MMWAVE MCUPLUS SDK Release Notes

Product Release 4.3

Release Date: November 14, 2022

Release Notes Version: 3.0

CONTENTS

1. Introduction

The mmWave mcuplus SDK enables the development of millimeter wave (mmWave) radar applications using TI mmWave sensors (see list of supported Platform/Devices). The SDK provides foundational components which will facilitate end users to focus on their applications. In addition, it provides few demo applications which will serve as a guide for integrating the SDK into end-user mmWave application. See what SDK components are supported by each device in the Device-Specific Support section.

Key mmWave SDK features:

- Building blocks
  - Layered approach to programming analog front end
- Demonstrations and examples
  - FreeRTOS based
  - Out of box demo with easy configurability via TI cloud based GUI
  - Representation of "point cloud" and benchmarking data from demo via GUI
  - Profiles tuned to common end user scenarios such as Range, Range resolution, Velocity, Velocity resolution.
- Documentation

mmWave SDK works along with the following external tools:

- Host tools including Pin Mux, Flashing utilities
- Code Composer Studio™ IDE for RTOS development

> ⚠ **NOTICE**: This software product is used to configure TI's mmWave devices, including RF emissions parameters for such devices. Note that many countries or regions impose regulations governing RF emissions. Users are responsible for understanding local RF emission regulations and operating the product within those regulations.

2. Release overview

2.1. What is new

- Support for devices mentioned in the Platform and Device Support section
- See what SDK components are supported by each device in the Device-Specific Support section
- New features can be found in New Features section.
- Tools update

2.2. Platform and Device Support

The devices and platforms supported with this release include:

Supported Devices	Supported EVM
AM273X ES1.0	AM273X EVM
AWR2243 ES1.1	AWR2243BOOST
AWR294X ES1.0	AWR294X EVM

> ⚠ **Silicon versions other than the ones in the table above are not supported**

> ⚠ This release of mmWave mcuplus SDK supports the foundation components for the devices mentioned in the table above. At system level, the mmWave SOC/EVM may interface with other TI ecosystem SOCs/Launchpads/EVMs and software for these other devices will not be a part of the mmWave mcuplus SDK foundation components.

2.3. Component versions

Components inside mmwave_mcuplus_sdk that have their own versions are shown below.

Component	Version	Type	Comment
mmwave sdk	4.3	Source and Binary	Overall package release version

2.4. Tools dependency

For building and using mmwave sdk the following tool versions are needed.

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Tool	Version	Download link
CCS	12.0	download link (Contact TI Representative for latest version)
MCU PLUS SDK (AM273X)	08.04.00.17	Included in mmwave mcuplus sdk installer
MCU PLUS SDK (AWR294X)	08.04.00.22	Included in mmwave mcuplus sdk installer
SYSCONFIG	1.13.0	Included in mmwave mcuplus sdk installer
TI ARM CLANG	2.1.1.LTS	Included in mmwave mcuplus sdk installer
TI CGT compiler	8.3.12	Installed with CCS12.0 installer
XDC	3.62.01.16	Installed with CCS12.0 installer
C66x DSPLIB	3.4.0.0	Included in mmwave mcuplussdk installer
C66x MATHLIB (little-endian, elf/coff format)	3.1.2.1	Included in mmwave mcuplussdk installer
mmWave Device Firmware Package (DFP - AWR2243 ES1.1)	02.02.04.00	Included in mmwave mcuplus sdk installer (includes RSS firmware and mmwavelink library)
mmWave Device Firmware Package (DFP - AWR294X ES1.0)	02.04.05.00	Included in mmwave mcuplus sdk installer (includes RSS firmware and mmwavelink library)
OpenSSL (optional)	1.1.1 or above	Needed for signing secondary bootloader image, required only if you want to build the SBL dependency images from scratch
TI Emulators package	Latest	Upgrade to the latest using CCS update process (Contact TI Representative for latest version)
Pinmux tool (optional)	Latest	Contact TI Representative for latest tool
Doxygen (optional)	1.8.11	Only needed if regenerating doxygen docs
Graphviz (optional)	2.36.0 (20140111.2315)	Only needed if regenerating doxygen docs

The following tools are needed at runtime

Runtime tool	Version	Link
mmWave Demo Visualizer	Latest	TI Gallery APP for configuring mmWave sensors and visualizing the point cloud objects generated by the mmWave SDK demo https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/ver/4.3.0/

2.5. Licensing

Please refer to the mmwave_mcuplus_sdk_software_manifest.html, which outlines the licensing status for mmwave_mcuplus_sdk package.

3. Release content

3.1. New Features

- DDMA processing chain optimizations
- DDMA processing chain object detection test cases
- Procedure to calibrate antenna
- Advance frame configuration support in DDMA processing chain
- Enabled BFP compression in HWA driver
- Enet Time stamp example
- HWA driver improvements:
  - Initialization of DMEM0-DMEM7 HWA peripheral memories.
  - Provides API (HWA_startRAMInit()) to initialize application buffers (HWA_WINDOW_RAM, WA_MULT_RAM, HWA_DEROT_RAM, HWA_SHUFFLE_RAM, HWA_2DSTAT_ITER_VAL_RAM, HWA_2DSTAT_ITER_IDX_RAM, HWA_2DSTAT_SMPL_VAL_RAM, HWA_2DSTAT_SMPL_IDX_RAM, HWA_HIST_RAM, HWA_HIST_THRESH_RAM).
  - Configures Local RAM access error (HWA_LOCAL_RAM_ERR) interrupt.
  - Provides API's (HWA_configureSingleStep(), HWA_triggerSingleStep()) to enable single step to enable and step through useful for debugging.
  - Update HWA_readDebugReg() API to report HWA peripheral FSM state information.

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- Below captured bug fixes:
    - MCUSDK-3809: SBL support for warm reset.
    - MMWSDK-2657: Disabling unused PADs using sysconfig
    - MMWSDK-2665: Optimize BSS Power up timing

3.2. Migration notes from Previous SDK versions

This section describes the changes that are relevant for users migrating to the mmWave mcuplus SDK 4.3.0 release from previous release.

Summary	Component (s)	Sub-component (s)	Affects SoC	Behavior of impact
DDMA cfarCfg CLI command added new argument to enable/disable Range CFAR DPU	Datapath	CFAR	AM273x & AWR294x	
measureRangeBiasAndRxChanPhase enabled for DDMA processing chain This command is to measure the parameters for antenna calibration.	Datapath	DPUs	AM273x & AWR294X	

3.3. Known Issues

3.3.1. mmWave Suite/Demos Known Issues

For issues related to DDMA processing chain please refer DDMA documentation in *mmwave_sdk_<ver>/docs/mmwave_sdk_module_documentation.html*.

The following issues are known at the time of this release.

Issue Type	Key	Summary	Comments
Bug	MMWSDK-2473	Static clutter removal command in the GUI Visualizer does not work as expected	
Bug	MMWSDK-2474	Max range/resolution selection in the Visualizer might not give the same in the plots	
Bug	MMWSDK-2475	minmaxFlag in aoaproc test case is not enabled for AWR294X	The same functionality has been tested in the objectdetection test case
Bug	MMWSDK-2560	sensorStart does not work immediately after issuing sensorStop	Workaround: The profile can be loaded again from the "Load Config from PC and Send" button of the visualizer without having to restart the demo.
		IPC communication between the MCAL CDD IPC (R5F) and MCU+SDK IPC (DSP) does not work due to the differences IPC messaging.	PDK uses mailbox driver which is compatible with MCAL CDD IPC. As part of the migration to MCU Plus SDK mailbox driver is merged to IPC driver which is not compatible with MCAL CDD IPC driver.
Bug	MMWSDK-2693	Advance Frame Config issue with non-zero chirp start index for sub-frame#1	In legacy chirp configuration / advance frame configuration (chirp config, per-chirp BPM, per-chirp PS) when the chirp start index in the current burst is non-zero, the index computation fails and picks up the phase information from an incorrect chirp index.

3.3.2. Limitations

3.3.2.1. mmWave Suite/Demos Limitations

Some of these limitations are captured in the "known issues" list shown in previous section.

1	Limited number of test cases are provided for DDMA libraries
2	Ethernet Streaming for DDM demo is not available.
3	CQ Data streaming for AWR294x is not tested as the OOB doesn't support continuous mode.

4. Test reports

Results of the unit tests can be found in the mmwave_mcuplus_sdk_<ver>/ti/docs/testlogs folder.

5. Installation instructions

mmwave_sdk installer is available as a Windows Installer and a Linux installer.

- **mmwave_mcu_plus_sdk_<version>-Windows-x86-Install.exe: Windows installer verified on Windows 10 machines**
- **mmwave_mcu_plus_sdk_<version>-Linux-x86-Install.bin: Linux installer verified on Ubuntu 18.04 64 bit machines.**

5.1. Installation in GUI mode

Depending on your development environment run the appropriate installer

- In Windows environment, double clicking the Windows installer from Windows explorer should start the installation process
- If in Linux environment,
    - On 64-bit machines: Since mmwave_mcu_plus_sdk_<version>-Linux-x86-Install.bin is a 32-bit executable, install modules that allows Linux 32bit binaries to execute: "sudo dpkg --add-architecture i386"
    - Enable execute permission for the Linux installer by running "chmod +x mmwave_mcu_plus_sdk_<version>-Linux-x86-Install.bin" command
    - Run the installer using "./mmwave_mcu_plus_sdk_<version>-Linux-x86-Install.bin" command
    - On 64-bit machines if the GUI does not show up you may need to install additional packages: "sudo apt-get install libc6:i386 libgtk2.0-0:i386 libxtst6:i386"

Installation steps:

- Setup
- Choose Destination Location: Select the folder to install (default is c:\ti\mmwave_mcu_plus_sdk_<version> on windows and ~/ti/mmwave_mcu_plus_sdk_<version> on linux). The installation folder selected should not have spaces in its full path.
- Select Components: The installer includes all the tools needed for building the mmWave SDK. You should see a screen like below (except that each component will also have version information appended). The only reason to deselect a tool is if the exact tool version is already installed in the destination folder.
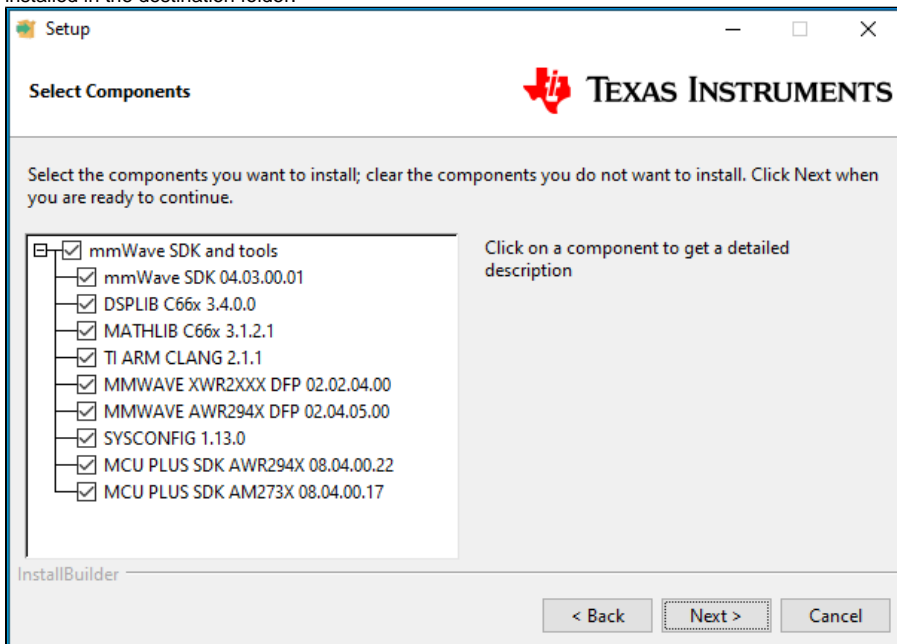
- Review installation decisions
- Ready to install
- Once installation starts all the selected components will be installed (if a component with the same version exists in the destination folder it will be overwritten)
- Installation complete

5.2. Installation in unattended command line mode

The installers can be run in command line mode without user intervention

- In Windows environment
    - Run the installer using "mmwave_mcuplus_sdk_<version>-Windows-x86-Install.exe --prefix <installation folder> --mode unattended" command. This will install all the components in the installer.
        - Please note that even though the command may finish immediately it takes sometime for all the folders to show up in the destination folder (double check if you have the folder structure in "Post Installation" section before proceeding)
        - For command line help including information about selective installation of components run the following command "mmwave_mcu_plus_sdk_<version>-Windows-x86-Install.exe --help"
- In Linux environment:
    - On 64-bit machines: Since mmwave_mcuplus_sdk_<version>-Linux-x86-Install.bin is a 32-bit executable, install modules that allows Linux 32bit binaries to execute: "sudo dpkg --add-architecture i386"
    - Enable execute permission for the Linux installer by running "chmod +x mmwave_mcuplus_sdk_<version>-Linux-x86-Install.bin" command
    - Run the installer using "./mmwave_mcuplus_sdk_<version>-Linux-x86-Install.bin --prefix <installation folder> --mode unattended" command. This will install all the components in the installer.
        - For command line help including information about selective installation of components run the following command "./mmwave_mcuplus_sdk_<version>-Linux-x86-Install.bin --help"

5.3. Post Installation

After the installation is complete the following folder structure is expected in the installation folder (except that each component will have appropriate version number in place of the VERSION placeholder shown below)

dsplib_c66x_[ver]	11/4/2022 3:17 PM	File folder
mathlib_c66x_[ver]	11/4/2022 3:17 PM	File folder
mcu_plus_sdk_am273x_[ver]	11/4/2022 3:17 PM	File folder
mcu_plus_sdk_awr294x_[ver]	11/4/2022 3:17 PM	File folder
mmwave_dfp_02_02_[awr2243_ver]	11/4/2022 3:17 PM	File folder
mmwave_dfp_02_04_[awr294x_ver]	11/4/2022 3:17 PM	File folder
mmwave_mcuplus_sdk_[ver]	11/4/2022 3:17 PM	File folder
sysconfig_[ver]	11/4/2022 3:17 PM	File folder
ti-cgt-armllvm_[ver]	11/4/2022 3:22 PM	File folder

Under the mmwave_mcuplus_sdk <ver> folder you should have the following directory structure.

```
mmwave_mcuplus_sdk_[ver]
  .metadata
  docs
  scripts
    unix
    windows
  ti
    alg
    board
    common
    control
    datapath
    demo
    platform
    utils
  tools
```

6. Device-Specific Support

The current release of mmwave SDK contains support for the following components

Component		AM273X EVM + AWR2243BOOST	AWR294X EVM
Control	Datapath Manager (dpm)	X	X
	mmwave High Level API (mmwave)	X	X
Datapath	RangeProc DPU	X	X
	RangeProc DDMA DPU	X (C66 Only)	X (C66 Only)
	Doppler DPU	X	X
	Doppler DDMA DPU	X (C66 Only)	X (C66 Only)
	CFAR DPU	X	X
	RangecfarProc DDMA DPU	X (C66 Only)	X (C66 Only)
	AoA DPU	X	X

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		Datapath EDMA	X	X
		Object Detection DPC	X	X
		Object Detection DDMA DPC	X (C66 Only)	X (C66 Only)
Alg		mmwavelib	X	X
		Group Tracking (gtrack)	X	X
Utilities		Command Line Interface (CLI)	X	X
		CBUFF Streaming + HSI header		X
		Mailbox driver test		X
		MSS VMON self-test		X
		Math Utilities (mathutils)	X	X
		Test Logger (testlogger)	X	X
		CCS Debug Utility (ccsdebug)	X	X
Tools		Binaries for appimage flashing	X	X
Demo		OOB Demo TDM	X	X
		OOB Demo DDM	X	X
		Ethernet-based streaming DDM		
		Ethernet-based streaming TDM	X	X
		LVDS streaming	X	X

7. Package Contents

The mmwave mcuplus sdk release package contains the following major components/folders.

7.1. Control

Control modules can be found under mmwave_mcuplus_sdk_<ver>/ti/control folder. Content of each of the control module is shown below

Component	Source & Prebuilt Library	API Document (doxygen)	Unittest (source & prebuilt binary)
datapath manager (dpm)	X	X	X
mmwave high level api	X	X	X

7.2. Datapath

Datapath modules can be found under mmwave_mcuplus_sdk_<ver>/ti/datapath folder. Content of each of the control module is shown below

Component	Source & Prebuilt Library	API Document (doxygen)	Unittest (source & prebuilt binary)
RangeProc DPU	X	X	X
RangeProc DDMA DPU	X (C66 Only)	X	X (C66 Only)
Doppler DPU	X	X	X

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Doppler DDMA DPU	**X** **(C66 Only)**	**X**	**X** **(C66 Only)**
CFAR DPU	**X**	**X**	**X**
RangecfarProc DDMA DPU	**X** **(C66 Only)**	**X**	
AoA DPU	**X**	**X**	**X**
Datapath EDMA	**X**	**X**	
Object Detection DPC[1]	**X**	**X**	**X**
Object Detection DDMA DPC[1]	**X** **(C66 Only)**	**X**	**X** **(C66 Only)**

[1] No pre-built library for Object Detection DPC

7.3. Demos

Demos can be found under mmwave_mcuplus_sdk_<ver>/ti/demo/<platform>. The following demos are included in the mmwave sdk package. Details on running demos can be found in the mmwave_mcuplus_sdk_user_guide.

Component	Source & Prebuilt Binary	Demo document (doxygen)	Demo GUI
mmw	X	X	X

Misc folders

Following folders are also part of mmwave_mcuplus_sdk_<ver>/ti folder.

- common: Common header files needed across all components
- platform: platform specific files
- utility: Contains
  - cli which is the cli helper utility used by the demos
  - mathutils is used to perform some common operations such as log2, rounding, saturation based on the core they need to run on (R5F, C66x)
  - testlogger which is the helper utility for driver unit tests
  - ccsdebug which is a utility that can be flashed on QSPI, and will loop forever. Meanwhile, CCS can be attached and developers can download the application which needs to be debugged
  - test contains below utilities :
    - cbuff_stream application streams raw ADC data over LVDS interface (applicable for only AWR294X SOC)
    - mailbox driver test application issues version command to BSS (applicable for only AWR294X SOC)
    - MSS VMON self-test application preforms voltage monitor self-tests and verifies the ESM interrupt
    - Cascade application communicates with two AWR2243 front ends (Application for only AM273x SOC and should only be tested on 2-chip Cascade EVM)

7.4. Scripts

Build scripts can be found in mmwave_mcuplus_sdk_<ver>/scripts folder. Build instructions can be found in mmwave_mcuplus_sdk_user_guide.

7.5. Tools

Dependencies needed for a successful flashing of binary images are located in mmwave_mcuplus_sdk_<ver>/tools. The User Guide details the steps for flashing the metaimages.

7.6. Docs

mmwave_mcuplus_sdk_<ver>/docs folder contains important documents related to the release such as

- mmwave_mcuplus_sdk_software_manifest.html: Software Manifest
- mmwave_mcuplus_sdk_release_notes.pdf: Release Notes (this document)
- mmwave_mcuplus_sdk_user_guide.pdf: User guide
- mmwave_sdk_module_documentation.html: Links to individual module's documentation
- testlogs: Unit test logs for mmWave SDK unit tests

mmwave_mcuplus_sdk_<ver>/docs/testlogs folder contains test results for each components in the package.

8. Related documentation/links

Other than the documents included in the mmwave_sdk package the following documents/links are important references.

- SoC links:
  - Automotive mmWave Sensors
  - Industrial mmWave Sensors
- Evaluation Modules (EVM) links:
  - Automotive Evaluation modules (Booster Pack, DEVPACK)
  - Industrial Evaluation modules (Booster Pack, ISK)