



STM32MP15 ecosystem release note



Contents



A quality version of this page, approved on 21 February 2020, was based off this revision.

The objective of this article is to describe the content of **STM32MP15-Ecosystem-v1.2.0** release of *STM32MPU Embedded Software distributions* and its associated ecosystem.

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1 Delivery purpose and scope

The new STM32MP15-Ecosystem-v1.2.0 release is dedicated to STM32MP15 microprocessors. It is an evolutive maintenance release that includes minor evolutions and corrections.

Like previous release, STM32MP15-Ecosystem-v1.2.0 aims at

- providing a full ecosystem for STM32MP15x devices
- working efficiently with STM32MP15 boards, using one of the packages (Starter Package, Developer Package or Distribution Package) developed by STMicroelectronics for STM32 MPUs.

Refer to [Which Package better suits your needs](#) for more information on these packages.

This ecosystem release consists of:

- **two STM32MPU distributions**
 - the *STM32MPU Embedded Software distribution*
 - the *STM32MPU Embedded Software distribution for Android*
- STM32 referenced tools
 - STM32CubeIDE - new STM32 IDE targeted to replace SW4STM32 (STM32-CoPro-MPU Eclipse plugin)
 - STM32CubeMX
 - STM32CubeProgrammer
 - Keygen tool
 - Signing tool

For more details refer to [Referenced tools release notes](#) chapter below.
- **Documentation**
 - The present user guide in wiki format
 - Documentation package (for more details refer to [Reference documents](#) chapter below)
- **Supported STM32MP15 boards**
 - STM32MP15 Evaluation board (for "STM32MPU Embedded Software distribution" and "STM32MPU Embedded Software distribution for Android")
 - STM32MP15 Discovery kit (for *STM32MPU Embedded Software distribution*)

More details can be found in [Board](#) chapter below.



2 Intended audience

The targeted audience is STMicroelectronics customers.



3 Licensing

This software package is licensed under a SOFTWARE LICENSE AGREEMENT FOR ST MATERIALS (SLA). The customers may not use this package except in compliance with the software license agreement (SLA).



4 Main features / main highlights

4.1 Boards

This STM32MP15-Ecosystem-v1.2.0 release supports the same boards as STM32MP15-Ecosystem-v1.0.0.

Boards	PCBs list	Content	Availability
STM32MP157C-EV1 board (board with Crypto)	<ul style="list-style-type: none"> • MB1263C (Daughter) • MB1262C (Mother) • MB1230C (Display) • MB1379A (Camera) 	<ul style="list-style-type: none"> • STM32MP1 STM32MP157CAA3 Rev.B • PMIC STPMIC1APQR cut1.2 • External oscillator 	Jan'19
STM32MP157A-EV1 board (board without Crypto)	<ul style="list-style-type: none"> • MB1263C (Daughter) • MB1262C (Mother) • MB1230C (Display) • MB1379A (Camera) 	<ul style="list-style-type: none"> • STM32MP1 STM32MP157AAA3 Rev.B • PMIC STPMIC1APQR cut1.2 • External oscillator 	Jan'19
STM32MP157C-DK2 board (board with Crypto)	<ul style="list-style-type: none"> • MB1272C (Mother) • MB1407B (Display) 	<ul style="list-style-type: none"> • STM32MP1 STM32MP157CAC3 Rev.B • PMIC STPMIC1APQR cut1.2 • External oscillator 	Jan'19
STM32MP157A-DK1 board (board without Crypto)	<ul style="list-style-type: none"> • MB1272C (Mother) 	<ul style="list-style-type: none"> • STM32MP1 STM32MP157AAC3 Rev.B • PMIC STPMIC1APQR cut1.2 • External oscillator 	Jan'19

Information

STLINK in EVAL and DISCO Rev.C boards integrates the latest firmware STLINK (V2J32M22) which requires upgraded USB PC drivers - [Windows USB driver](#)



4.2 Embedded software

4.2.1 OpenSTLinux (Cortex[®]-A7)

Openstlinux-20-02-19 is the new version delivered with STM32MP15-Ecosystem-v1.2.0 release. This software set consists of the following components:

- Build process
 - OpenEmbedded Thud (v2.6.4)
 - GCC version v8.2
- Software components
 - Kernel version LTS v4.19.94 - **NEW** version versus STM32MP15-Ecosystem-v1.1.0 release
 - TF-A version v2.0
 - U-Boot version v2018.11
 - OP-TEE version v3.3.0
 - OpenOCD version v0.10.0
- Applicative components
 - Weston version v5.0.0
 - GStreamer version v1.14.4
 - GCnano version v6.2.4
- **Main NEW features coming with STM32MP15-Ecosystem-v1.2.0 release**
 - Added support for STM32MP15x Rev.Z
 - Added support for new 800 MHz part numbers (D and F) - [STM32MP15_microprocessor](#)
 - [Operating points DT management wiki article - How_to_change_the_CPU_frequency](#)
 - Added support for DMA FIFO bypass (Direct mode)
 - Added PINCTRL RSVD (Reserved) pin configuration to reserve pins for the coprocessor.
 - Added support for I2C SMBus Alert
 - Added support for UART DMA TX/RX
 - Added STMPII02 DCMI/CSI convertor + Omnivision 5MP
 - Added STMFx (GPIO expander) driver backport from kernel mainline (STM32MP157x-EV1)
 - Added STPMIC driver backport from kernel mainline
 - Added SPI driver in U-boot
 - Added RTC driver for UEFI in U-boot
 - Migrated QUADSPI driver to spi-mem framework in U-boot
 - Activated U-Boot ENV support in boot device (NOR/NAND/eMMC or SD card)
- **Internal peripheral assignment at boot time**

At boot time, you can select two kernel configurations:

 - Configuration 1: all internal peripherals are assigned to Cortex-A7 for Linux drivers. Cortex-M4 coprocessing firmware TTY is executed by default.
 - Configuration 2: some internal peripherals are assigned to Cortex-M4 to execute Cortex-M4 delivered examples on the board (EVAL or DISCO) see ([How to run Cortex-M4 examples](#)).

Configuration 1 is activated by default if you do not specify "2" in the U-Boot console.
More information can be found in [How to assign an internal peripheral to a runtime context](#) article.
- **Userland part**
 - **NEW** This release introduces the [package repository](#) service that enables the live installation of packages.



4.2.2 STM32CubeMP1 (Cortex[®]-M4)

- **Main NEW features coming with STM32CubeMP1-v1.2.0 version, delivered within STM32MP15-Ecosystem-v1.2.0 release:**
 - Added support for STM32MP15x Rev.Z
 - Added support for new 800 MHz part numbers (D, F)
 - Added Keil[®] Project examples on STM32MP157C-DK2
 - Added IAR[™] Project examples on STM32MP157C-DK2
 - Added CubeIDE Project examples on STM32MP157C-DK2
 - Added new PSRAM HAL driver
 - Added RTC HAL + LL driver
 - Added new FreeRTOS + OpenAMP example
- **Features already available in previous version**
 - The *STM32Cube HAL*, *STM32 abstraction layer embedded software* ensuring maximized portability across the STM32 portfolio. HAL APIs are available for all peripherals.
 - Low-layer APIs (LL) offering a fast light-weight expert-oriented layer that is closer to the hardware than the HAL. LL APIs are available only for a set of peripherals.
 - A consistent set of middleware components such as FreeRTOS, OpenAMP.
 - All embedded software utilities, delivered with a full set of examples.

4.2.3 STM32MP15 distribution for Android (Cortex[®]-A7) - NEW

STM32MP15 distribution for Android[™] v1.1.0 (**st-android-10.0.0-2020-02-21** tag) is the version delivered within STM32MP15-Ecosystem-v1.2.0 release.

The objectives of this release are the following:

- **Android[™] 10.0.0** porting on OpenSTLinux BSP v1.2.0 (TF-A, U-Boot, OP-TEE, Linux kernel), provided as **demonstrator**
- Android[™] certifications are not ensured

See STM32MP15 distribution for Android release note for more details.

4.3 STM32CubeProgrammer, Signing tool, Keygen

STM32CubeProgrammer v2.4.0 is the version delivered within STM32MP15-Ecosystem-v1.2.0 release. This is an evolutive maintenance release for STM32CubeProgrammer.

- **Main NEW features coming with STM32CubeProgrammer-v2.4.0 version, delivered within STM32MP15-Ecosystem-v1.2.0 release:**
 - Flashload speed improvement over USB on Windows PC
 - Parallel programming on several targets
- **Features already available in previous version**
 - STM32CubeProg installer includes STM32CubeProgrammer, Keygen and Signing tools
 - Flashload SDCard, eMMC, NAND, NOR images through USB and UART for STM32MP157C-EV1, STM32MP157A-DK1, STM32MP157C-DK2 boards
 - Private and public keys generation
 - Images signature
 - Flashlayout file format change
 - STM32MP1 fuses management (with console interface only)
 - PMIC NVM management (with console interface only)



4.4 STM32CubeMX

STM32CubeMX-v5.6 is the version delivered within STM32MP15-Ecosystem-v1.2.0 release

- **Main NEW features coming with STM32CubeMX-v5.6 version, delivered within STM32MP15-Ecosystem-v1.2.0 release**
 - Added support for new D and F part numbers
 - Device tree (A7)
 - Device tree compliance with Openstlinux-20-02-19
 - DDR
 - Added support for LPDDR on 18x18, 16x16 packages
 - DDR tuning parameters saving: see the restriction below in this article
 - STM32CubeMP1 (M4)
 - Compliance with STM32CubeMP1 V1.2.0
 - Added support for Engineering mode
 - Added support for SMBus alert bit
 - PCC : Power data update
 - Added tutorial Videos
 - DDR tuning [1]
 - How to customize a DT from an ST board [2]

Information

STM32CubeMX V5.6 refers to **Openstlinux-4.19-thud-mp1-20-02-19** manifest, which corresponds to **Openstlinux-20-02-19** tag

- **Features already available in previous version**
 - I/O muxing and clock tree configuration
 - STM32MP1 contexts management (A7 non-secure, A7 secure, M4)
 - Device tree code generation
 - dtsi and header file inclusions
 - pinctrl and clock generation
 - System-on-chip device node positioning
 - multi-core related configurations (ETZPC binding, resources manager binding, peripheral assignment).

Information

Note: The other device tree parameters must be filled in manually through user section tags (from /* USER CODE BEGIN <node> */ to /* USER CODE END <node> */)

- ST32MP1Cube code generation
- Tuning of DDR settings

4.5 STM32CubeIDE

STM32CubeIDE V1.3.0 is the version delivered within STM32MP15-Ecosystem-v1.2.0 release.

- **Main NEW features coming with STM32CubeIDE V1.3.0 version, delivered within STM32MP15-Ecosystem-v1.2.0 release**
 - Added support for new D and F part numbers
- **Features already available in previous version**
 - Cortex-M4 STM32CubeMP1 in "Production mode" and "Engineering mode"



- Cortex-M4 Firmware compilation, loading and debugging
- PC Linux with Ethernet (recommended) or serial link
- PC Windows with Ethernet or Ethernet over USB link
- Cortex-M4 Firmware installation directory configurable

Information

Customers can go on using SW4STM32 IDE. However STMicroelectronics Eclipse reference is STM32CubeIDE. STMicroelectronics recommends the use of STM32CubeIDE tool and focuses on STM32CubeIDE support. SW4STM32 projects can be imported in STM32CubeIDE V1.3.0. Refer to [Reference documents](#) for explanations on the migration process.

4.6 Miscellaneous

- Detailed features are available in the release notes of the different components of this delivery.
- See sections STM32MPU Embedded Software distribution detailed release notes, Referenced tools release notes and Reference documents



5 Main restrictions

5.1 Embedded software

5.1.1 OpenSTLinux (Cortex[®]-A7)

- On STM32MP157C-DK2 boards, BT stack does not work any more after suspend / resume in Standby mode (function with Stop mode). This issue is linked to the Murata Wi-Fi/BT module that expects the 3.3 V supply to be kept, while this supply is switched off in STM32MP1 Standby mode. A similar workaround as for Wi-Fi can be used ([GitHub patch](#)). It consists in calling BT unbind and bind drivers before and after resume (`modprobe -r hci_uart && modprobe hci_uart`).
- For DDR initialization in TF-A, it is recommended to set up and enable all "boot-on" and "always-on" regulators at bootloader stage, after DDR power initialization. This is not yet implemented in V1.2.0 delivery. A patch is being prepared and will be available on GitHub.


5.1.2 STM32CubeMP1 (Cortex[®]-M4)

- To avoid errors in OpenAMP when compiling in MDK-ARM IDE, disable the « Use MicroLIB » in « Target » tab.
- The HAL RTC is delivered within this release. However use it with caution since this driver is also used by Linux. To remove any risk of contention between Linux and the HAL, proceed as follows:
 - The write protect (wpr) must be disabled by default and it must never be enabled in any driver (Linux nor HAL).
 - The HAL must use only Alarm B, since Linux uses Alarm A.
 - The RTC interrupt must be shared between Linux and the HAL to be able to receive alarm notifications on both sides.

5.2 STM32CubeProgrammer, Signing tool and Keygen

- Flashload through UART fails
- Key generation is not functional with STM32MP_KeyGen_CLI on Linux under Ubuntu 16.04 (functional with Ubuntu 18.04)

5.3 STM32CubeMX

- MR0 register for LPDDR settings is not set by STM32CubeMX in the generated device tree. This register must be set manually at 0.
- DDR tuning parameters saving does not work when DDR Test Suite tool is used. Use U-Boot tag `v2018.11-stm32mp-r4.1` on top of the ecosystem release v1.2.0 . This tag contains only one patch required by STM32CubeMX v5.6 ("ram: stm32mp1: display result for software read DQS gating").
- Warning: when opening a previous project built with STM32CubeMX version older than V5.6, the migration does not take into account the user section part. This part needs to be updated manually according the `Openstlinux-20-02-19` manifest.

5.4 STM32CubeIDE

- Using OpenOCD with ST-LINK does not check and force ST-LINK firmware update at debug launch. It is therefore recommended to manually update to the latest ST-LINK firmware for the best debug experience. Use the Help > ST-LINK Upgrade menu"



5.5 Miscellaneous

Restriction lists are available in each subcomponent release note. They are available in the following chapters in the present article:

- [STM32MPU Embedded Software distribution detailed release notes](#)
- [Referenced tools release notes](#)

Moreover, the software workarounds implemented in the ecosystem to provide solutions to the STM32MPU device errata are listed in [STM32MP15 ecosystem errata sheet](#).



6 Minor release updates

STMicroelectronics regularly delivers updates through the following github[®] components: tf-a, u-boot, optee-os, Linux kernel. You can decide to incorporate them into your Developer Package (refer to [STM32MP1 Developer Package](#) or [Distribution Package](#) below).

To update the Distribution package, proceed as follows:

1. Switch your Distribution package [reference source code](#) to github mode.
2. Use the `devtool modify <recipe name>` command to have direct access to the source code git repository used by the build process.
3. In the freshly cloned source code, check out the revision you want to start from via `git checkout -b WORK <github® TAG>`.

STMicroelectronics also delivers dedicated fixes on layers through github[®]. These changes can be integrated (via `git` commands) into your local [STM32MP1 Distribution Package](#) environment. Below the github[®] links corresponding to each layers:

- [meta-st-stm32mp](#)
- [meta-st-openstlinux](#)
- [meta-st-stm32mp-addons](#)

6.1 v1.2.3

[OpenSTLinux updates v1.2.3](#)

6.2 v1.2.2

[OpenSTLinux updates v1.2.2](#)

6.3 v1.2.1

[OpenSTLinux updates v1.2.1](#)



7 Reference documents

All the resources for the STM32MP1 Series are located in the Resources area of the STM32MP1 Series web page.

The resources below are referenced in some of the articles of this user guide.

Information

The different **STM32MP15** microprocessor **part numbers** available (with their corresponding internal peripherals, security options and packages) are described in the [STM32MP15 microprocessor part numbers](#).





means that the document (or its version) is new compared to what was delivered within the previous ecosystem release.

Reference	Name	Link	Version
Application notes			
AN4803	High-speed SI simulations using IBIS and board-level simulations using HyperLynx® SI on STM32 MCUs and MPUs	AN4803.pdf	v2.0
AN5027	Interfacing PDM digital microphones using STM32 MCUs and MPUs	AN5027.pdf	v2.0
AN5031	Getting started with STM32MP15 Series hardware development	AN5031.pdf	v1.0
AN5036	Thermal management guidelines for STM32 applications	AN5036.pdf	v3.0
AN5109	STM32MP1 Series using low-power modes	AN5109.pdf	v3.0
AN5122	STM32MP1 Series DDR memory routing guidelines	AN5122.pdf	v3.0
AN5168	STM32MP1 series DDR configuration	AN5168.pdf	v1.0
AN5225	USB Type-C™ Power Delivery using STM32xx Series MCUs and STM32xxx Series MPUs	AN5225.pdf	v2.0
AN5253	Migration of microcontroller applications from STM32F4x9 lines to STM32MP151, STM32MP153 and STM32MP157 lines microprocessor	AN5253.pdf	v1.0
AN5256	STM32MP151, STM32MP153 and STM32MP157 discrete power supply hardware integration	AN5256.pdf	v1.0










Reference	Name	Link	Version
Application notes			
AN5260	STM32MP151/153/157 MPU lines and STPMIC1B integration on a battery powered application	AN5260.pdf	v1.0
AN5275	USB DFU/USART protocols used in STM32MP1 Series bootloaders	AN5275.pdf	v1.0
AN5284	STM32MP1 series system power consumption	AN5284.pdf	v1.0
AN5348	FDCAN peripheral on STM32 devices	AN5348.pdf	v1.0
AN5431	The STPMIC1 PCB layout guidelines	AN5431.pdf	v1.1
AN5438	STM32MP1 Series lifetime estimates	AN5438.pdf	v1.0
Datasheets^[1]			
DS12505	STM32MP157C/F datasheet (secure)	DS12505.pdf	v3.0
DS12504	STM32MP157A/D datasheet (basic)	DS12504.pdf	v3.0
DS12503	STM32MP153C/F datasheet (secure)	DS12503.pdf	v3.0
DS12502	STM32MP153A/D datasheet (basic)	DS12502.pdf	v3.0
DS12501	STM32MP151C/F datasheet (secure)	DS12501.pdf	v3.0
DS12500	STM32MP151A/D datasheet (basic)	DS12500.pdf	v3.0
DS12792	STPMIC1 datasheet	stpmic1.pdf	v3.0
Errata sheets			
ES0438	STM32MP15xx device errata	ES0438.pdf	v4.0
Reference manuals^[1]			
RM0436	STM32MP157 reference manual (STM32MP157xxx advanced Arm [®] -based 32-bit MPUs)	RM0436.pdf	v4.0
	STM32MP153 reference manual	RM044	



Reference	Name	Link	Version
Application notes			
RM0442	(STM32MP153xxx advanced Arm [®] -based 32-bit MPUs)	2.pdf	 v4.0
RM0441	STM32MP151 reference manual (STM32MP151xxx advanced Arm [®] -based 32-bit MPUs)	RM0441.pdf	 v4.0
Boards schematics			
MB1262 schematics	STM32MP157C-EV1 motherboard schematics MB1262-C01 board schematic (Evaluation board)	MB1262-C01.pdf	v1.0
MB1263 schematics	STM32MP157C-EV1 daughterboard schematics MB1263-C01 board schematic (Evaluation board)	MB1263-C01.pdf	v1.0
MB1230 schematics	DSI 720p LCD display daughterboard schematics MB1230-C board schematic (Evaluation board)	MB1230-C.pdf	v1.1
MB1379 schematics	Camera daughterboard schematics MB1379-A01 board schematic (Evaluation board)	MB1379-A01.pdf	v1.0
MB1272 schematics	STM32MP157x-DKx motherboard schematics MB1272-DK2-C01 board schematic (Discovery kit)	MB1272-C01.pdf	v1.0
MB1407 schematics	STM32MP157x-DKx daughterboard schematics MB1407-LCD-C01 board schematic (Discovery kit)	MB1407-C01.pdf	v1.0
Boards user manuals			
UM2535	STM32MP157x-EV1 evaluation board user manual	UM2535.pdf	v2.0
UM2534	STM32MP157x-DKx discovery board user manual	UM2534.pdf	v1.0
Tools user manuals			
 UM2563	STM32CubeIDE installation guide	UM2563.pdf	v1.0
 UM2553	STM32CubeIDE quick start guide	UM2553.pdf	v1.0
 UM5360	Getting started with projects based on the STM32MP1 Series in STM32CubeIDE	UM5360.pdf	v1.0



Reference	Name	Link	Version
Application notes			
 UM 2609	Description of the integrated development environment for STM32 products	UM2609.pdf	v1.0
 UM 2579	Migration guide from System Workbench to STM32CubeIDE	UM2579.pdf	v1.0
 UM 1718	STM32CubeMX user manual	UM1718.pdf	v31.0
 UM 2237	STM32CubeProgrammer tool user manual	UM2237.pdf	v10.0
 UM 2238	STM32 Trusted Package Creator tool user manual	UM2238.pdf	v5.0
 UM 2542	STM32 Series Key Generator tool user manual	UM2542.pdf	v1.0
 UM 2543	STM32 Series Signing tool user manual	UM2543.pdf	v1.0



8 How to download the software and start with this release?

The list of embedded software packages available for download depends on the selected package.

The table below provides the available board part numbers as well as information in order to:

- get started with one of the three available Packages (Starter, Developer or Distribution Package)
- get started with the board
- find the associated embedded software distributions
- **download** source code
- **build** an embedded software

Board part number	Jump to
STM32MP157C-EV1 Evaluation board	STM32MP15 Evaluation boards - getting started, including software download
STM32MP157X-DKX Discovery kit	STM32MP15 Discovery kits - getting started, including software download



9 STM32MPU Embedded Software distribution detailed release notes

The table below lists the software packages available in the STM32MPU Embedded Software distributions, and provides the corresponding release notes.

The release notes give more information and details about the features and content of the packages.

They do not explain how to download the software. Refer to [How to get the software and start with this release](#) .

Firmware	Release note	Version
OpenSTLinux Distribution	STM32MP15 OpenSTLinux release note - v1.2.0	openstlinux-20-02-19
STM32Cube MPU Package	STM32CubeMP1 Package release note - v1.2.0	STM32CubeMP1-v1.2.0
STM32 MPU Distribution for Android	STM32MP15 distribution for Android release note - v1.1.0	st-android-10.0.0-2020-02-21



10 Referenced tools release notes

The table below lists the available tools, and provides links to the corresponding release notes.

Each release note gives information on how to install and use the corresponding tool.

The set of tools that can be downloaded depends on the Package that is used (double check [Which Package better suits your needs](#) article for more information on each Package).

Tools	Release notes	Host PC		Which Package may need the tool ?		
		Linux version	Windows version	Starter Package	Developer Package	Distribution Package
STM32Cube IDE	STM32Cube IDE_release_note	1.3.0	1.3.0			
STM32Cube MX	STM32Cube MX release note	from 5.6	from 5.6			
STM32Cube Prog	STM32Cube Programmer release note	2.4.0	2.4.0			
Keygen	KeyGen release note	1.0.0	1.0.0			
Signing tool	Signing tool release note	1.0.0	1.0.0			



11 References

- 1.01.1 The part numbers are specified in STM32MP15 microprocessor part numbers



12 Archives

STM32MP15 release	Ecosystem release note
STM32MP15-Ecosystem-v1.1.0	STM32MP15 ecosystem release note - v1.1.0
STM32MP15-Ecosystem-v1.0.0	STM32MP15 ecosystem release note - v1.0.0

(Software)Integrated development/design/debugging environment

Microprocessor Unit

Power Management Integrated Circuit

Evaluation board

Discovery kit

Trusted Firmware for Arm Cortex-A

Das U-Boot -- the Universal Boot Loader (see [U-Boot_overview](#))

Open Portable Trusted Execution Environment

Device Tree

Direct Memory Access

Inter-Integrated Circuit (Bi-directional 2-wire bus standard for efficient inter-IC control.)

System Management Bus

Universal Asynchronous Receiver/Transmitter

Transmit

Receive

Digital Camera Memory Interface

Multi Speed Internal oscillator (STM32 clock source)

General-Purpose Input/Output (A realization of open ended transmission between devices on an embedded level. These pins available on a processor can be programmed to be used to either accept input or provide output to external devices depending on user desires and applications requirements.)

Serial Peripheral Interface

Real Time Clock

former spelling for e•MMC ('e' in italic)

SD memory card (<https://www.sdcard.org>)

TeleTYpewriter

Hardware Abstraction Layer

Low layer of STM32Cube



Board support package

Non Volatile Memory, like a flash memory

Doubledata rate (memory domain)

Extended TrustZone Protection Controller

BlueTooth

technology for wireless local area networking with devices based on the IEEE 802.11 standards

USB port or connector

Device Firmware Upgrade

Universal Synchronous/Asynchronous Receiver/Transmitter

Printed Circuit Board

Display Serial Interface (MIPI[®] Alliance standard)