F&S i.MX91/93 Linux

First Steps

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About This Document

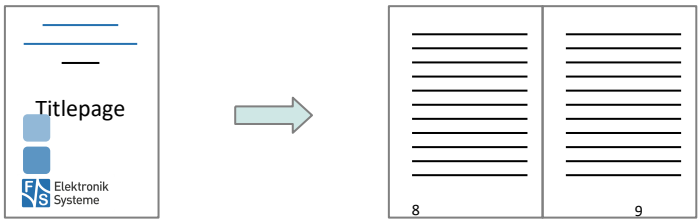
This document shows how to bring up F&S boards and modules under Linux, how to update firmware and how to use the system and the devices. It covers also compiling bootloader, Linux kernel and root filesystem as well as how to build your own applications for the device.

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
2024-03-19	1.0	fsimx93	A	ALL	Based on fsimx8ulp V1.0	AD
2024-09-09	1.1	fsimx93	A, M	2.1-2.4, 3.1-3.3, 4.11, 5.2.2	Add section Dockefile and changes because of new hardware revision Add OSM Starterkit	AD/ SC
2024-10-24	1.2	fsimx93	M	2.5	Add efus Starterkits	SC
2025-02-25	1.3	fsimx93	A,M,R	3.1.5, 3.1.6, 5.2.3	Update Deployment and Build for new Release Update Resources for EFUSMX93	SC
2025-09-02	1.4	fsimx93	R M	4 3	Move chapters to Linux on F&S Boards Adapt to other getting stated	PG PG
2026-02-27	1.5	fsimx93	A	2..4	Add Chapter for PicoCOM93	PG
2026-09-03	1.6	fsimx93	A	2.5	Add Chapter for NetDCU93	SC
2026-10-06	1.7	fsimx91/93	M	2.1 - 2.4, 4..2.1 - 4.2.7,	Add reference to fsimx91	SC

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

Table of Contents

1 Introduction 1

1.1 F&S Board Families and CPU Architectures 1

1.2 Scope of This Document 2

2 Setting up the Board 3

2.1 PicoCoreMX91/93 - Starterkit 3

2.2 FS 91/93 OSM-SF – Starterkit 5

2.3 efusMX91/93 5

2.4 PicoCOM93 8

2.5 NetDCU93 9

2.6 Serial Connection 11

2.7 Start Board 12

3 Software Installation 13

3.1 Download Images From F&S Website 13

3.2 Install Kernel, Device Tree and Root Filesystem 15

3.3 Set MAC Address 17

3.4 Restart Board 17

4 Next Steps 19

4.1 F&S Workshops 19

4.2 Further Information 19

4.2.1 Resources for PicoCoreMX93 20

4.2.2 Resources for PicoCoreMX91 20

4.2.3 Resources for FS 93 OSM-SF 20

4.2.4 Resources for FS 91 OSM-SF 20

4.2.5 Resources for efusMX93 21

4.2.6 Resources for PicoCOM93 21

4.2.7 Resources for NetDCU93 21

5 Appendix 22

5.1 List of Figures 22

5.2 List of Tables 22

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). For new projects there are different board families that are named armStone, efus, OSM, PicoCore, SMARC and SolderCore.

Family	Type	Size
armStone	Single Board Computer	100 mm x 72 mm (PicoITX)
efus	System on Module	62 mm x 47 mm
OSM	BGA System on Module SGeT	30 mm x 30 mm
PicoCore	System on Module	40 mm x 35 mm
SMARC	System on Module SGeT	82 mm x 50 mm
SolderCore	BGA System on Modul	35 mm x 35 mm

Table 1: F&S Board Families

Linux is available for all 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 different families.

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

Architecture	CPU	Platforms
fsimx6	NXP i.MX6	efusA9, QBlissA9, QBlissA9r2, armStoneA9, armStoneA9r2, PicoMODA9, NetDCUA9
fsimx6sx	NXP i.MX6-SoloX	efusA9X, PicoCOMA9X, PicoCoreMX6SX
fsimx6ul	NXP i.MX6-UltraLite	efusA7UL, PicoCOM1.2, PicoCoreMX6UL
fsimx7ulp	NXP i.MX7ULP	PicoCore
fsimx8mm	NXP i.MX8MM	PicoCore, OSM
fsimx8mp	NXP i.MX8MP	armStone, efus, PicoCore, SMARC
fsimx8ulp	NXP i.MX8ULP	OSM, PicoCore, SolderCore
fsimx91	NXP i.MX91	OSM, efus, PicoCore, PicoCOM , NetDCU
fsimx93	NXP i.MX93	OSM, efus, PicoCore, PicoCOM , NetDCU

Table 2: F&S Architectures

1.2 Scope of This Document

This document describes the *fsimx91 and fsimx93* architecture. That means all F&S boards and modules based on the NXP i.MX91 and i.MX93 SOC. The steps in this document will help you get 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 fsimx91 and *fsimx93* architecture and show the location of all connectors, especially the debug port.

2.1 PicoCoreMX91/93 - Starterkit

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 PicoCoreMX91/93.
- PicoCoreMX91/93 module.

For basic operation please make sure that the Serial Debug Port and power are connected correctly.

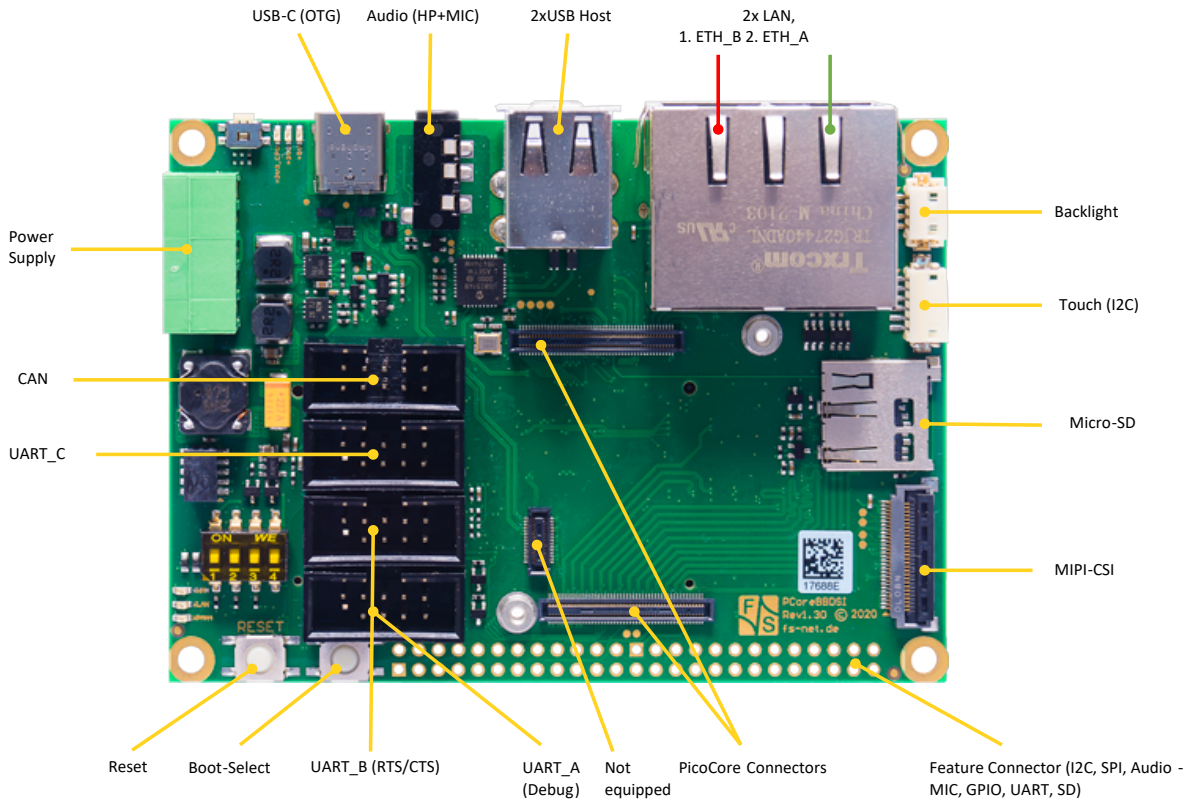


Figure 1: PicoCoreBBDSI Starterkit Top Side (PicCoreBBDSI – Rev. 1.30)

Figure 1 shows the connectors available on the top side of the PicoCoreMX93 SKIT carrier board.

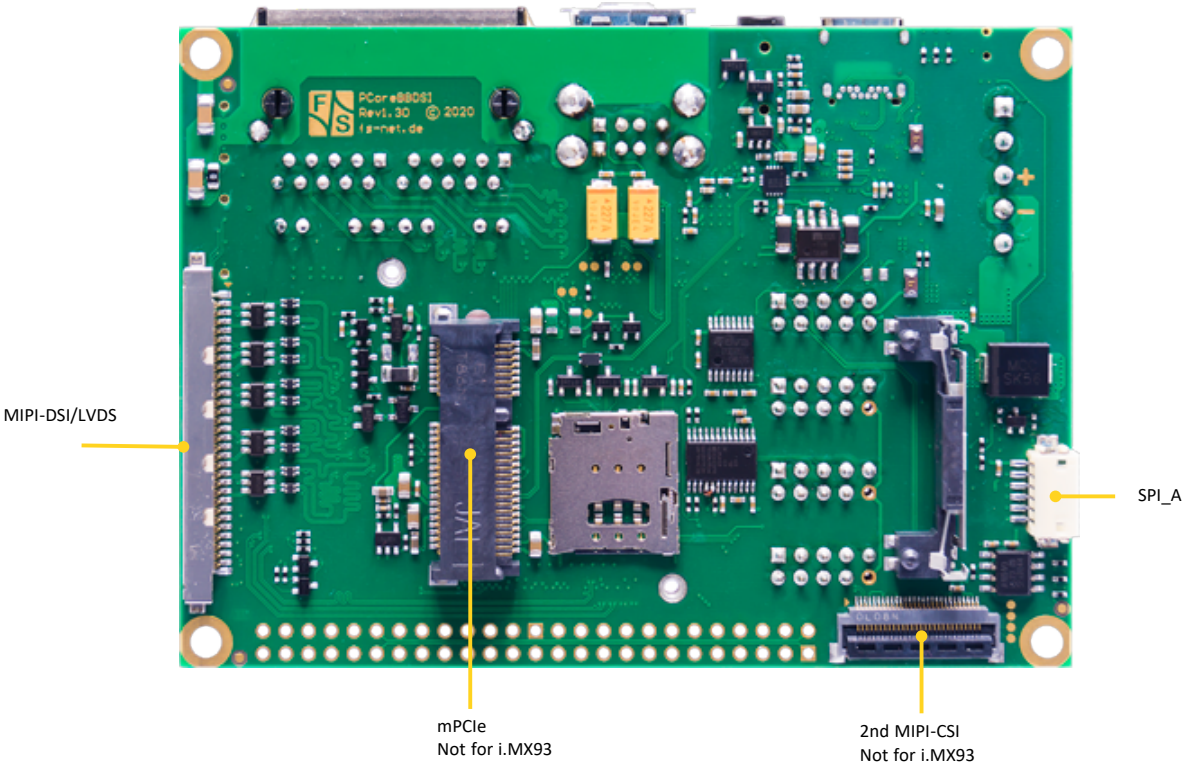


Figure 2: PicoCoreBBDSI Starterkit Bottom Side (PicCoreBBDSI – Rev. 1.30)

The connectors available from the bottom side of the PicoCoreMX93 SKIT can be seen in the Figure 2

Figure 3 shows the PicoCoreMX93 module.

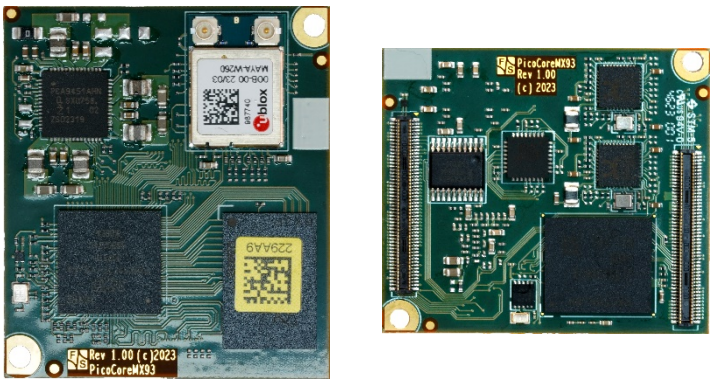


Figure 3: PicoCoreMX93 top and bottom view

2.2 FS 91/93 OSM-SF – Starterkit

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 ADP-OSM-BB.
- FS-91/93-OSM-SF soldered on ADP-OSM-BB.
- ADP-OSM-BB is the carrier for all OSM-SF Modules.
  It provides compatible Interfaces to PicoCoreBBDSI.

For basic operation please make sure that the Serial Debug Port and power are connected correctly.

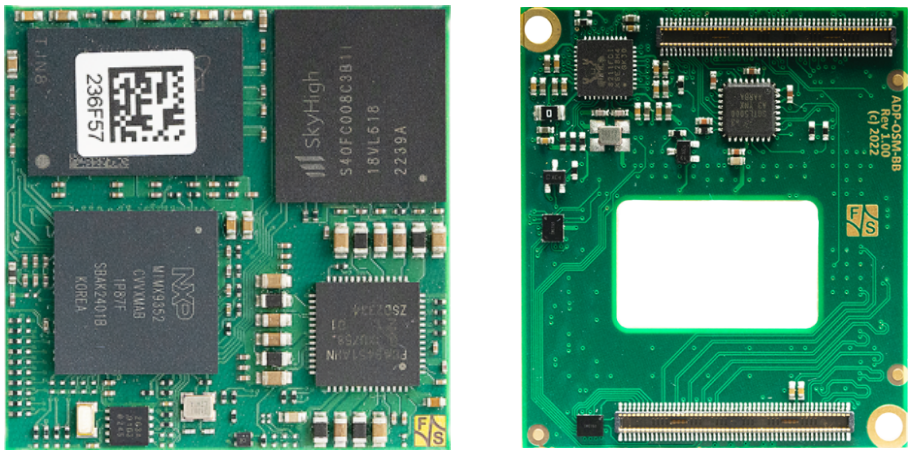


Figure 4: FS 93 OSM-SF and ADP-OSM-BB

2.3 efusMX91/93

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 efusMX93.
- efusMX93 module.

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

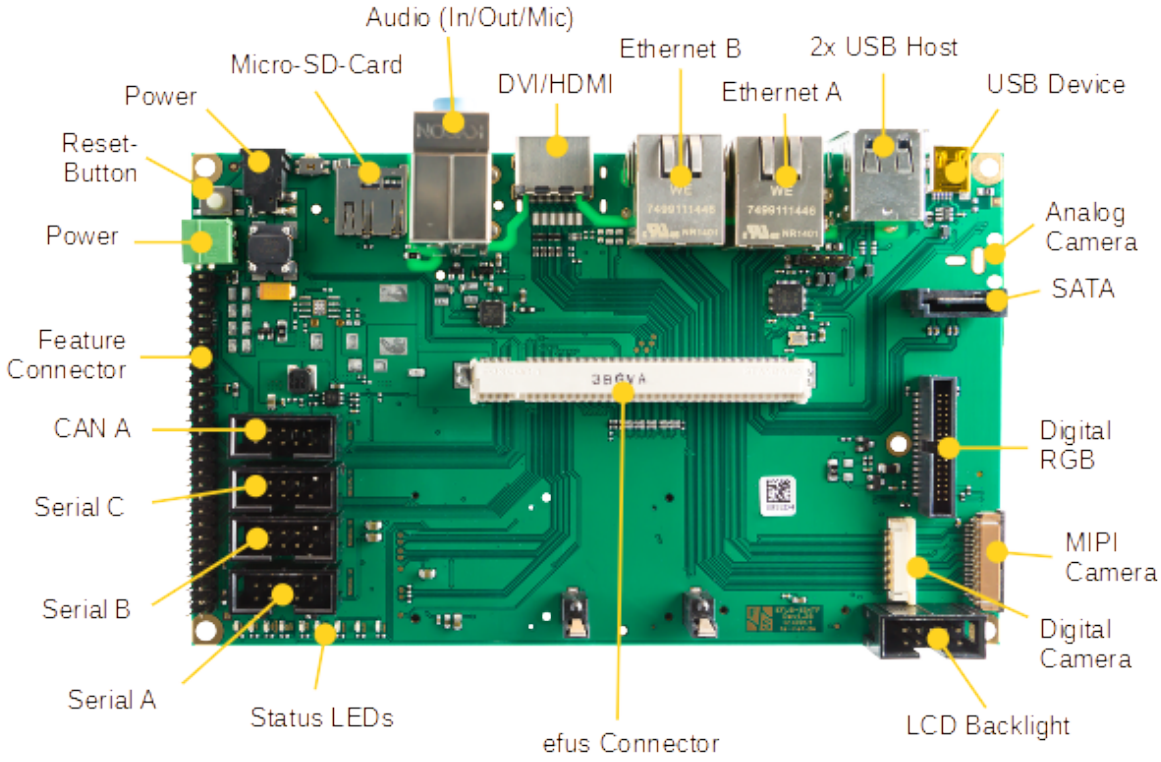


Figure 5: efusMX93 Starterkit top

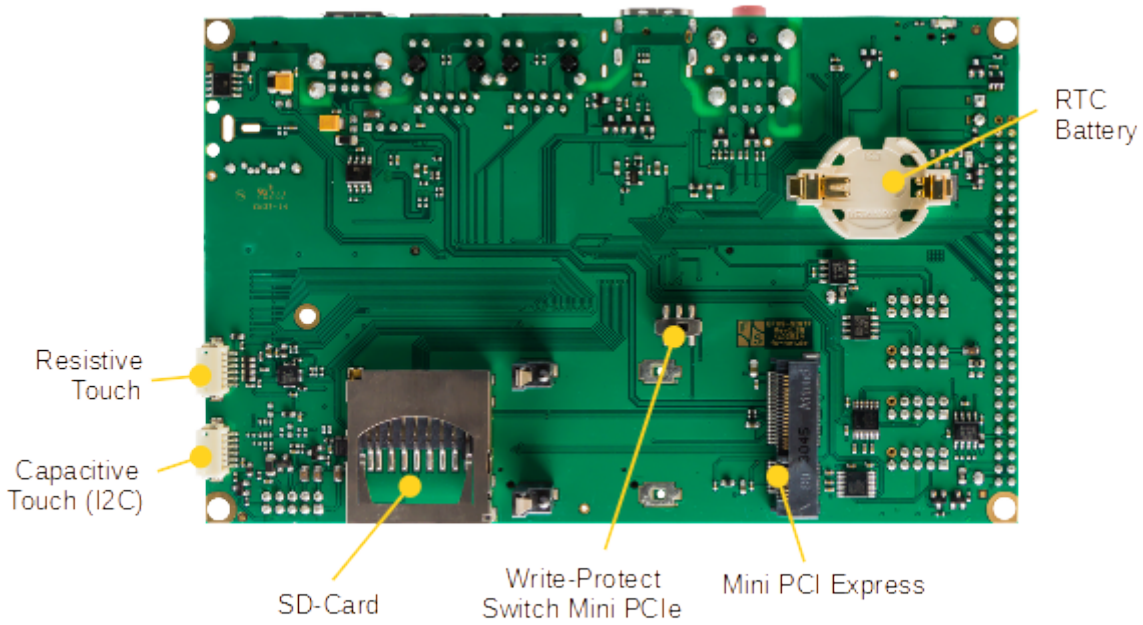


Figure 6: efusMX93 Starterkit bottom

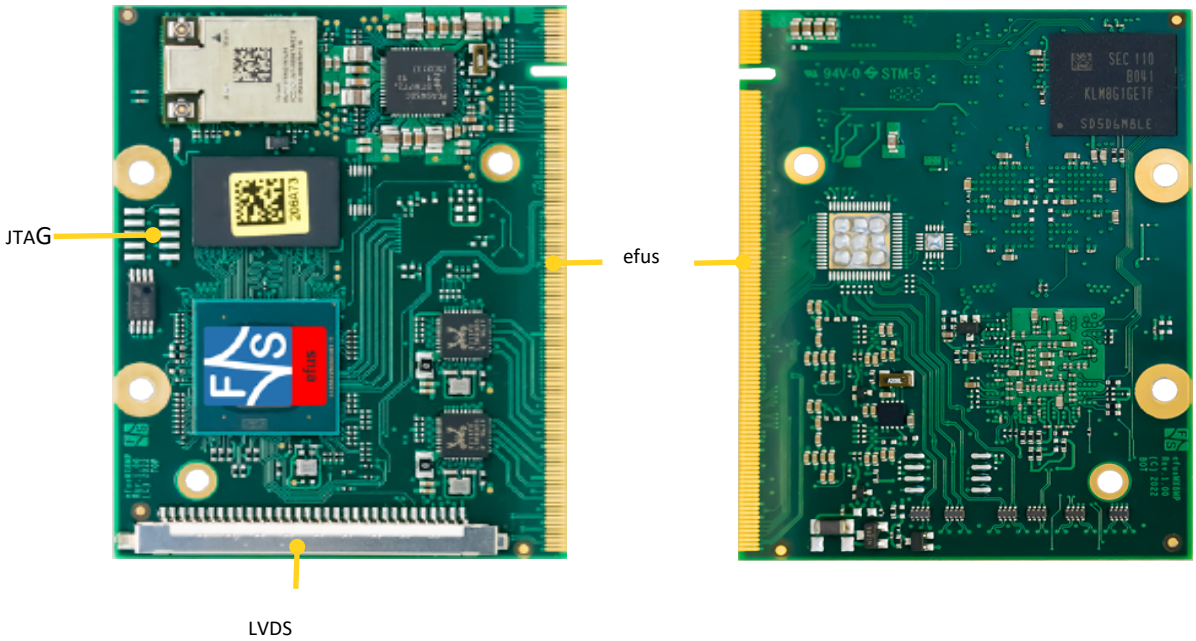


Figure 7: efusMX93 module top/bottom

2.4 PicoCOM93

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 PicoCOM93 interfaces.
- PicoCOM93 module.

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

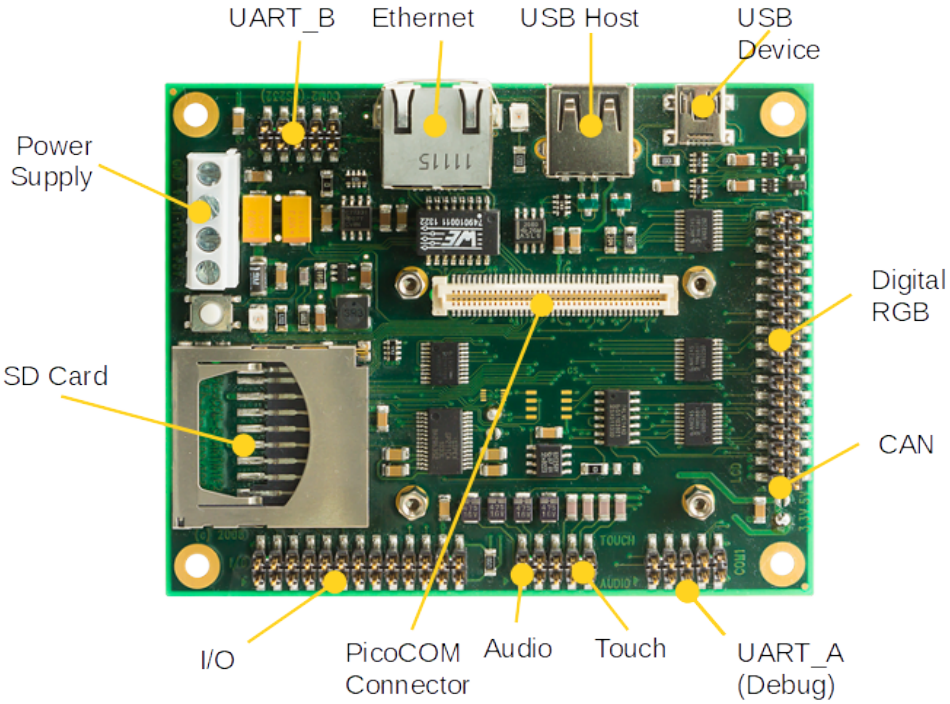


Figure 8 PicoCOM STARTINTF2 Starterkit

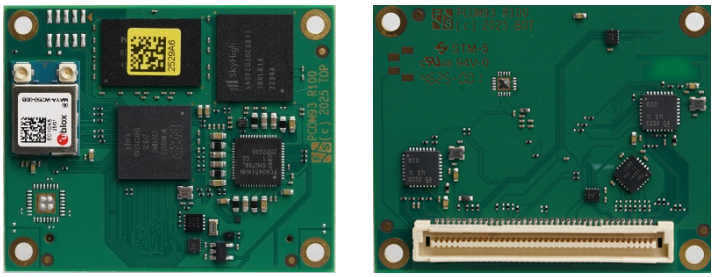


Figure 9 PicoCOM93

2.5 NetDCU93

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 NetDCU93 interfaces.
- NetDCU93 module.

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

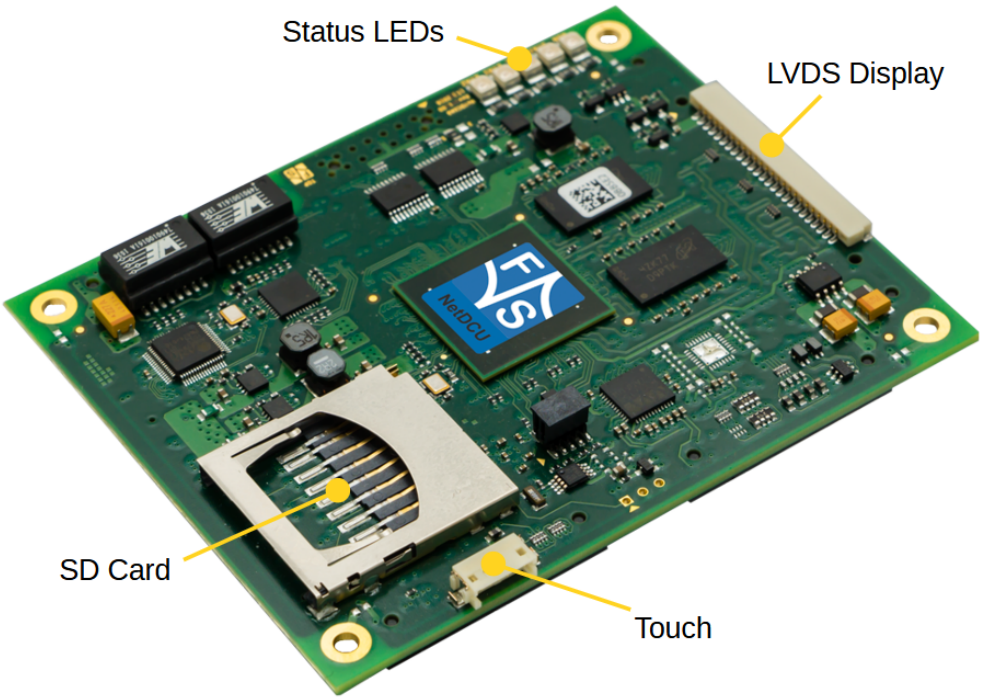


Figure 10: NetDCU93

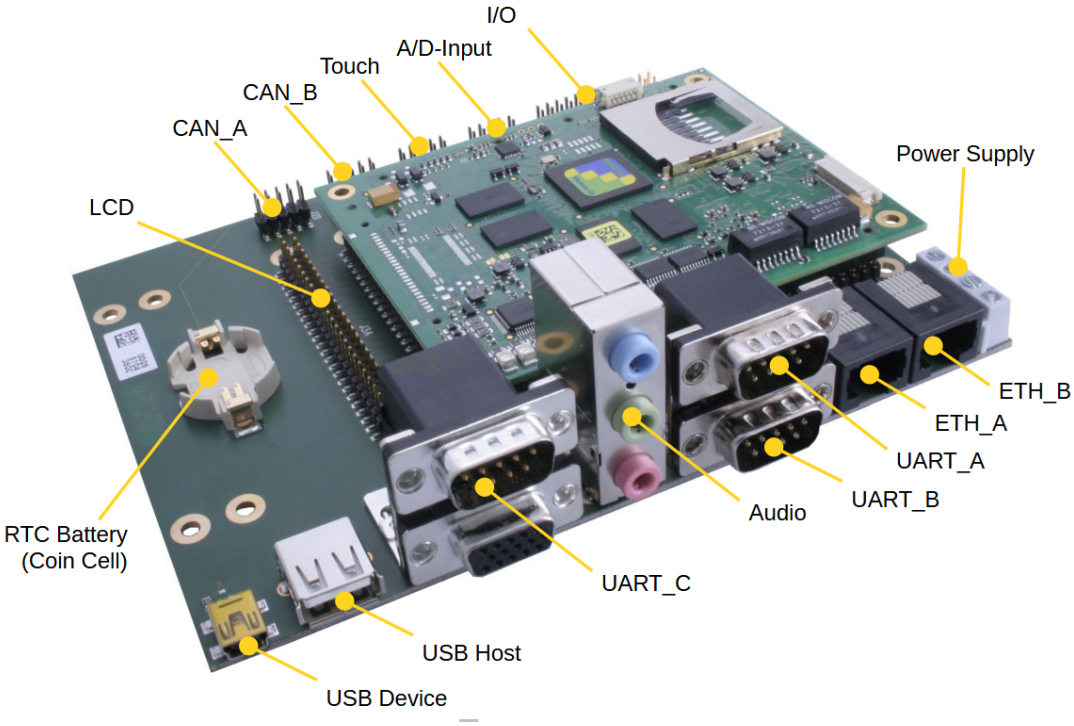


Figure 11: Starterkit with NetDCU

More detailed information about connectors available on NetDCUA93 can be found in the “Hardware documentation for NetDCU-SINTF-14”.

2.6 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 must either use a USB-to-serial adapter or you need to install a PCIe extension card with a serial port.

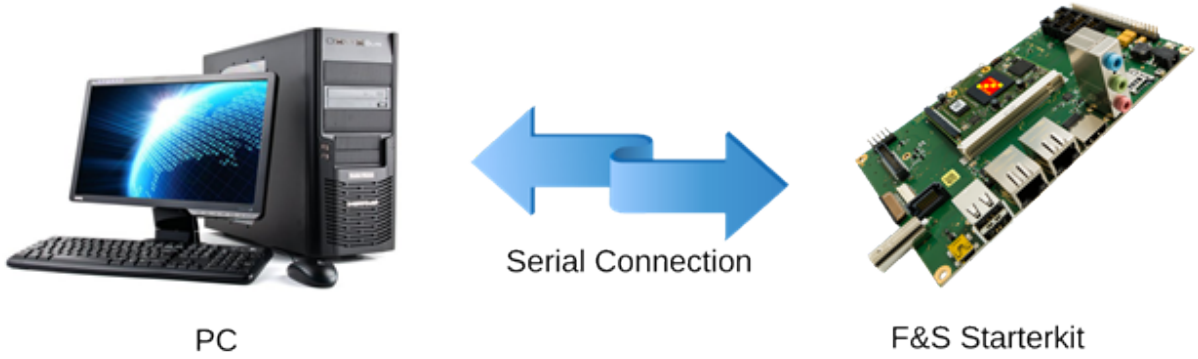


Figure 12: Serial connection from board to PC

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)

2.7 Start Board

Connect a power supply to the board. Please refer to section 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.

```
FUS i.MX Release Distro 5.0 fsimx93 ttyLP0
fsimx93 login:
```

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

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

https://www.fs-net.de/en/support/my-f-and-s

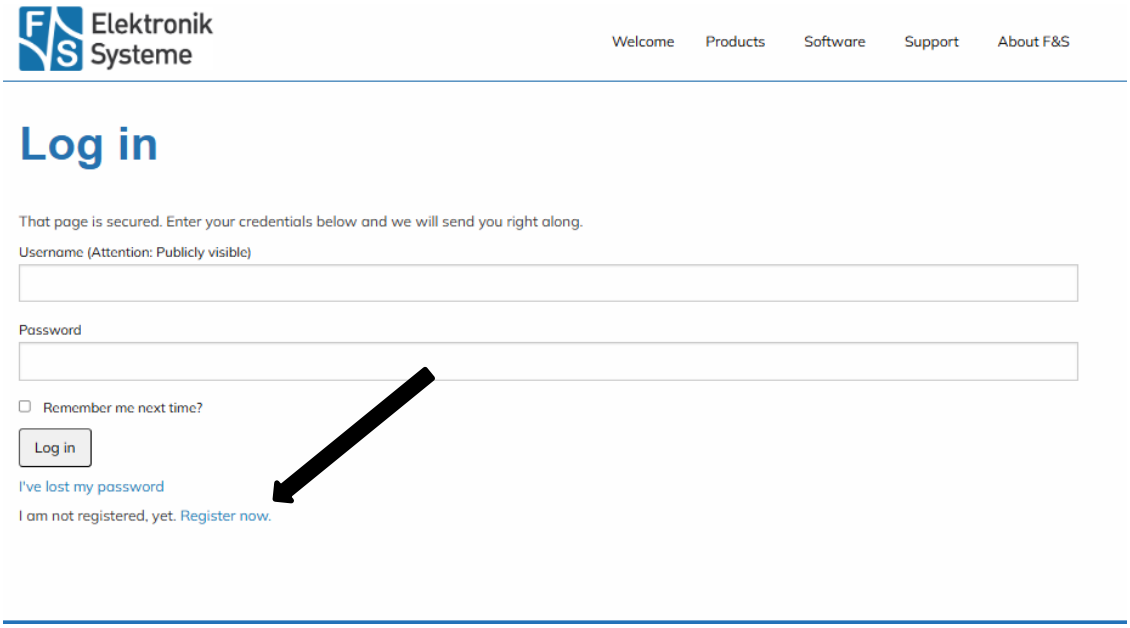


Figure 13 Register with F&S website

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.

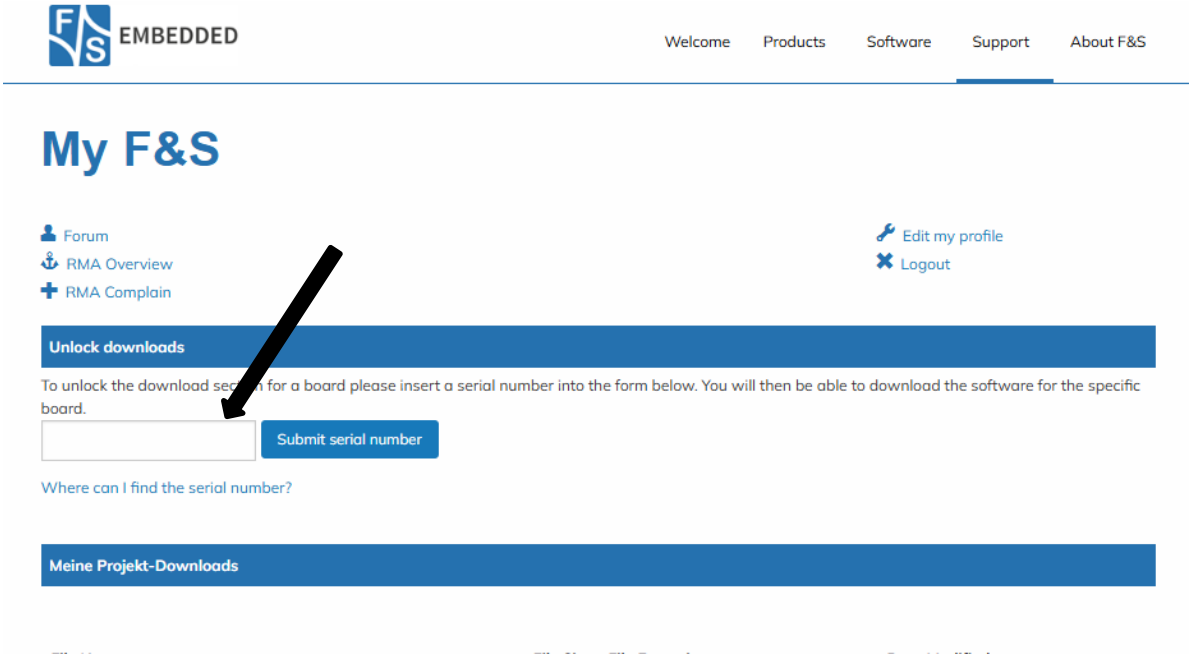


Figure 14 Unlock software with the serial number

To get access to the software of a specific board, you have to enter the serial number of one of these boards (see Figure 15). 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. PicoCoreMX93, 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 *fsimx93-Y2025.08*. 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

Figure 15: Unlock software with the serial number

are usually a file related to a release.

`fsimx93-<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-fsimx93-<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-fsimx93-<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 orginal 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. PicoCoreMX93); or the name of an architecture, if the package is valid on different boards of the same architecture (e.g. fsimx93), 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”.

Inside the release directory, you will find a `READE.md`. Please See this file for a detailed description of the release content.

3.2 Install Kernel, Device Tree and Root Filesystem

Boards with i.MX93 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 SPL 2024.04-01330-g97a04cb71 (Aug 15 2025 - 07:49:34 +0000)
Boot Stage: Primary boot
BOOTDEV: EMMC:0 PAGESIZE: 0x200
SOC: 0xa1009300
LC: 0x2040010
PMIC: Over Drive Voltage Mode
BOARD-ID: PCore93-FERT4.110
DRAM-CRC32: 0xcc32e464
DDR: 3200MTS
M33 prepare ok
Normal Boot
NOTICE:  TRDC init done
NOTICE:  BL31: v2.10.0  (release):3c117e7
NOTICE:  BL31: Built : 09:24:38, Jan 10 2025


U-Boot 2024.04-F+S-v2024.04-fus1.0 (Aug 22 2025 - 12:00:06 +0000)

Reset Status: POR

CPU:   NXP i.MX93(52) Rev1.1 A55 at 1700 MHz
CPU:   Industrial temperature grade  (-40C to 105C) at 31C

Model: F&S PicoCoreMX93
DRAM:  992 MiB
Core:  235 devices, 29 uclasses, devicetree: fit
MMC:   FSL_SDHC: 0, FSL_SDHC: 1
Env:   Loading from MMC... OK
Fail to setup video link
In:    serial
Out:   serial
Err:   serial

BuildInfo:
  - ELE firmware version 2.0.2-c4131933

switch to partitions #0, OK
mmc0(part 0) is current device
CFG:   Found at 0x20498000
NBoot: 2025.08-01330-g97a04cb71
Fastb: flash target is MMC:0
Net:   eth1: ethernet@42890000, eth0: ethernet@428a0000 [PRIME]
Fastb: Normal fastboot
Normal Boot
Hit any key to stop autoboot:  0
PicoCoreMX93 #
```

You must hit any key within 3 seconds to enter UBoot.

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 must 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.

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 3).

Figure 16: Barcode sticker

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 store 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).

```
setenv ethaddr 00:05:51:xx:yy:zy
setenv eth1addr 00:05:51:xx:yy:zz
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 0, 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.

```
fsimx93 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

This document only showed a very basic usage of the board and the Linux system. The next logical step is the generic Linux documentation `LinuxOnFSBoards_eng.pdf`. It will show you the ideas and concepts behind the F&S Linux environment and how you can work efficiently with these boards.

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 offers.

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.
PicoCoreBBDSI_eng.pdf	Hardware documentation: there are separate documents for each board and for the Starterkit baseboards. F&S also offers Eagle layout files for some of our Starterkits.
LinuxOnFSBoards.pdf	Shows how to use the bootloaders, Linux system and peripherals on F&S boards and modules

Table 5: Important documents, available on the F&S website

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 PicoCoreMX93

Hardware documentation for PicoCoreMX93 module itself, Starterkit baseboard, including schematics:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx93-with-nxp-imx93-cpu/#panel-8

Available accessories, adapters, and extensions:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx93-with-nxp-imx93-cpu/#panel-4

4.2.2 Resources for PicoCoreMX91

Hardware documentation for PicoCoreMX91 module itself, Starterkit baseboard, including schematics:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx91-mit-nxp-imx91/#panel-6

Available accessories, adapters, and extensions:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocore/picocoremx91-mit-nxp-imx91/#panel-4

4.2.3 Resources for FS 93 OSM-SF

Hardware documentation for FS-OSM-SF-MX93, Starterkit baseboard, including schematics:

https://www.fs-net.de/de/embedded-module/open-standard-module-osm/fs-osm-sf-mx93/#panel-6

Available accessories, adapters, and extensions:

https://www.fs-net.de/de/embedded-module/open-standard-module-osm/fs-osm-sf-mx93/#panel-4

4.2.4 Resources for FS 91 OSM-SF

Hardware documentation for FS-OSM-SF-MX91, Starterkit baseboard, including schematics:

https://www.fs-net.de/de/embedded-module/open-standard-module-osm/fs-osm-sf-mx91/#panel-6

Available accessories, adapters, and extensions:

https://www.fs-net.de/de/embedded-module/open-standard-module-osm/fs-osm-sf-mx91/#panel-4

4.2.5 Resources for efusMX93

Hardware documentation for efusMX93, Starterkit baseboard, including schematics:

https://www.fs-net.de/en/embedded-modules/computer-on-module-efus/efusmx93/#panel-6

Available accessories, adapters, and extensions:

https://www.fs-net.de/en/embedded-modules/computer-on-module-efus/efusmx93/#panel-4

4.2.6 Resources for PicoCOM93

Hardware documentation for PicoCOM93, Starterkit baseboard, including schematics:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocom/picocom93/#panel-7

Available accessories, adapters, and extensions:

https://www.fs-net.de/en/embedded-modules/computer-on-module-picocom/picocom93/#panel-4

4.2.7 Resources for NetDCU93

Hardware documentation for NetDCU93, Starterkit baseboard, including schematics:

https://www.fs-net.de/en/embedded-modules/computer-on-module-netdcu/netdcu93/#panel-5

5 Appendix

5.1 List of Figures

Figure 1: PicoCoreBBDSI Starterkit Top Side (PicCoreBBDSI – Rev. 1.30) 3
Figure 2: PicoCoreBBDSI Starterkit Bottom Side (PicCoreBBDSI – Rev. 1.30) 4
Figure 3: PicoCoreMX93 top and bottom view....4
Figure 4: FS 93 OSM-SF and ADP-OSM-BB....5
Figure 5: efusMX93 Starterkit top 6
Figure 6: efusMX93 Starterkit bottom 6
Figure 7: efusMX93 module top/bottom 7
Figure 8 PicoCOM STARTINTF2 Starterkit 8
Figure 9 PicoCOM93....8
Figure 10: NetDCU93....9
Figure 11: Starterkit with NetDCU 10
Figure 12: Serial connection from board to PC 11
Figure 13 Register with F&S website 13
Figure 14 Unlock software with the serial number 14
Figure 15: Unlock software with the serial number 14
Figure 16: Barcode sticker 17

5.2 List of Tables

Table 1: F&S Board Families 1
Table 2: F&S Architectures 2
Table 5: Important documents, available on the F&S website 19

5.3 Important Notice

The information in this publication has been carefully checked and is believed to be entirely accurate at the time of publication. F&S Elektronik Systeme assumes no responsibility, however, for possible errors or omissions, or for any consequences resulting from the use of the information contained in this documentation.

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