MMWAVE SDK Release Notes

Product Release 3.1.0

Release Date: Dec 15, 2018

Release Notes Version: 1.0

CONTENTS

1. Introduction

The mmWave 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.

Key mmWave SDK features:

- Building blocks
  - Full driver availability
  - Layered approach to programming analog front end
  - Catalog of mmwave algorithms optimized for C674x DSPs
- Demonstrations and examples
  - TI RTOS 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

2. Release overview

2. 1. What is new

- Support for devices mentioned in the "Platform and Device Support" section below
- New features can be found in New Features section.
- Bug fixes
- Tools update

2. 2. Platform and Device Support

The devices and platforms supported with this release include:

Supported Devices	Supported EVM
AWR1843 ES1.0	AWR1843BOOST - AWR1843 Evaluation Module RevB
AWR1642 ES2.0	AWR1642BOOST - AWR1642 Evaluation Module RevB
AWR1642_HS ES 2.0 *	
AWR1443 ES3.0	AWR1443BOOST - AWR1443 Evaluation Module RevB/RevA
IWR6843 ES1.0	IWR6843ISK+MMWAVEICBOOST - IWR6843 Evaluation Module
IWR1843 ES1.0	IWR1843BOOST - IWR1843 Evaluation Module RevB
IWR1642 ES2.0	IWR1642BOOST - IWR1642 Evaluation Module RevB
IWR1642_HS ES 2.0*	
IWR1443 ES3.0	IWR1443BOOST - IWR1443 Evaluation Module RevB/RevA

* High Secure (HS) devices need additional MMWAVE-SECDEV package

> xWR terminology is used in sections that are common for AWR and IWR devices
>
> **Silicon versions other than the ones in the table above are not supported**

This release of mmWave 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 SDK foundation components.

2. 3. Component versions

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

Component		Version	Type	Comment
mmwave sdk		3.1.0	Source and Binary	Overall package release version
RadarSS firmware (patch) for xwr14xx, xwr16xx, xwr18xx		1.2.0.3	Binary	RadarSS firmware is in ROM. Only the patch is included in the mmwave sdk release
RadarSS firmware for xwr68xx		6.0.5.0	Binary	
mmWaveLink Framework		1.2.0	Source and Binary	
FTDI		2.12	Binary	
Image Creator	gen_bincrc32	1.0	Windows and Linux binary	
	out2rprc	2.0	Windows binary	Need mono to run this on Linux
	Crc multicore image	1.0	Windows and Linux binary	
	Multicore image generator	1.0	Windows and Linux binary	
	create_ConfigRPRC	1.0	Windows and Linux binary	

2. 4. Tools dependency

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

Tool	Version	Download link
CCS	7.4 or later	download link
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
Mono JIT compiler	4.2.1	Only for Linux builds
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)
MMWAVE-SECDEV	2.0.0	Needed for xWR16xx high secure (HS) devices only Can be requested from link

Pinmux tool (optional)	Latest	Used to generate pinmux configuration for custom board https://dev.ti.com/pinmux (Cloud version)
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
Uniflash	Latest	Uniflash tool is used for flashing xWR1xxx devices Cloud version (Recommended): https://dev.ti.com/uniflash Offline version: http://www.ti.com/tool/uniflash
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/mmWaveDemoVisualizer

2. 5. Licensing

Please refer to the mmwave_sdk_software_manifest.html, which outlines the licensing status for mmwave_sdk package.

3. Release content

3. 1. New Features

- mmWave Suite enhancement
  - Cycle optimized certain existing mmwavelib detection algorithms
  - Added new osal function to get memory stats for default system heap
- mmWave Demos enhancement
  - Added demo for xwr18xx using the newly defined data processing layer.
- Test enhancement for DPUs and DPC
- mmWave Demo Visualizer updates to plotting capabilities

3. 2. Migration section

This section describes the changes that are relevant for users migrating to the mmWave SDK 3.1.0 release from 3.0.0 release. See release notes archive in the SDK release package for migrating from other older releases.

Summary	Component/s	Subcomponent	Behavior of impact
Updated components	-	-	Updated to latest radarss firmware for 14xx/16xx/18xx devices
AoA DPU stats structure update	Datapath	AoA DPU	Removed un-necessary numProcess field from output stats structure as DPC can keep track of it by itself and doesnt need DPU to report it back to DPC.
Change in reporting mechanism for memory usage stats from DPC	Datapath	ObjDetHWA DPC	Memory usage stats is returned back in the PreStartCfg structure instead of DPC INFO command as the INFO model was not appropriate for a remote instantiation of the DPC. mmW demo that consumes this structure would need corresponding change
Added more metrics to the DPC's stats structure	Datapath	ObjDetHWA DPC	New fields were added from debugging point of view
Updated SOC_Cfg structure to not expose MSS related fields for DSS	Drivers	SOC	Updated SOC_Cfg structure to not expose MPU and DSS unhalt related fields in DSS version of the SOC header since they are valid only for MSS.

3. 3. Issues fixed

The following issues from previous releases were fixed in this release

Issue Type	Key	Summary
Bug	MMWSDK-1632	Demo stops sending out data when number of detected objects is equal to zero
Bug	MMWSDK-1631	AoA causes buffer corruption by stepping over azimuth heatmap buffer
Bug	MMWSDK-1630	CLI command measureRangeBiasAndRxChanPhase fails during run time

Bug	MMWSDK-1621	HWA based range DPU crashes for numVirtualAnt = 12 and numRangeBins = 1024 case
Bug	MMWSDK-1619	ObjDetHWA DPC, when run on DSS, crashes when number of chirps is not multiple of 4 in frameCfg
Bug	MMWSDK-1611	Azimuth and elevation FoV parameters not handled correctly in AoA DPU
Bug	MMWSDK-1594	Visualizer: Needs to distinguish between number of doppler chirps and number of doppler bins
Bug	MMWSDK-1593	Visualizer: realtime tuning CFAR slider gets confused with multiple commands
Bug	MMWSDK-1580	SBL: Image parser adds extra 64Bytes even though image is 64B aligned
Bug	MMWSDK-1571	68xx mmW demo crashes with 1Tx 1Rx profile
Bug	MMWSDK-1552	68xx mmW demo: Errors in profile config or chirp config should not give exception
Bug	MMWSDK-1543	Fix the prototype in third party crc16_ccitt() API used in SBL
Bug	MMWSDK-1329	Visualizer needs to imitate C code for calculating rangeIdxToMeters

Known Issues

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

Issue Type	Key	Summary	Comments
Bug	MMWSDK-1654	AOA DPU process should return Int32 instead of Uint32	The process() function uses return value to communicate any errors encountered during AoA processing. These errors are encoded in negative space and hence the return value should be int32 instead of uint32. Currently the object detection DPC (the one that invokes AoA DPU) uses check of "!=0" to flag any errors returned by AoA DPU and hence this bug is not disastrous. Any other DPC or application should use this as a workaround as well.
Bug	MMWSDK-1542	AoA DPU: RX phase calibration does not work when measurement is done with less than the possible max antenna size (#tx < 3, #rx < 4 in case of IWR6843)	Documented procedure in past releases always mentioned that all the available antennas on the device be turned on for measurement - so this is not creating any deviation from that. This is listed as known issue so that user are aware of the limitation.
Bug	MMWSDK-1363	Range processing hwa DPU crashes when number of RX antenna is 4, and range fft size is 1024	For 1 TX 4 RX and numRangeBins = 1024, the BdstIndex for EDMA copy will go beyond its limit of 32768. The calculation is follows: BytesPerChirp = numRangeBins * numRxAnt * sizeof(cmplx16ImRe_t) = 16KB. For 1 TX antenna, due to ping/pong scheme, the jump will be 2 * BytesPerChirp = 32KB. The same case is solved by manually setting destination address in rangeProc DSP based implementation. For rangeProcHWA, the manually setting of destination address is not doable.
Bug	MMWSDK-1497	Intermittent failure in "monitoring results" for mmwavelink unit test for awr16xx	This issue is seen in noisy lab environment only. One out of many reports for noise figure has failure status. Observed noise figure from that report are logged at the end of the test run and can be used for debugging further, in case this is seen in other scenarios.
Bug	MMWSDK-1078	Limitation in processing chain + LVDS instrumentation use case	See limitations section below
Task	MMWSDK-533	GUI of mmw demo running slow from Firefox browser	Workaround: Please switch to Chrome browser.
Story	MMWSDK-319	CAN driver: DMA mode is not supported	
Story	MMWSDK-252	UART driver has not tested for Data Length 5 and 6	
Bug	MMWSDK-1157	Rare failure seen in UART loopback driver unit test - HW limitation	

3. 4. Limitations

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

1	CAN driver: • DMA and FIFO mode are not supported
2	CANFD driver: • DMA and Timestamping are not supported

3	CBUFF/CSI2/LVDS:
	• Driver does not support the following functionality:
	  • Multiple packets
	  • 3 channels
	• CSI2: ADC streaming has only been tested under 1 configuration in csi_stream usecase

4	CRC driver: "Auto" mode is not implemented.
5	DMA driver: MPU and Parity Feature not implemented.
6	EDMA driver: Privilege feature not implemented.
7	HWA driver: Any modes/algorithm outside the scope of mmWave demo are not tested (however they are implemented in the driver).
8	I2C driver: Verified only loopback mode on mmWave device TI EVM (however all features are implemented in the driver).
9	QSPI/QSPI Flash driver: ▪ dual-Read/Quad read in configuration mode is not supported ▪ setting write protections bits is not supported
10	SPI (MIBSPI) Limitations: • For xWR14xx, MIBSPI is only supported on SPIA, hence driver only supports SPIA. SPIB is not supported in xWR14xx. In xWR16xx, both instances are MIBSPI and are supported within the driver. • When MIBSPI mode is used in 4-pin slave mode, for every CHARLEN (8 bits or 16 bits), CS signal(from Master) has to be toggled and 2 VBUSP cycles need to be inserted. This needs to be taken care on SPI master device.
11	DMA based transactions are not supported for CRC and Mailbox driver.
12	mmW demo: See demo's doxygen page for more details.
13	Processing chain + LVDS instrumentation: ▪ This feature is not available for xWR14xx due to ADC Buffer being unavailable for streaming while datapath processing is active. ▪ For xWR16xx, CQ cannot be streamed out reliably when datapath processing is also enabled. The data corruption for CQ data over LVDS lanes is seen more pronounced when multiple chirps/chirp event is enabled

4. Test reports

Results of the unit tests can be found in the docs/test folder. The test folder has separate folders for all the SoC variants. System level test is run using demos.

5. Installation instructions

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

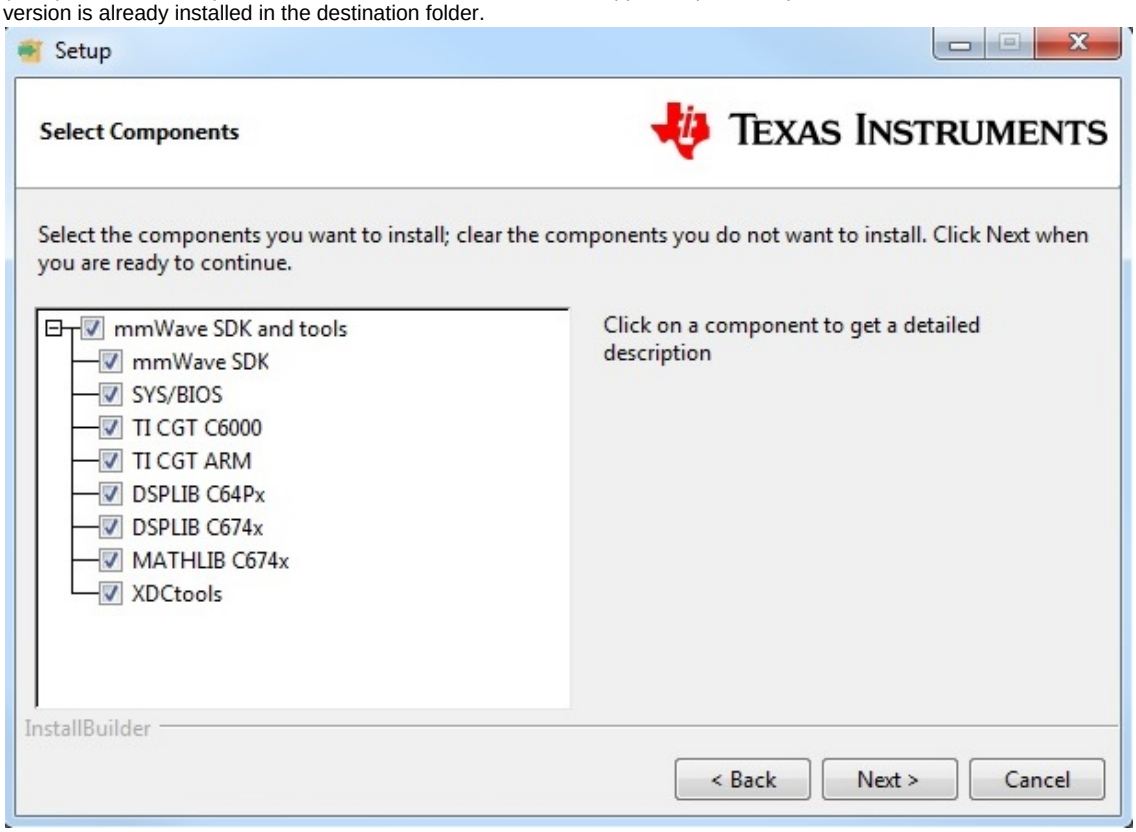
- **mmwave_sdk_<version>-Windows-x86-Install.exe: Windows installer verified on Windows 7 and Windows 10 machines**
- **mmwave_sdk_<version>-Linux-x86-Install.bin: Linux installer verified on Ubuntu 14.04 & Ubuntu 16.04 64 bit machines.**

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,
    - Enable execute permission for the Linux installer by running "chmod +x mmwave_sdk_<version>-Linux-x86-Install.bin" command
    - Run the installer using "./mmwave_sdk_<version>-Linux-x86-Install.bin" command

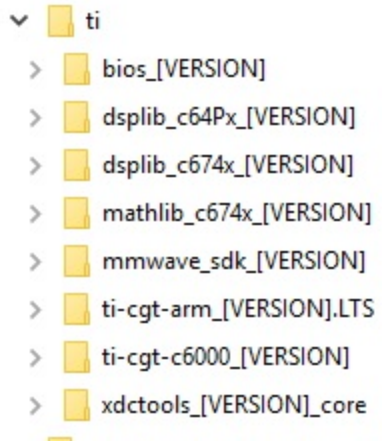
Installation steps:

- Setup
- Choose Destination Location: Select the folder to install (default is c:\ti on windows and ~/ti 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.

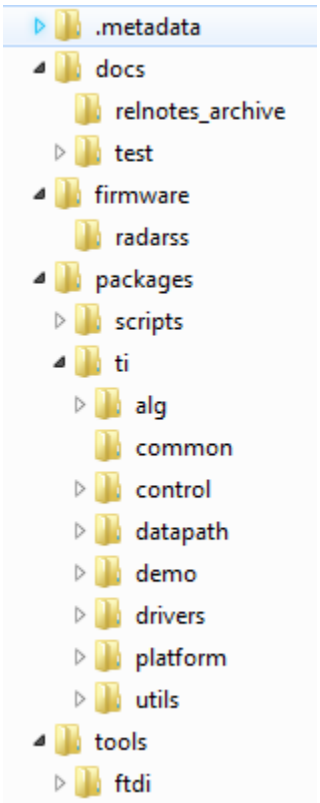


- Review installation decisions
- Ready to install
- Once installation starts all the selected components will be installed (if a component with the same version exists in the destination folder it will be overwritten)
- Installation complete

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)



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

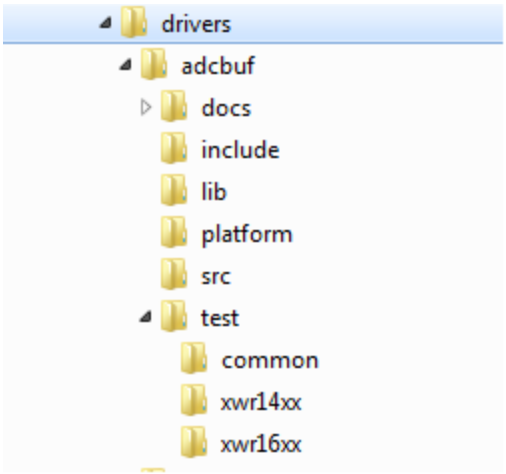


6. Package Contents

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

6. 1. Drivers

Drivers can be found under mmwave_sdk_<ver>/packages/ti/drivers folder. The directory structure of all drivers is similar to the one shown below for adcbuf (some drivers do not have a unit test as shown in the table below)



- docs: Driver API documentation done with doxygen
- include: Include files
- lib: Prebuilt libraries
- platform: Platform files
- src: Driver Source files
- test/<platform>: Unit test src files and prebuilt unit test binary for supported platforms
- test/common: Unit test src files common for all platforms
- driver base folder has external header file, make files

Content of each driver is indicated in the table below.

Component	Source & prebuilt library	API Document (doxygen)	Unit test (source & prebuilt binary)
ADCBUF	X	X	X
CAN	X	X	X
CANFD	X	X	X
CBUFF/LVDS	X	X	X
CRC	X	X	X
CRYPTO[1]	X	X	X
CSI2	X	X	X
DMA	X	X	X
EDMA	X	X	X
ESM	X	X	
GPIO	X	X	X
HWA	X	X	X
I2C	X	X	X
MAILBOX	X	X	X
OSAL	X	X	
PINMUX	X	X	
QSPI	X	X	X
QSPIFLASH	X	X	X
SOC	X	X	

SPI	**X**	**X**	**X**
UART	**X**	**X**	**X**
WATCHDOG	**X**	**X**	**X**

[1] CRYPTO is only supported on high secure (HS) devices

6. 2. Control

Control modules can be found under mmwave_sdk_<ver>/packages/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**
mmwavelink framework	**X**	**X**	**X**
mmwave high level api	**X**	**X**	**X**

6. 3. Datapath

Datapth modules can be found under mmwave_sdk_<ver>/packages/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**
Doppler DPU	**X**	**X**	**X**
Static Clutter DPU	**X**	**X**	**X**
CFAR CA DPU	**X**	**X**	
AoA DPU	**X**	**X**	
Datapath EDMA	**X**	**X**	
Object Detection DPC	**X**	**X**	**X**

6. 4. Algorithm

Algorithms can be found under mmwave_sdk_<ver>/packages/ti/alg folder. Currently algorithms applicable for mmwave functionality are provided under this folder:

Component	Source & Prebuilt Library	API Document (doxygen)	Unittest (source & prebuilt binary)
gtrack	**X**	**X**	**X**
mmwavelib	**X**	**X**	**X**

6. 5. Usecases

Usecases can be found under mmwave_sdk_<ver>/packages/ti/drivers/test folder.

Component	Source	API Document (doxygen)	Unittest (source & prebuilt binary)
csi_stream (IWR14xx only)	X	X	X
mem_capture	X	X	X

6. 6. Demos

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

Component	Source & Prebuilt Binary	Demo document (doxygen)	Demo GUI
mmw[1]	X	X	X

[1] Demo is supported for only IWR68xx and xWR18xx devices in this release

6. 7. Misc folders

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

- common: Common header files needed across all components
- platform: platform specific files
- utility: Contains
  - ccs debug utility which is the MSS/DSSbinary that needs to be flashed when connecting/developing using CCS (details can be found in mmwave_sdk_user_guide)
  - cli which is the cli helper utility used by the demos
  - cycleprofiler which is the helper utility used for profiling the various components inside the SDK
  - hsiheader which is a helper utility that creates a header for the data to be shipped over LVDS lanes.
  - mathutil is used to perform some common operations such as log2, rounding, saturation based on the core they need to run on (R4F, C674x)
  - secondary boot loader (sbl)
  - testlogger which is the helper utility for driver unit tests

6. 8. Scripts

Build scripts can be found in mmwave_sdk_<ver>/packages/scripts folder. Build instructions can be found in mmwave_sdk_user_guide.

6. 9. Firmware

RadarSS firmware for all supported devices is included under mmwave_sdk_<ver>/firmware/radarss folder. Procedure to flash the radarss is covered in the mmwave_sdk_user_guide.

6. 10. Tools

The following tools are included in the release in binary form. These can be found under mmwave_sdk_<ver>/tools folder.

- **Ftdi:** These Windows PC drivers are needed when interfacing to the board via MMWAVE-DEVPACK

6. 11. Docs

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

- mmwave_sdk_software_manifest.html: Software Manifest
- mmwave_sdk_release_notes.pdf: Release Notes (this document)
- mmwave_sdk_user_guide.pdf: User guide
- mmwave_sdk_module_documentation.html: Links to individual module's documentation

mmwave_sdk_<ver>/docs/relnotes_archive contains release notes from previous releases. Release notes contain migration information.

mmwave_sdk_<ver>/docs/test folder contains test results for each SoC. Each SoC folder in turn may contain multiple test group folders (such as module_test, alglib_test) which have the following files

- Report.html: Detailed Test report with links to logs
- *.log: Test logs for unit tests

7. 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)