **Multi Gesture and Motion Detection - 68xx**
- Under the expanded **Multi Gesture and Motion Detection** folder, there should be two CCS projects, **CCS Project - DSS** and **CCS Project - MSS**.
- For each of the two projects: Click on the project, which should open the project in the right main panel, and then click on the Import to IDE button .

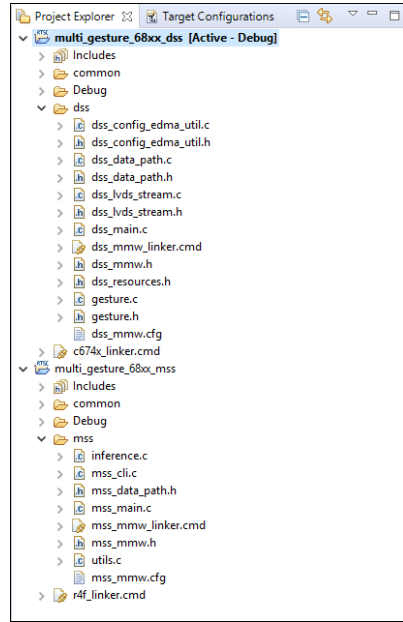
Expand for details on importing via CCS Import Projects specs



- In the top toolbar, navigate to **Project** → **Import CCS Projects...**
- With the **Select search-directory** option enabled, click **Browse...**, navigate to the **lab0023_multi_gesture_and_motion_det_68xx** folder at `C:\ti\<mmwave_industrial_toolbox_install_dir>\labs\lab0023_multi_gesture_and_motion_det_68xx`, and then click **OK**.
- Under **Discovered projects**, select **multi_gesture_68xx_dss** and **multi_gesture_68xx_mss** (ignore any other projects), then click **Finish**.

✓ Successful Import to IDE

After using either method, both projects should be visible in **CCS Project Explorer**



i Project Workspace

When importing projects to a workspace, a copy is created in the workspace. The copy in user's workspace is the one that gets built and all modifications will only be implemented for the workspace copy. The original project downloaded in mmWave Industrial Toolbox is not used once imported.

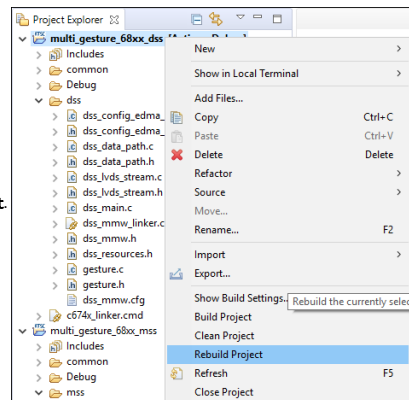
3. Build the Lab

Build DSS Project

The DSS project must be built before the MSS project.

With the **multi_gesture_68xx_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.

✓ Successful DSS Project Build

In the **Project Explorer** panel, navigate to and expand **multi_gesture_68xx_dss** → **Debug** directory. On successful build, the following files should appear in the **Debug** folder:

- multi_gesture_68xx_dss.xe674 (this is the C674x DSP binary used for CCS debug mode)

Build MSS Project

After the DSS project is successfully built, select **multi_gesture_68xx_mss** in **Project Explorer**, right click on the project and select **Rebuild Project**.



Successful MSS Project Build

In the **Project Explorer** panel, navigate to and expand **multi_gesture_68xx_mss** → **Debug** directory. The project has been successfully built if the following files appear in the **Debug** folder:

- **multi_gesture_68xx_mss.xer4f** (this is the Cortex R4F binary used for CCS debug mode)
- **multi_gesture_demo_68xx.bin** (this is the flashable binary used for deployment mode)



Build Fails with Errors

If the build fails with errors, please ensure that all the prerequisites are installed as mentioned under Software Requirements.



Note

As mentioned in the Quickstart section, pre-built binary files, are provided in
<Install_dir>\labs\lab0023_multi_gesture_and_motion_det_68xx\prebuilt_binaries

4. Execute the Lab

There are two ways to execute the compiled code on the EVM:

- **Deployment mode:** In this mode, the EVM boots autonomously from flash and starts running the bin image
 - Using Uniflash, flash the **multi_gesture_demo_68xx.bin** found at
<PROJECT_WORKSPACE_DIR>\multi_gesture_68xx_mss\Debug\multi_gesture_demo_68xx.bin
 - The procedure to flash the EVM is the same as detailed in the Flash the EVM section.
- **Debug mode:** This mode is used for downloading and running the executable (.xer4f and .xe674) from CCS. This mode enables JTAG connection with CCS while lab is running; useful during development and debugging

Expand for help with Debug mode:

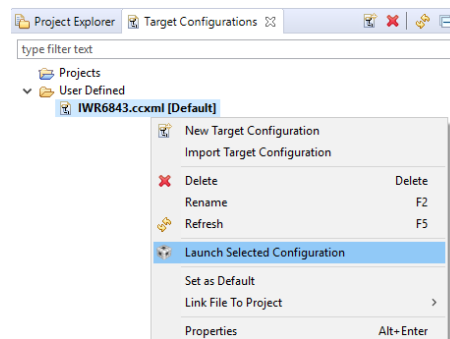
The CCS debug firmware (provided with the mmWave SDK) needs to be flashed once on the EVM.

- CCS Debug method is enabled by flashing the CCS Debug Firmware (provided with the mmWave SDK) using the methods covered in the Quickstart Flash the Device section.
- Use the following image instead

Image	Location	Comment
Meta Image 1/RadarSS	C:\ti\mmwave_sdk_<ver>\packages\ti\utils\ccsdebug\xwr68xx_ccsdebug.bin	Provided with the mmWave SDK

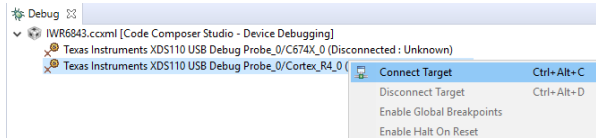
After the CCS debug firmware has been flashed, connect the EVM to CCS

- Create a target configuration (skip to "Open the target..." if config already created previously in another lab for xwr16xx)
 - Go to **File** → **New** → **New Target Configuration File**
 - Specify an appropriate file name (ex: IWR68xx.ccxml) and check "Use shared location". Click **Finish**.
- In the configuration editor window:
 - Select **Texas Instruments XDS110 USB Debug Probe** for Connection
 - Select **IWR6843** in the **Board or Device** text box.
 - Press the **Save** button to save the target configuration.
 - [Optional]: Press the **Test Connection** button to check the connection with the board.
- Open the target configuration window by going to **View** → **Target Configurations**.
 - Under **User Defined** configurations the target configuration previously created should appear.
 - Right click on the target configuration and select **Launch Select Configuration**. The target configuration will launch in the **Debug Window**.



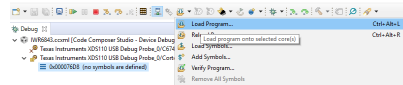
- Connect Target

- o Select **Texas Instruments XDS110 USB Debug probe/C674X_0** and then right click and select **Connect Target**
- o Select **Texas Instruments XDS110 USB Debug probe/Cortex_R4_0** and then right click and select **Connect Target**



- Load the binary

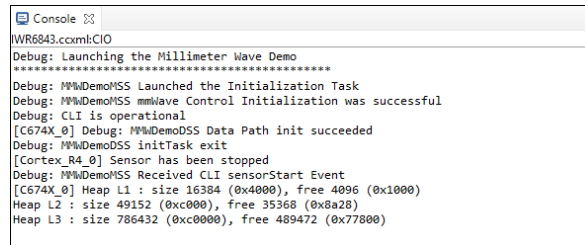
- o Once both targets are connected, click on the **C674X_0** target and then click **Load** button in the toolbar.



- o In the **Load Program** dialog, press the **Browse Project** button .
- o Select **indoor_false_det_68xx_dss.xe674** found at
`<PROJECT_WORKSPACE_DIR>\multi_gesture_68xx_dss\Debug\multi_gesture_68xx_dss.xe674`
and press **Ok**.
- o Press **Ok** again in the **Load Program** dialog.
- o Repeat the above Load the Binary process for the Cortex_R4_0 target, selecting instead **multi_gesture_68xx_mss.xer4f** found at
`<PROJECT_WORKSPACE_DIR>\multi_gesture_68xx_mss\Debug\multi_gesture_68xx_mss.xer4f`

- Run the binary

- o Select **Texas Instruments XDS110 USB Debug probe/C674X_0** and then press the **Run/Resume** button
- o Select **Texas Instruments XDS110 USB Debug probe/Cortex_R4_0**, press the **Run/Resume** button
- o The program should start executing and generate console output as shown.



After running the lab using either method, the demo firmware should be executing on the EVM and waiting for sensor configuration. After this point, please follow the instructions provided in the Quickstart section to run the demo.

Need More Help?

- Find answers to common questions on mmWave E2E FAQ (https://e2e.ti.com/support/sensor/mmwave_sensors/w/wiki)
- Search for your issue or post a new question on the mmWave E2E forum (https://e2e.ti.com/support/sensor/mmwave_sensors/f/1023)