

# i.MX Linux® Release Notes

## 1 Overview

This document contains important information about the package contents, supported features, known issues and limitations in this release.

This release is a Standalone SoC release for i.MX 8QuadXPlus.

Because this is built on a source and document base of previous releases of i.MX, many of the other SoCs can be built. However, this release provides no statement of support or validation for anything except the target for this release. Do not use this release for any production purposes even for i.MX SoC previously released as GA quality. Only i.MX 8QuadXPlus was tested and regressions might be possible on other SoCs.

This document includes information for all previously released active i.MX SoCs and this can be used as context only for understanding this release. A future consolidated GA release will test and support all previously released GA i.MX SoCs listed below.

For information on changes in this release, see the manifest Readme at [index: imx-manifest.git](#) and the Change Logs at [index: imx-manifest-ChangeLog.git](#).

### i.MX reference boards

- i.MX 8 Series
  - i.MX 8QuadXPlus MEK Board (Beta Quality)

## Contents

1	<a href="#">Overview.....</a>	1
2	<a href="#">What's New?.....</a>	7
3	<a href="#">SoC Feature Summary.....</a>	10
4	<a href="#">BSP Supported Features.....</a>	11
5	<a href="#">U-Boot and Device Trees.....</a>	22
6	<a href="#">Known Issues/Limitations.....</a>	31
7	<a href="#">Multimedia.....</a>	39
8	<a href="#">Revision History.....</a>	48



## Overview

- i.MX 8QuadMax MEK Board (Beta Quality)
- i.MX 8MQuad EVK Board
- i.MX 8MMini EVK Board - not available on this release
- i.MX 7 Series
  - i.MX 7Dual SABRE-SD Board
  - i.MX 7ULP EVK Board
- i.MX 6 Series
  - i.MX 6QuadPlus SABRE-SD and SABRE-AI Boards
  - i.MX 6Quad SABRE-SD and SABRE-AI Boards
  - i.MX 6DualLite SDP SABRE-SD and SABRE-AI Boards
  - i.MX 6SoloX SABRE-SD and SABRE-AI Boards
  - i.MX 6UltraLite EVK Board
  - i.MX 6ULL EVK Board
  - i.MX 6SLL EVK Board
  - i.MX 6SoloLite EVK Board

### NOTE

In this document, the following notation is used:

- 6SABRE-SD stands for the i.MX 6Quad, i.MX 6QuadPlus, i.MX 6DualLite, and i.MX 6DualPlus SABRE-SD Platforms.
- 6SABRE-AI stands for the i.MX 6Quad, i.MX 6QuadPlus, and i.MX 6DualLite SABRE-AI Platforms.
- 6SoloLite stands for the i.MX 6SoloLite EVK
- 6SoloX-SD stands for the i.MX 6SoloX SABRE-SD Platform.
- 6SoloX-AI stands for the i.MX 6SoloX SABRE-AI Platform.
- 7D-SABRE-SD stands for the i.MX 7Dual SABRE-SD Platform.
- 6UltraLite stands for the i.MX 6UltraLite EVK Platform.
- 6ULL stands for the i.MX 6ULL EVK Platform.
- 7ULP stands for the i.MX 7 Ultra Low Power Platform.
- 8QuadMax stands for the i.MX 8QuadMax MEK Platform.
- 8QuadXPlus stands for the i.MX 8QuadXPlus MEK Platform.
- 8MQuad stands for the i.MX 8MQuad EVK Platform.
- 8MMini stands for the i.MX 8MMini EVK Platform.

The following table lists the testing that was done for each SoC.

**Table 1. Board Validation and Support Scope**

SoC	Test Validation and Support Scope
8MQuad	Builds but not tested except for common graphics and multimedia components
8MMini	Not Available
8QuadMax	Builds but not tested except for common graphics and multimedia components
8QuadXPlus	Full Beta Test
7Dual/Solo	Builds but not tested
7ULP	Builds but not tested
6QuadPlus	Builds but not tested
6Quad	Builds but not tested
6DualLite	Builds but not tested
6SoloX	Builds but not tested

*Table continues on the next page...*

**Table 1. Board Validation and Support Scope (continued)**

SoC	Test Validation and Support Scope
6UltraLite	Builds but not tested
6ULL	Builds but not tested
6SLL	Builds but not tested
6SoloLite	Builds but not tested

## 1.1 References

i.MX has multiple families supported in software. The following are the listed families and SoCs per family. The i.MX Linux® Release Notes describes which SoC is supported in the current release. Some previously released SoCs might be buildable in the current release but not validated if they are at the previous validated level.

- i.MX 6 Family: 6QuadPlus, 6Quad, 6DualLite, 6SoloX, 6SoloLite, 6SLL, 6UltraLite, 6ULL
- i.MX 7 Family: 7Dual, 7ULP
- i.MX 8 Family: 8QuadMax
- i.MX 8M Family: 8MQuad, 8MMini
- i.MX 8X Family: 8QuadXPlus

This release includes the following references and additional information.

- *i.MX Linux® Release Notes* (IMXLXRN) - Provides the release information.
- *i.MX Linux® User's Guide* (IMXLUG) - Contains the information on installing U-Boot and Linux OS and using i.MX-specific features.
- *i.MX Yocto Project User's Guide* (IMXLXYOCTOUG) - Contains the instructions for setting up and building Linux OS in the Yocto Project.
- *i.MX Reference Manual* (IMXLXRM) - Contains the information on Linux drivers for i.MX.
- *i.MX Graphics User's Guide* (IMXGRAPHICUG) - Describes the graphics features.
- *i.MX BSP Porting Guide* (IMXXBSPPG) - Contains the instructions on porting the BSP to a new board.

The quick start guides contain basic information on the board and setting it up. They are on the NXP website.

- [SABRE Platform Quick Start Guide \(IMX6QSDPQSG\)](#)
- [SABRE Board Quick Start Guide \(IMX6QSDBQSG\)](#)
- [i.MX 6UltraLite EVK Quick Start Guide \(IMX6ULTRALITEQSG\)](#)
- [i.MX 6ULL EVK Quick Start Guide \(IMX6ULLQSG\)](#)
- [SABRE Automotive Infotainment Quick Start Guide \(IMX6SABREINFOQSG\)](#)
- [i.MX 6SoloLite Evaluation Kit Quick Start Guide \(IMX6SLEVKQSG\)](#)
- [i.MX 7Dual SABRE-SD Quick Start Guide \(SABRESDBIMX7DUALQSG\)](#)
- [i.MX 8MQuad Evaluation Kit Quick Start Guide \(IMX8MQUADEVKQSG\)](#)

Documentation is available online at [nxp.com](http://nxp.com).

- i.MX 6 information is at [nxp.com/iMX6series](http://nxp.com/iMX6series)
- i.MX SABRE information is at [nxp.com/imxSABRE](http://nxp.com/imxSABRE)
- i.MX 6SoloLite EVK information is at [nxp.com/6SLEVK](http://nxp.com/6SLEVK)
- i.MX 6UltraLite information is at [nxp.com/iMX6UL](http://nxp.com/iMX6UL)
- i.MX 6ULL information is at [nxp.com/iMX6ULL](http://nxp.com/iMX6ULL)
- i.MX 7Dual information is at [nxp.com/iMX7D](http://nxp.com/iMX7D)
- i.MX 7ULP information is at [nxp.com/imx7ulp](http://nxp.com/imx7ulp)
- i.MX 8 information is at [nxp.com/imx8](http://nxp.com/imx8)

## 1.2 Release contents

This release consists of the following:

- Prebuilt images
- Manufacturing tools
- Documentation
- Git repo open source distributions on the Code Aurora i.MX Project.
- Proprietary distributions on Yocto Project i.MX external mirror
- Limited access 3rd party distributions.

The GA releases are named "L<Kernel\_version>\_<x.y.z>".

"<Kernel\_version>": BSP Kernel version. (For example, "L4.9.88 indicates that this BSP release is based on the kernel version 4.9.88)

"<x.y.z>": Semantic versioning specification, where X is the major version, Y is the minor version, and Z is the patch version.

The following tables list the contents included in each package.

**Table 2. Release contents**

Component	Description
Linux® OS Kernel and Device Trees	4.9.88
U-Boot	v2017.03
SD Card images	Pre-built images used for testing to use on target i.MX reference boards.
Manufacturing Tools	Used to burn a production image into the board
i.MX Open Source repos	i.MX open source modifications or NXP original open source.
NXP Component downloads	System Controller Porting kit and AACPlus Decoder downloadable on nxp.com.
i.MX Proprietary on Yocto Project mirror	i.MX proprietary components for download on nxp.com Yocto Project mirror
i.MX Limited Access	i.MX 3rd party packages requiring marketing assistance

The release packages contain the following.

- Documentation
- Prebuilt binaries
  - SD Card prebuilt image for the release target SoC.
  - Kernel and Device trees
  - Boot Images
  - Applicable Arm Cortex-M4 Demos if applicable to target SoC
- Manufacturing Tools if supported

See the i.MX User's Guide for information on how to use these release contents.

The following packages are available on the NXP Yocto Project mirror. Each package is pulled into builds directly when doing a Yocto Project build but can also be retrieved using the following command on Linux.

```
wget https://www.nxp.com/lgfiles/NMG/MAD/YOCTO/*file.bin*
```

**Table 3. BSP and Multimedia standard packages**

File name	Description
imx-codec-4.4.0.bin	i.MX optimized Audio and Video core codec libraries
imx-parser-4.4.0.bin	i.MX optimized core parser
imx-vpuwrap-4.4.0.bin	i.MX VPU wrapper for VPU libraries.
imx-vpu-5.4.38.bin	i.MX VPU library for i.MX 6 with VPU.
imx-vpu-hantro-1.7.0.bin	i.MX VPU Hantro libraries for i.MX 8MQuad and 8MMini.
firmware-qca-2.0.bin	i.MX QCA Bluetooth WiFi firmware.
firmware-imx-7.6.bin	i.MX Firmware including firmware for VPU, DDR, EPDC, HDMI, SDMA, and SECO.
imx-gpu-viv-6.2.4.p1.6-aarch32.bin	i.MX Graphics libraries for i.MX 6 and 7 SoC with GPU.
imx-gpu-viv-6.2.4.p1.6-aarch64.bin	i.MX Graphics libraries for i.MX 8.
imx-gpu-g2d-6.2.4.p1.6.bin	i.MX Graphics G2D libraries for i.MX 6 and 7 with GPU.
imx-dpu-g2d-6.2.4.p1.6.bin	i.MX Graphics G2D libraries for i.MX 8.
firmware-bcmdhd-1.363.22.bin	Broadcom Bluetooth® firmware and Wi-Fi firmware
imx-sc-firmware-0.7.bin	i.MX System Controller Firmware for i.MX 8QuadMax and 8QuadXPlus reference boards
imx7d-sabresd-m4-freertos-1.0.bin	i.MX 7D Cortex-M4 Demo
imx7ulp-m4-demo-2.4.0.bin	i.MX 7ULP Cortex-M4 Demo
imx8qm-m4-demo-2.3.0.bin	i.MX 8QuadMax Cortex-M4 Demo
imx8qx-m4-demo-2.3.1.bin	i.MX 8QXP Cortex-M4 Demo
imx8mq-m4-demo-2.3.0.bin	i.MX 8MQuad Cortex-M4 Demo

**NOTE**

The Cortex-M MCUXpresso SDK is distributed by the MCUXpresso Web Builder tool. To obtain the MCUXpresso SDK for the Cortex-M core of your i.MX SoC, visit <http://mcuxpresso.nxp.com>.

The following packages are available for download on nxp.com.

**Table 4. NXP.com packages**

File name	Description
imx-aacpcodec-4.4.0.bin	Coding Technologies AACplus decoder
imx-scfw-portingkit-0.7.bin	System Controller Firmware porting kit

i.MX BSP also releases open source through repos on the Code Aurora Forum (CAF) [i.MX CAF Project](#). The following table lists all the repos on CAF and the associated branches.

**Table 5. i.MX Code Aurora Forum Distributed Repos**

Repo	Description
<a href="#">imx-manifest</a>	i.MX Rocko Yocto Project Linux BSP Manifest
<a href="#">linux-imx</a>	i.MX Linux Kernel
<a href="#">uboot-imx</a>	i.MX U-Boot

*Table continues on the next page...*

**Table 5. i.MX Code Aurora Forum Distributed Repos (continued)**

Repo	Description
<a href="#">imx-atf</a>	i.MX Arm Trusted Firmware for i.MX 8
<a href="#">imx-mkimage</a>	i.MX Mkimage boot image tool
<a href="#">imx-lib</a>	i.MX Libraries
<a href="#">imx-test</a>	i.MX Driver unit test applications
<a href="#">imx-optee-os</a>	i.MX OP-TEE OS
<a href="#">imx-optee-test</a>	i.MX OP-TEE Test
<a href="#">imx-optee-client</a>	i.MX OP-TEE Client
<a href="#">imx-xen</a>	i.MX Xen hypervisor
<a href="#">imx-gst1.0-plugin</a>	i.MX Multimedia Gstreamer Plugins
<a href="#">gst-plugsin-base</a>	i.MX Multimedia Gstreamer Base
<a href="#">gst-plugsin-bad</a>	i.MX Multimedia Gstreamer Bad
<a href="#">gst-plugsin-good</a>	i.MX Multimedia Gstreamer Good
<a href="#">gstreamer</a>	i.MX Multimedia Gstreamer Core
<a href="#">imx-alsa-plugins</a>	i.MX ALSA Plugins
<a href="#">libdrm-imx</a>	i.MX Graphics DRM
<a href="#">opencv-imx</a>	i.MX Graphics OpenCV
<a href="#">weston-imx</a>	i.MX Graphics Weston
<a href="#">wayland-protocols-imx</a>	i.MX Graphics Wayland Protocols
<a href="#">xf86-video-imx-vivante</a>	i.MX Graphics Xorg Vivante Driver
<a href="#">meta-fsl-bsp-release</a>	i.MX Yocto Project Release Layer
<a href="#">gtec-demo-framework</a>	i.MX Graphics Demo Framework on CAF@github

An additional part of the release are Yocto Project demos that show additional use cases on different i.MX hardware. These demos are layers that work on top of a public BSP release. These are listed below and are updated within a month of each consolidated GA release. These demos are not fully tested but show how to integrate different stacks of software to use with i.MX reference boards and our BSP release.

- meta-imx-gpu-sdk - Additional graphics demos for i.MX 8
- meta-imx-iot-gateway - AWS and IOT Gateway demos for i.MX 6UL/6ULL
- meta-nxp-agl - Autograde Linux for i.MX 6 and i.MX 8 auto boards
- meta-nxp-genivi - Genivi demo for i.MX 6 and i.MX 8 auto boards
- meta-nxp-xbmc - Kodi demo showing a multimedia playback with a framebuffer backend on i.MX 6

## 1.3 License

The Board Support Package (BSP) is composed of a set of packages and metadata (for Yocto Project Recipes) and each one has its own licensing. Verify the license of the target package before developing. The license can be found at the top of a recipe or a source file (such as \*.c or \*.h). For details, contact your NXP representative.

The following components are released as binary files on the Yocto Project Mirror and have NXP Proprietary Licenses. During the Yocto Project setup, to set up an i.MX build, accept the NXP license. This acceptance is recorded in the build configuration files so that the following proprietary binaries can be extracted during the build process. The NXP proprietary packages contain a Software Content Register (SCR) file that lists information about the package: imx-gpu-viv, imx-codec, and imx-parser.

## 1.4 Limited access proprietary packages

- Limited access packages listed in the following table are provided on [nxp.com](http://nxp.com) with controlled access because they require additional licensing by a 3rd party. Contact your sales representative for access. Each package has its own Readme file with instructions on how to build, install, and run.

**Table 6. Limited access packages for Yocto project releases**

Package	Description
imx-mscodec-4.4.0.bin	i.MX optimized Microsoft codec
imx-msparser-4.4.0.bin	i.MX optimized Microsoft ASF parser
imx-ac3codec-4.4.0.bin	i.MX Dolby AC3 core decoder
imx-ddpcodec-4.4.0.bin	i.MX Dolby DD-plus decoder
imx-real-4.4.0.bin	i.MX Real Networks RMVB Decoders and Parsers
firmware-eink-1.363.22.bin	E Ink REGAL/-D waveform for i.MX 7D SABRE-SD
firmware-bcmd-1.363.22.bin	Broadcom Bluetooth wireless technology and Wi-Fi firmware
imx-hifi4-1.0.2.bin	HiFi4 codec (MP2, MP3, BSAC, DRM, DABPlus,SBC) for i.MX 8QuadXPlus
imx-hifi4-aacp-1.0.2.bin	HiFi4 AACPlus decoder for i.MX 8QuadXPlus

## 2 What's New?

This section describes the changes in this release, including new features and defect fixes.

### 2.1 New features

A summary of the main new features is as follows.

New features added for all supported boards:

- Upgraded the kernel to 4.9.88 and includes Spectre and Meltdown patches.
- Updated EULA to v24 May 2018.
- Upgraded the Yocto Project to version 2.4 Rocko.
- Supports the GCC 7.3 toolchain.
- Graphics updates:
  - GPU driver upgraded to 6.2.4.p1.6.
  - For i.MX 8 QuadMax and QuadXPlus support for Vulkan and OpenVX
  - GPU SDK upgraded to 5.1.0
  - Weston upgraded to 4.0
- Chromium browser upgraded to v64.0.3282.186 for X11 and v64.0.3274.0 for XWayland.
- New sound features: Audio Mixer (AMIX) support.
- New multimedia features and changes:
  - GStreamer upgraded to 1.14
  - Qt upgraded to 5.9
  - On SoCs without hardware graphics acceleration (GPU) for Frame Buffer, X11 or Wayland graphic backends QT5 is handled only using mesa software graphics, and it is not supported by NXP.

## What's New?

- Supports 64-bit audio codecs and parsers for i.MX 8.
- Supports video rendering with OpenGL-ES, AV playback to multiple displays and cameras preview.
- New sound features: Audio Mixer (AMIX) support.
- Supports hardware audio decoder for AAC/HE-AAC/MP3.
- Supports Qualcomm Wi-Fi and Bluetooth for i.MX 8MQuad, 8MMini and 7ULP.
- Supports CAN FD mode in FlexCAN.
- Supports suspending and resuming.
- Supports MIPI DSI panel.
- Supports USB3.0 device mode for i.MX 8.
- Bootloader features for i.MX 8QuadMax and 8QuadXPlus:
  - The System Controller Firmware (SCFW) and U-Boot are contained in imx-boot as the bootloader for i.MX 8QuadMax and i.MX 8QuadXPlus.
  - The SCFW provides an abstraction to many of the underlying features of the hardware. This feature runs on an Arm<sup>®</sup> Cortex<sup>®</sup>-M processor that executes SCFW. Features include:
    - System initialization and boot
    - Power management
    - Resource management
    - System counter
    - Pad configuration
    - One-Time-Programmable (OTP) storage
    - Temperature monitoring
    - Watchdog

### Features on i.MX 8QuadMax:

- Supports the i.MX 8QuadMax with the Arm v8 architecture:
  - 4x Cortex-A53 SMP enabled.
  - 2x Cortex-A72 SMP enabled.
- Supports the SMMU-500 for the IOMMU functionality.
- Supports the pin/pad, clock/power/resource management through the System Controller Unit (SCU).
- Supports LVDS-HDMI through the LVDS-HDMI Mini-SAS daughter card.
- Supports display and audio through the HDMI interface.
- Supports the RM67191 OLED display panel through the MIPI DSI interface.
- Supports the CAAM security driver.
- Supports the SAI and Audio-codec.
- Supports the 2x GC7000XSVX GPU Graphics Processing Unit (GPU).
- Supports the SD/MMC/eMMC, FlexSPI, and LPSPI storage devices.
- Supports the ENET, USB, PCIe, CAN, and I2C connectivity (PCIe enabled based on the v4.6 kernel).
- Supports connectivity using RPMsg with MS support to FreeRTOS.
- Supports display with triple-buffer support in PAN display API for the frame buffer.
- Supports Camera V4L TV-In through ADV7180 and V4L Camera support through Quad Camera board (3 cameras per board and parallel-in).

### Features on i.MX 8MQuad

- Engineering release

### Features on i.MX 8MMini

- Supports booting from SD, eMMC, and FlexSPI.
- Supports low-power features: CPU hot-plug, Arm DVFS, and CPU idle.
- Supports 1080p60 display with ADV7535 (MIPI-HDMI adapter).
- Supports 1080p30 camera with OV5640.
- Supports Wayland Weston accelerating with GPU2D.
- Supports audio capture from PDM microphone.
- Supports Audio expansion board for:

- Multiple-channel audio receiver and transmitter
- SPDIF receiver and transmitter
- Supports 1080p60 video playback of HEVC, H264, VP9, and VP8.

Features on i.MX 8QuadXPlus MEK:

- Supports i.MX 8QuadXPlus B0 chip.
- VPU Using two M0 cores to run decode and encode firmware.
- GPU frequency increased from 600 MHz to 700 MHz LVDS and MIPI uses AVPLL.
- Removed A0 workaround for ESAI ADMA request.
- Added ADC support.
- Supports the i.MX 8QuadXPlus MEK with the Arm v8 architecture:
  - 4x Cortex-A35 SMP enabled.
- Supports the pin/pad, clock/power/resource management through the System Controller Unit (SCU).
- Supports the SAI/ESAI and Audio-codec.
- Supports the GC7000Lite GPU Graphics Processing Unit (GPU).
- Supports the SD/MMC, QSPI-NOR storage devices.
- Supports the ENET, USB, PCIe, CAN, and I2C connectivity.
- Supports connectivity using RPMmsg with MS support to FreeRTOS.
- Supports display with triple-buffer support in PAN display API for the frame buffer.
- Supports HIFI DSP.
- Supports MIPI CSI.

## 2.2 Power management supported features

The following common power management features are supported on i.MX 6 and i.MX 7:

- CPU/GPU frequency throttle for SoCs with GPU
- GPU dynamic power management for SoCs with GPU
- CPU idle framework with two working levels: pure WFI and WFI with wait mode enabled
- Low power mode: standby and dormant (mem) mode
- Thermal temperature

Power management features supported on 6SoloLite, 6SABRE-SD, and 6SABRE-AI:

- LDO bypass
- CPUFreq driver: CPU frequency adjusted based on the CPU loading and Interactive governor
- VPU/GPU dynamic power management for SoCs with VPU and GPU
- LDO bypass
- Bus frequency support
- SD3.0 dynamic clock management
- USB remote wake-up and USB charger

## 2.3 Graphics

This section describes new features and bug fixes for the graphics provided in this release.

Graphics Changes are now available in the following locations

- Changes for i.MX with GPU are documented on <https://source.codeaurora.org/external/imx/imx-manifest.git/tree/GraphicsChangeLogv6?h=imx-linux-rocko>.

### 3 SoC Feature Summary

The following table describes the SoC features summarized into groups. In this table, common features are shown on which SoC it supports.

**Table 7. SoC Hardware Acceleration Features**

Feature	SoC
2D Graphics with GPU	i.MX 6 Family: 6Quad, 6DualLite, 6Solo, 6SoloX, 6SoloLite i.MX 7 Family: 7ULP i.MX 8M Family: 8MMini
3D GPU	i.MX 6 Family: 6Quad, 6DualLite, 6Solo, 6SoloX i.MX 7 Family: 7ULP i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus i.MX 8M Family: 8MQuad, 8MMini
2D Graphics with DPU	i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus
Vulkan GPU	i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus
OpenVX	i.MX 8 Family: 8QuadMax
VPU	i.MX 6 Family: 6Quad, 6DualLite i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus i.MX 8M Family: 8MQuad, 8MMini
EPDC	i.MX 6 Family: 6DualLite, 6SoloLite, 6SLL, 6ULL i.MX 7 Family: 7Dual
PXP	i.MX 6 Family: 6DualLite, 6SoloLite, 6SLL, 6UL, 6ULL i.MX 7 Family: 7Dual
Frame Buffer Display	i.MX 6 Family: 6Quad, 6DualLite, 6Solo, 6SoloX, 6SoloLite, 6SLL, 6UL, 6ULL i.MX 7 Family: 7Dual, 7ULP
DRM Display	i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus i.MX 8M Family: 8MQuad, 8MMini
M4 Boot	i.MX 6 Family: 6SoloX i.MX 7 Family: 7Dual, 7ULP i.MX 8 Family: 8QuadMax i.MX 8X Family: 8QuadXPlus i.MX 8M Family: 8MQuad, 8MMini
HiFi4 DSP	i.MX 8X Family: 8QuadXPlus

## 4 BSP Supported Features

The following table describes the features that are supported in this BSP release. In this table, if no board is explicitly stated, the feature is shared across all boards listed in Supported Hardware in the Release contents section; otherwise, the feature is only supported on the boards listed.

**Table 8. Supported features**

Feature	Supported board	Comment
<b>Kernel</b>		
Kernel	All i.MX	Kernel version: 4.9.88
File System	All i.MX	EXT2/EXT3/EXT4 are used as the file system in MMC/eMMC/SD card. On i.MX 6SABRE-AI and 7D-SABRE-SD, <ul style="list-style-type: none"> <li>• UBIFS is used for NAND.</li> <li>• JFFS2/UBIFS is used for Parallel NOR, QSPI NOR.</li> </ul>
<b>Boot Image</b>		
U-Boot	All i.MX	<p>U-Boot delivery is based on U-Boot version v2017.03.</p> <p>Clock, Anatop regulator, ENET, UART, MMC/SD, eMMC4.3/4.4/4.5.</p> <p>High-Assurance Boot, ROM Plug-in Mode.</p> <p>SPI-NOR, Parallel NOR, SATA, NAND, FlexSPI-NOR, USB Mass Storage.</p> <p>See Table 2 in Section 1.1 for U-Boot configurations supported on each board for SPI_NOR, NAND, Parallel NOR, FlexSPI-NOR. These are not supported on all boards.</p> <p>i.MX 6QuadPlus/Quad/DualLite SABRE-SD and SABRE-AI support DDR3 528 MHz @ 64 bit.</p> <p>i.MX 6SoloX SABRE-SD and SABRE-AI support LPDDR3 400 MHz @ 32 bit.</p> <p>i.MX 6SoloLite EVK supports LPDDR2 400 MHz @ 32 bit and boot using L2Cache as OCRAM.</p> <p>i.MX 6SoloLite EVK supports LPDDR.</p> <p>i.MX 7Dual SABRE-SD supports DDR3 533 MHz @ 32 bit and boot using L2Cache as OCRAM.</p> <p>i.MX 6UltraLite EVK supports DDR3 400 MHz @ 16 bit.</p> <p>i.MX 6ULL supports DDR3 400 MHz @ 16 bit.</p> <p>i.MX 7ULP supports Clock, UART, MMC/SD, eMMC4.3/4.4/4.5, High-Assurance Boot, ROM Plug-in Mode QuadSPI-NOR, USB Mass Storage I2C, and SPI.</p> <p>i.MX 8 uses imx-mkimage to produce the flash.bin file that contains the i.MX 8 system controller firmware and U-Boot, and the flash.bin file that can be flashed to the SD cards with the command: <code>dd if=flash.bin of=/dev/sd&lt;x&gt; seek=33 bs=1K</code>.</p> <p>8MMini, 8MQuad, 8QuadMax, and 8QuadXPlus use seek=33 bs=1k.</p>
Boot Firmware	All i.MX 8	<p>All i.MX require Arm Trusted Firmware</p> <p>i.MX 8QuadMax and 8QuadXPlus require System Controller Firmware</p> <p>i.MX 8QuadMax and 8QuadXPlus require SECO firmware</p> <p>i.MX 8QuadMax requires signed HDMI firmware</p>

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
OP-TEE	All i.MX 6 All i.MX 7 All i.MX 8M	OP-TEE OS is required on the boot partition with the TEE file for OP-TEE enablement
Xen Hypervisor	All i.MX 6 All i.MX 7 All i.MX 8M	Xen goes into the boot image
<b>Machine-specific layer</b>		
Arm® Core	All i.MX	<p>6SABRE-SD, 6SABRE-AI, 6SoloLite, 6SLL, 6SoloX-SD, and 6SoloX-AI support the Arm Cortex-A9 processor.</p> <p>7D-SABRE-SD supports the Arm Cortex-A7 processor.</p> <p>7ULP EVK supports the Arm Cortex-A7 processor.</p> <p>6UltraLite EVK supports the Arm Cortex-A7 processor.</p> <p>6ULL EVK, 6UltraLite EVK, and 7D-SABRE-SD support the Arm Cortex-A7 processor.</p> <p>i.MX 8QuadXPlus processor consists of five cores:</p> <ul style="list-style-type: none"> <li>• Four Arm Cortex-A35</li> <li>• One Arm Cortex-M4F</li> </ul> <p>i.MX 8QuadMax processor consists of eight cores:</p> <ul style="list-style-type: none"> <li>• Four Arm Cortex-A53 cores</li> <li>• Two Arm Cortex-A72 cores</li> <li>• Two Arm Cortex-M4F cores</li> </ul> <p>Innovative multicore architecture provides four Cortex-A53 cores, two Cortex-A72 cores, and two Cortex-M4 cores.</p> <p>i.MX 8MQ and i.MX 8MMini supports four Cortex-A53 cores.</p>
Memory	All i.MX	<p>On i.MX 6 and i.MX 7 SoC, the user/kernel space is split 2G/2G.</p> <p>On i.MX 8 with 64-bit configuration, the memory is not split.</p> <p>8QuadMax supports two 32-bit LPDDR4 channels @ 1600 MHz.</p> <p>8QuadXPlus supports one 32-bit LPDDR4 channel @ 1200 MHz.</p>
Interrupt	All i.MX	GIC
Clock	All i.MX	Controls the system frequency and clock tree distribution.
Timer	All i.MX	<p>System timer tick and broadcast timer support.</p> <p>GPT Timer used for i.MX 6 and i.MX 7.</p> <p>On i.MX 8MQuad, 8MMini and 8QuadXPlus, system counter timer instead of GPT.</p> <p>On i.MX 8, Arm Arch timer used instead of GPT</p> <p>On i.MX 6 and i.MX 7 Enhanced Periodic Interrupt Timer (EPIT) available</p>
GPIO/EDIO	All i.MX	GPIO is initialized in earlier phase according to hardware design.
IOMUX	All i.MX	Provides the interfaces for I/O configuration. IOMUX-V3 version is used on i.MX 6 and i.MX 7 boards. For i.MX 8QuadMax and 8QuadXPlus the system controller manages access to the IOMUX.

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
System Controller	8QuadMax 8QuadXPlus	Provides abstraction to the hardware features and runs on Arm Cortex executing firmware.
<b>DMA engine</b>		
SDMA	All i.MX 6 All i.MX 7 8MQuad	Conforms to the DMA engine framework.
APBH-Bridge-DMA	6SABRE-AI	Conforms to the DMA engine framework. This feature requires a NAND U-Boot.
<b>Character device drivers</b>		
UART	All i.MX	<p>i.MX 6 SABRE-SD, and SoloLite EVK support console through internal Debug UART1.</p> <p>i.MX 6SoloX SABRE-SD and SABRE-AI support Cortex-A9 processor through UART1 and Cortex-M4 processor through UART2.</p> <p>i.MX 7Dual SABRE-SD Cortex-A7 processor through UART1 and Cortex-M4 processor through UART2.</p> <p>i.MX 6UltraLite EVK and i.MX 6ULL Cortex-A7 processor through UART1.</p> <p>i.MX 6 SABRE-AI supports console through internal Debug UART 4.</p> <p>i.MX 7ULP EVK supports through LPUART. There are two LPUARTs on the i.MX 7ULP EVK board. LPUART0 is connected to Arm Cortex-M4 domain and LPUART4 to Arm Cortex-A7 domain.</p> <p>i.MX 8 supports Cortex-A53 processor through UART0 and Cortex-M4 processor through UART2.</p>
<b>Power Management Drivers</b>		
Anatop Regulator	All i.MX 6 All i.MX 7	Supports Anatop regulator management.
Lower Power mode	All i.MX 6 All i.MX 7 All i.MX 8M	Supports standby mode and dormant (mem) mode on i.MX 6 and i.MX 7 boards.
CPUIidle	All i.MX 6 All i.MX 7	2 levels CPUIidle supported: purely WFI and WFI with wait mode enabled.
CPUFreq	All i.MX	CPUFreq can be used for CPU frequency adjustment. The Interactive governor is added and enabled by default.
BusFreq	All i.MX 6 7D-SABRE-SD	Supports the system bus clock frequency scaling on i.MX 6 and i.MX 7D boards.
Battery charging	All i.MX 6 All i.MX 7	
<b>Networking drivers</b>		
ENET	All i.MX 6 7D-SABRE-SD All i.MX 8	<p>i.MX 6Quad/SoloX board supports AR8031 PHY, i.MX 6UltraLite EVK board supports KSZ8081 PHY, and i.MX 7Dual SABRE-SD board supports BCM54220 PHY.</p> <p>i.MX 6SoloX SABRE-SD, SABRE-AI, and i.MX 7Dual SABRE-SD support AVB features.</p> <p>i.MX 8 supports Atheros AR8031 PHY with 10/100/1000 bps mode and AVB features.</p>

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
IEEE® 1588	All i.MX 6 All i.MX 7 8QuadMax 8QuadXPlus	Supports Linux PTP stack. Supports IPv4, IPv6, and IEEE 802.3 transport. Supports E2E, and P2P transparent clock. Supports IEEE802.1AS-2011 in the role of end station.
PCIe	All i.MX	With the platform that supports the PCIe module.
PCIe EP/RC validation system	i.MX 6Quad SD i.MX 6SoloX-SD 7D-SABRE-SD	Two of the same i.MX 6Quad SD boards, i.MX 7Dual SABRE-SD boards, or i.MX 6SoloX SDB boards. One is used as RC, and the other is used as EP. <ul style="list-style-type: none"> <li>EP can be initialized/enumerated by RC.</li> <li>EP can access the memory of RC.</li> <li>RC can access the memory of EP.</li> <li>EP can trigger MSI, and the triggered MSI can be captured by RC.</li> </ul>
MediaLB	6SABRE-AI 6SoloX-AI	On i.MX 6SABRE-AI, CPU1 supports MLB 150 and MLB 25/50. On i.MX 6SABRE-AI, CPU2 and i.MX 6QuadPlus SABRE-AI supports MLB 25/50 only. On i.MX 6SoloX-AI, it supports MLB 25/50.
FlexCAN	All i.MX 6 7D-SABRE-SD 8QuadMax 8QuadXPlus	Supports one CAN with the default device tree on i.MX 6SABRE-AI. Supports both CANs using the FlexCAN device tree but has a pin conflict with FEC. Supports with the default device tree on i.MX 6SoloX-SD and i.MX 6SoloX-AI. Supports with the default device tree on i.MX 7Dual SABRE-SD. Supports with the default device tree on i.MX 6UltraLite EVK. Supports with the default device tree on i.MX 6ULL EVK. With the platform that supports the FlexCAN module, FlexCAN supports CANFD mode.
Wi-Fi/Bluetooth wireless technology	All i.MX	Supports Murata 1PJ (QCA9377-3) Wi-Fi/Bluetooth on i.MX 7ULP EVK. Supports Murata 1CQ (QCA6174A) Wi-Fi/Bluetooth on i.MX 8MQuad needs to add kernel parameter "pci=noms". Supports Murata 1PJ (QCA9377) Wi-Fi/Bluetooth on i.MX 8MMini. For i.MX 8QuadXPlus supports the Broadcom/Murata BCM4359 1FD Bluetooth/Wi-Fi module. Supports Murata Broadcom Wi-Fi/Bluetooth on i.MX 6 and i.MX 7Dual. Supports the WL_HOST_WAKE (OOB) feature for all the listed boards except i.MX 6UL/ULL EVK, which requires hardware rework. The Broadcom CONFIG_BCM4339 performance optimization option is not enabled by the default kernel. Users can enable it manually to gain big performance improvement. i.MX 6SoloLite EVK does not support enabling CONFIG_BCM4339 due to the known Wi-Fi driver limitation. For Bluetooth A2DP, if Yocto Project has no frame buffer, for example, the 6UltraLite G1 part chip has no LCDIF, run PulseAudio manually with the command:  <code>/usr/bin/pulseaudio --start --log-target=syslog</code>
<b>Security drivers</b>		
CAAM	6SABRE_SD 6SABRE_AI	Cryptographic Acceleration and Assurance Module.
SNVS	All i.MX 6 All i.MX 7	Secure Non-Volatile Storage.

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
SIMv2	6UltraLite 7D-SABRE-SD	Smart Card Interface.
<b>Sound drivers and DSP</b>		
DSP	8QuadXPlus	One HiFi 4 DSP
WM8962/SSI WM8960/SSI	6SABRE-SD 6SoloLite 6SoloX-SD 7D-SABRE-SD 6UltraLite 6ULL 7ULP	Supports playback
SAI/MQS	8QuadMax	Supports playback.
S/PDIF	6SABRE-SD 6SABRE-AI 6SoloX-AI 8QuadMax 8QuadXPlus	Supports 16 bit and 24 bit stereo playback from 32 kHz to 48 kHz sample rate. Supports 24 bit stereo record from 16 kHz to 96 kHz.
ASRC	6SABRE-AI 6SoloX-SD 6UltraLite 6ULL 8QuadMax 8QuadXPlus	Supports sample rates conversion from 5 kHz to 192 kHz and output sample rates from 32 kHz to 192 kHz. Supports ALSA plug-in library playback.
ESAI/CS42888	6SABRE-AI 6SoloX-AI 8QuadMax 8QuadXPlus	Supports 16 bit, 24 bit PCM format, channel from 2 to 6, and sample rate from 8 kHz to 192 kHz for playback with ASRC P2P. Supports sample rate from 8 kHz to 96 kHz for record and playback without ASRC. Supports 4 channels input and 8 channels output. Supports full duplex operations. Supports amixer alsamixer control from user space.
SAI/MQS/WM8962	6SoloX-SD 7D-SABRE-SD 6UltraLite 6ULL 7ULP 8MQuad 8MMini 8QuadMax	Supports 16 bit, 24 bit, and 32 bit PCM format. Supports sample rate from 8 kHz to 96 kHz for record and playback . Supports full duplex operations. Supports amixer alsamixer control from user space. Supports clock control. Support MQS only on i.MX 6 and i.MX 7 Supports WM8962 only on i.MX 8QuadMax

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
	8QuadXPlus	
AMIX	8QuadMax 8QuadXPlus	Supports 16 bit, 18 bit, 20 bit, 24 bit, and 32 bit PCM format. Supports sample rate from 8 kHz to 96 kHz for record and playback . Supports amixer alsamixer control from user space.
HDMI Audio	6SABRE-SD 6SABRE-AI 7D-SABRE-SD 8QuadMax 8MQuad	For i.MX 8QuadMax not supported on the reference board but able to add to custom board. i.MX 8MQuad supports audio playback through HDMI.
<b>Input device drivers</b>		
USB devices	All i.MX	Supports USB mouse and USB keypad through USB ports.
Touch panel	All i.MX 6 All i.MX 7	6SABRE-SD, 6SABRE-AI. Supports EGalaxy capacitive touch screen. 6SoloLite supports E Ink® touch screen on DC2/DC3 add-on card. 7Dual SABRE-SD supports E Ink touch screen with a separate package download. 6SoloX SABRE-SD and SABRE-AI support LVDS panel. 7ULP EVK supports touch through DSI panel
Keypad	6SoloLite 6UltraLite 7D-SABRE-SD 7ULP	6SoloLite supports 4x4 keypads on DC2/DC3 add-on card. 6UltraLite EVK , 7ULP EVK and 7D SABRE-SD support the resistive touch panel.
<b>Storage drivers</b>		
FlexSPI-NOR	6SoloX-SD 6SoloX-AI 6UltraLite 6ULL 7D-SABRE-SD All i.MX 8	i.MX 6SoloX SABRE-AI supports QSPI1. i.MX 6SoloX SABRE-SD supports QSPI2. i.MX 6UltraLite EVK supports QSPI1. i.MX 7Dual SABRE-SD supports QSPI1. i.MX 8QuadXPlus, 8MQuad and 8MMini support FlexSPI1. i.MX 8MMini supports NOR Flash Boot.
SPI-NOR	6SABRE-AI 6SoloLite	Supports M25P32 On i.MX 6SABRE-SD Dual/Quad/DualLite there is a pin conflict for supporting SPI-NOR
NAND	6SABRE-AI 6SoloX-AI 7D-SABRE-SD 8QuadXPlus 8MQuad 8MMini	Normal NAND and ONFI NAND asynchronous mode with BCH40/BCH62.
Parallel NOR	6SABRE-AI 8QuadMax	Supports Parallel NOR by using the EIM interface on i.MX 6 SABRE-AI.

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
SATA	6SABRE-SD 6SABRE-AI 8QuadMax	Serial ATA 2.0 supports only i.MX 6DualQuad SABRE-SD and SABRE-AI and i.MX 6QuadPlus SABRE_SD and SABRE-AI and 8QuadMax.
<b>USB drivers</b>		
USB Host	6SABRE-AI 6SoloLite 6SoloX 6UltraLite 6ULL All i.MX 7 All i.MX 8	Supports USB HOST1 and USB OTG host.  i.MX 8 supports USB 3.0 ports
USB Device	All i.MX	Supports USB OTG device mode.
USB	All i.MX	Supports USB OTG2.0, USB Host2.0.  i.MX 8 support USB 3.0 and Type-C ports.  USB Host mode: MSC, HID, UVC, and USB audio.  USB device mode: MSC, Ethernet, and Serial.  USB OTG pin detect support for Dual-role switch at USB2.
<b>Graphics and Video drivers</b>		
GPU	6SABRE-SD 6SABRE-AI 6SoloX 6SoloLite 7ULP All i.MX 8	<p>Graphics Chips Details:</p> <p>One GC7000-Lite on 8MQuad.</p> <p>One GC7000-NanoUltra and GC520I on 8MMini.</p> <p>Two GC7000SXVX on 8QuadMax.</p> <p>One GC7000-Lite on 8QuadXPlus.</p> <p>One GC7000-NanoUltra and GC328 on 7ULP.</p> <p>GC2000, GC355, and GC320 on 6Dual/6Quad</p> <p>GC2000+, GC355, and GC320 on 6QuadPlus</p> <p>GC880 and GC320 on 6Solo/DualLite</p> <p>GC400T on 6SoloX</p> <p>The GPU on the chips listed above supports these features that include 2D and 3D hardware acceleration:</p> <ul style="list-style-type: none"> <li>• Supports EGL 1.5 for fbdev, X11, XWayland</li> <li>• Supports OpenGL ES1.1</li> <li>• Supports OpenGL ES2.0 (WebGL 1.0.1 compatible on X11)</li> <li>• Supports OpenGL ES3.0</li> <li>• Supports ESS 3.1 and ESS 3.2 on i.MX 8QuadMax and 8QuadXPlus</li> <li>• Supports Vulkan and OpenVX on i.MX 8QuadMax</li> <li>• Supports OpenVG1.1</li> <li>• Supports OpenCL1.1 on GC7000SXVX, GC2000 and GC2000+.</li> <li>• Supports OpenGL2.1</li> </ul> <p>GC355 and GC320 on 6SoloLite, which includes only 2D hardware acceleration</p>

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
		<ul style="list-style-type: none"> <li>Supports EGL 1.5 for fbdev, X, Wayland</li> <li>Supports OpenVG1.1</li> </ul>
Frame Buffer Display	All i.MX 6 and 7	<p>MXC Frame buffer driver for IPU V3 on i.MX 6SABRE-SD and i.MX 6SABRE-AI.</p> <p>MXC Frame buffer driver for PXP on i.MX 6SoloLite, i.MX 6SoloX SABRE-SD/SABRE-AI, i.MX 6UltraLite EVK i.MX 6ULL EVK and i.MX 7Dual SABRE-SD.</p>
Direct Rendering Manager (DRM) Display	All i.MX 8	<p>i.MX DPU DRM is used for i.MX 8QuadMax and 8QuadXPlus.</p> <p>LCDIF is used for i.MX 8MQuad and 8MMini.</p> <p>DCSS is used for i.MX 8MQuad</p>
Framebuffer compression	8MQuad	<p>Supports graphic framebuffer compression with DEC400.</p> <p>Supports video framebuffer compression with DTRC.</p>
VDOA	6SABRE-SD 6SABRE-AI	Supports Video Data Order Adapter for tiling.
LVDS	6SABRE-SD 6SABRE-AI 6SoloX-SD 6SoloX-AI 8QuadMax 8QuadXPlus	<p>Supports HannStar LVDS panel on i.MX 6. It is the default display if no other video option is setup. Uses the LDB controller.</p> <p>On the SABRE-AI there are 2 ports. Port 0 is the default.</p> <p>For i.MX 8, supports the Mixel controller</p>
HDMI Display	6SABRE-SD 6SABRE-AI 6SoloLite 6SoloX-SD 6SoloX-AI 7D-SABRE-SD 7ULP	<p>i.MX 6SABRE-SD, 6SABRE-AI and 7Dual support on-chip HDMI hardware.</p> <p>i.MX 6SoloLite and i.MX 6SoloX SABRE-SD and SABRE-AI support external HDMI hardware.</p> <p>i.MX 7ULP EVK supports HDMI through the MIPI pins with external HDMI hardware.</p>
HDMI/Display Port	8MQuad 8QuadMax	<p>i.MX 8QuadMax supports HDMI audio and on-chip HDMI hardware through MIPI pins.</p> <p>i.MX 8MQuad supports HDMI through DCSS.</p>
LVDS to HDMI	8QuadMax 8QuadXPlus	Uses ITE Driver IT6263
MIPI to HDMI	All i.MX 8	Uses Advantec adv7535
HDCP	6SABRE-SD	Supports HDCP v1.2 specifications on specific HDCP parts.
MIPI-DSI Display	6SABRE-SD All i.MX 7	<p>Supports 2 lanes through MIPI daughter card on i.MX 6 and i.MX 7-SABRE-SD.</p> <p>Support 2 lanes MIPI DSI with direct connection on i.MX 7ULP</p> <p>Supports 4 lanes driven by DPU with up to 1080p60 on i.MX 8QuadMax and 8QuadXPlus.</p> <p>Supports 4 lanes driven by cLCDIF with up to 720p60 on i.MX 8MQuad.</p> <p>Supports 4 lanes driven by eLCDIF up to 1080p60 on i.MX 8MMini.</p> <p>Supports 4 lanes driven by DCSS with up to 1080p60 on i.MX 8MQuad.</p>

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
		Supports RM67191 OLED display panel through the MIPI DSI on i.MX 8.
Parallel-LCD Display	All i.MX 6 All i.MX 7	Supports SEIKO WVGA panel. For i.MX 6UltraLite, i.MX 6ULL and i.MX 7Dual SABRE-SD, it supports Embest LCD8000-43T LCD panel.
PxP	6DualLite-SD 6SoloLite 6SLL 6SoloX-SD 6SoloX-AI 7D-SABRE-SD 6UltraLite 6ULL	Enables PxP Driver for EPDC on i.MX 6SoloLite, 6SLL EVKs and 6DualLite SABRE-SD. Enables PxP driver for EPDC on i.MX 7Dual, 6UltraLite 6ULL. Conforms to DMA engine framework.
EPDC	6DualLite-SD 6SoloLite 6SLL 6ULL 7D-SABRE-SD	Supports RGB565 frame buffer format. Supports Y8 frame buffer format. Supports full and partial EPD screen updates. Supports up to 256 panel-specific waveform modes. Supports automatic optimal waveform selection for a given update. Supports synchronization by waiting for a specific update request to complete. Supports screen updates from an alternate (overlay) buffer. Supports automated collision handling. Supports 64 simultaneous update regions. Supports pixel inversion in a Y8 frame buffer format. Supports posterization of the update contents (driving all pixels to either solid black or white). Supports use of a color map to remap Y8 frame buffer contents. Supports 90, 180, and 270 degree HW-accelerated frame buffer rotation. Supports panning (y-direction only). Supports three EPDC driver display update schemes: Snapshot, Queue, and Queue and Merge. Supports user control of the delay between completing all updates and powering down the EPDC. Supports dithering. i.MX 7Dual supports E Ink but requires a separate download. Contact Marketing representative.
VPU	6SABRE-SD 6SABRE-AI All i.MX 8	i.MX 6 Encoder: MPEG-4, H.263, H.264 (AVC/MVC), MJPEG i.MX 8QuadMax Encoder: H264 i.MX 6 Decoder: MPEG-4, H.263, H.264 (AVC/MVC), VC-1, MPEG-2, MJPEG, AVS, VP8. i.MX 8QuadMax and 8QuadXPlus Decoder: HEVC, H264, RV, MPEG2.

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
		i.MX 8MQuad Decoder: HEVC, VP9, H.264, MPEG-2, MPEG-4p2, VC-1, VP8, RV9, AVS, MJPEG, H.263. i.MX 8MMini Decoder: HEVC, VP9, H.264, MPEG-2, MPEG-4p2, VC-1, VP8, RV9, AVS, MJPEG, H.263.
DPU	>8QuadMax 8QuadXPlus	Supports through DRM display framework and provides 2D Graphics processing. Supports CRC checking Supports DPR tiling
DCSS	>8MQuad	Supports display frame buffers in memory out to Ultra HD or HDTVs.
IPU	6SABRE-SD 6SABRE-AI	On i.MX 6SABRE-SD and i.MX 6SABRE-AI, the IPU driver provides interfaces to access IPU V3 modules.
PRE/PRG driver	6QuadPlus-SD 6QuadPlus-AI	On i.MX 6QuadPlus provides interfaces to support prefetch linear frames or resolve tiled frames for display.
V4L2 Output	All i.MX 6 All i.MX 7	i.MX 6SABRE-SD and i.MX 6SABRE-AI use the IPU post-processing functions for video output. i.MX 6SoloLite, i.MX 6SoloX SABRE-SD and SABRE-AI, i.MX 6UltraLite EVK and i.MX 7D SABRE-SD use the PXP post-processing functions for video output. i.MX 7ULP EVK uses MIPI connection for V4L2 output.
<b>Video Capture drivers</b>		
V4L2 Capture	All i.MX	Supports 2 cameras on i.MX 6SABRE-SD and SABRE-AI. Supports one camera on i.MX 6SoloLite EVK , 6SoloX SABRE-SD, 6UltraLite EVK, 6ULL EVK, and 7D-SABRE-SD. Supports 2 cameras on i.MX 8MQuad and 8MMini Supports 4 cameras on i.MX 8QuadXPlus Supports 8 cameras on i.MX 8QuadMax
MIPI Camera CSI	6SABRE-SD 7D-SABRE-SD 7ULP 8MQuad 8MMini 8QuadMax 8QuadXPlus	Supports 2 lane CSI MIPI camera OV5640 with 720p30, 1080p30, 2592x1944@15. Also supports CSI MIPI camera OV10635 with 720p30, 1080p30, 2592x1944@15 on i.MX 8QuadMax and 8QuadXPlus.
Parallel CSI	6SABRE-SD 6SoloLite 6SoloX-SD 6UltraLite 6ULL 8MQuad 8QuadXPlus	Supports OV5640 camera sensor.
VIU	6SoloX	Supports capture through VIU controller.

*Table continues on the next page...*

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
	7ULP	
ISI	8QuadMax 8QuadXPlus	Supports capture through ISI controller.
IPU-CSI	6SabreSD	Supports capture through IPU CSI controller.
TV-IN	6SABRE-AI 8QuadMax	Supports TV-IN through ADV7180 on the 6SABRE-AI with bt656, NTSC, and PAL. Supports TV-IN through ADV7180 on the 8QuadMax with NTSC, and PAL.
<b>General drivers</b>		
uSDHC	All i.MX	Supports SD2.0 and SDXC. Supports SD3.0 on all i.MX except 6SABRE-SD. Supports eMMC 1bit/4bit/8bit SDR/DDR mode. i.MX 6SABRE-SD is soldered, i.MX 6SABRE-AI uses the daughter card, and i.MX 6SoloX-SD is not soldered. Supports eMMC4.5 on i.MX 6SoloLite and i.MX 6SoloX-SD. Supports eMMC5.0 on i.MX 7Dual SABRE-SD. Supports eMMC5.1 on i.MX 8QuadMax and 8QuadXPlus.
Watchdog	All i.MX	Supports Watchdog reset.
I <sup>2</sup> C	All i.MX	Supports I <sup>2</sup> C master.
SPI	All i.MX	Supports SPI master mode.
Pulse Width Modulator	All i.MX	Supports the backlight driver through PWM.
ADC	6SoloX-SD 6SoloX-AI 7D-SABRE-SD 6UltraLite 6ULL 7ULP 8QuadMax 8QuadXPlus	Supports the ADC driver.
Temperature monitor	All i.MX	Pre-calibrated. See the "Thermal Driver" chapter in <i>i.MX Linux® Reference Manual</i> (IMXLXRM) for more information.
Accelerometer	6SABRE-SD 6SABRE-AI 6SoloLite 6SoloX-SD 6SoloX-AI 6UltraLite 6ULL 7D-SABRE-SD 7ULP	Supports the MMA8451 sensor on i.MX 6SABRE and i.MX 6SoloX. Supports the MMA8450 sensor on i.MX 6SoloLite. Supports the FXLS8471Q sensor on 6UltraLite EVK and 6ULL EVK. Supports the FXOS8700 sensor on the i.MX 7. Supports the FXOS8700 sensor on the i.MX 8.

Table continues on the next page...

**Table 8. Supported features (continued)**

Feature	Supported board	Comment
	8QuadXPlus	
GPIO Expander	6SABRE-SD	Supports the MAX7310 GPIO expander on i.MX 6 SABRE-SD and SABRE-AI.
	6SABRE-AI	Supports the 74LV595 GPIO expander on i.MX 7Dual SABRE-SD.
	7D-SABRE-SD	Supports PCA9557 on i.MX 8.
	8QuadMax	
	8QuadXPlus	
SNVS RTC	All i.MX 6 All i.MX 7	SNVS is a block that interfaces with CAAM and SRTC.
Ambient Light Sensor	6SABRE-SD	Supports the ISL29023 sensor on i.MX 6 SABRE-SD, SABRE-AI and 6 SoloX boards.
	6SABRE-AI	Supports the ISL29023 sensor on i.MX 8 QuadMax and i.MX 8QuadXPlus boards
	6SoloX-SD	
	6SoloX-AI	
	8QuadMax	
	8QuadXPlus	
Gyroscope Sensor	All i.MX 7	Supports FXA2100 gyroscope sensor
Pressure Sensor	7D-SABRE-SD	Supports MPL3115 pressure sensor
	8QuadMax	
	8QuadXPlus	
Magnetometer Sensor	i.MX 6	Supports MAG3110 magnetometer sensor on all i.MX 6 except 6SLL and 6SoloLite.
AM/FM module	6SABRE-AI	Supports the SI4763 AM/FM module. Supports FM by using the SSI interface.

## 5 U-Boot and Device Trees

This section describes the different U-Boots and Device trees and different kernel and boot parameters.

### 5.1 U-Boot configurations

In the following table, the U-Boot configurations are listed for each machine configuration. The machine configurations are provided through the Yocto Project layers in the meta-freescale and meta-fsl-bsp-release layers in the `conf/machine` sub-directory.

**Table 9. U-Boot configurations**

U-Boot configuration for Boot device	Description	Supported machine configuration
sd	sd supports boot from an SD card. This is the default U-Boot configuration.	imx6qsabresd, imx6qpsabresd, imx6dlsabresd imx6qsabreauto, imx6qpsabreauto, imx6dlsabreauto

*Table continues on the next page...*

**Table 9. U-Boot configurations (continued)**

U-Boot configuration for Boot device	Description	Supported machine configuration
	For boards supporting eMMC, such as i.MX 6QuadPlus/Quad/DualLite, SD boot can be flashed in eMMC for boot from eMMC instead of an SD card.	imx6slevk imx6sllevk imx6xsabresd imx6xsabreauto imx7dsabresd imx6ulevk imx6ull14x14evk imx7ulpevk imx8qmmek imx8mqevk imx8mmevk imx8qxpmev
spi-nor	Supports boot from SPI-NOR.	imx6qsabreauto, imx6dlsabreauto imx6qpsabreauto imx6slevk
eim-nor	Supports boot from Parallel NOR.	imx6qsabreauto, imx6dlsabreauto, imx6solosabreauto imx6qpsabreauto
nand	Supports boot from NAND.	imx6qsabreauto, imx6dlsabreauto, imx6solosabreauto imx6qpsabreauto imx6xsabreauto imx7dsabresd imx6ull14x14evk
sata	Supports boot from SATA.	imx6qsabresd, imx6qpsabresd imx6qsabreauto, imx6qpsabreauto
qspi	Supports booting from QSPI. Booting from the Arm® Cortex®-M4 processor is supported through QSPI2 and QSPI1. Use U-Boot command “bootaux” to boot the Arm Cortex-M4 processor. The booting address for QSPI2 is 0x78000000. The booting address for QPIS1 is 0x68000000.	imx6xsabresd with QSPI2 imx6xsabreauto with QSPI1 imx7dsabresd with QSPI1 imx6ulevk with QSPI1
emmc	Supports boot from eMMC. eMMC is not populated on the reference boards listed. Users need to populate it if needed. For other boards supporting eMMC such as i.MX 6QuadPlus/Quad/DualLite, SD boot is used.	imx6xsabresd imx7dsabresd imx6ull14x14evk imx7ulpevk
m4fastup	Supports boot from Arm Cortex-M4 processor by disabling QSPI2 from using Arm Cortex-M4 processor.	imx6xsabresd
epdc	Supports EPDC splash screen in U-Boot.	imx6slevk imx7dsabresd

Table continues on the next page...

**Table 9. U-Boot configurations (continued)**

U-Boot configuration for Boot device	Description	Supported machine configuration
flexspi (fspi)	Supports FlexSPI boot.	imx8qmmek imx8mmek imx8qxpmeek

## 5.2 Kernel device trees

The following table describes the kernel and device trees included in this release. A list of several device tree files are provided for each board to offer examples on how to handle different pin conflicts due to pin muxing.

**Table 10. Kernel and device tree configurations**

Kernel and device tree configuration	Description
Kernel Binary Image	i.MX 6 and i.MX 7 zImage kernel is built with the imx_v7_defconfig in arch/arm/configs. i.MX 8 image kernel is built with defconfig in arch/arm64/configs.
DTB Descriptions	<p>Each reference board has a standard device tree as follows:</p> <ul style="list-style-type: none"> <li>zImage-imx6q-sabresd.dtb, zImage-imx6qp-sabresd.dtb</li> <li>zImage-imx6dl-sabresd.dtb</li> <li>zImage-imx6q-sabreauto.dtb, zImage-imx6qp-sabreauto.dtb</li> <li>zImage-imx6dl-sabreauto.dtb</li> <li>zImage-imx6sl-evk.dtb</li> <li>zImage-imx6sx-sdb.dtb, zImage-imx6sx-sdb-reva.dtb</li> <li>zImage-imx6sx-sabreauto.dtb</li> <li>zImage-imx7d-sdb.dtb</li> <li>zImage-imx6ul-14x14-evk.dtb, zImage-imx6ul-9x9-evk.dtb</li> <li>zImage-imx6ull-14x14-evk.dtb</li> <li>zImage-imx7ulp-evk.dtb</li> <li>Image-fsl-imx8mq-evk.dtb</li> <li>Image-fsl-imx8mm-evk.dtb</li> <li>Image-fsl-imx8qm-mek.dtb: Supports one LVDS-HDMI through the LVDS0-CH0 on the LVDS-HDMI daughter card.</li> <li>Image-fsl-imx8qxp-mek.dtb: Supports one LVDS-HDMI through the LVDS0-CH0 on the LVDS-HDMI daughter card.</li> </ul> <p>Note: zImage-imx6sx-sdb.dtb is used for supporting the i.MX 6SoloX SABRE-SDB Rev. B board, and imx6sx-sdb-reva.dtb is used for supporting the legacy SABRE-SDB Rev. A board.</p> <p>zImage-imx7d-sdb.dtb is used for supporting the i.MX 7Dual SABRE-SDB Rev. C and Rev. D boards, and zImage-imx7d-sdb-reva.dtb is used for supporting the legacy SABRE-SDB Rev. A board.</p>
i.MX 8 Device Trees	
8QuadXPlus DTB	<ul style="list-style-type: none"> <li>Image-fsl-imx8qxp-mek-dom0.dtb: Xen Linux guest Linux DTB file.</li> <li>Image-fsl-imx8qxp-mek-dsi-rm67191.dtb: Supports RM67191 MIPI OLED display panel.</li> <li>Image-fsl-imx8qxp-mek-enet2.dtb: Supports ENET port on base boards.</li> </ul>

Table continues on the next page...

**Table 10. Kernel and device tree configurations (continued)**

Kernel and device tree configuration	Description
	<ul style="list-style-type: none"> <li>Image-fsl-imx8qxp-mek-enet2-tja1100.dtb: ENET2 uses TJA1100 Ethernet PHY.</li> <li>Image-fsl-imx8qxp-mek.dtb: Default DTB for MEK boards.</li> </ul>
8QuadMax DTB	<ul style="list-style-type: none"> <li>Image-fsl-imx8qm-mek.dtb: Supports one LVDS-HDMI through the LVDS0-CH0 on the LVDS-HDMI daughter card. This is the default DTB.</li> <li>Image-fsl-imx8qm-mek-hdmi.dtb: Supports Native HDMI interface on the CPU board. Currently the HDMI FW loading is not ready yet.</li> <li>Image-fsl-imx8qm-mek-jdi-wuxga-lvds1-panel.dtb: Supports the dual-channel LVDS panel, connecting the two mini-SAS ports with the LVDS1 CH0 and LVDS1 CH1.</li> <li>Image-fsl-imx8qm-mek-dsi-rm67191.dtb: Supports up to two RM67191 OLED display panels through the MIPI DSI0/1 on the daughter card.</li> <li>Image-fsl-imx8qm-mek-it6263.dtb: Supports two HDMI displays connected with two LVDS-HDMI converts. You must connect two LVDS-HDMI converts with the boards before booting up systems to get the display working.</li> <li>Image-fsl-imx8qm-mek-dsi-adv7535.dtb: Supports up to two HDMI displays connected with two MIPI-HDMI converts.</li> <li>Image-fsl-imx8qm-mek-it6263-adv7535.dtb: Supports up to four HDMI displays (two LVDS-HDMI and two MIPI-HDMI). You must connect at least two LVDS-HDMI converts with the board before booting up systems to get the display working.</li> <li>Image-fsl-imx8qm-mek_ca53.dtb: Supports four CortexA53 cores only.</li> <li>Image-fsl-imx8qm-mek_ca72.dtb: Supports two Cortex-A72 cores only. You need to build the special boot image through the imx-mkimage tools, and select the flash_ca72 build target.</li> </ul>
8MQuad DTB	<ul style="list-style-type: none"> <li>Image-fsl-imx8mq-evk.dtb: for HDMI output</li> <li>Image-fsl-imx8mq-evk-lcdif-adv7535.dts: for MIPI-DSI output with the MIPI-to-HDMI adapter by using the LCDIF display controller</li> <li>Image-fsl-imx8mq-evk-dcss-adv7535.dtb: for MIPI-DSI output with the MIPI-to-HDMI adapter by using the DCSS display controller</li> <li>Image-fsl-imx8mq-evk-dcss-rm67191.dtb: for MIPI-DSI output with the MIPI panel by using the DCSS display controller</li> <li>Image-fsl-imx8mq-evk-dual-display.dtb: for dual-display-to-HDMI and MIPI-to-HDMI adapter</li> </ul>
8MMini DTB	<ul style="list-style-type: none"> <li>Image-fsl-imx8mm-evk.dtb: Default device tree</li> <li>Image-fsl-imx8mm-evk-ak4497.dtb</li> <li>Image-fsl-imx8mm-evk-ak5558.dtb</li> <li>Image-fsl-imx8mm-evk-m4.dtb</li> <li>Image-fsl-imx8mm-evk-tdm.dtb</li> </ul>
<b>MX6 and MX7 Device Trees</b>	
GPMI and EIM_NOR	<p>Enables the GPMI and EIM-NOR. Due to pin conflicts, the GPMI and EIM-NOR are disabled by default. See the device tree file for more details:</p> <ul style="list-style-type: none"> <li>&gt;zImage-imx6dl-sabreauto-gpmi-weim.dtb</li> <li>zImage-imx6q-sabreauto-gpmi-weim.dtb</li> <li>zImage-imx6qp-sabreauto-gpmi-weim.dtb</li> <li>zImage-imx7d-sdb-gpmi-weim.dtb and zImage-imx7d-sdb-reva-gpmi-weim.dtb</li> </ul>

*Table continues on the next page...*

**Table 10. Kernel and device tree configurations (continued)**

Kernel and device tree configuration	Description
LDO	<p>In standard DTB file, the LDO bypass is enabled. Therefore, to use LDO device trees on configurations with CPU@1.2GHz, which does not support LDO bypass mode, it is important to enable LDO. The LDO is enabled in the following DTB files:</p> <ul style="list-style-type: none"> <li>• zImage-imx6q-sabresd-ldo.dtb</li> <li>• zImage-imx6qp-sabresd-ldo.dtb</li> <li>• zImage-imx6ul-9x9-evk-ldo.dtb</li> <li>• zImage-imx6dl-sabresd-ldo.dtb</li> <li>• zImage-imx6sl-evk-ldo.dtb</li> <li>• zImage-imx6sx-sdb-ldo.dtb, zImage-imx6sx-sdb-reva-ldo.dtb</li> </ul>
HDCP	<p>Enables the HDMI-HDCP feature. This avoids the pin conflict between the I2C2 and HDCP-DDC pins.</p> <ul style="list-style-type: none"> <li>• zImage-imx6q-sabresd-hdcp.dtb</li> <li>• zImage-imx6dl-sabresd-hdcp.dtb</li> <li>• zImage-imx6qp-sabresd-hdcp.dtb</li> </ul>
eCSPI	<p>Enables eCSPI, which is disabled in the default DTB.</p> <ul style="list-style-type: none"> <li>• zImage-imx6dl-sabreauto-ecspi.dtb</li> <li>• zImage-imx6q-sabreauto-ecspi.dtb</li> <li>• zImage-imx6qp-sabreauto-ecspi.dtb</li> </ul>
flexcan1	<p>Enables flexcan1, which is disabled by default in standard DTB file due to pin conflicts with FEC.</p> <ul style="list-style-type: none"> <li>• zImage-imx6q-sabreauto-flexcan1.dtb</li> <li>• zImage-imx6dl-sabreauto-flexcan1.dtb</li> <li>• zImage-imx6qp-sabreauto-flexcan1.dtb</li> </ul>
csi	<p>Enables CSI support for V4L2.</p> <p>On i.MX 6UltraLite EVK, this device tree avoids the pin conflict between SIM and CSI.</p> <ul style="list-style-type: none"> <li>• zImage-imx6sl-evk-csi.dtb</li> <li>• zImage-imx6ul-14x14-evk-csi.dtb</li> <li>• zImage-imx6ul-9x9-evk-csi.dtb</li> </ul>
enetirq	<p>An example to demonstrate GPIO6 workaround for the bug where only the ENET wake-up interrupt request can wake the system from Wait mode.</p> <p>Since the pad GPIO6 is used by I2C3 on the board, these device trees have I2C3 disabled to enable this workaround</p> <ul style="list-style-type: none"> <li>• zImage-imx6q-sabresd-enetirq.dtb</li> <li>• zImage-imx6dl-sabresd-enetirq.dtb</li> <li>• zImage-imx6dl-sabreauto-enetirq.dtb</li> <li>• zImage-imx6q-sabreauto-enetirq.dtb</li> </ul>
emmc	<p>The eMMC chip is DNP by default. This requires hardware modifications to burn the eMMC4.5 chip on the eMMC socket on uSDHC0 and connect eMMC signals as well as disconnect BOOT SD CARD slot signals.</p> <ul style="list-style-type: none"> <li>• zImage-imx6sx-sdb-emmc.dtb</li> <li>• zImage-imx7ulp-evk-emmc.dtb</li> </ul>
Cortex-M4	<p>Disable the access of ADC 1 &amp; 2, FlexCAN 1 &amp; 2, I2C3, UART 2 and QSPI 2 from Cortex-A processor when Arm Cortex-M4 processor is running.</p> <ul style="list-style-type: none"> <li>• zImage-imx6sx-sdb-m4.dtb</li> </ul>

*Table continues on the next page...*

**Table 10. Kernel and device tree configurations (continued)**

Kernel and device tree configuration	Description
	<ul style="list-style-type: none"> <li>• zImage-imx6sx-sabreauto-m4.dtb</li> <li>• zImage-imx7d-sdb-m4.dtb</li> </ul>
epdc	Pin conflict between HDMI and EPDC, disable HDMI for EPDC. <ul style="list-style-type: none"> <li>• zImage-imx7d-sdb-epdc.dtb</li> <li>• zImage-imx7d-sdb-reva-epdc.dtb</li> </ul>
qspi	Enable DDR Quad mode for Macronix QSPI chip mx25l51245g by setting Quad bit in status register. <ul style="list-style-type: none"> <li>• zImage-imx7-sdb-qspi.dtb zImage-imx7-sdb-reva-qspi.dtb</li> <li>• zImage-imx7ulp-evk-qspi.dtb</li> </ul>
Audio	Enable WM8960 audio as the default one and disable HDMI audio. <ul style="list-style-type: none"> <li>• zImage-imx7ulp-evk-wm8960.dtb</li> </ul>
HDMI Audio	Enable HDMI audio as the default one and disable WM8960 audio. <ul style="list-style-type: none"> <li>• zImage-imx7d-sdb-reva-hdmi-audio.dtb</li> </ul>
touch	Add tsc2046 touch screen controller support. Because the pin PENIRQ of tsc2046 conflicts with the interrupt pin of HDMI, this disables the HDMI. <ul style="list-style-type: none"> <li>• zImage-imx7-sdb-reva-touch.dtb</li> </ul>
MIPI Display	Enable MIPI-DSI. <ul style="list-style-type: none"> <li>• zImage-imx7d-sdb-mipi-dsi.dtb</li> <li>• zImage-imx7ulp-evk-mipi.dtb</li> </ul>
Bluetooth® wireless technology Wi-Fi	Enable the Broadcom Bluetooth wireless technology and Wi-Fi hardware. <ul style="list-style-type: none"> <li>• zImage-imx6q-sabresd-btwifi.dtb</li> <li>• zImage-imx6qp-sabresd-btwifi.dtb</li> <li>• zImage-imx6dl-sabresd-btwifi.dtb</li> <li>• zImage-imx6sl-evk-btwifi.dtb</li> <li>• zImage-imx6sll-evk-btwifi.dtb</li> <li>• zImage-imx6sx-sabresd-btwifi.dtb</li> <li>• zImage-imx6ul-14x14-evk-btwifi.dtb</li> <li>• zImage-imx6ul-9x9-evk-btwifi.dtb</li> <li>• zImage-imx6ull-14x14-evk-btwifi.dtb</li> </ul>
USB	Enable USB certification for i.MX 6UltraLite. <ul style="list-style-type: none"> <li>• zImage-imx6ul-14x14-evk-usb-certi.dtb</li> </ul>
LP UART	Enable LPUART. <ul style="list-style-type: none"> <li>• zImage-imx7ulp-evk-lpuart.dtb</li> </ul>
sd1	Enable sd1 on uSDHC1 on the base board. <ul style="list-style-type: none"> <li>• zImage-imx7ulp-sd1.dtb</li> </ul>

## 5.3 Kernel boot parameters

Depending on the booting or usage scenario, you may need different kernel boot parameters.

The following table describes different boot parameters.

To force the i.MX 6SABRE-AI board to disable SMP to remove overhead, add boot parameters "nosmp". Disabling CONFIG\_SMP configuration can remove further overhead for single core.

**Table 11. Common kernel boot parameters**

Kernel parameter	Description	Typical value	Used when
console	Where to output the kernel logging by printk.	console=ttymx0,115200 For 6SABRE-AI, console=ttymx3,115200 For 6SoloX-AI, console=ttymx0,115200 For 7ULP, console=ttyLP0, 115200 console=ttymx0, 115200	All use cases
nosmp	A command-line option of 'nosmp' disables SMP activation entirely.	nosmp	CONFIG_SMP is defined. Use this to disable SMP activation. SMP is activated by default through the CONFIG_SMP configuration.
ip	Tells the kernel how or whether to get an IP address.	ip=none ip=dhcp ip=static_ip_address	"ip=dhcp" or "ip=static_ip_address" is mandatory in "boot from TFTP/NFS."
nfsroot	Location of the NFS server/directory.	nfsroot=<ip_address>:<rootfs path>	Used in "boot from tftp/NFS" together with "root=/dev/nfs."
root	Location of the root file system.	root=/dev/nfs or root=/dev/mmcblk0p2	Used in "boot from tftp/NFS" (that is, root=/dev/nfs); Used in "boot from SD" (that is, root=/dev/mmcblk0p2). root is set by default by U-Boot to the SD/MMC slot that U-Boot is booting from.
rootfstype	Indicates the file system type of the root file system.	rootfstype=ext4	Used in "boot from SD" together with "root=/dev/mmcblkXpY" (X is the MMC device number while Y is the rootfs partition number.)
rootwait	Waits (indefinitely) for the root device to show up.	rootwait	Used when mounting SD root file system.
mem	Tells the kernel how much memory can be used.	None or mem=864M	Note: MemTotal-<mem> - <gpu_memory> is reserved.
max17135	Configures the maximum of 17135 EPD PMIC pass number and VCOM voltage.	max17135:pass=[pass_num],vcom=[vcom_uV] For 7D-SABRE-SD (EPDC panel upgrade to DC4): max17135:pass=2,vcom=-2370000	Used when enabling EPDC. pass_num should equal 2 for all IMXEBOOKDC2 cards. vcom_uV, in microvolts, should be equal to the value printed on the cable connector that is attached the E Ink panel being used.
fec.macaddr	Tells the Ethernet MAC address.	fec.macaddr=0x00,0x04,0x9f,0x01,0x30,0x05	Changes the FEC MAC address.
maxcpus	[SMP] Maximum number of processors that SMP kernel should use.	maxcpus=1	maxcpus=n : n >= 0 limits the kernel to using 'n' processors. n=0 is a special situation. It is equivalent to "nosmp".

*Table continues on the next page...*

**Table 11. Common kernel boot parameters (continued)**

Kernel parameter	Description	Typical value	Used when
epdc	Enables EPDC	video=mxcepdcfb:E060SCM,bpp=16  For 7D-SABRE-SD (EPDC panel upgrade to DC4): video=mxcepdcfb:ED060XC8	Adds to kernel options only if E Ink is the primary display panel. If other display panel is primary, this option may result in a pixel clock conflict and improper display function.
video on 6SABRE-SD	Tells the kernel/driver which resolution/depth and refresh rate should be used for display port 0 or 1.  See the parameter information under Documentation/fb/modedb.txt  Tells the kernel/driver which IPU display interface format should be used.	<ol style="list-style-type: none"> <li>1. video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24 video=mxcfb1:dev=ldb,if=RGB666</li> <li>2. video=mxcfb0:dev=ldb,if=RGB666 video=mxcfb1:dev=hdmi, 1920x1080M@60,if=RGB24</li> <li>3. video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24</li> <li>4. video=mxcfb0:dev=ldb,if=RGB666</li> <li>5. video=mxcfb0:dev=lcd,CLAA-WVGA,if=RGB656</li> <li>6. video=mxcfb0:dev=mipi_dsi,TRULY-WVGA,if=RGB24</li> </ol>	<ol style="list-style-type: none"> <li>1. Used when primarily displaying on HDMI with 1080P60 mode. Secondly displaying on LVDS with XGA mode.</li> <li>2. Used when primarily displaying on LVDS with XGA mode. Secondly displaying on HDMI with 1080P60 mode.</li> <li>3. Used when primary displaying on HDMI with 1080P60 mode.</li> <li>4. Used when primary displaying on the HannStar LVDS1.</li> <li>5. Used when primary displaying on the CLAA-WVGA dumb parallel LCD panel.</li> <li>6. Used when primary displaying on the TRULY-WVGA MIPI DSI LCD panel.</li> </ol> <p>NOTE: GBR24/RGB565/YUV444 represents the display HW interface format. Typical values for certain different display devices are as follows:</p> <p>TVOUT: YUV444</p> <p>VGA: GBR24</p> <p>HDMI&amp;DVI: RGB24</p> <p>CLAA WVGA LCD: RGB565</p> <p>Typical values for dev= are shown as follows:</p> <p>ldb: LVDS</p> <p>hdmi: HDMI on chip or sii902x</p> <p>dvi: DVI port</p> <p>vga: VGA through TVE</p> <p>tve: TVOUT</p>
video on 6SABRE-AI	Tells the kernel/driver which resolution/depth and refresh rate should be used for display port 0 or 1.	<ol style="list-style-type: none"> <li>1. video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24 video=mxcfb1:dev=ldb,if=RGB666</li> <li>2. video=mxcfb0:dev=ldb,if=RGB666 video=mxcfb1:dev=hdmi, 1920x1080M@60,if=RGB24</li> <li>3. video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24</li> </ol>	<ol style="list-style-type: none"> <li>1. Used when primarily displaying on HDMI with 1080P60 mode. Secondly displaying on LVDS with XGA mode.</li> <li>2. Used when primarily displaying on LVDS with XGA mode. Secondly displaying on HDMI with 1080P60 mode.</li> </ol>

Table continues on the next page...

**Table 11. Common kernel boot parameters (continued)**

Kernel parameter	Description	Typical value	Used when
	See the parameter information under Documentation/fb/modedb.txt  Tells the kernel/driver which IPU display interface format should be used.	4. video=mxcfb0:dev=ldb,if=RGB666 5. video=mxcfb0:dev=hdmi, 1920x1080M@60,if=RGB24	3. Used when primary displaying on HDMI with 1080P60 mode. 4. Used when primary displaying on the HannStar LVDS0. 5. Used when enabling HDMI 1080P60 mode and LVDS0. To enable second display, run "echo 0 > /sys/class/graphics/fb2/blank"  NOTE: GBR24/RGB565/YUV444 represents the display HW interface format. Typical values for certain different display devices are shown as follows:  TVOUT: YUV444 VGA: GBR24 HDMI&DVI: RGB24 CLAA WVGA LCD: RGB565 Typical values for dev= are shown below:  ldb: LCD interface ldb: LVDS hdmi: HDMI on chip or sii902x dvi: DVI port vga: VGA through TVE tve: TVOUT
video on 6SoloLite	Tells the EPDC FB driver which E Ink panel is in use and what bpp should be used for the Frame Buffer.	video=mxcepdcfb:E060SCM,bpp=16	Used when enabling EPDC to select the correct E Ink panel parameters to use.  bpp=16 selects RGB565 FB pix format bpp=8 selects Y8 FB pixel format
video on 6SoloLite	Tells the ELCDIF FB driver which LCD panel is in use and which bpp should be used for the Frame Buffer.	video=mx_elcdif_fb:SEIKO-WVGA,bpp=16	Used when enabling LCDIF to select the correct panel parameters to use.  bpp=16 selects RGB565 FB pix format  Note: if only use EPDC FB, then turn off ELCDIF FB by "video=mx_elcdif_fb:off"
video on 7D SABRE-SD	Tells the ELCDIF FB driver which LCD panel is in use and which bpp should be used for the Frame Buffer.	video=mxcfb0:dev=mipi_dsi,TRULY-WVGA,if=RGB24	Used when primary displaying on the TRULY-WVGA MIPI DSI LCD panel.
dmfc	Tells the kernel/driver how to set the IPU DMFC segment size.	None Or	"dmfc=1" means DMFC_HIGH_RESOLUTION_DC.

Table continues on the next page...

**Table 11. Common kernel boot parameters (continued)**

Kernel parameter	Description	Typical value	Used when
		dmfc=3	"dmfc=2" means DMFC_HIGH_RESOLUTION_DP. "dmfc=3" means DMFC_HIGH_RESOLUTION_ONLY_DP. DMFC_HIGH_RESOLUTION_ONLY_DP can only be set by the command line. It is recommended to set this when no IPU connects the two panels. When it is set, each IPU can only connect one panel.
mtdparts on 6SABRE-AI	Tells the kernel MTD partition information.	mtdparts=gpmi-nand:16m(boot), 16m(kernel),1024m(rootfs),-(user)	When to enable NAND. The partition: 16m (boot),16m (kernel),1024m (rootfs) is an example, you can change it according to your needs.
uart clock from osc for 6SoloX low power idle and scenario of Linux OS and FreeRTOS running together	Chooses the UART's clock parent.	uart_from_osc	This is necessary for low power idle and all use cases with the FreeRTOS running on ARM Cortex-M4 processor. When setting this parameter, UART sources clock from OSC instead of PLL3_80M, and then all PLLs can be off in low power idle.

**NOTE**

For full command line list, see kernel source tree Documentation/Kernel-parameter.txt.

## 6 Known Issues/Limitations

Read through all hardware-related reference material and ensure that the necessary hardware modifications are made before using the software.

The following tables list some key known issues.

**Table 12. Known issues and workarounds for i.MX 8 Family SoC**

SoC	Module	Source	Description	Workaround
8QuadMax	Yocto rootfs	Software	The armhf 32-bit application cannot run in rootfs and some rebuild applications with aarch64 toolchain cannot run well.	No workaround.
8QuadMax	Native HDMI	Software/ Hardware	HDMI display cannot show correctly, which can be observed that the Wayland GUI is abnormal. Restarting Weston cannot improve the situation.	Under investigation.

*Table continues on the next page...*

**Table 12. Known issues and workarounds for i.MX 8 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
8QuadMax	Wayland	8QuadMax software	ES32 CTS on 8QuadMax Wayland backend, meets some items failure and core dumping.	Under investigation.
8QuadMax	GPU	Software	OpenCL 1.2FP and ES31 conformance test random fails.	No workaround.
8QuadMax	Display	Hardware	The display flicker was observed during the stress test under high system loading or high temperature. The display interfaces using the DPLL as the clock source are impacted.	No workaround.

**Table 13. Known issues and workarounds for i.MX 8X Family SoC**

SoC	Module	Source	Description	Workaround
8QuadXPlus	VPU	Software	Repeatedly loop one H.264 stream over 10 hours, which causes system crash.	No workaround.
8QuadXPlus	VPU	Software	Multi-instance playback and record are not supported.	No workaround.
8QuadXPlus	DPU	Software	MIPI HDMI Display has problem when switching between several display modes.	Contact FAEs to get the latest workaround patch.
8QuadXPlus	GPU	Software	When combining VPU output video with non-VPU output video frame with imxcompositor_g2d, imxcompositor_g2d cannot exist and prints lots of warning messages.	No workaround.
8QuadXPlus	GPU	Software	XWLD: OpenCL 1.2FP CTS cannot pass the test.	No workaround.
8QuadXPlus	GPU	Software	XWLD: The es31 conformance test meets segmentation fault and core dump.	No workaround.
8QuadXPlus	GPU	Software	XWLD: GPU dump and system hang occur in multiple CTS tests.	No workaround.
8QuadXPlus	GPU	Software	XWLD: WebGL 2.0.0 conformance test fails.	No workaround.
8QuadXPlus	GPU	Software	The process is stuck during the GPU PM stress test.	No workaround.
8QuadXPlus	VPU	Software	One special H.264 stream cannot be played, which causes system crash.	No workaround.

*Table continues on the next page...*

**Table 13. Known issues and workarounds for i.MX 8X Family SoC (continued)**

SoC	Module	Source	Description	Workaround
8QuadXPlus	DPU	Software	Kernel panic occurs during the power state device test when connecting the MIPI panel.	Contact FAEs to get the latest workaround patch.
8QuadXPlus	DPU	Software	Kernel dump occurs during the reboot stress test when connecting the MIPI camera.	No workaround.
8QuadXPlus	JPEG	Software	JPEG decode and encode cannot work.	No workaround.
8QuadXPlus	SECO	Software	RTC HW clock is lost after reboot.	No workaround.
8QuadXPlus	CAAM	Software	CAAM: The SM test fails with the error message, "no keystore units available".	No workaround.

**Table 14. Known issues and workarounds for i.MX 8M Family SoC**

SoC	Module	Source	Description	Workaround
8MQuad	DTRC	Software	The display turns to green sometimes when playback video with DTRC enabled.	Disable the playback video with DTRC.
8MQuad	NAND Boot	Hardware	Fails to boot up from NAND when the boot file is integrated with the HDMI firmware.	Boot up from NAND with the boot file that does not have the HDMI firmware.
8MQuad	MIPI CSI	Hardware	MIPI CSI: prompts lots of "Rx fifo overflow" when running capture and video playback simultaneously.	Use different DDR and NoC configuration from Errata.
8MMini	MfgTools	Software	USB recognition may fail in serial download mode.	Use SD boot mode without an SD card in socket to force ROM to enter serial download mode, and then the MFGTools can work.

**Table 15. Known issues and workarounds for i.MX 7 Family SoC**

SoC	Module	Source	Description	Workaround
7ULP	GPU	Software	Chromium crashes on Xwayland graphics.	No workaround.
7ULP	DTB	Software	The imx7ulp-evk-sd1.dtb in the release image does not support 3.0 SD Card, because it has the property of "no-1-8-v".	Delete the "no-1-8-v" property.
7ULP	DTB	Software	The display coordinates under the touch panel node in imx7ulp-evk.dts is configured incorrectly, which may cause the touch point to be inaccurate.	Change the display-coords to <0, 0, 480, 854>.

Table continues on the next page...

**Table 15. Known issues and workarounds for i.MX 7 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
7ULP	GPU	Software	16 test cases of WebGL1.0.2 CTS failed with the error of timeout.	The issue is related with Chromium v64 version, and it can be fixed with a new version of chromium.
7ULP	GPU	Software	OpenCL 1.2FP and ES31 conformance test random fails.	No workaround.
7Dual	Thermal	Hardware	The Temperature Monitor should only be enabled for chips that have undergone proper thermal sensor calibration. MC marked devices have undergone temperature calibration.	Ensure proper temperature calibration before using the temperature monitor. See the "Thermal Driver" Chapter in the <i>i.MX Linux® Reference Manual</i> (IMXLXRM).
7Dual	Ethernet	Software	When booting an image from the local storage, the network connection over Ethernet is not established automatically. This is because connman is masked.	To solve this problem, unmask connman and start:  <pre>\$ systemctl unmask connman \$ systemctl enable connman \$ systemctl start connman</pre> Otherwise, udhcpd can be used to establish a network connection:  <pre>\$ udhcpd</pre>
7Dual	EPDC	Software	EPDC does not function for REGAL/-D due to license issue.	The upper-layer application or framework needs to check the correct touch driver.
7Dual	HDMI	Software	HDMI supports only one startup resolution mode 1280x720 when booting to X backend rootfs.	Cannot port Vivante or NXP EXA driver to the i.MX 7Dual board, because the EXA driver depends on Vivante's 2D library and there is no GPU hardware on i.MX 7Dual. Therefore, a default software version driver (FBDEV) is used for i.MX 7Dual. The FB video mode is changed by FB command, but the UI cannot get the video mode changed event, because i.MX 7Dual has no GPU hardware and still draws the UI to original video mode. No workaround.
7Dual	HDMI	Software	After booting up, it connects to the HDMI cable. The X backend desktop cannot display.	Cannot port Vivante or NXP EXA driver to the i.MX 7Dual board, because the EXA driver depends on Vivante's 2D library and there is no GPU hardware on i.MX 7Dual. Therefore, a default software version driver (FBDEV) is used for i.MX 7Dual. It is expected, because FB video mode is changed after the HDMI cable is plugged in, and the UI cannot handle the HDMI cable plugin event or change the UI to new video mode. No workaround.
7Dual	Wi-Fi	Software	Wi-Fi does not support suspend/resume when doing IPERF.	Broadcom Wi-Fi is not supported.
7Dual	PCIe	Hardware	Cannot probe up PCIe devices on Rev. C board.	Hardware rework is required. Rework: Change C459&C458 caps to 0 ohm resistors.
7Dual	eMMC	Software	eMMC fast boot fails with plug-in U-Boot.	1. Use U-Boot SPL to replace the plug-in boot, which supports the uSDHC

Table continues on the next page...

**Table 15. Known issues and workarounds for i.MX 7 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
				<p>driver. SPL can read the remaining U-Boot from eMMC by itself without using ROM's API.</p> <p>2. Plug-in implements its own eMMC read routine to read the remaining U-Boot.</p>
7Dual	Low power	Hardware	TKT291710 low-power idle stress test fails in the Linux OS kernel, with identical hardware settings. CPU #0 runs into exception, and CPU #1 is successful.	No workaround.

**Table 16. Common known issues and workarounds for i.MX 6 Family SoC**

SoC	Module	Source	Description	Workaround
All	Thermal	Hardware	The Temperature Monitor should only be enabled for chips that have undergone proper thermal sensor calibration. MC marked devices have undergone temperature calibration.	Ensure proper temperature calibration before using the temperature monitor. See the "Thermal Driver" Chapter in the <i>i.MX Linux® Reference Manual</i> (IMXLXRM).
All	Ethernet	Software	When booting an image from the local storage, the network connection over Ethernet is not established automatically. This is because connman is masked.	<p>To solve this problem, unmask connman and start:</p> <pre>\$ systemctl unmask connman \$ systemctl enable connman \$ systemctl start connman</pre> <p>Otherwise, udhcpc can be used to establish a network connection:</p> <pre>\$ udhcpc</pre>
All	Memory Management	Software	The system reports page allocation failure: order:9, mode:0xd0 when the system does not have sufficient physical continuous memory to allocate.	This may be caused by the kernel page reclaiming issue. One workaround for this: <code>echo 1 &gt; /proc/sys/vm/drop_caches</code> before you run the application.
6QuadPlus	PCIe	Hardware/Software	To pass the PCIe compliance tests, external OSC should be used as the PCIe REF clock. Therefore, to import the external OSC to PCIe, the PLL6_ENET should be set to bypass mode. Then, the ENET/SATA cannot work simultaneously.	Add one extra DTB file to support PCIe to pass the compliance tests. For example, "imx6qp-sabresd-ldo-pcie-cert.dtb" used by i.MX 6QuadPlus SABRE-SD board to pass the PCIe compliance tests.
6ULL	EMMC/SD/SDIO	Hardware	Existing errata ERR010450, EMMC HS200, and SD/SDIO 3.0 SDR104 at 1.8 V can only work below or equal to 150 MHz. EMMC DDR52 and SD/SDIO DDR50 at 1.8 V can only work below or equal to 45 MHz.	No workaround.
6QuadPlus/Quad/Dual/Solo	Arm core	Software	smp_wmb performance is very low.	This is the common side-effect of SMP. No workaround.

Table continues on the next page...

**Table 16. Common known issues and workarounds for i.MX 6 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
6QuadPlus	PRE	Hardware	When the software <code>write(hw_pre_ctrl_pio_write)</code> and the hardware <code>write(hw_pre_ctrl_enable_enable)</code> are in the same clock cycle, the hardware write is ignored, because the software write has a higher priority. It causes the PRE to stop working unless the whole PRE+PRG + IPU corresponding channel is restarted.  This issue is tracked by the PDM ticket TKT275991. The relevant framebuffer pan display or set par operations are likely to cause the PRE to stop working due to accidentally triggering the hardware bug.	No workaround.
6QuadPlus /Quad/ Dual/SoloX	GPU	Software	OpenCL 1.2FP and ES31 conformance test random fails.	No workaround.
6QuadPlus /Quad/ Dual/Solo/ SoloX	GPU	Software	There are some errors with the WebGL conformance test. This is a Chrome application problem, which does not pass down the correct parameters to the GPU driver, and does not handle the application error correctly.	Upgrade the Chrome application to the stable version with V52.
6Quad/ Dual/Solo	IPU	Software	The framebuffer driver and V4L2 output driver share the same fb device. For example, <code>/dev/video16</code> also uses the <code>/dev/fb0</code> to do video playback.	Frame Buffer operations not supported during video playback on the same FB device.
6Quad/ Dual/Solo	IPU	Hardware	Currently, only supports 4-stripe and 2-stripe split mode. When doing large ratio up-scaling from low resolution frames to high resolution frames, for example, 64x64 to 1920x1080, the requirement cannot be covered by the current split mode solution, that is, each stripe would exceed 1024 pixels for width. Therefore, the video cannot display a full screen.	No workaround.
6Quad/ Dual/Solo	IPU	Hardware	Default 24bpp on the second display used by HDMI. IPU keeps printing error for hardware bandwidth limitation.	No workaround.
6Quad/ Dual/Solo	IPU	Hardware	CSI_SMFC_MEM capture channel cannot support 32 pixel IDMAC burst size for non-interleaved and partial-interleaved YUV pixel formats with non-16byte-aligned UV stride line. Little horizontal stripes can be seen on the capture frames.	Change 32 pixel burst size to 16 pixel burst size which causes capture performance penalty.
6QuadPlus /Quad/ Dual/Solo/ SoloX	LVDS	Hardware	HannStar HSD100PXN1 panel, backlight brightness does not change from 0 to 2. This is limitation that comes from the panel itself. This is also a limitation for all the i.MX 6Quad/QuadPlus/DualLite/SoloX	No workaround.

*Table continues on the next page...*

**Table 16. Common known issues and workarounds for i.MX 6 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
			platforms, which use this HannStar HSD100PXN1 panel.	
6QuadPlus/ Quad/ Dual/Solo	HDMI	Software	HDMI cannot be set to 1080p@60hz with kernel configuration settings.	Use the <code>xrandr</code> application to configure the HDMI resolution from user-space.
6Quad/ Dual/Solo	ASRC	Hardware	Two ASRC M2M instances and one P2P instance conversion simultaneously meet serious noise on 176 kHz and 192 kHz sampling rates.	When there are three instances, the total MIPS consumption should not exceed the ASRC master clock (132 MHz). In this situation, the total MIPS consumption is more than 120 MHz, and it is close to the threshold (132 MHz) in theory. Therefore, this is a capability issue of ASRC, and the noise is expected.
6Quad/ Dual	SPI NOR boot	Hardware	SPI NOR boot is not supported by the i.MX 6 SABRE-SD board.	Current SD board uses KEY relative PINs as SPI interface. However, this set of PINs are not supported by ROM. Therefore, SPI NOR boot is not supported by the i.MX 6 SABRE-SD board.
6Quad/ Dual	CPU hotplug	Software	System hangs after conducting CPU hot plug many times during heavy interrupt.	Known Arm Linux OS limitation. No workaround.
6Quad	SATA Boot	Hardware	The system cannot boot from SATA on the i.MX 6Dual/6Quad SABRE-SD Rev.B board.	Remove R7.
6Quad/ Dual	Boot	Hardware	The system cannot boot sometimes when it is powered on the i.MX 6Dual/6Quad SABRE-SD Rev. B board for the first time.	Add 2.2M ohm resistor to 24M OSC.
6Quad/ Dual	Suspend/ Resume	Hardware/ Software	Suspend/Resume failure if i.MX 6Dual/6Quad SABRE-SD board rework "Add 2.2M ohm resistor to 24M OSC".	Remove rework.
6DualLite	PMIC	Hardware	The i.MX 6DualLite SD board depopulates the resistor R30 and takes away the ability of the processor to turn off the PMIC in hardware.	Use dumb mode by default.
6DualLite/ SoloLite	EPDC	Software	Enabling E Ink Auto-update mode (Device Drivers > Graphics Support > E Ink Auto-update Mode Support) causes E Ink panel updates to be distorted and unstable.	Disable the E Ink Auto-update Mode feature in the menuconfig.
6DualLite	EPDC	Hardware	The three boards cannot boot with EPDC DC2 attached while they boot normally without DC2 daughter cards.	This occurs when the SW3 (KEYPAD_LOCK) switch on the EBOOK DC2 board is switched "ON", which affects the boot bin "EIM_DA7" (BT_CFG1_7). You need to set the SW3 in DC2 board to "OFF."
6Solo	Arm core	Software	CONFIG_SMP should be disabled.	To remove overhead caused by SMP for better performance, CONFIG_SMP is expected to be disabled for single core.
6Quad/ Dual/Solo	eCompass	Hardware	eCompass cannot work after EIM-NOR or SPI-NOR are enabled on the kernel.	No workaround.

*Table continues on the next page...*

**Table 16. Common known issues and workarounds for i.MX 6 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
6Quad/ Dual/Solo	USB	Software	USB OTG and USB host cannot work after EIM-NOR or SPI-NOR are enabled on kernel.	No workaround.
6Quad/ Dual	TV-IN	Software	Error messages may be expected along with bad quality at first frames on the TV-IN interface. This may occur on a hot plug connection.	No workaround.
6Quad	U-Boot	Hardware	eMMC 4.4 fails to boot on SABRE-AI boards.	No workaround.
6Quad/ Dual/SoloX	MLB	Software	The SYNC mode cannot work stably in the test.	No workaround.
6Quad/ Dual/ SoloLite	SDIO3.0	Software	No available device to do the SDIO 3.0 test.	No workaround.
6Dual/Solo	Hardware manufactur e	Hardware	HDMI, SD3 card detection, and eGalax touch screens are found to fail on some SABRE-AI boards.	This is because some PINs are not soldered well. If any basic feature, which is announced to be supported, does not work on your board, check the board.
6SoloLite	System	Hardware	Reboot may not work on the EVK board.	Reboot function should be always okay if the hardware can trigger PMIC reset, which ensures RESET key and watchdog reset can control PMIC_ON_REQ pin.
6SoloLite	CSI/EPDC	Hardware	Cannot be used simultaneously, because these two modules share the same pins on the EVK board.	The board file in BSP configures these pins for proper function through DTS. Use imx6sl-evk.dts for EPDC, and imx6sl-evk-csi.dts for CSI.
6SoloLite	X- Acceleratio n	Hardware/ Software	Out of memory error during the x11perf test.	It is a system limitation since the x11perf needs a lot of memory. No work-around on the EVK board (with only 512 MB of LPDDR2 memory). Users may use a larger memory to work around this issue.
6SoloLite	Mfgtool2	Software	Mfgtool2 may fail to execute the <code>frf</code> command if there is no <code>send</code> or <code>pipe</code> command executed prior to it.	Remove the <code>frf</code> command from <code>ucl2.xml</code> to fix this issue.
6SoloLite	FUSE for RTC	Hardware	SEC_CONFIG[0] fuse bit is not burned, which leads the RTC not to be functional.	In U-Boot prompt, run the command "imxotp blow --force 4 0x2". This action is irreversible.
6SoloLite	HDMI	Software	i.MX 6SoloLite EVK: on some special resolutions, such as 1400x1050, the Yocto Project GUI display on HDMI is distorted. This is caused by <code>xrandr</code> and tries to expand the frame buffer size to 1408x1050 to align with 16 bytes. However, i.MX 6SoloLite ELCDIF does not support stride buffer and cannot crop 1400x1050 from the buffer 1408x1050, which then causes distortion.	No workaround. Only found on 1400x1050 mode until now.
6SoloLite	WiFi/ BCMDHD	Software	i.MX 6SoloLite EVK does not support enabling CONFIG_BCM4339 to optimize	This release does not support CONFIG_BCM4339.

Table continues on the next page...

**Table 16. Common known issues and workarounds for i.MX 6 Family SoC (continued)**

SoC	Module	Source	Description	Workaround
			performance due to known Wi-Fi driver limitation.	
6SoloX	Video	Software	The video display has a green line at bottom during gplay.	No workaround.
6SoloX	CAAM	Software	The system reboots after the CAAM RNG test is suspended and resumed.	There is hardware function conflict between the Mega/Fast mix off feature and CAAM. To use CAAM after kernel bootup, the user should enable the CAAM wakeup function to avoid Mega mix off in DSM. Workaround: echo enabled > /sys/bus/platform/devices/2100000.aips-bus/2100000.caam/2101000.jr0/power/wakeup
6SoloX	VADC	Software	Sometimes VADC cannot correctly detect the video standard. CSI works in NTSC mode but the VADC input is PAL.	The VADC auto standard detect function is not required. VADC input device does not change in product. Hard code VADC input standard in the VADC driver.
6SoloX	QSPI-NOR	Hardware	PMIC needs to be reset to reset the QSPI-NOR flash on the board to the default 3 bytes mode.	Connect NOR chip pin 3 to U6 pin 15.
6SoloX	PCIe	Hardware/ Software	When the extremely power save mode is enabled on i.MX 6SoloX PCIe, the i.MX 6 SoloX PCIe PHY/controller would be powered off completely, all the TLPs on the PCIe link would be discarded, and link would be down in suspend. The i.MX 6 SoloX PCIe and the PCIe link would be re-initialized completely during resume operations. There is one known issue when the pcie2usb device is used during suspend/resume. The development node of the pcie2usb device maybe changed, since the pcie2usb device is reset when the i.MX 6SoloX PCIe is re-initialized during resume.	No workaround.
6SoloX	MMC	Software	Hynix eMMC times out when the rootfs automatically mounts the RPMB partition on i.MX 6SoloX SD.	Rootfs should not automatically mount the RPMB partition, because it is a secure partition.
6SoloX	CSI/LCD	Hardware	CSI and LCD cannot be used simultaneously since the two modules share the same pins on the i.MX 6SoloX SABRE-SD board.	No workaround.
6SoloX	UART	Hardware	UART cannot wake up with the RTS pin programmed with hard flow control enabled. And there is limitation of the framesize to about 16.	No workaround.

## 7 Multimedia

This chapter contains the information on the 4.4.0 multimedia component of the BSP.

The GStreamer version in this release is 1.12.2.

## 7.1 i.MX GStreamer plugins

**Table 17. i.MX GStreamer 1.0 plugins**

Plugin	Features
Demux	aiurdemux: aiur universal demuxer plugin supporting Supports AVI, MKV, MP4, MPEG2, ASF, OGG, FLV, WebM, RMVB
Audio decoder	beepdec: unified audio decoder plugin Supports MP3, AAC, AAC+, WMA, AC3, Vorbis, DD+, AMR, RA
Audio encoder	avenc_mp2: MP3 encoder plugin from gst-libav
Video decoder	i.MX 8M/i.MX6 family: <ul style="list-style-type: none"> <li>vpudec: VPU-based video decoder plugin</li> </ul> i.MX 8QuadXPlus: <ul style="list-style-type: none"> <li>v4l2h265dec: V4L2 H265 Decoder</li> <li>v4l2h264dec: V4L2 H264 Decoder</li> <li>v4l2mpeg4dec: V4L2 MPEG4 Decoder</li> <li>v4l2mpeg2dec: V4L2 MPEG2 Decoder</li> </ul> i.MX all: <ul style="list-style-type: none"> <li>Software video decoder plugins: uses gst-libav plugins</li> </ul>
Video encoder	i.MX 8QuadXPlus: <ul style="list-style-type: none"> <li>v4l2h264enc: V4L2 H.264 Encoder</li> </ul> i.MX 6 family: <ul style="list-style-type: none"> <li>vpuenc_h264: VPU-based AVC/H264 video encoder</li> <li>vpuenc_h263: VPU-based H263 video encoder</li> <li>vpuenc_mpeg4: VPU-based MPEG4 video encoder</li> <li>vpuenc_jpeg: VPU-based JPEG video encoder</li> </ul>
Video render	i.MX 8MM/i.MX8QuadXPlus: <ul style="list-style-type: none"> <li>waylandsink: video sink based on Wayland interfaces</li> </ul> i.MX 8MQuad: <ul style="list-style-type: none"> <li>kmssink: video sink based on the DCSS KMS driver</li> </ul> i.MX 6 family: <ul style="list-style-type: none"> <li>overlaysink : G2D-based video sink plugin</li> <li>imxv4l2sink: V4L2-based video sink plugin</li> </ul> i.MX with GPU3D: <ul style="list-style-type: none"> <li>glimagesink: video sink based on EGL</li> </ul>
Video source	i.MX 8 family: <ul style="list-style-type: none"> <li>v4l2src: V4L2-based camera source plugin</li> </ul> i.MX 6 family: <ul style="list-style-type: none"> <li>imxv4l2src: V4L2-based camera source plugin</li> </ul>
Video convert	i.MX 2D hardware based video convert plugins to perform video color space conversion, resize, rotate, etc. <ul style="list-style-type: none"> <li>imxvideoconvert_g2d: GPU2D-based video convert plugin</li> <li>imxvideoconvert_ipu: IPU-based video convert plugin</li> <li>imxvideoconvert_pxp: PXP-based video convert plugin</li> </ul>

*Table continues on the next page...*

**Table 17. i.MX GStreamer 1.0 plugins (continued)**

Plugin	Features
Video compositor	<p>i.MX 2D hardware based video compositor plugins can compose multiple videos into one, support color space conversion, resize, rotate, alpha, z-order, and keep aspect ratio feature at the same time while composition.</p> <ul style="list-style-type: none"> <li>• imxcompositor_g2d: GPU2D-based video compositor plugin</li> <li>• imxcompositor_ipu: IPU-based video compositor plugin</li> <li>• imxcompositor_pxp: PXP-based video compositor plugin</li> </ul>
OpenGL (ES) Plugins	<ul style="list-style-type: none"> <li>• gleffects: GL Shading Language effects plugin</li> <li>• gldeinterlace: video deinterlacing based on shaders</li> <li>• glvideomixer: compositing multiple videos together</li> <li>• glcolorconvert: video color space convert based on shaders</li> <li>• glcolorbalance: adjusting brightness, contrast, hue, and saturation on a video stream</li> </ul>

**NOTE**

- To support WMA, AAC+, AC3, DD+, and RA decoding, install separate packages.
- vpudec plugins are only for SoCs with the VPU hardware.
- Enable video framebuffer compression (DTRC) by using: kmssink force-hantrotile=true.

## 7.2 i.MX playback example

i.MX provides an example gplay-1.0 application based on GStreamer's high-level API GstPlayer. The example provides the following functions.

**Table 18. i.MX playback engine example**

Function	Feature
Playback	<ul style="list-style-type: none"> <li>• Play, Stop</li> <li>• Pause, Resume</li> <li>• Fast seek, Accurate seek</li> <li>• Playback rate control (fast forward, fast rewind, slow forward)</li> </ul>
Media Info	<ul style="list-style-type: none"> <li>• Media meta data (artist, year, etc.)</li> <li>• Video Thumbnail</li> <li>• Audio Album Art</li> </ul>
Subtitle	<ul style="list-style-type: none"> <li>• Supports internal and external subtitle</li> </ul>
Track Selection	<ul style="list-style-type: none"> <li>• Audio Track Selection</li> <li>• Video Track Selection</li> <li>• Subtitle Selection</li> </ul>
Display Control	<ul style="list-style-type: none"> <li>• Resize</li> </ul>

## 7.3 i.MX recording engine API

i.MX provides a high-level API set for easier-making camera-related applications based on the GStreamer framework. This API set is based on the camerabin, which is from the gst-plugins-bad package.

This API can be found at `gst1.0-fsl-plugin/tools/grecorder/recorder_engine.h`.

## Multimedia

This API is only supported in i.MX 6 platform, which has VPU hardware encoder.

This API set can provide the following functions.

**Table 19. Recording engine functions**

Function	Feature
Image capture	Captures images from the camera with different resolutions and saves them to JPEG files.
Video recording	Records audio and video into various file formats, supporting (MP3) x (H264, MPEG4, H263, MJPEG) x (MP4, MKV, AVI, FLV, TS)
Meta data	Adds the time and date information to the captured image or recorded video.
Endless recording	Records to multiple file segments and specifies the total file segment count and each file's maximum size. It can record a file endlessly, saving to file segments in a loop. This function can only work with the TS file format.
Web camera	Records audio and video and sends them out through RTP. This function can only work with the TS file format.
Graphic effect	Supports adding the graphic effect in the video and record into the file.
Device selection	Supports selecting different camera and audio sources.

### NOTE

This recording engine is only available in platforms with VPU.

## 7.4 i.MX Qt applications

The following applications based on Qt demonstrate the multimedia features on the X11 backend.

**Table 20. Qt applications**

Application	Feature
IMXPlayer	Based on the playback engine, it provides all the features supported in the playback engine.
IMXCamera	Based on the recording engine, it provides all the features supported in the recording engine.

### NOTE

The demo applications are only available in platforms with VPU and in an X11 environment.

## 7.5 Multimedia feature matrix

This section provides feature matrix details of various codecs used for playback.

### 7.5.1 Parser/Demuxer specifications

The demuxer support of a particular audio or video type requires the availability of the codec.

**Table 21. Parser/Demuxer supported audio/video**

	Demuxer feature	ASF	AVI	MP4	OGG	FLV	MPG2	MKV	RMVB
Video	H264	-	Y	Y	-	Y	Y	Y	-
	MPEG2	-	Y	-	-	-	Y	Y	-
	MPEG4	Y	Y	Y	-	-	-	Y	-
	H263	-	Y	Y	-	Y	-	Y	-
	MJPEG	-	Y	Y	-	-	-	Y	-
	VC1	Y	Y	-	-	-	-	Y	-
	DivX	Y	Y	Y	-	-	-	Y	-
	Xvid	-	Y	-	-	-	-	Y	-
	VP8	-	-	-	-	-	-	Y	-
	VP6	-	-	-	-	Y	-	Y	-
	Theora	-	-	-	Y	-	-	-	-
	RV	-	-	-	-	-	-	Y	Y
Audio	AAC	-	Y	Y	-	Y	Y	Y	Y
	MP3	Y	Y	Y	-	Y	Y	Y	-
	WMA	Y	Y	-	-	-	-	Y	-
	AC3	-	Y	Y	-	-	Y	Y	-
	PCM/ADPCM	Y	Y	Y	-	Y	Y	Y	-
	AMR	-	-	Y	-	-	-	Y	-
	Vorbis	-	Y	Y	Y	-	-	Y	-
	SPEEX	-	-	-	Y	Y	-	Y	-
	DTS	-	-	-	-	-	Y	Y	-
	FLAC	-	-	-	Y	-	-	Y	-
	DD+	Y	-	Y	-	-	Y	Y	-
	RA	-	-	-	-	-	-	-	Y

## 7.5.2 Video codec specifications

The tables in this section show the video codec specifications with and without VPU acceleration. Check Section [BSP Supported Features](#) to determine if your board supports VPU with software decoder.

VPU is not supported in the Alpha release.

**Table 22. Video codec specification for hardware with VPU acceleration**

	Format	Platform	Profile	Resolution	Frame rate	Bitrate	Comment
Video Decoder	HEVC	i.MX 8MQuad	main/main 10	3840 x 2160	60 fps	160 Mbps	-
		i.MX 8MMini	main/main 10	1920 x 1080	60 fps	100 Mbps	-
		i.MX 8QuadXPlus	main/main 10	3840 x 2160	30 fps	100 Mbps	-
	H264	i.MX 8MQuad	HP/MP/BP	3840 x 2160	30 fps	60 Mbps	-

Table continues on the next page...

**Table 22. Video codec specification for hardware with VPU acceleration (continued)**

	Format	Platform	Profile	Resolution	Frame rate	Bitrate	Comment
		i.MX 8MMini	HP/MP/BP	1920 x 1080	60 fps	60 Mbps	-
		i.MX 8QuadXPlus	HP/MP/BP	1920 x 1080	30 fps	50 Mbps	-
		i.MX 6	HP/MP/BP	1920 x 1080	60 fps	50 Mbps	-
	VP9	i.MX 8MQuad	profile 0, 2	3840 x 2160	60 fps	100 Mbps	-
		i.MX 8MMini	profile 0, 2	1920 x 1080	60 fps	100 Mbps	-
	VP8	i.MX 8MQuad	-	1920 x 1080	60 fps	60 Mbps	-
		i.MX 8MMini	-				-
		i.MX 6Quad	-	1920 x 1080	30 fps	20 Mbps	-
		i.MX 6DualLite	-	1280 x 720	30 fps	20 Mbps	-
	MPEG4	i.MX 8MQuad	SP/ASP	1920 x 1080	60 fps	-	-
		i.MX 8QuadXPlus	SP/ASP	1920 x 1080	30 fps	-	-
		i.MX 6	SP/ASP	1920 x 1080	30 fps	40 Mbps	-
	MPEG2	i.MX 8MQuad	MP	1920 x 1080	60 fps	-	-
		i.MX 8QuadXPlus	MP	1920 x 1080	30 fps	-	-
		i.MX 6	MP	1920 x 1080	30 fps	50 Mbps	-
	H263	i.MX 8MQuad	P3	1920 x 1080	60 fps	-	-
		i.MX 6	P3	1920 x 1080	30 fps	20 Mbps	-
	VC1	i.MX 8MQuad	AP/MP/SP	1920 x 1080	60 fps	-	-
		i.MX 6	AP/MP/SP	1920 x 1080	30 fps	45 Mbps	-
	MJPEG	i.MX 8MQuad	-	1920 x 1080	60 fps	180 Mpixl	-
		i.MX 6	-	1920 x 1080	30 fps	120 Mpixl	-
	RV	i.MX 8MQuad	9	1920 x 1080	60 fps	-	-
		i.MX 6	8/9/10	1920 x 1080	30 fps	40 Mbps	-
Video Encoder	H264	i.MX 8MMini	HP/MP/BP	1920 x 1080	60 fps	60 Mbps	-
		i.MX 6	BP	1920 x 1080	30 fps	20 Mbps	-
Software Video Decoder	/	i.MX All	/	According to system performance	According to system performance	According to system performance	Supported with FFmpeg

### 7.5.3 Audio codec specification

**Table 23. Audio codec specification**

Decoder	Feature/Profile	Channel	Sample rate (kHz)	Bit rate (kbps)	H/W or S/W	Comment
MP3	MPEG-1 (Layer-1/ Layer-2/Layer-3)  MPEG-2 (Layer-1/ Layer-2/Layer-3)  MPEG-2.5 (Layer-3)	stereo/mono	<= 48	8 - 448	8QuadXPlus supports H/W.	-

Table continues on the next page...

**Table 23. Audio codec specification (continued)**

Decoder	Feature/Profile	Channel	Sample rate (kHz)	Bit rate (kbps)	H/W or S/W	Comment
					8QuadMax does not support H/W audio decoder.	
AACLC	MPEG-2 AACLC MPEG-4 AACLC	<= 5.1	8 - 96	8 - 256	8QuadXPlus supports H/W. 8QuadMax does not support H/W audio decoder.	For H/W, it only supports mono and stereo channels.
HE-AAC	HE-AAC V1 HE-AAC V2	stereo/mono	8 - 96	Mono: 8 - 384 stereo: 16 - 768	S/W	-
WMA10 Std	L1 @ QL1	stereo/mono	44.1	64 - 161	S/W	-
	L2 @ QL1	stereo/mono	<= 48	<= 161	S/W	-
	L3 @ QL1	stereo/mono	<= 48	<= 385	S/W	-
WMA10 Pro	M0a @ QL2	stereo/mono	<= 48	48 - 192	S/W	-
	M0b @ QL2	stereo/mono	<= 48	<= 192	S/W	-
	M1 @ QL2	<= 5.1	<= 48	<= 384	S/W	-
	M2 @ QL2	<= 5.1	<= 96	<= 768	S/W	-
	M3 @ QL2	<= 7.1	<= 96	<= 1500	S/W	-
WMA 9 Lossless	N1	stereo/mono	<= 48	<= 3000	S/W	-
	N2	<=5.1	<= 96	<= 3000	S/W	-
	N3	<=7.1	<= 96	<= 3000	S/W	-
AC-3	-	<=5.1	<= 48	32 - 640	S/W	-
FLAC	-	<=7.1	8 - 192	-	N/A	-
BSAC	-	<=5.1	<= 48	64 per channel	N/A	Core codec only
Ogg Vorbis	q1 - q10	Stereo	8 - 192	<= 500	S/W	-
DD-plus	-	<=7.1	32, 44.1, 48 64, 88.2, 96	<= 6.144 Mbps	S/W	-
RA	cook	stereo/mono	8k, 11.025k, 22.05k, 44.1k	-	S/W	-

**NOTE**

- The bitrate (bps) supported for MP3 encoder: 32 k, 48 k, 56 k, 64 k, 80 k, 96 k, 112 k, 128 k, 160 k, 192 k, 224 k, 256 k, 320 k
- The sample and supported bitrate (bps) combinations for WMA8 encoder:
  - For mono output:
    - 22050 Hz: 20 k, 16 k, 22 k, 17.6 k

- 32000 Hz: 20 k, 22 k
- 44100 Hz: 32 k, 35.2 k, 48 k, 52.8 k
- For Stereo output:
  - 22050 Hz: 35.2 k, 32 k, 22 k, 20 k
  - 32000 Hz: 52.8 k, 48 k, 44 k, 40 k, 35.2 k, 32 k
  - 44100 Hz: 211.2 k, 192 k, 176 k, 160 k, 140.8 k, 128 k, 105.6 k, 96 k, 88 k, 80 k, 70.4 k, 64 k
  - 48000 Hz: 211.2 k, 192 k, 176 k, 160 k, 140.8 k, 128 k

## 7.5.4 Image codec specification

**Table 24. Image codec specification**

	Feature	Profile	Max. resolution	H/W or S/W
Image decoder	JPEG	Baseline	Memory-related	S/W
	PNG	N/A	Memory-related	S/W
	GIF	N/A	Memory-related	S/W
	BMP	N/A	Memory-related	S/W
Image encoder	JPEG	Baseline	Memory-related	S/W

## 7.5.5 Speech codec specification

**Table 25. Speech codec specification**

	Feature	Sample rate	Bit rate (kbps)	H/W or S/W
Speech codec	G.711	8 kHz	64	S/W
	G.723.1	8 kHz	5.3, 6.3	S/W
	G.726	8 kHz	16, 24, 32, 40	S/W
	G.729ab	8 kHz	8	S/W
	AMR_NB	8 kHz	12.2, 10.2, 7.9, 7.4, 6.7, 5.9, 5.15, 4.75	S/W
	AMR_WB	16 kHz	23.85, 23.05, 19.85, 18.25, 15.85, 14.25, 12.65, 8.85, 6.6	S/W

## 7.5.6 Streaming protocol specification

**Table 26. Streaming protocol specification**

Protocol	Feature
HTTP	HTTP progressive streaming
RTSP	RTP, SDP
RTP/UDP	RTP/UDP MPEGTS streaming

## 7.5.7 RTSP streaming server specification

To support the RTSP server, the `gst-rtsp-server` open source package needs to be installed. See Section “RTSP Streaming Server” in the *i.MX Linux® User’s Guide (IMXLUG)* for information on how to build and install it.

**Table 27. RTSP streaming server specification**

Demux feature		AVI	MP4	FLV	MKV	MP3	AAC
Video	H264	Y	Y	Y	Y	-	-
	MPEG4	Y	Y	-	Y	-	-
Audio	MP3	Y	Y	Y	Y	Y	-
	AAC	Y	Y	Y	Y	-	Y

## 7.5.8 Subtitle specification

**Table 28. Subtitle specification**

Internal/External	Subtitle format
Internal	SRT, SSA, ASS
External	SRT

## 7.6 Known issues and limitations for multimedia

Issues seen on GStreamer 1.x:

- As the maximum buffer size of the playbin multiqueue is 2 MB, problems may be seen with some long audio or video interleaved streams. You can enlarge this buffer size to support these special use cases.
- AAC decoder: The ADIF format does not support seek mode nor FF/FB.
- Playing recorded AVI file on i.MX with VPU (MPEG4 (vpu) + AVI (avimux)) fails because the AVIMUX mark MPEG4 video to DIVX is not supported.
- The accurate seek mode may have a longer time delay.
- Because the stream container does not have an index table, seeking is not supported.
- Fast rewind of audio does not support audio-only streams.
- PulseAudio is only available for the X11 backend.
- Rotation on i.MX 6 with VPU is not supported for interlaced streams whose width or height is larger than 968 x 968 when enabled deinterlacing due to a driver limitation.
- Rewind may report an EOS when using libav for video decoding.
- For the clips with long audio/video interleaved streams, it requires to enlarge the multiqueue maximum buffer size.
- AAC clips with ADIF format do not support seek/trick (FB/FF) mode.
- Accurate seek mode may take a longer time delay.
- For clips with no index table in containers (or video with only very few key frames), seeking is not supported.
- Audio-only clips do not support FB.
- For PulseAudio, it automatically starts with X11 backend. For others, users need to manually start the daemon.

## 8 Revision History

This table provides the revision history.

**Table 29. Revision history**

Revision number	Date	Substantive changes
L4.9.51_imx8qxp-alpha	11/2017	Initial release
L4.9.51_imx8qm-beta1	12/2017	Added i.MX 8QuadMax
L4.9.51_imx8mq-beta	12/2017	Added i.MX 8MQuad
L4.9.51_8qm-beta2/8qxp-beta	02/2018	Added i.MX 8QuadMax Beta2 and i.MX 8QuadXPlus Beta
L4.9.51_imx8mq-ga	03/2018	Added i.MX 8MQuad GA
L4.9.88_2.0.0-ga	05/2018	i.MX 7ULP and i.MX 8MQuad GA release
L4.9.88_2.1.0_8mm-alpha	06/2018	i.MX 8MMini Alpha release
L4.9.88_2.2.0_8qxp-beta2	07/2018	i.MX 8QuadXPlus Beta2 release

**How to Reach Us:****Home Page:**[nxp.com](http://nxp.com)**Web Support:**[nxp.com/support](http://nxp.com/support)

Information in this document is provided solely to enable system and software implementers to use NXP products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits based on the information in this document. NXP reserves the right to make changes without further notice to any products herein.

NXP makes no warranty, representation, or guarantee regarding the suitability of its products for any particular purpose, nor does NXP assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in NXP data sheets and/or specifications can and do vary in different applications, and actual performance may vary over time. All operating parameters, including "typicals," must be validated for each customer application by customer's technical experts. NXP does not convey any license under its patent rights nor the rights of others. NXP sells products pursuant to standard terms and conditions of sale, which can be found at the following address: [nxp.com/SalesTermsandConditions](http://nxp.com/SalesTermsandConditions).

While NXP has implemented advanced security features, all products may be subject to unidentified vulnerabilities. Customers are responsible for the design and operation of their applications and products to reduce the effect of these vulnerabilities on customer's applications and products, and NXP accepts no liability for any vulnerability that is discovered. Customers should implement appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP, the NXP logo, NXP SECURE CONNECTIONS FOR A SMARTER WORLD, COOLFLUX, EMBRACE, GREENCHIP, HITAG, I2C BUS, ICODE, JCOP, LIFE VIBES, MIFARE, MIFARE CLASSIC, MIFARE DESFire, MIFARE PLUS, MIFARE FLEX, MANTIS, MIFARE ULTRALIGHT, MIFARE4MOBILE, MIGLO, NTAG, ROADLINK, SMARTLX, SMARTMX, STARPLUG, TOPFET, TRENCHMOS, UCODE, Freescale, the Freescale logo, Altivec, C-5, CodeTEST, CodeWarrior, ColdFire, ColdFire+, C-Ware, the Energy Efficient Solutions logo, Kinetis, Layerscape, MagniV, mobileGT, PEG, PowerQUICC, Processor Expert, QorIQ, QorIQ Qonverge, Ready Play, SafeAssure, the SafeAssure logo, StarCore, Symphony, VortiQa, Vybrid, Airfast, BeeKit, BeeStack, CoreNet, Flexis, MXC, Platform in a Package, QUICC Engine, SMARTMOS, Tower, TurboLink, and UMEMS are trademarks of NXP B.V. All other product or service names are the property of their respective owners. Arm, AMBA, Artisan, Cortex, Jazelle, Keil, SecurCore, Thumb, TrustZone, and  $\mu$ Vision are registered trademarks of Arm Limited (or its subsidiaries) in the EU and/or elsewhere. Arm7, Arm9, Arm11, big.LITTLE, CoreLink, CoreSight, DesignStart, Mali, Mbed, NEON, POP, Sensinode, Socrates, ULINK and Versatile are trademarks of Arm Limited (or its subsidiaries) in the EU and/or elsewhere. All rights reserved. Oracle and Java are registered trademarks of Oracle and/or its affiliates. The Power Architecture and Power.org word marks and the Power and Power.org logos and related marks are trademarks and service marks licensed by Power.org.

© 2018 NXP B.V.

Document Number IMXLXRN  
Revision L4.9.88\_2.2.0\_8qxp-beta2, 07/2018

