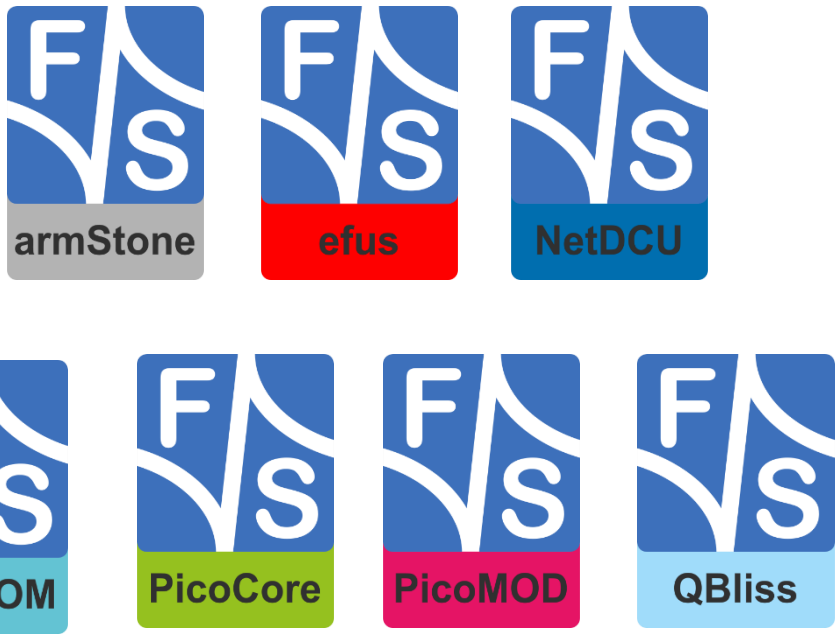
F&S i.MX8M-Plus Linux

First Steps

Version 1.7
(2024-09-06)



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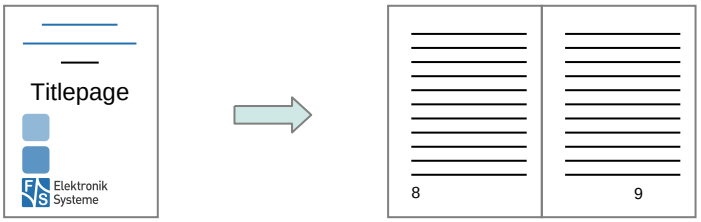
About This Document

This document shows how to bring up F&S boards and modules under Linux, how to update firmware and how to use the system and the devices. It covers also compiling bootloader, Linux kernel and root filesystem as well as how to build your own applications for the device.

Remark



The version number on the title page of this document is the version of the document. It is not related to the version number of any software release! The latest version of this document can always be found at http://www.fs-net.de.

How To Print This Document

This document is designed to be printed double-sided (front and back) on A4 paper. If you want to read it with a PDF reader program, you should use a two-page layout where the title page is an extra single page. The settings are correct if the page numbers are at the outside of the pages, even pages on the left and odd pages on the right side. If it is reversed, then the title page is handled wrongly and is part of the first double-page instead of a single page.

Typographical Conventions

We use different fonts and highlighting to emphasize the context of special terms:

`File names`

Menu entries

```
Board input/output
```

`Program code`

```
PC input/output
```

```
Listings
```

```
Generic input/output
```

`Variables`

History

Date	V	Platform	A,M,R	Chapter	Description	Au
2021-06-04	1.0	fsimx8mp	M	ALL	Based on fsimx8mm V1.5	AD
2021-07-09	1.1	fsimx8mp	M	5.2.5	Add new bootloader environments	AD
2021-12-10	1.2	fsimx8mp	M	2.1.1	Add pin 1,2 labels to figure 1	AD
2022-11-22	1.3	fsimx8mp	M,R	2.1.2	Add armStoneMX8MP description, remove buildroot chapter	AD
2023-03-29	1.4	fsimx8mp	M,R	2.1.3	Add efusMX8MP description	AD
2023-09-06	1.5	fsimx8mp	R	4,5	Remove chapters. They can be found in Linux on F&S Boards	PG
2024-06-21	1.6	fsimx8mp	A	2.1.4	Add SMARCMX8MP description	PG
2024-09-06	1.7	fsimx8mp	A	2.1.2	Add information for armStoneMX8MP rev 1.10	PG

V Version
A,M,R Added, Modified, Removed
Au Author

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1 Introduction

1.1 F&S Board Families And CPU Architectures

F&S offers a whole variety of Systems on Module (SOM) and Single Board Computers (SBC). There are different board families that are named NetDCU, PicoMOD, PicoCOM, armStone, QBliss, efus, and PicoCore (see Table 1).

Family	Type	Size
NetDCU	Single Board Computer	80 mm x 100 mm
PicoMOD	System on Module	80 mm x 50 mm
PicoCOM	System on Module	40 mm x 50 mm
armStone	Single Board Computer	100 mm x 72 mm (PicoITX)
QBliss	System on Module	70 mm x 70 mm (Qseven)
efus	System on Module	62 mm x 47 mm
PicoCore	System on Module	40 mm x 35 mm

Table 1: F&S Board Families

Linux is available for all of these platforms. F&S combines releases for platforms with the same CPU – or rather SoC (System on Chip) – as so-called *architecture releases*. All the boards of the same architecture can use the same sources, and the binaries can be used on any board of this architecture. Please note the difference: *board families* are grouped by form factor, *architectures* are grouped by CPU type, i.e. they usually contain boards of differ- ent families.

Table 2 shows all the architectures that are currently supported by F&S.

Architecture	CPU	Platforms
fsvybrid	NXP Vybrid VF6xx	PicoCOMA5, NetDCUA5, armStoneA5, PicoMOD1.2
fsimx6	NXP i.MX6	efusA9, QBlissA9, QBlissA9r2, armStoneA9, arm-StoneA9r2, PicoMODA9, NetDCUA9
fsimx6sx	NXP i.MX6-SoloX	efusA9X, PicoCOMA9X, PicoCoreMX6SX
fsimx6ul	NXP i.MX6-UltraLite	efusA7UL, PicoCOM1.2, PicoCoreMX6UL
fsimx7ulp	NXP i.MX7ULP	PicoCoreMX7ULP
fsimx8mm	NXP i.MX8MM	PicoCoreMX8MM
fsimx8mp	NXP i.MX8MP	PicoCoreMX8MP(r2), armStoneMX8MP, efusMX8MP, SMARCMX8MP

Table 2: F&S Architectures

Remark

In December 2015, the two companies Freescale and NXP merged and both companies are now working under the brand name NXP. The name Freescale will disappear in the future, which is why we only use “NXP” throughout this document now. However, some programs still output “Freescale” at some places. We have not touched this output to reflect the situation as it is.

1.2 Scope of This Document

This document describes the *fsimx8mp* architecture. That means all F&S boards and modules based on the NXP i.MX8MP SoC. The steps in this document will help you getting to know your board and do some basic operations in Linux, so that you can try out all the periphery and do some first tests and comparisons.

The additional document `LinuxOnFSBoards_eng.pdf` explains the more generic ideas and concepts of Linux on F&S boards and modules. So after having become acquainted with the board, you should continue reading that Linux document to get a more in-depth knowledge of the board and software.

2 Setting up the Board

In this chapter we will show how to connect the board to the PC. For a first test of the board functions, we only need a serial connection between PC and board. So as a first step, we will introduce all the boards and Starterkits of the *fsimx8mp* architecture and show the location of all connectors, especially the debug port.

2.1 Locate the Connectors on the Starterkit

2.1.1 PicoCoreMX8MP

The Starterkit includes all components that are required for an initial setup. This includes:

- Cables (Serial, power, USB …).
- Software (source, binaries, install scripts, examples).
- Starterkit carrier board that offers connectivity for most interfaces available in PicoCoreMX8MP.
- PicoCoreMX8MP module.

For basic operation please make sure that power and serial debug port are connected correctly.

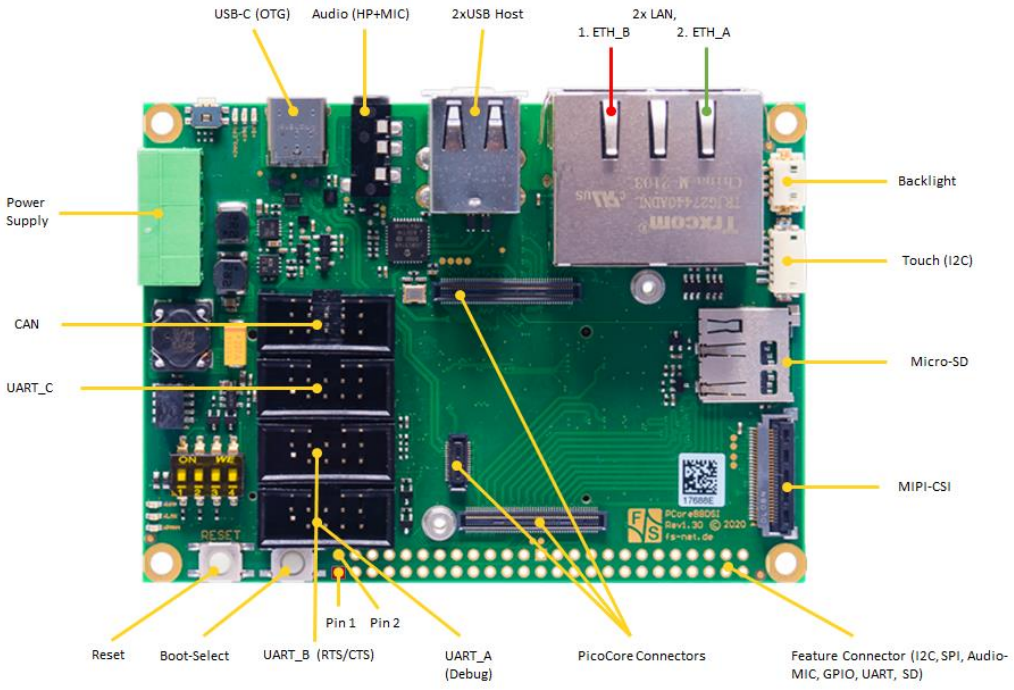

Figure 1: Top side of PicoCoreMX8MP Starterkit baseboard (PicoCoreBBDSI – Rev. 1.30)

Figure 1 shows the connectors available on the top side of the PicoCoreMX8MP SKIT carrier board.

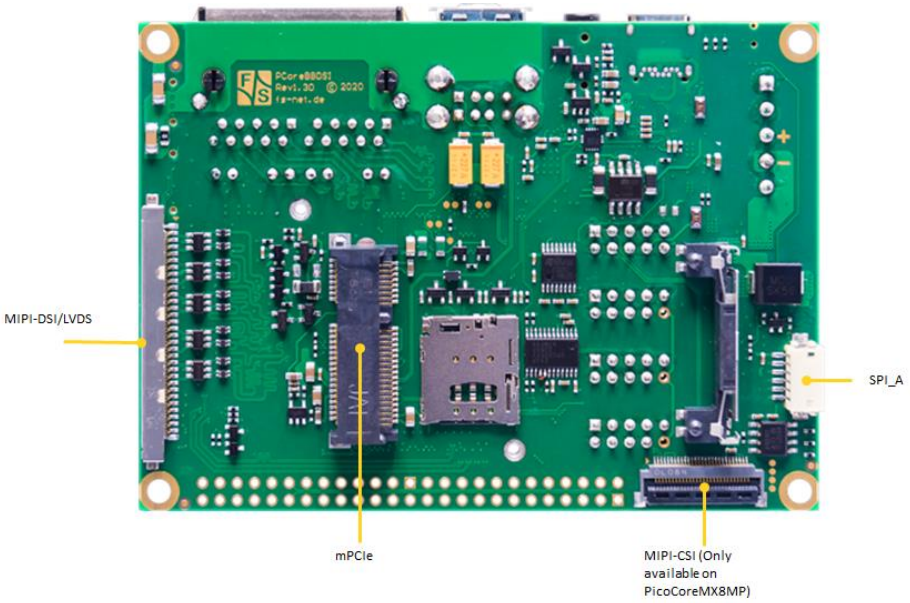

Figure 2: Bottom side of PicoCoreMX8MP Starterkit baseboard (PicoCoreBBDSI – Rev. 1.30)

The connections available from the bottom side of the PicoCoreMX8MP SKIT can be seen in Figure 2.

Figure 3 shows the PicoCoreMX8MP-V4I module.

Figure 3: PicoCoreMX8MP-V4I top and bottom

2.1.2 armStoneMX8MP

The Starterkit includes all components that are required for an initial setup. This includes:

- Cables (Serial, power, USB …).
- Software (source, binaries, install scripts, examples).
- armStoneMX8MP module.

For basic operation please make sure that power and serial debug port are connected correctly.

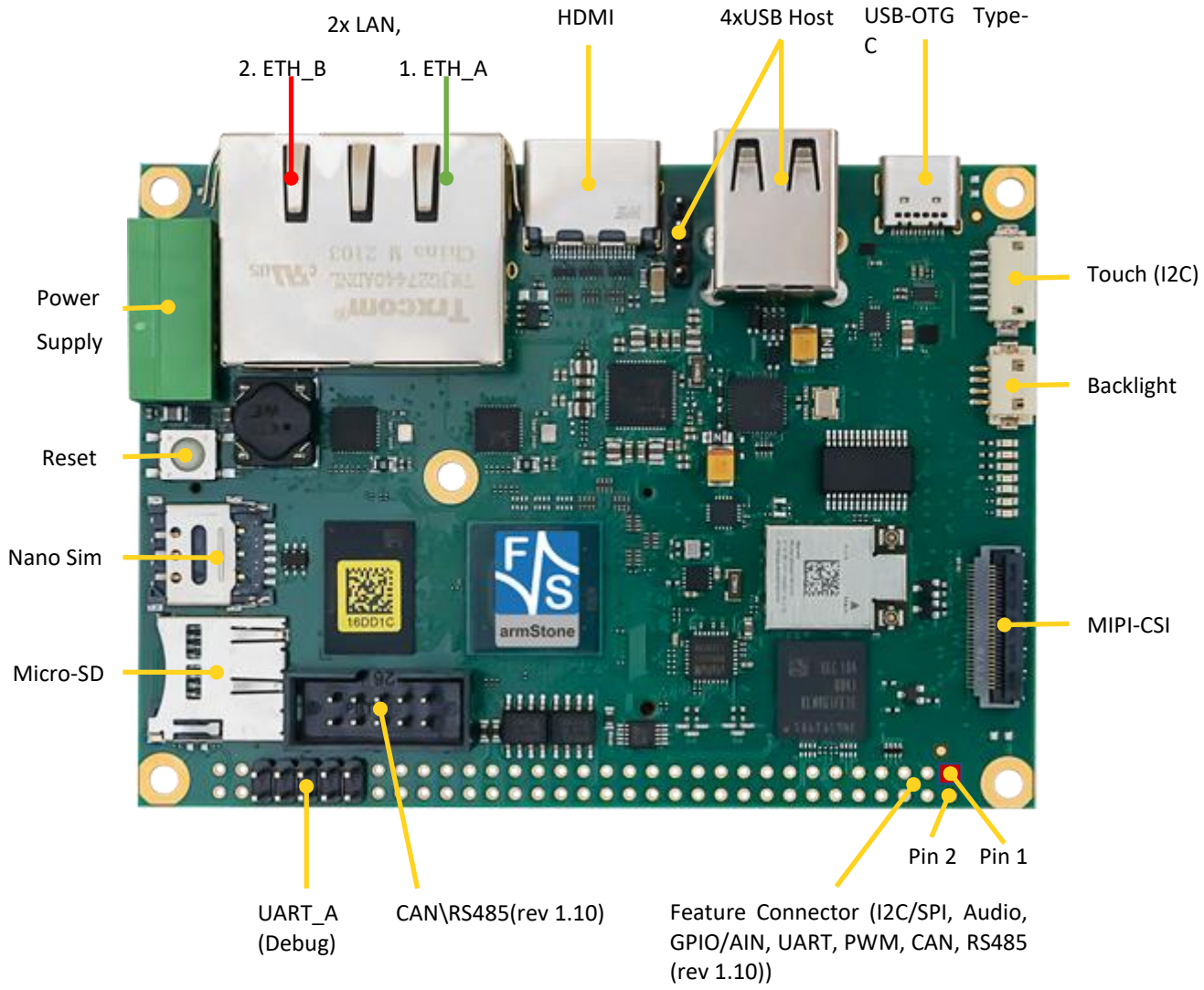

Figure 4: armStoneMX8MP-V4I top

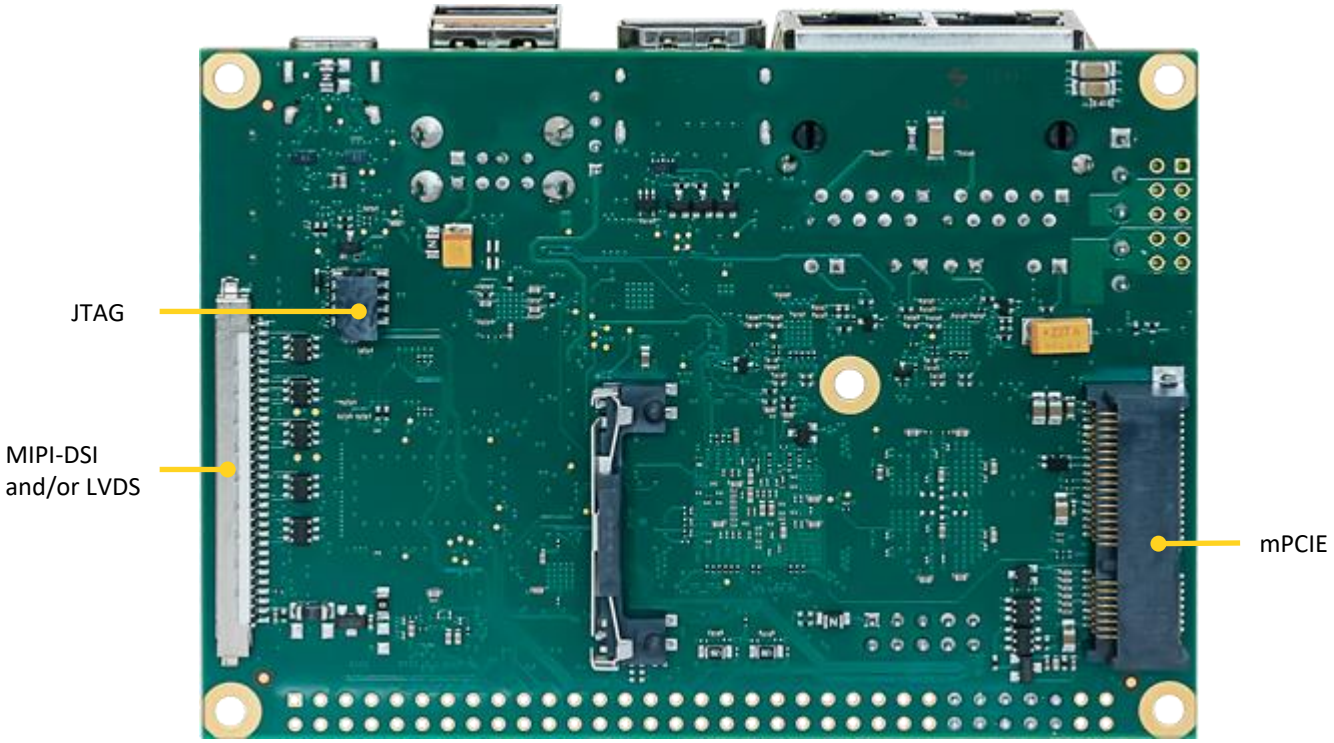

Figure 5: armStoneMX8MP-V4I bottom

2.1.3 efusMX8MP

The Starterkit includes all components that are required for an initial setup. This includes:

- Cables (Ethernet, serial, power, USB, …).
- Software (source, binaries, install scripts, examples).
- Starterkit carrier board that offers connectivity for most interfaces available in efusMX8MP.
- efusMX8MP module.

For basic operation please make sure that power and Serial A debug port are connected correctly.

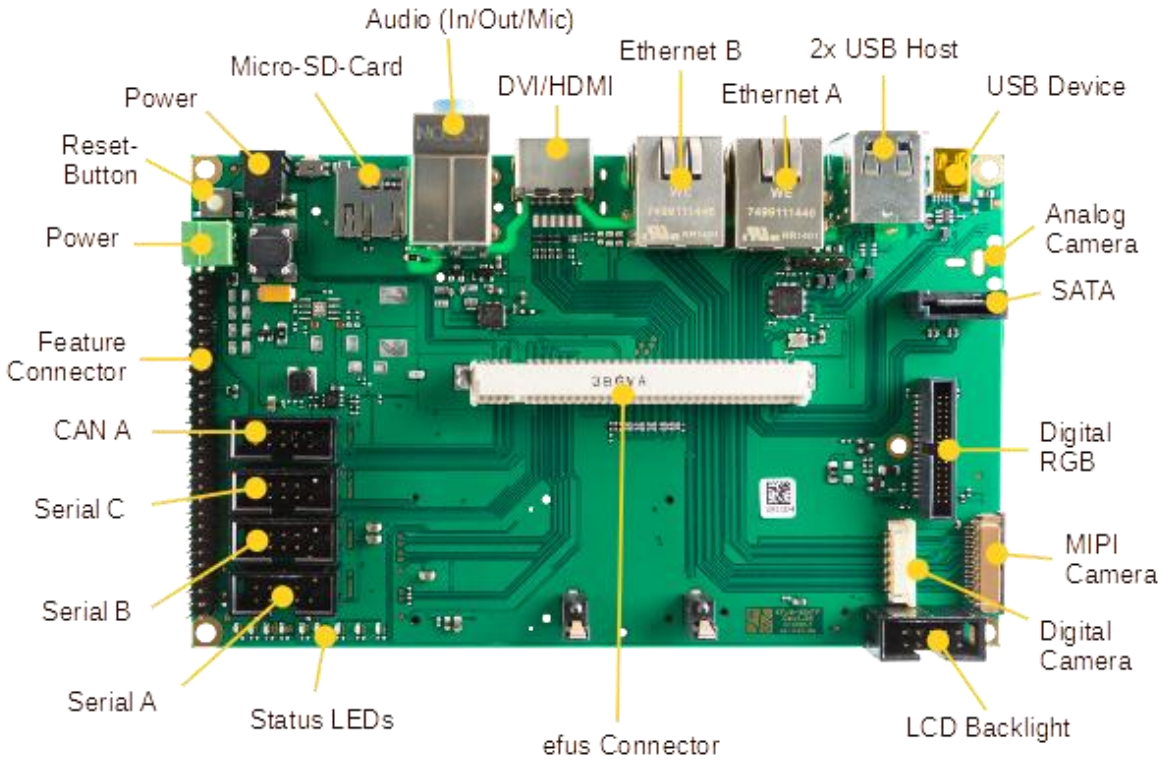

Figure 6: efusMX8MP StarterKit top

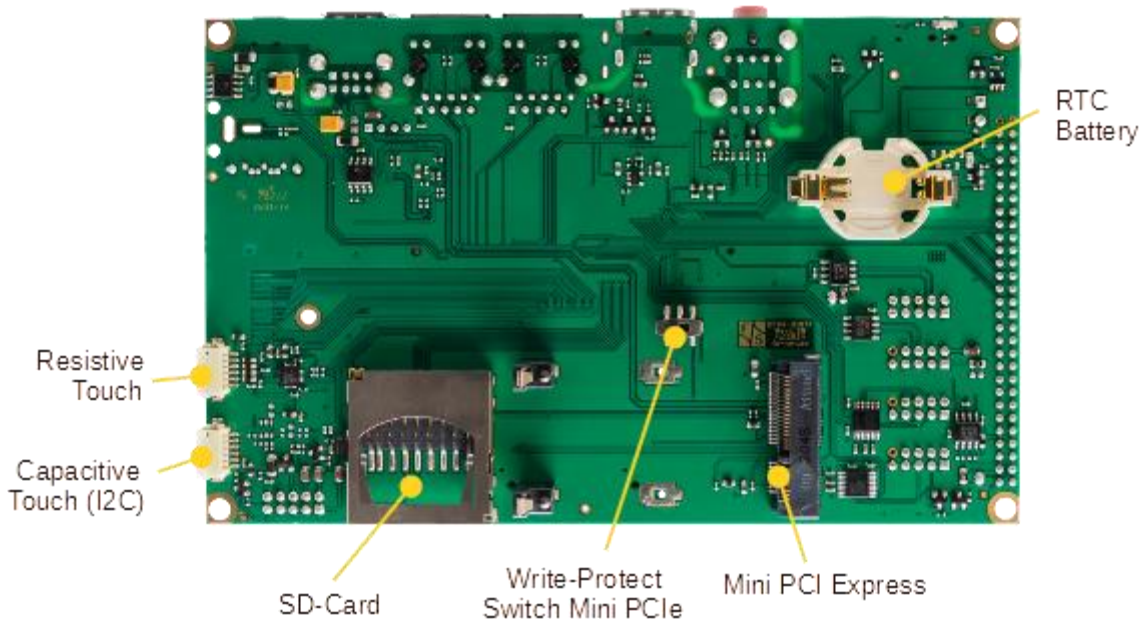

Figure 7: efusMX8MP StarterKit bottom

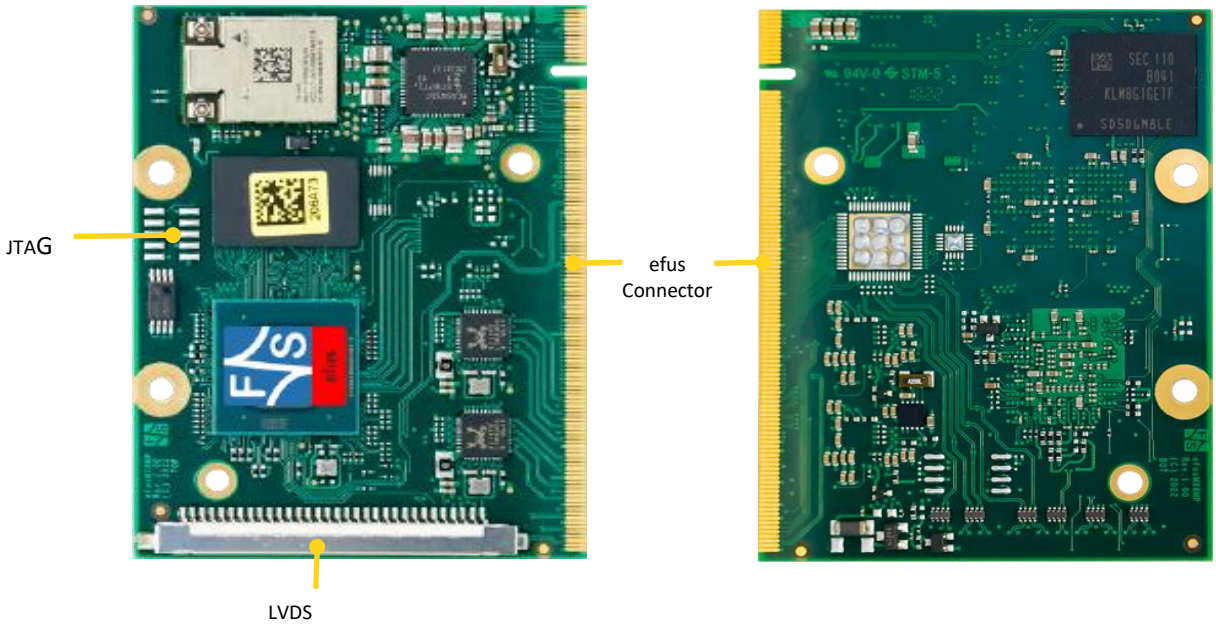

Figure 8: efusMX8MP module top/bottom

2.1.4 SMARCMX8MP

The Starterkit includes all components that are required for an initial setup. This includes:

- Cables (Ethernet, serial, power, USB, …).
- Software (source, binaries, install scripts, examples).
- Starterkit carrier board that offers connectivity for most interfaces available in SMARCMX8MP.
- SMARCMX8MP module.

For basic operation please make sure that power and Serial A debug port are connected correctly.

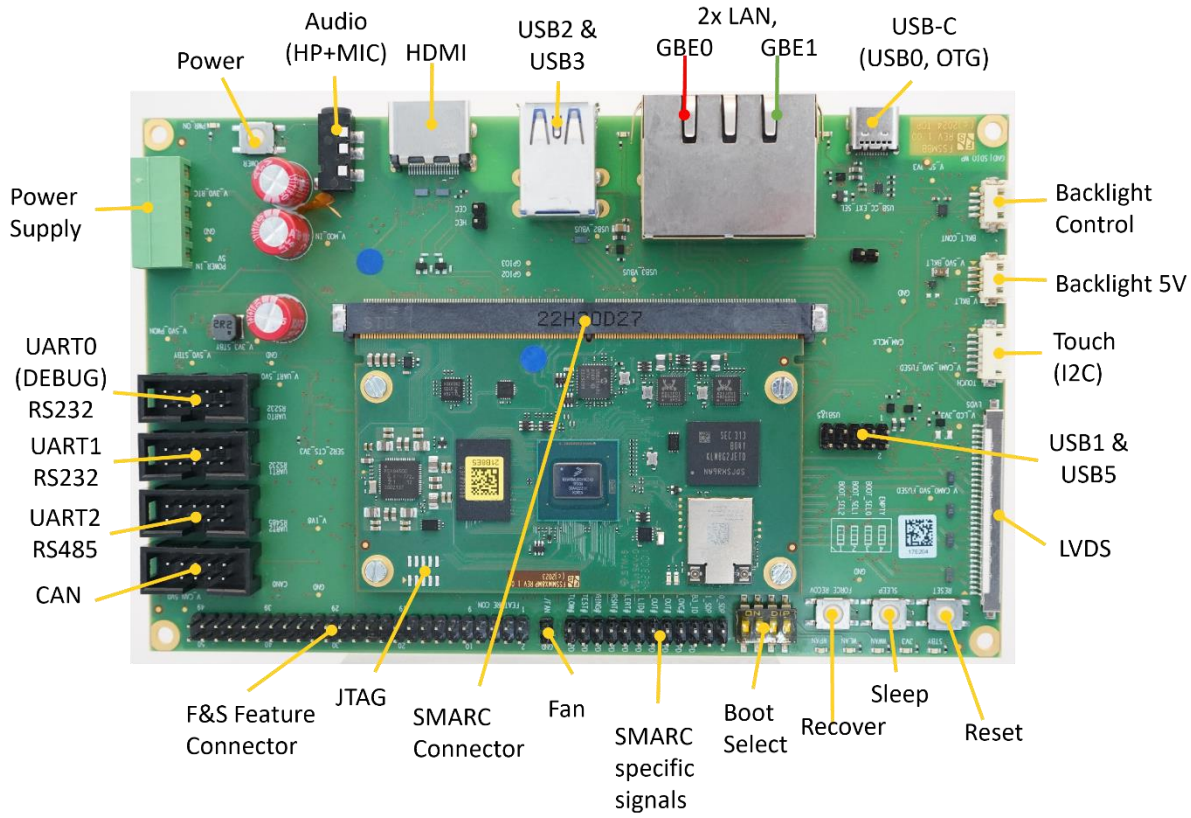

Figure 9 SMARCMX8MP StarterKit top

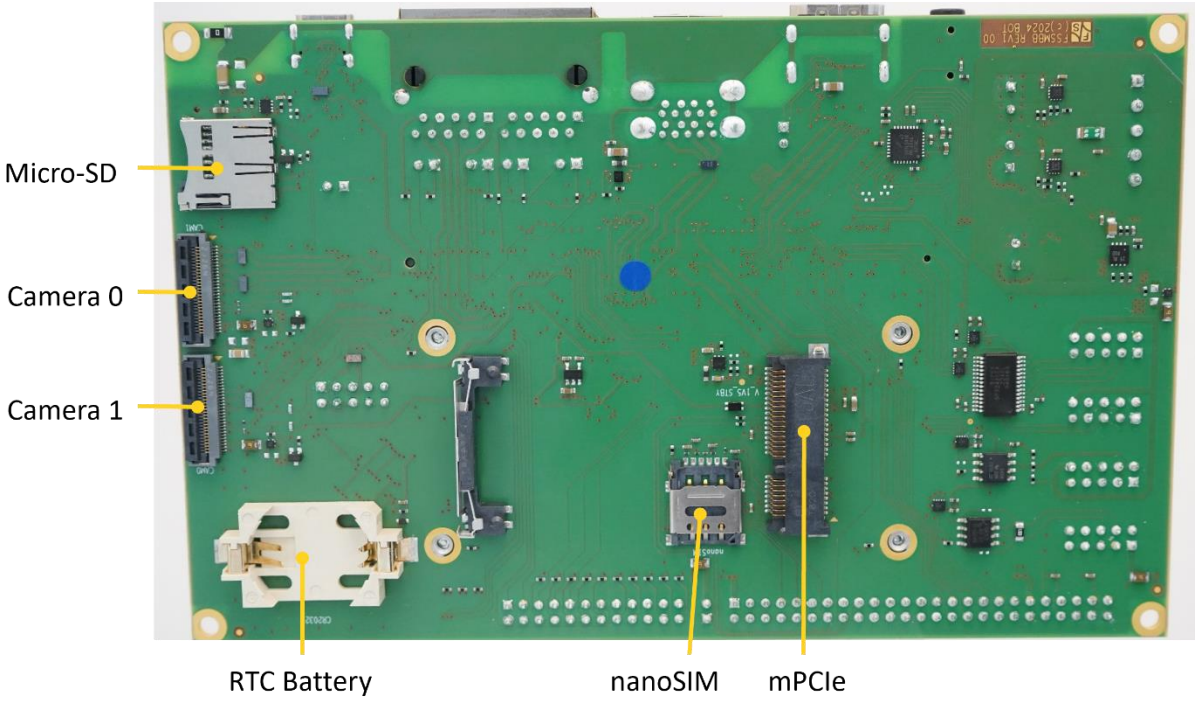

Figure 10 SMARCMX8MP StarterKit bottom

2.2 Serial Connection

To work with the board, you need a serial connection with your PC. Use the provided Null-Modem cable and connect the debug port of the board (or Starterkit baseboard) with the serial port of a PC. Please refer to chapter 2.1 for the location of the COM ports. A serial port is mandatory on your PC, because we control the whole board via the serial port. If your PC does not provide a serial port, you have to either use a USB-to-serial adapter or you need to install a PCIe extension card with a serial port.

Figure 11: Serial connection from board to PC

For a first test, a Linux PC is not necessarily required. You can also use a Windows PC. But later for development, you definitely need a Linux PC, either native or as a Virtual Machine. With a Virtual Machine, you compile your software in Linux but you can still have the serial connection done in Windows and use tools from Windows. This uses the best of both worlds.

On your PC, start a terminal program and open a serial connection to the board. Use 115200 baud, 1 start, 1 stop bit, no flow control. We recommend a terminal program that supports a 1:1 binary download and also supports ANSI Escape Sequences for color and text highlighting. Examples are:

- `TeraTerm` (Windows)
- `PuTTY` (Windows/Linux, does not support 1:1 download)
- `minicom` (Linux, does not support 1:1 download, but not needed in Linux)

F&S also provides a small terminal program for Windows called `DCUTerm`. You can find `DCUTerm` in the Tools-Section of the Download Area (in My F&S). However, `DCUTerm` does not support ANSI Escape Sequences, which means the output of a Linux command like `ls` is nearly unreadable. Instead of different colours for different file types, you will see a mixture of file names and verbatim escape sequences. Also accessing the command history with the up and down arrow keys is not possible in `DCUTerm`. So `DCUTerm` is not suited very well for Linux. However, it supports a 1:1 binary download. So `DCUTerm` is actually a good companion for `PuTTY`. Use DCUTerm for serial downloads and `PuTTY` for everything else.

2.3 Start Board

Connect a power supply to the board. Please refer to chapter 2.1 for the location of the power supply pins. You need to supply +5V.

Now switch on the power supply. Quite immediately the terminal program should show boot messages from the booting Linux system. This will go on for a few seconds and then a login prompt should appear.

```
Welcome to F+S i.MX8MP

fsimx8mp login:
```

Enter `root` to log in. In the default configuration, no password is required.

If everything went well, you can skip the next chapter and proceed with entering Linux commands.

3 Software Installation

When you get a Starterkit from F&S, the Linux system is usually pre-installed and boots to the Linux login prompt right away. In this case you can skip this chapter. But if you are switching over from a different operating system, if you are upgrading from a previous release, or if your board is empty for some other reason, the following sections describe how to install some standard software on your platform.

Here we will only show a very simple automatic installation procedure using an SD card or USB stick and some pre-compiled images from the F&S website. This is the easiest way to get to a running system. Of course, there are other ways to install software, for example via network (TFTP). However, this would go beyond the scope of this First Steps document.

3.1 Download Images From F&S Website

To download any software, go to the F&S main website

http://www.fs-net.de

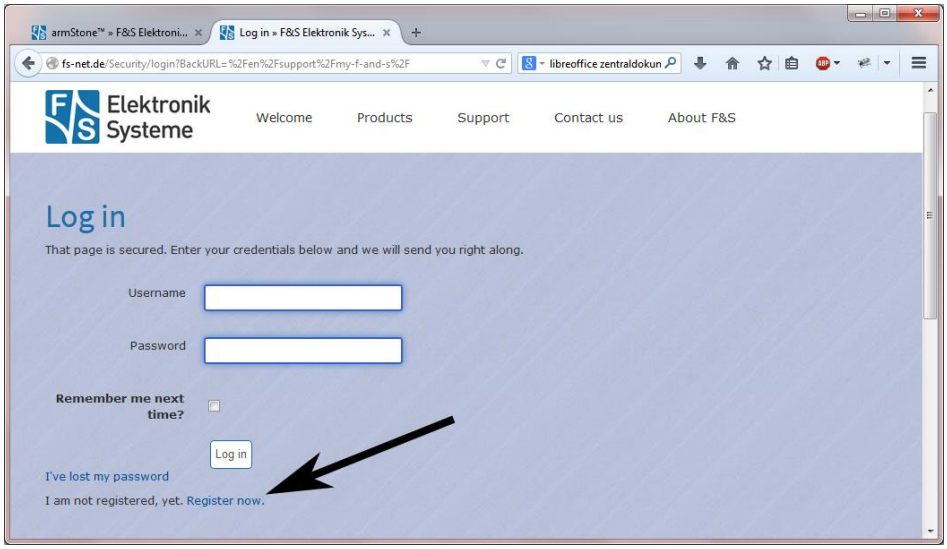

Figure 12: Register with F&S website

To download any software, you first have to register with the website. Click on *Login* right at the top of the window and on the text “I am not registered, yet. Register now” (see Figure 12).

In the screen appearing now, fill in all fields and then click on *Register*. You are now registered and can use the personal features of the website, for example the Support Forum and downloading software.

After logging in, you are at your personal page, called “My F&S”. You can always reach this place by selecting *Support → My F&S* from the top menu. Here you can find all software downloads that are available for you. In the top sections there are private downloads for you or your company (may be empty) and in the bottom section you will find generic downloads for all registered customers.

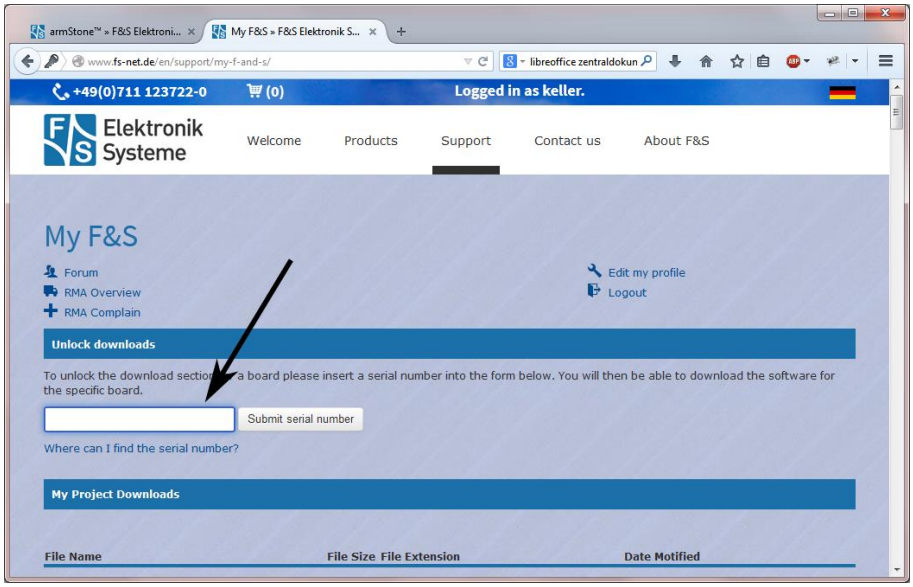

Figure 13: Unlock software with the serial number

To get access to the software of a specific board, you have to enter the serial number of one of these boards (see Figure 13). Click on “Where can I find the serial number” to get pictures of examples where to find this number on your product. Enter the number in the white field and press *Submit serial number*. This enables the software section for this board type for you. You will find Linux, Windows CE, and all other software and tools available for this platform like `DCUTerm` or `NetDCUUsbLoader`.

First click on the type of your board, e.g. PicoCoreMX8MP, then on Linux. Now you have the choice of Buildroot or Yocto. For the first steps here, we will use the newest Yocto release, because this is the software that is also installed on our Starterkits. So click on Yocto. This will bring up a list of all our Yocto releases. Old releases up to 2018 had V<x>.<y> as version identifier, new releases use Y<year>.<month>. We will abbreviate this as <v> from now on. Select the newest version, for example *fsimx8mp-Y2021.06*. This will finally show two archives that can be downloaded.

When you look at our Linux releases, you will find a list of all our releases and a README text. There are usually a file related to a release.

`fsimx8mp-<v>.tar.bz2` . . . . . This is the main release itself containing all sources, the binary images, the documentation and the toolchain in case of buildroot.

`sdcard-fsimx8mp-<v>.tar.bz2` Files that can be stored on an SD Card or USB stick to allow for easy installation.

For now we will only need the SD card archive. This archive contains some pre-compiled images of bootloaders, Linux kernel, device trees and root filesystem. It is compressed with bzip2. To see the files, you first have to unpack the archive, for example in Linux with

```
tar xvf sdcard-fsimx8mp-<v>.tar.bz2
```

This will create a directory `<arch>-<v>` that contains all files of the release. They often use a common naming scheme:

`<package>-<platform>-<v>.<extension>`

With the following meaning:

<package>	The name of the package (e.g. uboot, linux, rootfs). If it is a source package, we also add the version number of the original package that our release is based on, for example linux-5.4.70
<platform>	The name of a board, if the package is only valid on one board (e.g. PicoCoreMX8MP); or the name of an architecture, if the package is valid on different boards of the same architecture (e.g. fsimx8mp), or the string f+s or fus if the package is architecture independent.
<v>	Release version, consisting of a letter (B for Buildroot based releases, Y for Yocto based releases) and the year and month of the release (e.g. Y2021.06)
<extension>	The extension of the package (e.g. .bin, .tar.bz2, etc.). Please note that some file types do not have an extension, for example the Image file of the Linux kernel.
<bootdev>	The bootdev means on which boot medium the board is booting. At the moment we support either “nand” or “sd”.

The following table lists the files that you get after unpacking the release archive. Entries in green are only part of a Yocto release.

Note

Please take care that Buildroot BSP release is currently not available.

To avoid having a too excessive list, we use the wildcard * in some entries to refer to a whole group of similar file names that only differ in the name of the board or module.

Directory/File	Description
/	**Top directory**
`Readme-yocto-f+s.txt`	Release information (Yocto)

Directory/File	Description
setup-yocto	Script to unpack Yocto source packages to a build directory
binaries/	**Images to be used with the board directly**
nboot-<arch>-<v>.fs	N-Boot image
uboot-<arch>-<v>.fs	U-Boot image
Image-<arch>-<v>	Linux kernel image
fus-image-std-<arch>-<v>.ext4	Standard root filesystem (EXT4 format)
fus-image-std-<arch>-<v>.sysimg	SD card image
install-<arch>-<v>.scr	Install script for U-Boot (mkimage format)
*-<v>.dtb	Device trees, one file for each board
sdcard/	**Files to copy to SD card**
emmc-<arch>.sysimg	SD card image
install.scr	Install script for U-Boot, name as expected by install script without version number
dl/	**Additional packages for Yocto**
*	If there are additional packages required for Buildroot or Yocto, they will appear here
doc/	**Documentation**
<boardname>-<document>_eng.html	Link to download documentation
<arch>-FirstSteps_eng.pdf	First Steps document
LinuxOnFSBoards_eng.pdf	The Linux environment on F&S boards and modules

Table 3: Content of the created release directory

3.2 Install Kernel, Device Tree and Root Filesystem

Remark

Boards with i.MX8M-Plus should have at least U-Boot installed. If U-Boot is missing for some reason, it requires a more complicated setup including a USB tool to download some software. This is not handled in this First Steps document.

Insert the installation device into the board or Starterkit baseboard. The remaining installation is fully automatic and is done by U-Boot. Simply switch on the board. This will show something like this:

```
U-Boot 2020.04 (Nov 22 2022 - 08:17:58 +0000) for F&S

CPU:   i.MX8MP[8] rev1.1, 1600 MHz (running at 1200 MHz)
CPU:   Industrial temperature grade (-40C to 105C)
Reset: POR
Model: PicoCoreMX8MPr2
Board: PicoCoreMX8MPr2 Rev 1.00 (2x LAN, WLAN, eMMC, 1x DRAM)
DRAM:  2 GiB
TCPC:  Vendor ID [0x1fc9], Product ID [0x5110], Addr [I2C2 0x52]
MMC:   FSL_SDHC: 0, FSL_SDHC: 2
Loading Environment from MMC... OK
In:    serial
Out:   serial
Err:   serial

 BuildInfo:
  - ATF 1842d08
  - U-Boot 2020.04

flash target is MMC:2
Net:   eth1: ethernet@30be0000, eth0: ethernet@30bf0000 [PRIME]
Fastboot: Normal
Normal Boot
Hit any key to stop autoboot:  3
```

The number in the last line will count down to zero, then the installation procedure will start. The files are loaded from the installation media and are stored in eMMC flash on the board. When the installation is over, you will see the following line.

```
Installation complete
Please set/verify ethernet address(es) now and call saveenv
```

3.3 Set MAC Address

When we erased the U-Boot environment including the MAC address for the Ethernet chip. We have to set it again now and save it permanently.

The MAC address is a unique identifier for a network device. Each network device has its own address that should be unique across the whole world. So each network port on each board needs a unique MAC address.

Figure 14: Barcode sticker

A MAC address consists of twelve hexadecimal digits (0 to 9 and A to F), that are often grouped in pairs and separated by colons. The first six digits for F&S boards are always the same: 00:05:51, which is the official MAC address code for the F&S company. The remaining six digits can be found on the bar-code sticker directly on your board (see Figure 14).

The full MAC address for this example would be 00:05:51:07:93:4B. If your board supports two ethernet ports, you need two MAC addresses. The second one is the first one plus 1, i.e. 00:05:51:07:93:4C.

The following two commands will set the MAC addresses and stores the current environment (including the newly set MAC addresses) in NAND flash. Of course you have to replace `xx:yy:zz` with the six hex digits from the bar-code sticker on your board (and xx:yy:vv with the six hex digits plus 1).

```
PicoCoreMX8MP # setenv ethaddr 00:05:51:xx:yy:zz
PicoCoreMX8MP # setenv eth1addr 00:05:51:xx:yy:vv
PicoCoreMX8MP # saveenv
```

Warning

If you do not set this unique address, a default address is used that is the same for all boards of this type. This will definitely lead to problems in real networking scenarios.

3.4 Restart Board

Installation is complete. To check if everything was done correctly, restart the board. You can either enter U-Boot command, …

```
reset
```

… or press the reset button, or simply switch the power off and on again. Like in chapter 2.3, the terminal program should show boot messages from the booting Linux system. This will go on for a few seconds and then a login prompt should appear.

```
Welcome to F+S i.MX8MP

fsimx8mp login:
```

Enter `root` to log in. In the default configuration, no password is required. If this is still not working, you should repeat the steps from the whole chapter.

4 Next Steps

With iMX8 processor series from NXP, we have other processor platform compared to iMX6. Currently we use NXP core as basis for our BSP, but we are working on new concepts to bring our iMX6, 7 and 8 platforms together. For this reason not all information's from our generic documentation `LinuxOnFSBoards_eng.pdf` can be used for iMX8 processors.

However we recommend having a look at this documentation because it will show you the ideas and concepts behind the F&S Linux environment and how you can work efficiently with these boards.

We are continuously working on our documentation so please visit our homepage or forum for more new information's.

4.1 F&S Workshops

F&S also offers several workshops. Especially if you are new to working with embedded boards or even new to Linux, we recommend visiting the workshop "Linux on F&S Modules". Working with an embedded system is quite different to working with a desktop Linux. This workshop will show you a basic introduction to Linux, how to use NBoot, U-Boot and Linux on an F&S board, how to compile the system software, how to download files to the board, and how to write your own programs. The workshop lasts four hours and takes place in Stuttgart at the F&S company building. It may save you many hours of reading, trying, and even frustration.

Additional workshops are available for working with Buildroot, Asymmetric Multiprocessing, Secure Boot, Working with GIT. Please look at our website for any additional offerings.

4.2 Further Information

Many additional resources of information are available on the F&S website.

Document	Description
`AdvicesForLinuxOnPC.pdf`	Explains how to install server software and tools on a Linux development PC that is used with F&S Linux boards.
`*-GPIO-Reference-Card_eng.pdf`	Lists all pins of the board and which GPIO number needs to be used in Linux
`*_Hardware_eng`	Hardware documentation; there are separate documents for each board and also for the Starterkit baseboards. F&S also offers Eagle layout files for some of our Starterkits.

Table 4: Important documents, available on the F&S website

We do not include all these documents in the release to make sure that you always get the newest version when you start. The following sections give direct links to important places like documentation and add-ons.

A good source for information is also our internet forum. If you have any questions or specific problems, please feel free to go to: https://forum.fs-net.de/.

4.2.1 Resources for PicoCoreMX8MP

Hardware documentation for PicoCoreMX8MP module itself, Starterkit baseboard, including schematics:

https://fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx8mp-nxp-imx8m-plus-cpu/#panel-6

Available accessories, adapters and extensions:

https://fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx8mp-nxp-imx8m-plus-cpu/#panel-4

4.2.2 Resources for armStoneMX8MP

Hardware documentation for armStoneMX8MP

https://fs-net.de/en/embedded-modules/single-board-computer-armstone/armstonemx8mp/#panel-6

Available accessories, adapters and extensions:

https://fs-net.de/en/embedded-modules/single-board-computer-armstone/armstonemx8mp/#panel-4

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Important Notice

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