

## MMWAVE MCUPLUS SDK Release Notes



**Product Release 4.5.0.2**

**Release Date: November 29, 2023**

**Release Notes Version: 1.0**

## CONTENTS

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- 1. Introduction
  - 2. Release overview
    - 2.1. What is new
    - 2.2. Platform and Device Support
    - 2.3. Component versions
    - 2.4. Tools dependency
    - 2.5. Licensing
  - 3. Release content
    - 3.1. Change Summary
    - 3.2. Migration notes from Previous SDK versions
    - 3.3. Known Issues
      - 3.3.1. mmWave Suite/Demos Known Issues
      - 3.3.2. Limitations
        - 3.3.2.1. mmWave Suite/Demos Limitations
  - 4. Test reports
  - 5. Installation instructions
    - 5.1. Installation in GUI mode
    - 5.2. Installation in unattended command line mode
    - 5.3. Post Installation
  - 6. Device-Specific Support
  - 7. Package Contents
    - 7.1. Control
    - 7.2. Datapath
    - 7.3. Demos
    - 7.4. Misc folders
    - 7.5. Scripts
    - 7.6. Tools
    - 7.7. Docs
  - 8. Related documentation/links
- 



## 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
<a href="#">AM273X ES1.0</a>	<a href="#">AM273X EVM</a>
<a href="#">AWR2243 ES1.1</a>	<a href="#">AWR2243BOOST</a>
<a href="#">AWR294X ES2.0</a>	<a href="#">AWR294X EVM</a>
<a href="#">AWR2544 ES1.0</a>	<a href="#">AWR2544 EVM</a>



**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 SOC/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	4.5.0.2	Source and Binary	Overall package release version

### 2.4. Tools dependency

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

Tool	Version	Download link
CCS	12.4	<a href="#">download link</a> (Contact TI Representative for latest version)
MCU PLUS SDK (AM273X)	08.05.00.24	Included in mmwave mcuplus sdk installer
MCU PLUS SDK (AWR294X) <sup>1</sup>	09.00.00.15	Included in mmwave mcuplus sdk installer
MCU PLUS SDK (AWR2544)	09.00.00.06	Included in mmwave mcuplus sdk installer
SYSCONFIG	1.17.0	Included in mmwave mcuplus sdk installer
TI ARM CLANG	2.1.3.LTS	Installed with CCS12.2 installer
TI CGT compiler	8.3.12	Installed with CCS12.2 installer
XDC	3.62.01.16	Installed with CCS12.2 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 - AWR2544/AWR294X)	02.04.12.01	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

<sup>1</sup> To re-build driver level example applications sysconfig is expected to be installed at "c:\ti\" location

The following tools are needed at runtime

Runtime tool	Version	Link
mmWave Demo Visualizer  <b>Note: AWR2544 device is not supported</b>	Latest	TI Gallery APP for configuring mmWave sensors and visualizing the point cloud objects generated by the mmWave SDK demo  <a href="https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/">https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/</a>

## 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. Change Summary

- New Features:
  - OOB Demo for AWR2544
    - Transmission of compressed radar cube over Ethernet interface at 1Gbps.
    - RangeProcReal2x DPU specific to AWR2544
      - Supports both 1X and 2X mode of HWA operation.
      - Supports both EGE and BFP mode of compression.
      - SysConfig support to configure the HWA paramsets and common registers.
    - Both TDM, DDM profile configuration via CLI.
    - Python script to parse, decompress and plot (one chirp per frame) the ethernet captured data on Linux PC.
    - LVDS streaming of raw ADC data.
    - Power optimization hooks
      - MSS loading task.
      - Ethernet-Phy loopback.



- HWA dynamic clock gating.
- HWA clock gating and power gating when idle.
- Clock gating of unused peripherals.
- ADC data delay dithering configuration via CLI. ( Work around for Errata ANA#46: [Description](#))
- Added support for AWR2544 device in MCU PLUS SDK
  - Autophy (DP83TG720S) driver support.
  - Ethernet support for 1Gbps transmission.
  - SBL\_QSPI updated to perform PBIST memory test for TCMA, TCMB, L2 and L3 memories
  - HWA driver support for FFT and compression operating modes.
  - SysConfig support to configure the HWA paramsets and common registers.
- Clock configuration of 50MHz XTAL is supported.

## 3.2. Migration notes from Previous SDK versions

This section describes the changes that are relevant for users migrating to the mmWave mcuplus SDK 4.5.x release from previous release

Summary	Component (s)	Sub-component (s)	Affected SoC	Affected SDK Version	Behavior of impact
AWR294x firmware RPRC patch image is renamed from xwr2xxx_radarss_metarprc.bin to xwr29xx_radarss_metarprc.bin	DFP	Patch image name	AWR294x	4.4.1	setenv updates
Mmwave Link Test is moved from <a href="#">mmwave_dfp_02_04_&lt;ver&gt;/ti/control/mmwave/link</a> to <a href="#">mmwave_mcuplus_sdk_&lt;ver&gt;/ti/control/mmwave/link_test</a>	mmwavelink	mmwavelink test	AWR294X /AWR2544	4.4.1	

## 3.3. Known Issues

### 3.3.1. mmWave Suite/Demos Known Issues

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

Issue Type	Key	Summary	Platform	Comments
Bug	MMWSDK-3069	Run time calibration is disabled. This is done because bookkeeping registers (frame count, chirp count) get updated possibly due to calibration chirps.	AWR2544	This update in bookkeeping registers results in wrong Ethernet packet header value.
Bug	MMWSDK-3042	Ethernet PTP example not working	AWR2544	
Task	MMWSDK-3071	16 bit Network Packet Buffer CRC is not verified	AWR2544	
Bug	MMWSDK-2475	minmaxFlag in aoaproc test case is not enabled	AWR294x	The same functionality has been tested in the objectdetection test case
Bug	MMWSDK-2560	sensorStart does not work immediately after issuing sensorStop	AWR294x	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.
Bug	MMWSDK-2972	IPC communication between the MCAL CDD IPC (R5F) and MCU+SDK IPC (DSP) does not work due to the differences IPC messaging.	AWR294x	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.

### 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.

SI No	Limitation	Platform
1	No synchronization between HWA populated Radar cube and CPSW transferring 1D-FFT Data. This can be taken care by carefully triggering the first CPSW transfer. This is configurable via procChain (<ethPktRdyCnt> and <ethPerPktDly>) CLI.	AWR2544
2	Simultaneous LVDS raw data transfer and 1d-FFT data on ethernet interface does not work for few profile configurations. This is because LVDS transfer needs longer chirp idle time while Ethernet transfers data at 1Gbps.	AWR2544

3	ADC data transfer rate is limited by HSI Clock configured in SDK (1000MHz which is 500 Mbps); ensure the generated data per chirp can be transferred within chirp idle time.  Chirp idle time > ADC data per chirp / 500 Mbps where ADC data per chirp = Number of ADC samples * Number of Rx * 16 bits	AWR2544
4	Ethernet data capture and validation is supported only on Linux PC.	AWR2544
5	Ethernet Streaming for DDM demo is not available.	AWR294x
6	CQ Data streaming for AWR294x is not tested as the OOB doesn't support continuous mode.	AWR294x
7	In DDM Chain, point cloud data of only limited number of objects can be exported due to UART baudrate constraints. To transmit data of more objects, decrease the fps.	AWR294x
8	In DDM Chain, since a limited number of objects can be stored/processed (which is ~800) due to resource constraints; most of the detected objects space is consumed for objects that are close leaving no space for objects that are far away. To detect further farther objects, a limit can be set on detected number of objects per range bin.	AWR294x



#### AWR2544 (Tools support)

- CCS support:
  - CCS 12.4 version does not detect AWR2544 by default. Please contact TI representative for latest Chip Support Package (CSP).
  - Steps to follow:
    - Unzip the CSP
    - Copy the common\targetdb\devices\awr2544.xml file into C:  
\\ti\<ccs\_install\_path>\ccs\ccs\_base\common\targetdb\device
    - Copy the common\targetdb\Modules\radar\awr2544 directory into C:  
\\ti\<ccs\_installed\_path>\ccs\ccs\_base\common\targetdb\Modules\radar
- Sysconfig support
  - Currently released sysconfig tool (version 1.17) does not support AWR2544 device. For sysconfig tool to recognize AWR2544 device and successfully build applications, follow below steps after mmwave\_mcuplus\_sdk installation is complete:
    - Copy "device.json" file and "AWR2544" folder available at: [mmwave\\_mcuplus\\_sdk\\_<version>/mmwave\\_mcuplus\\_sdk\\_<version>/tools/sysconfig\\_awr2544/](#) to [mmwave\\_mcuplus\\_sdk\\_<version>/sysconfig\\_<ver>/dist/device\\_data](#) to build applications in [mmwave\\_mcuplus\\_sdk\\_<version>/sysconfig\\_<ver>/dist/device\\_data](#) to build applications in [mmwave\\_mcuplus\\_sdk\\_<version>/sysconfig\\_<ver>/dist/device\\_data](#)
    - To build applications in [mcu\\_plus\\_sdk\\_awr2544\\_<ver>](#), ensure that [dist/device\\_data](#) folder present at [SYSCFG\\_PATH](#) in imports.mak file has "device.json" file and "AWR2544" folder copied.

## 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\_mcuplus\_sdk installer is available as a Windows Installer and a Linux installer.

- **mmwave\_mcuplus\_sdk\_<version>-Windows-x86-Install.exe:** Windows installer verified on Windows 10 machines
- **mmwave\_mcuplus\_sdk\_<version>-Linux-x86-Install.bin:** Linux installer verified on Ubuntu 18.04 64 bit machines.

### 5.1. Installation in GUI mode

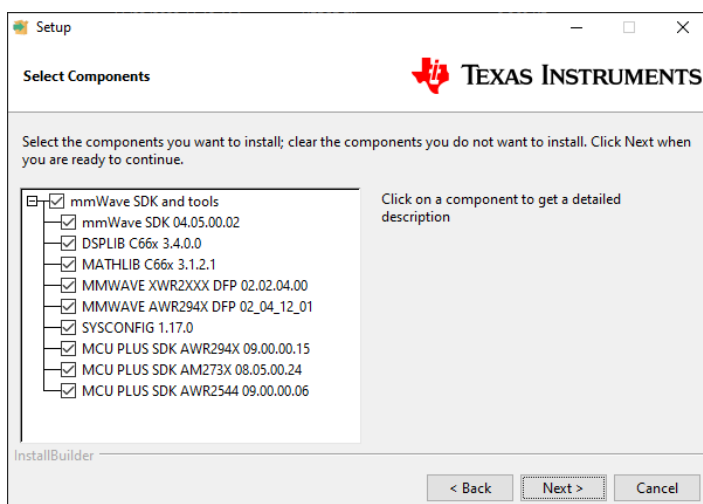
Depending on your development environment run the appropriate installer

- 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\_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" 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 libxst6:i386"

Installation steps:

- Setup
- Choose Destination Location: Select the folder to install (default is c:\ti\mmwave\_mcuplus\_sdk\_<version> on windows and ~/ti/mmwave\_mcuplus\_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 mcuplus 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

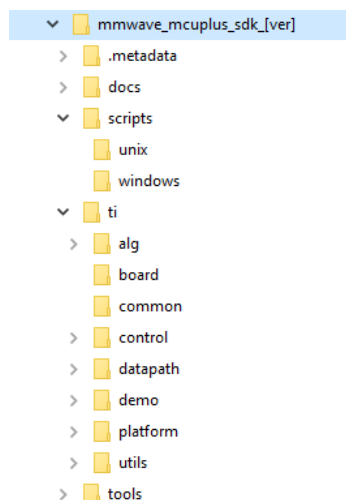
- In Windows environment
  - Run the installer using "mmwave\_mcuplus\_sdk\_<version>-Windows-x86-Install.exe --prefix <installation folder> --mode unattended" command. This will install all the components in the installer.
    - Please note that even though the command may finish immediately it takes 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\_mcuplus\_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]	08-09-2023 09:47 PM	File folder
mathlib_c66x_[ver]	08-09-2023 09:50 PM	File folder
mcu_plus_sdk_am273x_[ver]	08-09-2023 10:14 PM	File folder
mcu_plus_sdk_awr294x_[ver]	08-09-2023 09:56 PM	File folder
mcu_plus_sdk_awr2544_[ver]	08-09-2023 10:38 PM	File folder
mmwave_dfp_02_02_[ver]	08-09-2023 09:50 PM	File folder
mmwave_dfp_02_04_[ver]	08-09-2023 09:50 PM	File folder
mmwave_mcuplus_sdk_[ver]	08-09-2023 09:40 PM	File folder
sysconfig_[ver]	08-09-2023 09:51 PM	File folder

Under the mmwave\_mcuplus\_sdk <ver> folder you should have the following directory structure.



## 6. Device-Specific Support

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

Component		AM273X EVM + AWR2243BOOST	AWR294X EVM	AWR2544 EVM
Control	Datapath Manager (dpm)	X	X	
	mmwave High Level API (mmwave)	X	X	X
Datapath	RangeProc DPU	X	X	
	RangeProc DDMA DPU	X (C66 Only)	X (C66 Only)	
	RangeprocReal2x DPU			X
	Doppler DPU	X	X	
	Doppler DDMA DPU	X (C66 Only)	X (C66 Only)	
	CFAR DPU	X	X	
	RangeccarProc DDMA DPU	X (C66 Only)	X (C66 Only)	
	AoA DPU	X	X	
	Datapath EDMA	X	X	X
	Object Detection DPC	X	X	
	Object Detection DDMA DPC	X (C66 Only)	X (C66 Only)	
Alg	mmwavelib	X	X	X
	Group Tracking (gtrack)	X	X	
Utilities	Command Line Interface (CLI)	X	X	X
	CBUFF Streaming + HSI header		X	X
	Mailbox driver test		X	X
	MSS VMON self-test		X	X
	Math Utilities (mathutils)	X	X	X
	Test Logger (testlogger)	X	X	X



	CCS Debug Utility (ccsdebug)	X	X	X
Tools	Binaries for appimage flashing	X	X	X
Demo	OOB Demo TDM	X	X	X
	OOB Demo DDM	X	X	X
	Ethernet-based streaming DDM			X
	Ethernet-based streaming TDM	X	X	X
	LVDS streaming	X	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) <sup>1</sup>	X	X	X
mmwave high level api	X	X	X

<sup>1</sup> Applicable for AWR294x and AM273x

### 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 <sup>1</sup>	X	X	X
RangeProc DDMA DPU <sup>1</sup>	X (C66 Only)	X	X (C66 Only)
Doppler DPU <sup>1</sup>	X	X	X
Doppler DDMA DPU <sup>1</sup>	X (C66 Only)	X	X (C66 Only)
CFAR DPU <sup>1</sup>	X	X	X
RangeFarProc DDMA DPU <sup>1</sup>	X (C66 Only)	X	X
AoA DPU <sup>1</sup>	X	X	X
Datapath EDMA	X	X	
Object Detection DPC <sup>1</sup>	X	X	X
Object Detection DDMA DPC <sup>1</sup>	X (C66 Only)	X	X (C66 Only)
RangeProcReal2x <sup>2</sup>	X	X	X



<sup>1</sup> Applicable for AWR294x and AM273x only

<sup>2</sup> Applicable for AWR2544 only

Note: 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 <sup>1</sup>	X	X	X
power optimization <sup>2</sup>	X	X	

<sup>2</sup>power optimization demo is only for AWR294X platform.

<sup>1</sup>mmw demo GUI not supported for AWR2544 platform

## 7.4. 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 and AWR2544 SOC)
    - mailbox driver test application issues version command to BSS (applicable for only AWR294X and AWR2544 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)

## 7.5. Scripts

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

## 7.6. 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.

## 7.7. 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_mcuplus_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)

