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# AXEL

**Solo / Dual / Quad ARM Cortex-A9  
CPU Module**

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**Axel Embedded Linux Kit (XELK)**

***Quick Start Guide***

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# 1 Preface

## 1.1 About this manual

This manual describes the AXEL Embedded Linux Kit (XELK) and serves as a quick guide for start working with the development kit.

## 1.2 Copyrights/Trademarks

Ethernet® is a registered trademark of XEROX Corporation.

All other products and trademarks mentioned in this manual are property of their respective owners.

All rights reserved. Specifications may change any time without notification.

## 1.3 Standards

**DAVE Embedded Systems** is certified to ISO 9001 standards.

## 1.4 Disclaimers

**DAVE Embedded Systems** does not assume any responsibility for availability, supply and support related to all products mentioned in this manual that are not strictly part of the AXEL CPU modules, the AXELEVB-Lite carrier board and the Dacu carrier board.

AXEL CPU Modules are not designed for use in life support appliances, devices, or systems where malfunctioning of these products can reasonably be expected to result in personal injury. **DAVE Embedded Systems** customers who are using or selling these products for use in such applications do so at their own risk and agree to fully indemnify **DAVE Embedded Systems** for any damage resulting from such improper use or sale.

## 1.5 Warranty

AXEL SOMs, AXELEVB-Lite and Dacu are guaranteed

against defects in material and workmanship for the warranty period from the shipment date. During the warranty period, **DAVE Embedded Systems** will at its discretion decide to repair or replace defective products. Within the warranty period, the repair of products is free of charge provided that warranty conditions are observed.

The warranty does not apply to defects resulting from improper or inadequate maintenance or handling by the customer, unauthorized modification or misuse, operation outside of the product's specifications or improper installation or maintenance.

**DAVE Embedded Systems** will not be responsible for any defects or damages to other products not supplied by **DAVE Embedded Systems** that are caused by a faulty AXEL module, AXELEVB-Lite or Dacu.

## 1.6 Technical Support

We are committed to making our products easy to use and will help customers use our CPU modules in their systems.

Technical support is delivered through email for registered kits owners. Support requests can be sent to [support-axel@dave.eu](mailto:support-axel@dave.eu). Software upgrades are available for download in the restricted download area of **DAVE Embedded Systems** web site: <http://www.dave.eu/reserved-area>. An account is required to access this area.

Please refer to our Web site at <http://www.dave.eu/dave-cpu-module-imx6-axel.html> for the latest product documents, utilities, drivers, Product Change Notices, Board Support Packages, Application Notes, mechanical drawings and additional tools and software.



## 1.7 Related documents

Document	Location
<b>DAVE Embedded Systems</b> Developers Wiki	<a href="http://wiki.dave.eu/index.php/Main_Page">http://wiki.dave.eu/index.php/Main_Page</a>
i.MX6 Application Processor Reference Manual	<a href="http://cache.freescale.com/files/32bit/doc/ref_manual/IMX6DQRM.pdf?fpsp=1&amp;WT_TYPE=Reference%20Manuals&amp;WT_VENDOR=FREESCALE&amp;WT_FILE_FORMAT=pdf&amp;WT_ASSET=Documentation">http://cache.freescale.com/files/32bit/doc/ref_manual/IMX6DQRM.pdf?fpsp=1&amp;WT_TYPE=Reference%20Manuals&amp;WT_VENDOR=FREESCALE&amp;WT_FILE_FORMAT=pdf&amp;WT_ASSET=Documentation</a>
Freescale I.MX community website	<a href="https://community.freescale.com/community/imx">https://community.freescale.com/community/imx</a>
Freescale L3.10.17-1.0.0 documentation bundle	<a href="https://www.freescale.com/webapp/Download?colCode=L3.10.17_1.0.0_IMX6QDLS_BUNDLE&amp;appType=license&amp;location=null&amp;WT_TYPE=Board%20Support%20Packages&amp;WT_VENDOR=FREESCALE&amp;WT_FILE_FORMAT=gz&amp;WT_ASSET=Downloads&amp;fileExt=.gz&amp;Parent_noDelId=1337637154535695831062&amp;Parent_pageType=product">https://www.freescale.com/webapp/Download?colCode=L3.10.17_1.0.0_IMX6QDLS_BUNDLE&amp;appType=license&amp;location=null&amp;WT_TYPE=Board%20Support%20Packages&amp;WT_VENDOR=FREESCALE&amp;WT_FILE_FORMAT=gz&amp;WT_ASSET=Downloads&amp;fileExt=.gz&amp;Parent_noDelId=1337637154535695831062&amp;Parent_pageType=product</a>
AXEL main page on <b>DAVE Embedded Systems</b> Developers Wiki	<a href="http://wiki.dave.eu/index.php/Category:Axel">http://wiki.dave.eu/index.php/Category:Axel</a>
AXEL Hardware Manual	<a href="http://www.dave.eu/sites/default/files/files/axel-hm.pdf">http://www.dave.eu/sites/default/files/files/axel-hm.pdf</a>
AXEL Software Manual	<a href="http://wiki.dave.eu/index.php/Software_Manual_(Axel)">http://wiki.dave.eu/index.php/Software_Manual_(Axel)</a>
AXELEVB-Lite page on <b>DAVE Embedded</b>	<a href="http://wiki.dave.eu/index.php/AxelEVB-Lite">http://wiki.dave.eu/index.php/AxelEVB-Lite</a>

Document	Location
<b>Systems</b> Developers Wiki	
Dacu User's Guide	Provided with kit documentation
Building Embedded Linux Systems By Karim Yaghmour.	This book covers all matters involved in developing software for embedded systems. It is not a reference guide, but it provides a complete and exhaustive overview that helps the developer save a lot of time in searching for such information on the Internet
Training and Docs sections of Free Electrons website.	Brief but still exhaustive overview of the Linux and Embedded Linux world.

**Tab. 1:** Related documents

## 1.8 Conventions, Abbreviations, Acronyms

Abbreviation	Definition
BTN	Button
DVDK	Dave Virtual Development Kit
EMAC	Ethernet Media Access Controller
GPI	General purpose input
GPIO	General purpose input and output
GPO	General purpose output
LTIB	Linux Target Image Builder
OVA	Open Virtualization Archive
PCB	Printed circuit board
PMIC	Power Management Integrated Circuit
PSU	Power supply unit
RTC	Real time clock
SOC	System-on-chip

Abbreviation	Definition
SOM	System-on-module
WDT	Watchdog
XELK	AXEL Embedded Linux Kit

**Tab. 2:** Abbreviations and acronyms used in this manual

**Revision History**

<b>Version</b>	<b>Date</b>	<b>Notes</b>
1.0.0	November 2013	First official release
1.0.1	January 2014	Released with XELK 1.1.0 Minor fixes
1.0.2	May 2014	Added support for AXELLite SOM Minor fixes Released with XELK 1.2.0
1.0.3	November 2014	Released with XELK 2.0.0
1.0.4	April 2015	Released with XELK 2.1.0
1.0.5	February 2016	Minor fixes Released with XELK 2.2.0

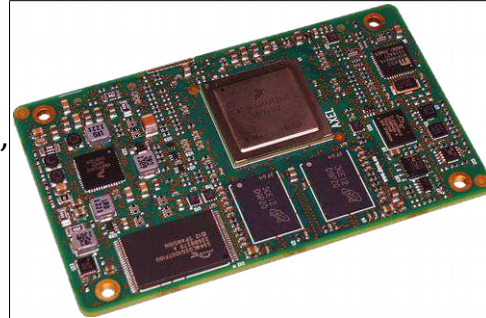
## 2 Introduction

### 2.1 AXEL SOM

AXEL is the new top-class Solo/Dual/Quad core ARM Cortex-A9 CPU module by **DAVE Embedded Systems**, based on the recent Freescale i.MX6 application processor.

Thanks to AXEL, customers have the chance to save time and resources by using a compact solution that

permits to reach scalable performances that perfectly fits the application requirements avoiding complexities on the carrier board.



**Fig. 1:** Axel Ultra CPU module



**Fig. 2:** AXEL-LITE – Solo / Dual / Quad core ARM Cortex A9

The use of this processor enables extensive system-level differentiation of new applications in many industry fields, where high-performance and extremely compact form factor (85mm x 50mm) are key factors. Smarter system designs are made possible, following the trends in functionalities and interfaces of the new, state-of-the-art embedded products. AXEL offers great computational power, thanks to the rich set of peripherals, the Scalable ARM Cortex-A9 together with a large set of high-speed I/Os (up to 5GHz).

AXEL enables designers to create smart products suitable

for harsh mechanical and thermal environments, allowing the development of high computing and reliable solutions. Thanks to the tight integration between the ARM Core-based processing system, designers are able to share the application through the multi-core platform and/or to divide the task on different cores in order to match with specific application requirements (AMP makes possible the creation of applications where RTOS and Linux work together on different cores). Thanks to AXEL, customers are going to save time and resources by using a powerful and scalable compact solution, avoiding complexities on the carrier PCB.

AXEL is designed and manufactured according to **DAVE Embedded Systems** Ultra Line specifications, in order to guarantee premium quality and technical value for customers who require top performances and flexibility. AXEL is suitable for high-end applications such as medical instrumentation, advanced communication systems, critical real-time operations and safety applications.

For further information, please refer to AXEL Hardware Manual.



## 2.2 XELK

AXEL Embedded Linux Kit (XELK for short) provides all the necessary components required to set up the developing environment for:

- building the bootloader (U-Boot)
- building and running Linux operating system on AXEL-based systems
- building Linux applications that will run on the target

The heart of AXEL SOM is Freescale i.MX6 Solo/Dual/Quad core application processor. From a software point of view, Freescale supports this processor family through so-called Linux BSPs. The Linux BSP releases are published on a regular basis and the release packages have a reference code as L<Kernel\_version>\_<x.y.z> (eg: L3.10.17\_1.0.3). For more details please refer to:

- [http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=i.MX6Q&fosp=1&tab=Design\\_Tools\\_Tab](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=i.MX6Q&fosp=1&tab=Design_Tools_Tab)
- [https://community.freescale.com/community/imx/content?filterID=contentstatus\[published\]~category\[imx6all\]&filterID=contentstatus\[published\]~objecttype~objecttype\[document\]](https://community.freescale.com/community/imx/content?filterID=contentstatus[published]~category[imx6all]&filterID=contentstatus[published]~objecttype~objecttype[document])

AXEL Embedded Linux Kit, in turn, is directly derived from L<Kernel\_version>\_<x.y.z> BSP versions. Hence XELK documentation often refers to L<Kernel\_version>\_<x.y.z> resources.







**DAVE Embedded Systems** adds to the latest BSP from Freescale the customization required to support the AXEL platform. For this reason most of the documentation provided by Freescale remains valid for the XELK development kit. However, some customization is required, in particular at bootloader and Linux kernel levels.

XELK 2.0.0 introduced support for the **Yocto** build system, an open source collaboration project that provides templates, tools and methods to help creating custom Linux-based systems for embedded products. It is derived

from OpenEmbedded, but it provides a less steep learning curve, a graphical interface for Bitbake and very good documentation. **DAVE Embedded Systems** provides the so-called recipes/meta-repositories required to build all the XELK software components (bootloader, kernel and root file system) with the **Yocto** build system. For further details, please refer to <https://wiki.yoctoproject.org/wiki/FAQ>.

## 2.2.1 Kit Contents

The following table lists the XELK components:

Component	Description
	AXEL ULTRA <b>or</b> AXEL LITE SOM CPU: Freescale i.MX6
	AXELEVB-Lite Carrier board
	DACU Carrier board
	Ampire AM-800480STMQW 7" 800x480 LCD display LVDS interface
	AC/DC Single Output Wall Mount adapter Output: +12V – 2.0 A
	MicroSDHC card with SD adapter and USB adapter

## 2.2.2 XELK Release Notes

### 2.2.2.1 Version 1.0.0

- First official release

**2.2.2.2 Version 1.1.0**

- Minor update that adds support for more peripherals: NAND, RTC, I<sup>2</sup>C, SPI
- Touch screen works properly
- CAN works @ 1Mbps
- The system can boot from SD

**2.2.2.3 Version 1.2.0**

- Added support for AXEL LITE SOMs
- Bug fixes and minor changes

**2.2.2.4 Version 2.0.0**

- Updated u-boot and kernel versions
- Bug fixes and minor changes
- Added support for Yocto 1.5

**2.2.2.5 Version 2.1.0**

- Updated u-boot and kernel versions
- Added ConfigID support ([http://wiki.dave.eu/index.php/ConfigID\\_and\\_UniqueID](http://wiki.dave.eu/index.php/ConfigID_and_UniqueID))
- Bug fixes and minor changes

**2.2.2.6 Version 2.2.0**

- Added splash screen support in U-Boot
- Updated u-boot and kernel versions
- Bug fixes and minor changes

**2.2.2.7 Releases history**

	<b>XELK Version</b>					
Release number	1.0.0	1.1.0	1.2.0	2.0.0	2.1.0	2.2.0
Status	Released	Released	Released	Released	Released	Released
Release date	November 2013	January 2014	May 2014	November 2014	April 2015	January 2016
Release type	Major (see 2.2.2.8)	Maintenance (see 2.2.2.8)	Maintenance (see 2.2.2.8)	Major (see 2.2.2.8)	Maintenance (see 2.2.2.8)	Maintenance (see 2.2.2.8)
Release notes	Version 1.0.0	Version 1.1.0	Version 1.2.0	Version 2.0.0	Version 2.1.0	Version 2.2.0
SOM PCB version	AXEL Ultra: CS030713	AXEL Ultra: CS030713A	AXEL Ultra: CS030713A AXEL Lite: CS335013A	AXEL Ultra: CS030713A AXEL Lite: CS335013A	AXEL Ultra: CS030713B AXEL Lite: CS335013B	AXEL Ultra: CS030713B AXEL Lite: CS335013B
Supported carrier boards	AXELEVB-Lite Dacu	AXELEVB-Lite Dacu	AXELEVB-Lite Dacu	AXELEVB-Lite Dacu	AXELEVB-Lite Dacu	AXELEVB-Lite Dacu
U-Boot version	2013.10-xelk-1.0.0	2013.10-xelk-1.1.0	2013.10-xelk-1.2.0	2013.04-xelk-2.0.0	2013.04-xelk-2.1.0	2013.04-xelk-2.2.0
Linux version	3.0.35-xelk-1.0.0	3.0.35-xelk-1.1.0	3.0.35-xelk-1.2.0	3.10.17-xelk-2.0.0	3.10.17-xelk-2.1.0	3.10.17-xelk-2.2.0
Drivers	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1 NAND RTC I <sup>2</sup> C SPI	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1 NAND RTC I <sup>2</sup> C SPI	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1 NAND RTC I <sup>2</sup> C SPI Video Input (MIPI)	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1 NAND RTC I <sup>2</sup> C SPI Video Input (MIPI)	SPI NOR Flash (boot) UART debug (2-wire) USB Host USB OTG SD/MMC1 CAN Touch screen controller EMAC SATA HMDI LVDS1 NAND RTC I <sup>2</sup> C SPI Video Input (MIPI)

	XELK Version					
					PCIe ConfigID	PCIe ConfigID Splash screen
Freescale BSP version	L3.0.35-4.1.0	L3.0.35-4.1.0	L3.0.35-4.1.0	L3.10.17-1.0.0	L3.10.17-1.0.0	L3.10.17-1.0.3
Graphic Libraries	Qt 4.8	Qt 4.8	Qt 4.8	Qt 5.3.2	Qt 5.3.2	Qt 5.3.2
Build tool	LTIB	LTIB	LTIB	Yocto 1.5	Yocto 1.5	Yocto 1.5

### 2.2.2.8 Release type

XELK release type can be:

- **Major**, when substantial changes are applied to the BSP (eg: major kernel version upgrades) or to the development kit (eg: new features, build system updates, ..). This usually means that a new DVDK is created for the XELK release.
- **Maintenance**, when minor updates and bug fixes are introduced. This usually means that the DVDK remains the same provided with the previous major version, and only an update of the source tree repositories (and the tftp binaries) is required.

As an example, XELK 2.2.0 is a maintenance release, so it provides the DVDK released with the 2.0.0 major release; customers can easily upgrade to the 2.2.0 release by updating the software components as described in Section 3.5.6.



### 2.2.2.9 Known limitations

The following table reports the known limitations of the latest XELK version, which will be solved for the next releases of the development kit:

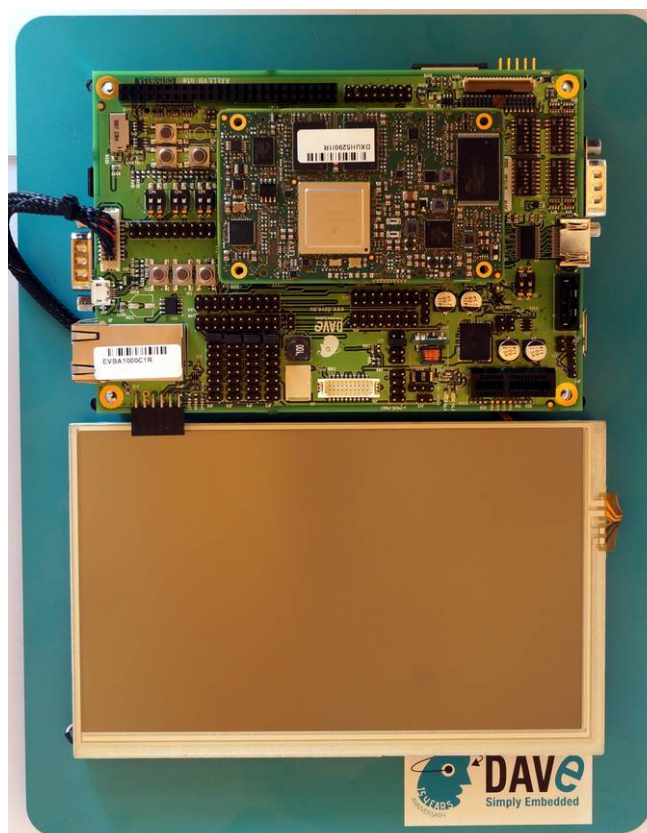
<b>Issue</b>	<b>Description</b>
USB OTG	Verified in Host and Device modes
Reboot from software	Rebooting the system from software (eg: launching the reboot command from Linux user space) can lead to a system lock. To solve it, reset the board with the dedicated button (S10)
Ethernet	10 Mbps connections have not been tested

## 3 XELK Quick Start

This chapter describes how to quickly start working with the XELK kit. The following paragraphs will guide you through the setup and installation procedures.

### 3.1 Unboxing

Once you've received the kit, please open the box and check the kit contents with the packing list included in the box, using the table on chapter 2.2.1 as a reference. The hardware components (SOM, carrier boards and display) are pre-assembled, as shown in the picture below:



## 3.2 Hardware setup

This section describes how to quick start an AXEL system composed of a AXEL SOM plugged into the AXELEVB-Lite and then mounted on the DACU carrier board, provided that it is programmed according to the XELK configuration.

The MicroSD provided with the XELK can be used to boot the system, since it contains a bootable partition (mmcbk0p1) and a root file system partition (mmcbk0p2).

1. insert the MicroSD card provided with the development kit into the MicroSD slot
2. connect the 12Vcc power supply to JP2 on the DACU board
3. (optional) connect a serial cable between the J25<sup>1</sup> connector on the DACU board and PC COM port through a NULL-modem ([https://en.wikipedia.org/wiki/Null\\_modem](https://en.wikipedia.org/wiki/Null_modem)) cable (not provided)
4. (optional) start your favorite terminal software on PC; communication parameters are:

Parameter	Value
Baud rate	115200 bps
Data bits	8
Stop bits	1
Parity	None

5. (optional) to connect the system to Ethernet LAN, please plug cable on connector J6 connector of the AXELEVB-Lite

The system is configured to boot automatically from the SD card when powered up.

## 3.3 First boot

Once power has been applied, U-Boot bootloader will be

---

<sup>1</sup> For the previous versions of the AXELEVB LITE hardware (PCB rel. CS151613), the serial console is available on the J28 DB9 connector.

executed from the SPI NOR flash, and the debug messages will be printed on the serial console. U-Boot automatically runs the autoboot macro, that loads the kernel and launches it with the options for mounting the root file system from the mmcblk0p2 partition. At the end of the boot process, a demo application is launched and you can interact with the system using the touchscreen.

Moreover, the Linux shell is available on the serial console. Lastly, both telnet and ssh services are available to connect to the system through the network.

Please refer to Appendix 6.3 for an example of the boot messages.

## 3.4 Selecting boot device

The boot device is the one used to load U-Boot and is selected through S5-S9 dip switches configuration.

### 3.4.1 Boot from SD

Dip switch	1	2	3	4	5	6	7	8
S5	ON	OFF	ON	ON	ON	ON	OFF	OFF
S6	OFF	OFF	ON	ON	OFF	ON	ON	ON
S7	OFF	OFF	ON	ON	ON	ON	ON	ON
S8	ON	OFF	ON	ON	OFF	ON	ON	ON
S9	OFF	OFF						

### 3.4.2 Boot from SPI NOR flash (XELK default)

Dip switch	1	2	3	4	5	6	7	8
S5	ON	ON	OFF	OFF	ON	ON	OFF	OFF
S6	OFF	OFF	ON	ON	OFF	ON	ON	ON
S7	OFF	OFF	ON	OFF	OFF	OFF	ON	OFF
S8	ON	OFF	ON	ON	OFF	ON	ON	ON
S9	OFF	OFF						

## 3.5 DVDK installation

**DAVE Embedded Systems** Virtual Development Kit is a virtual machine, based on Oracle VirtualBox that allows developers to start using **DAVE Embedded Systems** platform without wasting time in installing the development environment. The Virtual Machine comes with all the development tools and source code (pre-configured), and requires only a minimal setup by the end user (usually only to adapt network interface to the user environment).

DVDK can also be converted, easily, into a physical environment, for example to increase speed on slower machines. Please note that DVDK can be used also with VMWare.

Please refer to DVDK page (<http://wiki.dave.eu/index.php/Category:DVDK>) on **DAVE Embedded Systems** Developer's Wiki for further information.

### 3.5.1 DVDK features

- VirtualBox virtual machine (.OVA archive)
- Based on Lubuntu 12.04 LTS (64-bit version)
- Pre-installed VirtualBox Guest Additions
- LXDE desktop environment available
- Boot disk with pre-installed Lubuntu Linux 12.04.2 LTS and pre-configured basic Linux services (TFTP, NFS, ...)
- Secondary disk<sup>2</sup> containing source code and tools:
  - Bootloader (u-boot) source tree cloned from **DAVE Embedded Systems** public git repository
  - Linux kernel source tree cloned from **DAVE Embedded Systems** public git repository
  - External pre-built toolchain

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<sup>2</sup> Please note that the secondary disk is not automatically mounted at DVDK boot. It must be mounted manually using a dedicate script, as described in Section 3.5.5 at point 4.

- Yocto bsp for AXEL
- Pre-installed Yocto-based root file systems with setup scripts, makefiles, example applications, ...
- Administrator account (dvdk) with autologin. Please note that the user account credentials are provided with the development kit (you can find them into the README file contained in the `sw/dvdk` folder of the kit distribution)

### 3.5.2 MicroSD contents

The microSD provided with XELK provides:

- A bootable partition (**mmcblk0p1, vfat**) containing:
  - binary images (U-Boot, Linux and device tree images), up to date with the latest XELK release
  - XELK documentation
  - DVDK virtual machine image (in a compressed .OVA archive, see the `sw/dvdk/README` file)
- XELK root file system partition (**mmcblk0p2, ext3**)

XELK contains all the required software and documentation to start developing Linux application on the AXEL platform.