User's Guide
SPRUIL2A–February 2019–Revised September 2019

OMAP-L138/C6748 Low-Cost Development Kit (LCDK)

The OMAP-L138/C6748 Low-Cost Development Kit (LCDK) is a complete hardware and software reference design for Analytics, Biometrics, Audio, and so forth. This user guide documents the hardware of the LCDK and enables more collaboration, project sharing and knowledge exchanges.

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1 Introduction

The LCDK is an easy-to-use, affordable and scalable introduction to the world of TI's C6000 DSP value line family. Beginners and experienced users alike can use the kit to create low-power and low-cost solutions for biometrics, analytics, audio, and communications.

TI provides two variants of LCDK, LCDK6748 for DSP only developers and LCDKL138 for Arm® and DSP developers.

For more information, see the following:

- OMAPL138 LCDK
- C6748 LCDK

1.1 Features

- TI TMS320C6748 DSP or OMAP-L138 Application Processor
- 456-MHz C674x Fixed/Floating Point DSP
- 456-MHz ARM926EJ RISC CPU (OMAP-L138 only)
- On-Chip RTC
- 128 MByte DDR2 SDRAM running at 150 MHz
- 128 MByte 16-bit wide NAND FLASH
- 1 Micro SD/MMC Slot
- One mini-USB Serial Port (on-board serial to USB)
- One Fast Ethernet Port (10/100 Mbps) with status LEDs
- One USB Host port (USB 1.1)
- One mini-USB on the go (OTG) port (USB 2.0)
- One SATA Port (3Gbps)
- One VGA Port (15 pin D-SUB)
- One LCD Port (Beagleboard XM connectors)
- One Composite Video Input (RCA Jack)
- One Leopard Imaging Camera Sensor Input (36-pin ZIP connector)
- Three AUDIO Ports (1 LINE IN and 1 LINE OUT and 1 MIC IN)
- 14-pin JTAG header (No onboard emulator; external emulator is required)

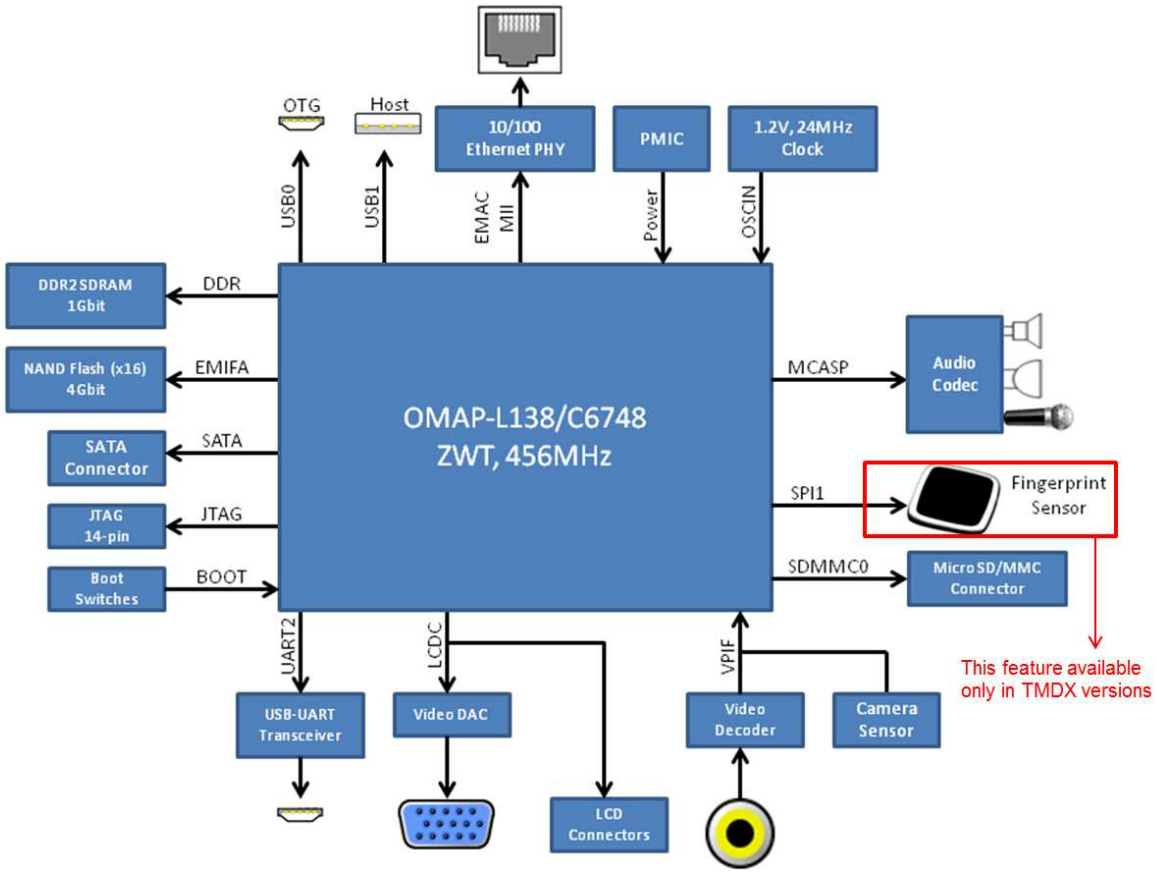

Figure 1. LCDK Block Diagram

NOTE:

- The LCDK does not have an onboard emulator. An external emulator from TI or a third-party will be required.
- The LCD port connector was designed to support an off-the-shelf LCD panel that is no longer available from any vendor. We are not aware of any other off the shelf LCD panel that will work with LCDK. You need to create your own adapter board in order to evaluate an LCD panel using the LCDK board.

1.2 Getting Started

Table 1. Resources and Training

Steps to Get Started	TMDSLCDK6748	TMDSLCDK138
Take a tour of the hardware	Introduction to TMDSLCDK6748	Introduction to TMDSLCDKL138
Run out of the box demo	Video Training	Video training
Software download	Processor SDK OMAPL138	Processor SDK OMAPL138
Hardware setup	TMDSLCDK6748 Hardware setup	TMDSLCDKL138 Hardware Setup
RTOS software setup	Processor SDK RTOS Getting Started Guide	
	OMAP-L138/C6748 LCDK Hardware Setup with CCS	
Linux softwaresetup	Not applicable	Processor SDK Linux Getting Started Guide

Table 2. Tools

Tool	Order Today
LCDK	C6748-LCDK
	OMAP-L138 LCDK
Emulators Visit the online TI store for an up-to-date list of available emulators.	XDS100
	XDS200
	XDS510
	XDS560
	XDS110 - Supported on C6748 LCDK ONLY

NOTE:

- Distributor prices may vary

Table 3. Included Devices

Included Devices	Description	Documentation
TMS320C6748	TMS320C6748 Fixed/Floating Point DSP	*TMS320C6748™ Fixed- and Floating-Point DSP Data Sheet*
OMAPL138	OMAPL138 DSP+ARM9 Processor	*OMAP-L138 C6000™ DSP+ ARM® Processor Data Sheet*

Table 4. Software Downloads (1)

Compiler/Debugger (IDE)	Download Now!
Code Composer Studio (CCS)	Download Now (Requires TI Login)
Processor SDK (Latest)	Download Now (Requires TI Login)

(1) For the latest version of CCS and SDK, see the Processor SDK RTOS and Linux release notes.

2 Included in the Box

2.1 OMAP-L138/C6748 Low-Cost Development Kit Contents

- LCDK development board
- Mini A/B USB cable
- Micro SD card with SD-adapter
- Quick start guide

2.2 Development Support

The OMAP-L138/C6748 LCDK boards are supported under Processor SDK RTOS.

2.3 Embedded Linux Application Development Support

The Linux Software development kit (available only with the OMAP-L138 LCDK) is included to help jump start the Linux application development with the latest open source kernel running on the ARM9 core of OMAP-L138. Linux-based DSP tools are provided with the kit as well to enable programming of the C674 DSP core.

3 Setting up the OMAP-L138/C6748 Development Kit (LCDK)

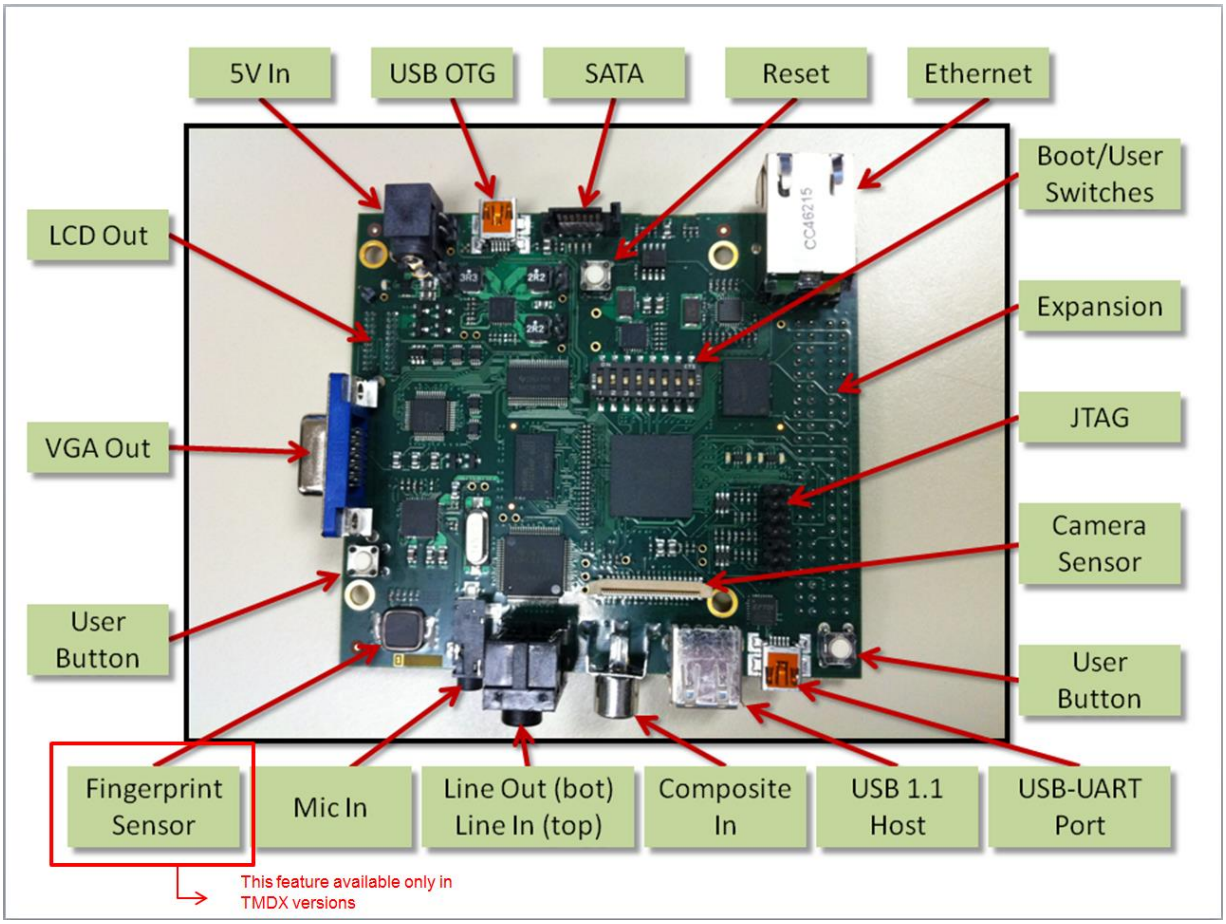

Figure 2. LCDK Hardware Features

3.1 User Interface

Switches 1-4 on SW1 are used to set the BOOT mode, as described in Table 5.

Table 5. Switches 1-4 on SW1

Switch Number	UART2	NAND 16	MMC/SD0
1	OFF	OFF	OFF
2	ON	ON	OFF
3	OFF	ON	OFF
4	ON	ON	ON

Switches 5-8 on SW1 are user switches connected to GPIOs, as described in Table 6. When the switch is ON, the pin is pulled low. When the switch is OFF, the pin is pulled high.

Table 6. Switches 5-8 on SW1

Switch Number	Pin
5	GPIO0[1]
6	GPIO0[2]
7	GPIO0[3]
8	GPIO0[4]

3.1.1 Push Buttons

There are three push buttons on the board connected, as described in Table 7. When a button is pressed, the attached signal is pulled low; otherwise it is pulled high.

Table 7. Push Buttons

Switch Number	Pin
S1	Reset
S2	GPIO2[4]
S3	GPIO2[5]

3.1.2 LEDs

There are seven LEDs on the board which function, as described in Table 8.

Table 8. LEDs

LED	Signal	Lit when...
D1	5V_IN	5 V is applied to J1
D2	VOLT_ERR	Input voltage is > 5.8 V
D3	VCC_5VD_IN	Board is powered from either J1 or USB
D4	GPIO6[13]	Signal is high
D5	GPIO6[12]	Signal is high
D6	GPIO2[12]	Signal is high
D7	GPIO0[9]	Signal is high

3.1.3 Power

The board can be powered with 5 V input through the J1 barrel connector.

3.1.4 USB-to-UART Port (J3)

The board features FD232 USB UART IC, which acts an external serial port. It is connected to the OMAP-L138/C6748 UART2 peripheral.

Windows and Linux drivers for the chip can be found on the FTDI product page.

3.2 Setup the Out of the Box Demonstration on LCDK

The LCDK provides a quick start guide in the packaging that walks users through the hardware setup to run the out of the box demonstration that is programed in the flash or on the SD card included in the kit. Please follow the instruction in the quick start guide to setup the demonstration. The Quick start guide is also available to access online on ti.com in URLs provided below:

- *TMSLCDK6748 Quick Start Guide*
- *OMAP-L138 DSP+ARM9™ Development Kit (LCDK) Quick Start Guide*

3.3 Initial Setup

The following steps describe the initial setup of the LCDK:

1. Set DIP switch SW1 as shown in Figure 3:
   a. Positions 2, 3, and 4 ON
   b. Positions 1, 5, 6, 7, and 8 OFF

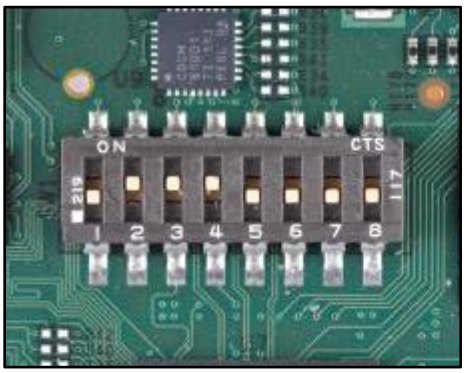

Figure 3. SW1 Settings

2. Connect the supplied mini USB cable to J3 on the LCDK, as shown in Figure 4. Connect the other end of the cable to a USB port on your host computer.

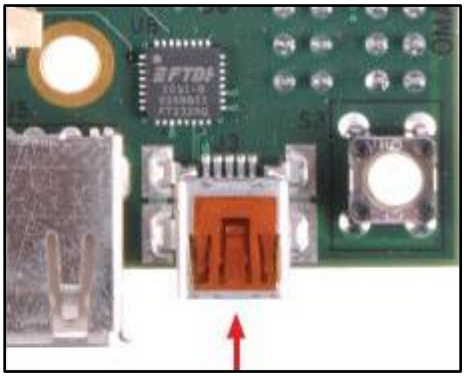

Figure 4. UART-to-USB Port

3. Open a serial port terminal (Tera Term) on the host computer and select the connection to the USB serial port.

Figure 5. Tera Term Port Selection

4. Configure the serial port as shown in Figure 5.
   a. Select the COM port that corresponds to the USB device.
   b. Baud rate: 115200
   c. Data: 8 bit
   d. Parity: none
   e. Stop: 1 bit

NOTE: To do this in Tera Term, go to Setup → Serial port.

Figure 6. Tera Term Baud Rate Selection

5. Power the board up.

3.4 Running the Face Detect Demo

1. To run the Face Detect demo, external hardware is needed.
   a. Connect the composite camera input at J6 on the composite video input port.
   b. Connect the composite display out at J4 on the composite video out port.

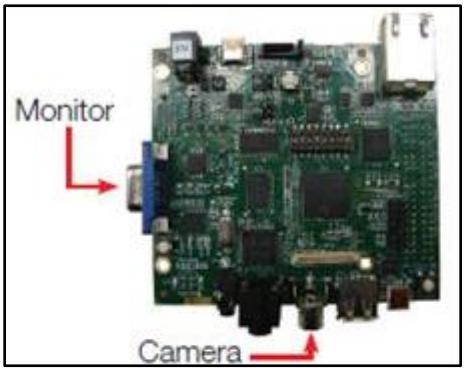

Figure 7. Face Detect Demo Connections

2. Run the Face Detect demo. In less than 10 seconds, Tera Term will display output indicating that the demo is running.

3. The system continues capturing the number of detected objects in each frame and displays its status as shown in Figure 8.

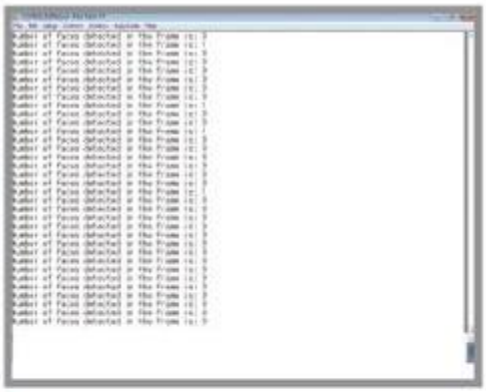

Figure 8. Face Detect Demo Status Window

The Face detect demo is based of older Legacy BIOS C6SDK software that is no longer supported. For reference to this software baseline, see the collateral and software at http://www.ti.com/tool/BIOSSW-C6748.

The BIO C6SDK installer is provided on the SD card. Start your development with the BIOS C6SDK for C6748 users by installing the SDK executable. Install the Code Composer Studio Integrated Development Environment and Code Gen Tools before installing the C6SDK installer. For details on starting the development, see the user's guide that is provided with the BIOS C6SDK.

NOTE: The Processor SDK baseline is the only supported and actively maintained software baseline for these devices. TI strongly urges users to begin with Processor SDK for new development.

3.5 Procedure to Flash and Boot the LCDK

The NAND may be flashed either through the USB-serial port or through CCS. The software provided in the following application note provides both tools.

OMAPL138/C6748 ROM Bootloader Resources and FAQ

The following AISgen config file has the correct settings for NAND16 boot, with the CPU running at 300 MHz, and DDR2 at 150 MHz.

- LCDK AISgen Config
- Serial Port Method

1. Determine what serial port is assigned to the on-board UART->USB IC as show in Section 3.1.4.
2. Set the boot pins to UART2 boot mode as shown in Section 3.1.
3. Perform the following actions, where "COMx" refers to the COM port found in the previous step (COM8). For C6748 boards, replace "OMAPL138_LCDK" with "C6748_LCDK".
   a. Erase the entire NAND (optional):

```
sfh_OMAP-L138.exe -targettype OMAPL138_LCDK -flashtype NAND -p COMx -erase
```

   b. Flash bootable AIS image (ais_image.bin) to block 1 of the NAND

```
sfh_OMAP-L138.exe -targettype OMAPL138_LCDK -flashtype NAND -p COMx -
flash_noubl ais_image.bin
```

   Run the commands and then power cycle or reset the board to initiate the process.

   c. CCS Method

4. SD/MMC Flashing
   a. Connect to the Arm or DSP with the GEL file loaded, which auto-initializes the DDR.
   b. Open (CCS3) or import (CCS4, CCS5) the NANDWriter_ARM or the NANDWriter_DSP project.
   c. Modify the #define "NANDWIDTH_8" to "#define NANDWIDTH_16" in nandwriter.c.
   d. Rebuild and run the code.

   For more information, see the OMAPL138/C6748 ROM Bootloader Resources and FAQ

4 LCDK Features

4.1 Video

Table 9. Video DAC

Component	U13
Part Number	THS8135PFP
Data Sheet	SLAS343
Description	Texas Instruments 10-bit Video DAC

Table 10. Video Decoder

Component	U21
Part Number	TVP5147M1PFP
Data Sheet	SLES099
Description	Texas Instruments 10-bit Digital Video Decoder

4.2 Memory

Table 11. NAND Flash

Component	U18
Part Number	MT29F4G16ABADAH4-IT:D
Data Sheet	4Gb, 8Gb, 16Gb: x8, x16 ECC NAND M60A Data Sheet
Description	Micron 4Gbit NAND Flash (x16 data width)

Table 12. DDR2 SDRAM

Component	U17
Part Number	W971GG6KB-25
Data Sheet	WBNDS03072-1
Description	Micron 4Gbit NAND Flash (x16 data width)

4.3 Connectivity

Table 13. Ethernet PHY

Component	U23
Part Number	LAN8710A-EZK
Data Sheet	Microchip
Description	Micron 4Gbit NAND Flash (x16 data width)

4.4 LCD Connector

Table 14. LCD Connector

Component	Description
P1, P2	Provide connectivity to CircuitCo ULCD7 Lite LCD

5 Power Sequencing

NOTE: To keep the cost low, the OMAP-L138/C6748 LCDK has not followed the right power sequencing recommended by OMAP-L138/C6748 data sheet. The designer needs to implement the right power sequencing for reliable operation. For details, see the following documents.

- *OMAPL138*
- *TMS320C6748*

6 Online Resources

6.1 C6748/ OMAP-L138 Product Information

- TMS320C6748 Data Sheets, Silicon Errata and Technical Reference Manuals
- OMAP-L138 Data Sheets, Silicon Errata and Technical Reference Manuals

6.2 LCDK Hardware and Software Documentation

6.2.1 LCDK Board Revision History

Table 15. LCDK Board Revision History

S.NO	Board Name	Board Revision	Silicon Revision	Status	Major Changes
1	TMDXLCDK138/6748	A5	PG2.1 or Older	Obsolete	Finger print sensor available (U26)
2	TMDXLCDK138/6748	A6A	PG2.1 or older	Obsolete	Finger print sensor (U26 Depopulated),Samsung K4T1G164QF-BCF8 (U17)-DDR2
3	TMDSLCDK138/6748	A7A	PG2.3	Active	Finger print sensor (U26 Depopulated),Winbond W971GG6KB-25 (U17)-DDR2)

6.3 CCS XML and GEL Files

- Latest GEL files for LCDK Board are included as part of CCSv6.0 and later versions.
- CCS4 and higher contain configuration XML files and GEL files for initializing the DDR interface| Download Now

NOTE: GEL files and XML files are included in current CCS releases by default and it is not required to download explicitly to setup a connection for the board.

6.4 Hardware Setup With CCS

- EVM Hardware Setup

6.5 Software

- Processor SDK for OMAPL138 Processors for Linux and TI-RTOS Support

7 Projects

7.1 Finger Printing Demonstration

C6748 LCDK comes with preprogrammed Flashed demos. Authentec finger print sensor mounted on the board is capable of sensing finger with 100% accuracy. The finger print demo provides flexibility to create multiple finger selection for different users by swipe sensor technology. The finger prints are matched in fraction of seconds. Enrollment for each user is completed in four steps and it takes fraction of a second to match the finger print on 300 MHz on the C674x floating point DSP. This demo is also 100% percent accurate for results and has an easy connection to the PC for running the demo and viewing the results.

NOTE: This demo can be recreated only on initial versions of LCDK that were populated with the fingerprint sensor.

7.2 Face Detection Demonstartion

Second pre flashed demonstration is Face Detection. This demo supports frontal face detection by using an OpenCV based Haar detect object algorithm. The demo can detect multiple faces in a frame and uses a composite camera to capture and VGA to display the image. The demo also supports D1(720x480) resolution image processing and real time video capture and display This requires additional hardware to be connected to the board to take VGA capture through composite camera interface and output is displayed on the VGA display connected to the VGA port.

The above demonstrations comes with the C6748 BIOS C6 Software development Kit with the source code of the projects.

NOTE: The demo code is provided as part of the C6BIOS SDK. The DSP compiled version of OpenCV libraries are provided only in object code.

8 Support

For community support, visit: www.ti.com/e2e.

9 References

- OMAP-L138 Development Kit (LCDK)
- TMS320C6748 DSP Development Kit (LCDK)
- Texas Instruments: *OMAP-L138 DSP+ARM9™ Development Kit (LCDK) Quick Start Guide*
- Texas Instruments: *C6748 Development Kit (LCDK) Quick Start Guide*

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (February 2019) to A Revision **Page**

- Update was made in the Abstract. 1
- Update was made in Table 2. 5
- New section was added - Section 3.1. 6
- New section was added - Section 3.1.3. 7
- New section was added - Section 3.2. 7
- New section was added - Section 3.3. 8
- New section was added - Section 3.4. 9
- New section was added - Section 3.5. 10
- New section was added - Section 7. 13

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