sysmocom

sysmocom - systems for mobile communications GmbH

sysmoOCTSIM User Manual

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REVISION HISTORY

NUMBER	DATE	DESCRIPTION	NAME
v1	March 2021	Initial version	ms, hw
v2	March 2025	Update info for new firmware	sk

Contents

1 Introduction

This manual describes the sysmoOCTSIM, an octal USIM carrier board with integrated management for remote SIM forwarding capabilities.

The target audience are system integrators who use the sysmoOCTSIM to build their own products, such as nodes for cellular network quality monitoring or roaming testing.

1.1 Purpose

The purpose of this document is to outline the design of a professional and robust multi SIM card reader solution (called sysmoOCTSIM) to fulfill the requirements for a solution for remote SIM serving systems.

1.2 Designated use

The designated use of the sysmoOCTSIM is to be used as a smart card reader for one to eight contact-based smart cards such as subscriber identity cards of cellular networks (SIM, USIM, RUIM, UICC, ISIM, ...).

It is the customer's responsibility to

- mount the product in a suitable enclosure providing
  - protection from environmental influences
  - protection from ESD (Electrostatic Discharge) exposure to the bare circuit board assembly
  - maintain EMC (Electromagnetic Compatibility) compliance
  - providing sufficient heat dissipation capability for the product
- connect a suitable compatible power supply
- separately obtain and install the SIM cards intended to be used in the given application

1.3 Intended audience

The intended audience of this manual is the technical staff of the systems integrator who integrates the sysmOCTSIM into a customer-specific product/appliance within the designated use stated above.

1.4 Regulatory compliance

The product is designed to be conforming with all applicable harmonized standards in the EU. As such, the series-produced units will be accompanied with a declaration of conformity for the European market.

However, only a given reference configuration of the product is submitted to related conformance testing. This reference configuration includes

- a typical shielded metal enclosure (19" 1U style)
- a CE conforming AC power supply for supplying 5V DC
- a CE conforming personal computer connected to the USB B port

Due to the many variable parameters of any customer-specific appliance built from the sysmoOCTSIM, it is the responsibility of said system integrator to test and declare conformity with all applicable norms and standards on his final product.

2 Specifications

- 160 x 120 mm four-layer PCB assembly with two-sided component placement
- 5 mounting holes (M3) for mounting on PCB spacers/stands
- 8 SIM/UICC slots for cards in ETSI/3GPP 2FF form-factor
- 1 USB device port on USB mini-B connector or 2.54mm pin header (factory option)
- 1 Atmel SAMD54/E54 microcontroller, running the device firmware
  - temperature monitoring
  - 8 SIM card front-end ICs for individual control and interfacing in four different speeds and three different voltages, including SIM card fault detection
  - SIM card forwarding
  - Ethernet RJ45 connection (hardware prepared for future expansion)
  - CAN connection (hardware prepared for future expansion)
- on-board programmable LED for each SIM slot (typical use: SIM activity)

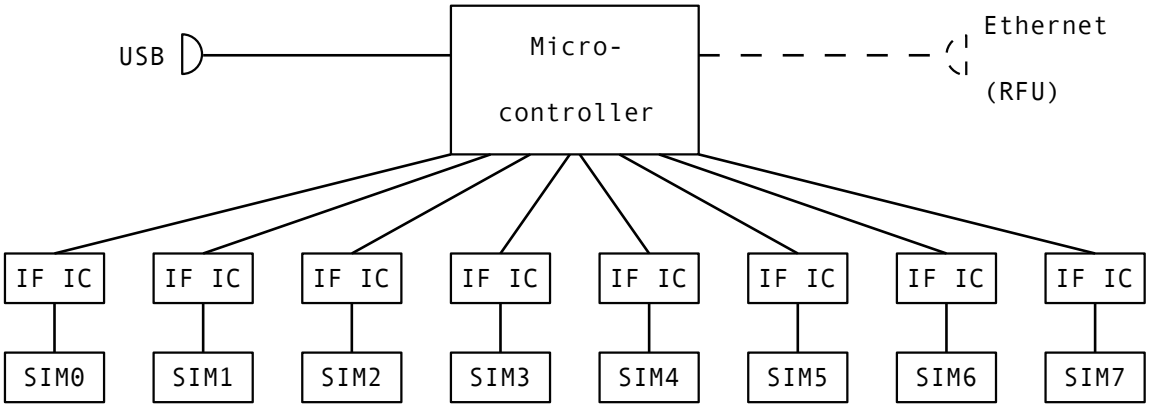

Figure 1: block diagram

2.1 Electrical

Table 2: Electrical Specifications

Parameter	Min	Typ	Max	Unit
Supply Voltage	4.7	5	5.5	Vdc
Supply Current		0.12	0.67	Adc

The current rating is determined almost exclusively by the types of SIM card used and their communication speed above figure is the worst-case peak consumtion with 70 mA (each). The board itself doesn't draw a significant amount of power, typically 80-120 mA @5V only.

2.2 Environmental Specifications

The sysmoOCTSIM has been designed exclusively from parts specified for the **full industrial temperature range from -40 to 85 centigrade**.

NOTE
The actual usable temperature range might be limited by system integration. Care must be taken to ensure sufficient heat dissipation.

Please also observe the environmental specification of the SIM cards you intend to use. They might have a more limited range than the sysmoOCTSIM board itself.

3 sysmoOCTSIM Hardware

The sysmoOCTSIM hardware consists of a two-sided quad-layer printed circuit board assembly (PCBA), sized 120x160mm, and an attached two-sided, two-layer daughter PCBA carrying another four SIM card holder.

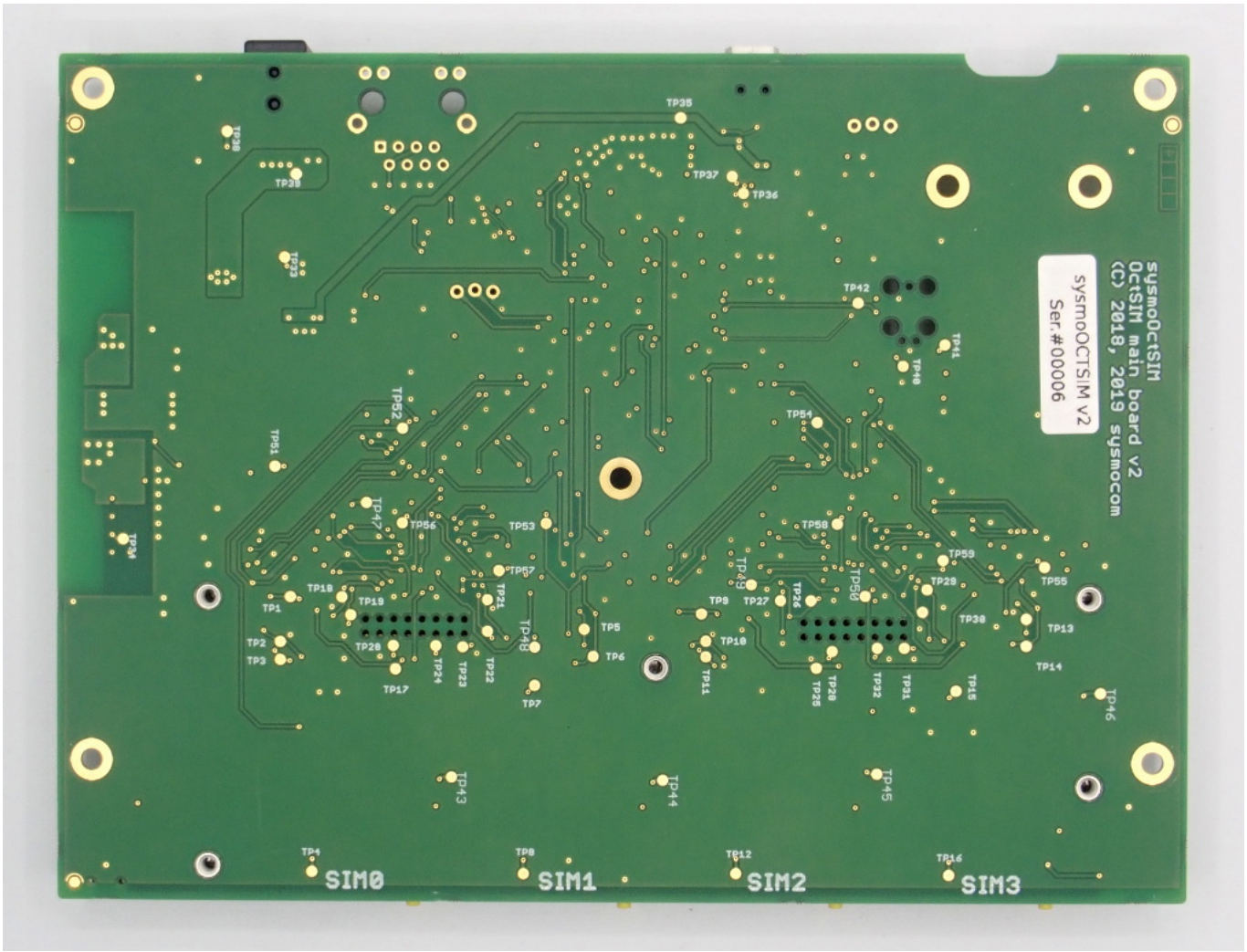

Figure 2: sysmoOCTSIM PCBA top side

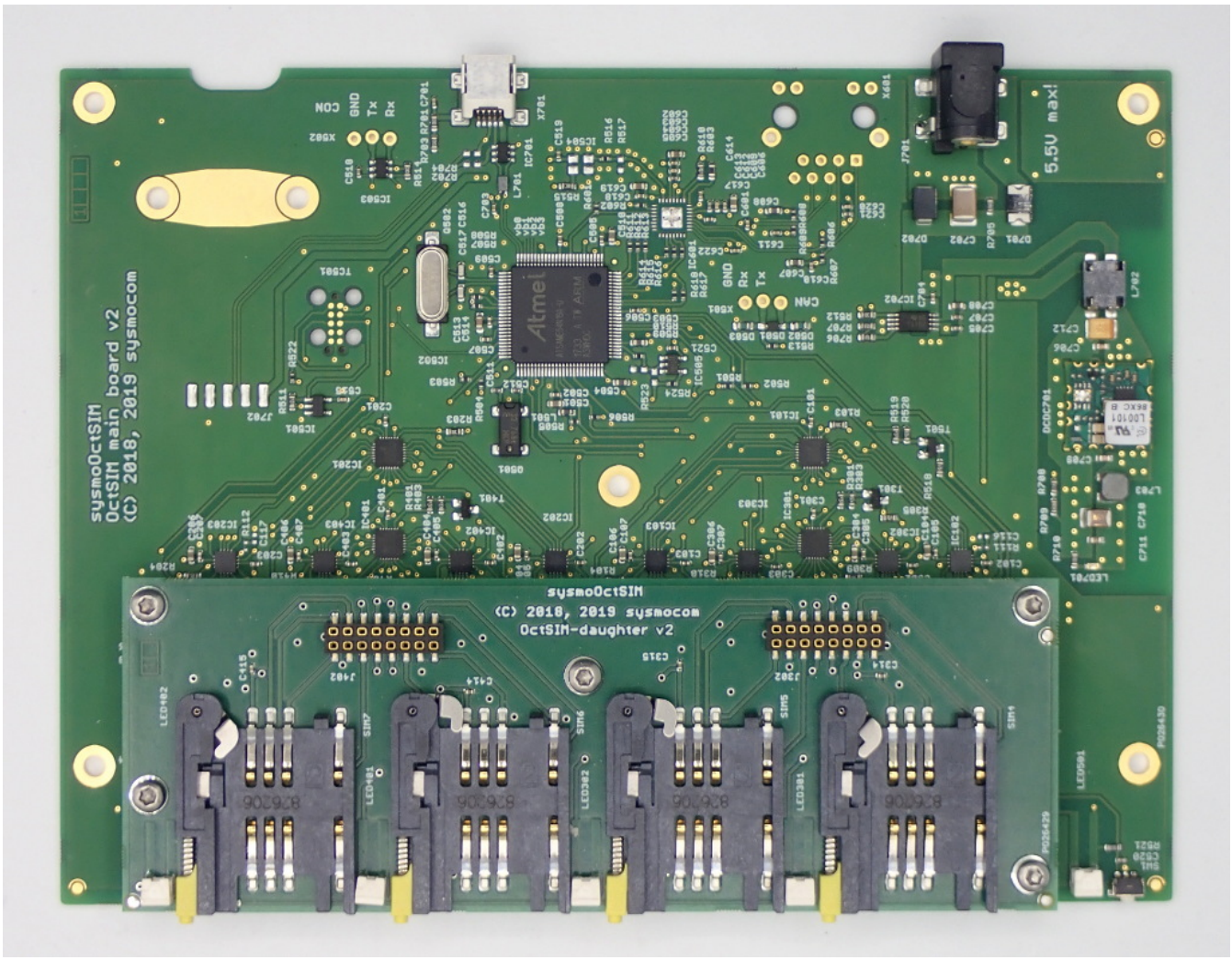

Figure 3: sysmoOCTSIM PCBA bottom side

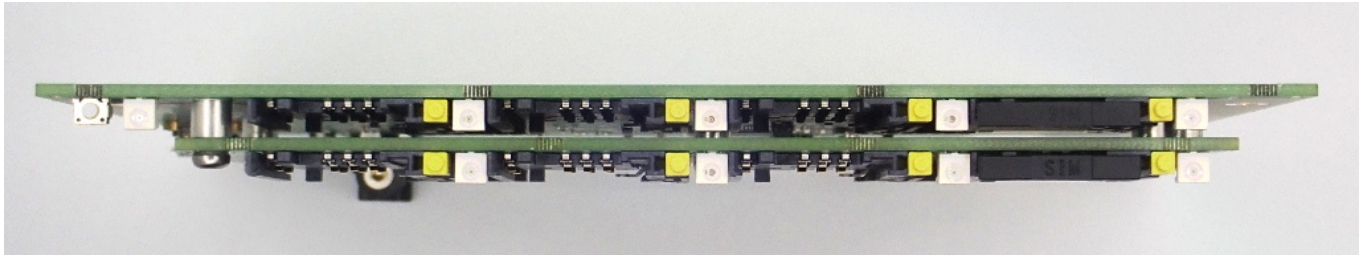

Figure 4: sysmoOCTSIM PCBA, front side, two SIM drawer in place

3.1 Power Supply

The sysmoOCTSIM has one nominal 5V DC power input which is used to power all on-board circuits. This 5V DC input can be supplied via the barrel-type power jack **J701** (center positive).

The power input has on-board protection diodes to prevent polarity reversal as well as an over-voltage zener diode. However, there **is no internal on-board fuse**, so the power supply should have reasonable current limits in place, or an external fuse shall be used.

Due to its low power requirements, the sysmoOCTSIM PCBA can be sourced also via the USB port which connects to a host. The sysmoOCTSIM features a power priority circuit which gives priority to a supply connected to the 5V barrel connector in cases when this supply is used as well as a USB 5V source from host (X701 or J702).

NOTE

We strongly suggest powering the PCBA via the 5V barrel connector as worst-case power demands with eight Class A SIM cards exceed USB bus-powered device specification. Thus we cannot guarantee function when unit is only powered by USB host power.

3.1.1 On-board voltage rails

An on-board step-down DC/DC converter provides the main 3.3V supply voltage. All parts on the board are powered from this rail excluding the eight SIM cards which are served by individual SIM card front-end ICs with dedicated voltage supplies (LDOs). They feature 1.8V, 3V and 5V supply and are selected individually by SIM card requirements (automatically) or forced by user requirements (depending on sysmoOCTSIM firmware and SIM card capabilities).

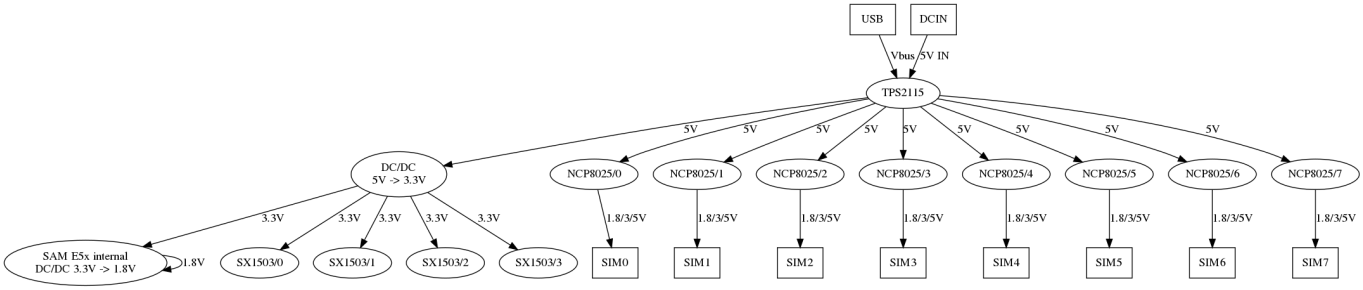

Figure 5: on-board power tree

3.2 Connectors

The sysmoOCTSIM has the following physical connections:

- General
  - J701: Barrel-type DC input (center positive)
  - X701: USB 2.0 Mini B connector
  - J702: optional USB host connection via 2,54mm PC-style USB connector
    - USB traces are connected to either X701 (default) **or** J702
  - TC701: JTAG + SWD connector for SAMD5x/E5x microcontroller
  - X502: 3.3V serial console of SAMD5x/E5x microcontroller (shared with card slot 7)
  - X501: CAN port of SAMD5x/E5x microcontroller (RFU)
  - X601: Ethernet port SAMD5x/E5x microcontroller (RFU)
- SIM/USIM
  - SIM0: SIM card slot for SIM 0
  - SIM1: SIM card slot for SIM 1
  - SIM2: SIM card slot for SIM 2
  - SIM3: SIM card slot for SIM 3
  - SIM4: SIM card slot for SIM 4

- SIM5: SIM card slot for SIM 5
- SIM6: SIM card slot for SIM 6
- SIM7: SIM card slot for SIM 7

NOTE

As the device serves as a USB CCID reader (see firmware section), the SIM slots are numbered according to the CCID numbering scheme starting from 0.

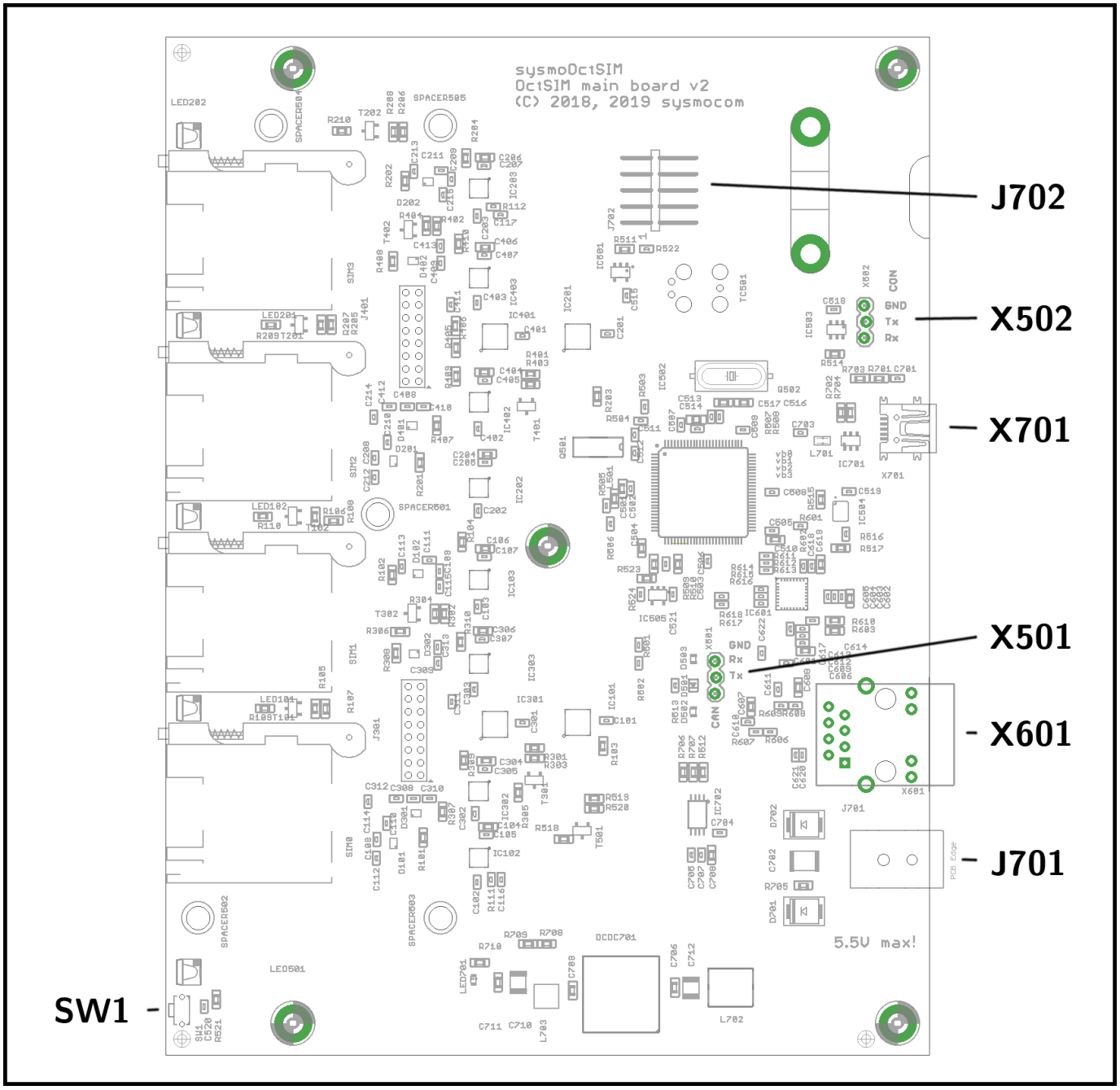

Figure 6: connector names and positions on sysmoOCTSIM board, bottom view

Also shown in the above picture is the position of the tactile switch SW1.

3.2.1 J701: Barrel-type DC Input

This is a 5.5mm diameter barrel-type DC input connector with 2.5mm pin diameter and the following pin-out:

Table 3: J701 barrel connector pinout

Pin	Function	Type
Center	+VIN	5V DC Input (positive)
Outer	-VIN	5V DC Input (ground, **not chassis ground**)

3.2.2 X701: USB 2.0 Mini Type B

This is a standard USB 2.0 Mini B connector. It is used to connect the sysmoOCTSIM to a USB host.

The power which could be needed for driving the sysmoOCTSIM with 8 worst-case Class-A SIM cards exceeds USB specifications for bus powered devices. Thus a sufficient power supply should be used in case of this cabling solution.

3.2.3 J702: USB header compatible with common PC mainboards

To provide the possibility of easy supplied cabling, the sysmoOCTSIM provides a connector which is compatible to most USB on PC Mainboard headers using port 1 (pins 1,3,5,7,9). The connector on the sysmoOCTSIM is a horizontal single-row 1x5 pos header.

J702 is a placement option, and resistors R702/R704 must be in place when J702 is placed and used (as the default option is "X702 placed").

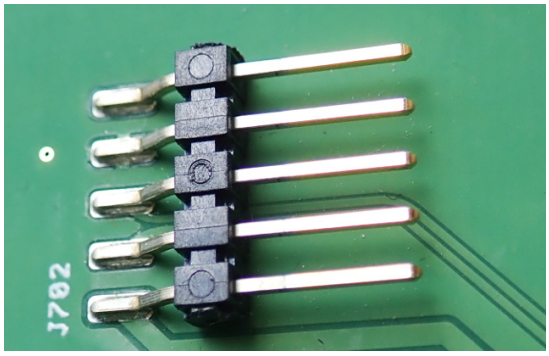

Figure 7: J702 horizontal USB 1x5 pin header placed (option)

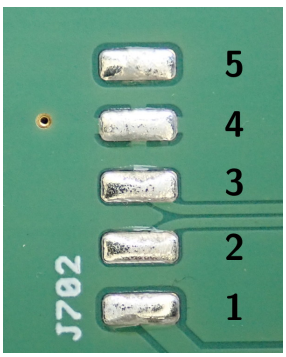

Figure 8: J702 horizontal USB, header not placed (default), pins annotated

Table 4: J702 Pinout

pin number	pin name	description
1	VBus	+5V Power
2	D1-	negative USB differential signal
3	D1+	positive USB differential signal
4	GND	GND of supply power
5	NC	Not Connected

We suggest to make use of a strain relief when using this cable option. There are holes for mounting a cable bracket (or even a simple cable tie). Suggested cables brackets are of type 5120b.99 by Vogt AG. [1]

Figure 9: Vogt cable clamp type 5120b.99

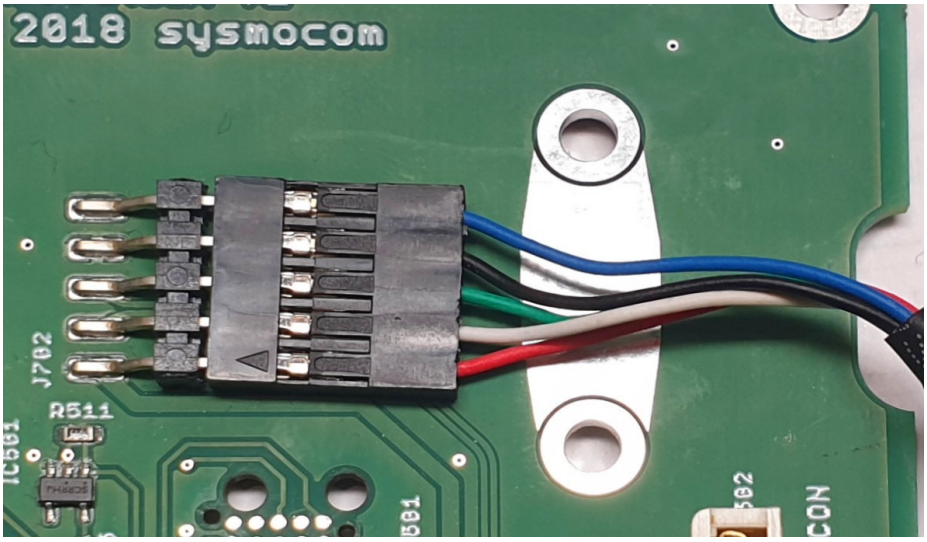

Figure 10: J702 horizontal USB with USB cable (suggestion; blue cable not used here)

As stated above, the power which could be needed for driving the sysmoOCTSIM with 8 worst-case Class-A SIM cards exceeds USB specifications for bus powered devices. Thus a sufficient power supply should also be used in case of this USB cabling solution.

Furthermore, to be clear, the USB signal integrity requirements as specified in the USB 2.0 Specification apply! The D+/D- differential lines must use a suitable USB-compatible shielded twisted pair cable of 90 Ohms differential impedance. The use of flat-ribbon cables with uncontrolled impedance is at the risk of the user.

[1] https://www.vogtshop.ch/index.cfm?content=productData&Language=2&ObjId=3DA02C05-38A5-4059-B94A-4D51E03645F6

3.2.4 TC501: SWD connector for SAM5 microcontrollers

This is a 10-pin TagConnect connector, compatible with the TC2050 plug. Using this connector has the advantage of having zero cost impact on the PCB side, as the "connector" is just a PCB footprint.

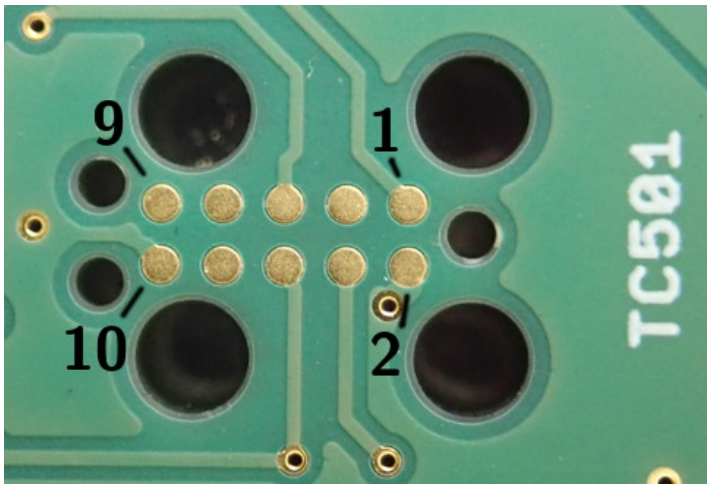

Figure 11: pin assignment TC501

The pin-out is as follows:

Table 5: TC501 Pinout

Pin	Function	Type
1	SWCLK/TCK	Input
2	GND	Reference
3	n.c.	
4	VDD_3V3	Reference
5	SWDIO/TMS	Input
6	!RESET	Input
7	n.c.	
8	n.c.	
9	n.c.	
10	GND	Reference

As JTAG, SWD can be used for flash programming, factory testing and firmware development/debugging of the SAM5 microcontroller.

3.2.5 X502: serial console port of SAMD5x/E5x microcontroller

This connector exposes the serial debug UART of the SAM5 microcontroller. During development and testing, this can be used for debugging and firmware updates.

Table 6: X502 Pinout

Pin	Function	Type
1	RXD	input
2	TXD	output
3	GND	GND reference

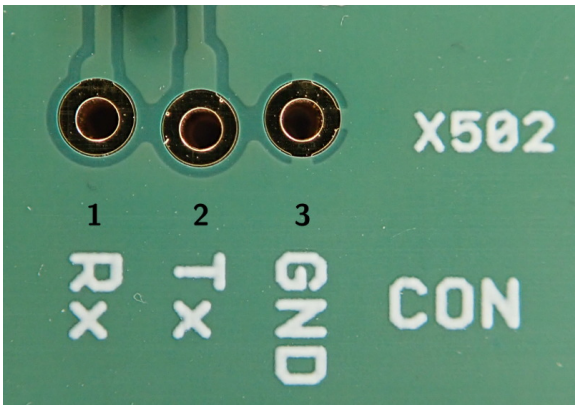

Figure 12: pin assignment X502

NOTE
The console port is shared with card slot 7 (SIM7). You can either use the console port, or you can use SIM7 - but never both.

3.2.6 X501: CAN port of SAMD5x/E5x microcontroller (RFU)

X501 exposes the CAN port of the microcontroller and might serve as an option for interconnecting sysmoOCTSIM PCBAs. The port is intended to run in a tranceiver-less configuration.

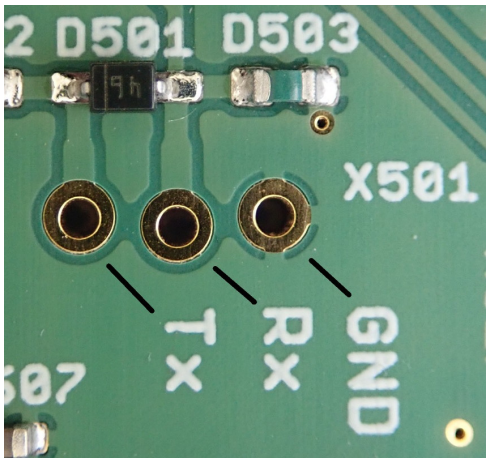

Figure 13: pin assignment X501

NOTE
This port ist reserved for future use and has no function right now.

3.2.7 X601: Ethernet port SAMD5x/E5x microcontroller (RFU)

X601 exposes the Ethernet port of the microcontroller and might serve as an option for connecting sysmoOCTSIM PCBAs to an e.g. Ethernet switch. Also, an Ethernet PHY IC must be placed for this port to physically work.

NOTE
This port ist reserved for future use and has no function right now.

3.2.8 SIM slots SIM0-SIM7

sysmoOCTSIM provide eight SIM slots in ETSI 2FF form-factor. The SIM slots are drawer-style slots and accessible from the long (160mm) PCB edge. Four slots are mounted on the lower side of the PCB, four slots on a stacked daughter PCB.

With a nominal thickness of the PCB of 1.55mm, the total stacking height of the two PCBs is 6.55mm.

The SIM card holder is a two-part solution with a drawer/slider, into which the SIM card is inserted. That drawer is then pushed into the slot, where it is locked against accidental removal (e.g. by vibrations) by means of a retainer. If the card is to be released, a small eject button must be pushed via a pointy metal object (paper clip into a hole in the front panel (similar to iPhone SIM card holder).

NOTE
Of course the board stack could also be turned up-side-down. However, the SIM drawer then have their openings towards the floor.

For the pin-out, please refer to the ETSI/3GPP specifications on SIM/UICC cards.

The card slot type is a Molex 91228-3001.

Figure 14: Molex 91228-3001 SIM Slot

It requires that SIM cards are inserted into the Molex Card Holder 91236-0001.

Figure 15: Molex 91236-0001 SIM Holder

3.3 Hardware Options

The hardware can be built with some options, among them are

- USB connector type can be either
  - regular Mini-USB-B connector, or
  - horizontal USB 1x5 pin header with a respective PC cable
- Debug UART header can be present/soldered or not

Please state the exact required options in the questionnaire for your use case when placing an order with sysmocom.

3.3.1 Enclosure option for sysmoOCTSIM

sysmoOCTSIM is also available in an enclosure. The product then consists of:

- sysmoOCTSIM PCBA in extruded aluminium enclosure, including 8 SIM card drawers
- 2 extra SIM card drawers
- USB cable
- 5V power supply (with EU cable included; different plugs on request)
- 8x adapters for micro/nano SIM cards + ejector pins
- 10x sysmoISIM-SJA2 cards

Figure 16: sysmoOCTSIM EVK in enclosure, front view

Figure 17: sysmoOCTSIM EVK in enclosure, back view

3.4 LEDs

Each SIM slot has a respective LED which, in default firmware function, shows SIM card activity. Furthermore, there is one user-exposed green LED close to the tactile switch which serves a a generic "units switched on" LED.

All user-visible LEDs are controlled by the processor and hence can get user-defined blink pattern / meanings. In the following table, the default behaviour is shown.

There are nine user-visible and one non-user-visible LEDs:

3.4.1 User-visible LEDs

Table 7: User-visible LEDs

LED Number	Connected to	Color	Description
LED101	MCU	yellow	SIM 0 activity
LED102	MCU	yellow	SIM 1 activity
LED201	MCU	yellow	SIM 2 activity
LED202	MCU	yellow	SIM 3 activity
LED301	MCU	yellow	SIM 4 activity
LED302	MCU	yellow	SIM 5 activity
LED401	MCU	yellow	SIM 6 activity
LED402	MCU	yellow	SIM 7 activity
LED501	MCU	green	unit powered on, unit in bootloader mode, etc.

Note
Mentioned colors for user-visible LEDs are default and can be changed per production batch. If you require different fixed colors for user LEDs, this is subject of MOQ and must be stated during inquiry/ordering.

3.4.2 Non-user-visible LEDs

This LED is for diagnostic purposes and not normally exposed to the end user.

Table 8: Non-user-visible LEDs

LED Number	Color	Description
LED701	Green	Main 3.3V DC voltage present

3.4.3 Front panel layout considerations

All SIM slots are arranged with their associated eject buttons and respective LED on the same side, avoiding erroneous operation.

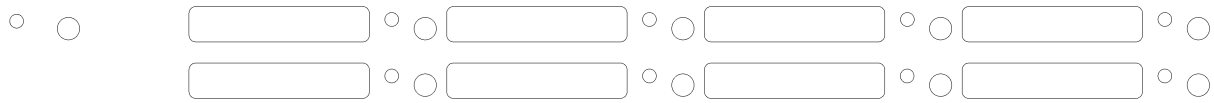

Figure 18: suggested face plate cutouts

To support LEDs with this method of stacking, the LEDs are “Side LEDs”. Suiting light guides are e.g. available from Mentor, their principle of mounting is illustrated below:

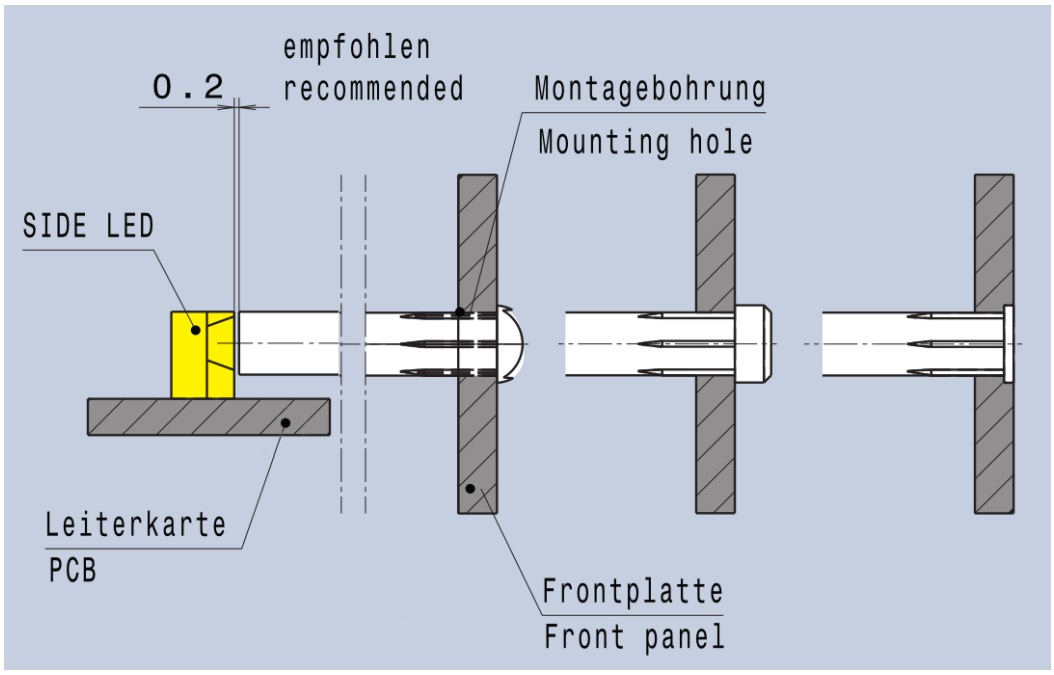

Figure 19: light guide mounting for face plate (example by Mentor)

Light guides are not included with sysmoOCTSIM. It is left to the system integrator to select light guides matching the mechanical constraints of the enclosure design. Even a tiny hole in the face plate (e.g. similar size as the ejector opening) could serve. Depending on customer needs, if only remote management is planned, those openings might be left away completely.

4 Firmware

The firmware consists of two parts:

- The bootloader `osmo-asf4-dfu`, implementing the USB DFU (Device Firmware Upgrade) protocol for upgrading the device firmware over USB without the need of a programming adapter
- The main firmware `osmo-ccid-firmware`, implementing the actual smart card reader functionality and exposing a USB CCID interface to the USB host computer

The first 16kBytes of memory (up to offset 0x4000) are used for the bootloader, while the remaining memory is available for the main firmware.

sysmoOCTSIM boards are shipped with both bootloader and CCID firmware pre-installed.

NOTE

The firmware can not easily detect whether an inserted SIM card drawer contains a (valid of invalid) SIM card or not: the SIM_PRESENT switch will get closed in either case, and the firmware then has to start probing for a SIM. If no SIM is then present, probing will always introduce additional delays and / or timeouts. **Don't insert empty SIM card drawer** - either always supply a SIM card with them or leave any empty drawer removed.

4.1 Source Code

The complete and corresponding source code to both the bootloader and the main firmware is maintained as open source software by sysmocom. You can obtain it from the Osmocom project, specifically:

- http://git.osmocom.org/osmo-asf4-dfu/ for the bootloader
- http://git.osmocom.org/osmo-ccid-firmware/ for the main CCID firmware

NOTE
Check also the commit logs for further information

4.2 Binary builds

Automated builds of the firmware are made available via the Osmocom open source project.

You can find bootloader images at http://ftp.osmocom.org/binaries/osmo-asf4-dfu/ and main application (CCID) firmware builds at http://ftp.osmocom.org/binaries/osmo-ccid-firmware/

The latest (nightly) builds are available from the respective *latest* subdirectory, while all intermediate versions are also published from the *all* subdirectory.

4.3 Installation of `osmo-asf4-dfu` via JTAG

In normal circumstances, it is not expected that users require to re-install the bootloader of the sysmoOCTSIM. However, in case it should be required, some instructions can be found below.

Requirements:

- sysmoOCTSIM board; powered via USB or 5V DC jack
- SWD-capable JTAG programmer
  - sysmocom offers jtag-lockpick-tiny in its webshop
  - other alternatives include ST-LINK v2
- Tag-Connect TC2050 cable interfacing between programer and sysmoOCTSIM connector TC501
- OpenOCD software (most Linux distributions ship a package)
- firmware binary, should be named `bootloader-*.bin`, e.g. `bootloader-0.1.1-5554.bin` at time of writing

```
$ ~/osmo-asf4-dfu > openocd --file interface/stlink.cfg --file ./openocd-flash.cfg

Open On-Chip Debugger 0.10.0+dev-00697-g2739f551 (2019-02-23-17:32)
Licensed under GNU GPL v2
For bug reports, read
        http://openocd.org/doc/doxygen/bugs.html
hla_swd
same54
0x2ba01477
Info : The selected transport took over low-level target control. The results might differ ↩
    compared to plain JTAG/SWD
none separate
adapter speed: 2000 kHz
Info : clock speed 2000 kHz
Info : STLINK V2J17S4 (API v2) VID:PID 0483:3748
Info : Target voltage: 3.503086
Info : same54.cpu: hardware has 6 breakpoints, 4 watchpoints
Info : Listening on port 3333 for gdb connections
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0x000019e8 msp: 0x20010480
Bootloader protected in the first 0 bytes
Info : SAM MCU: SAME54N19A (512KB Flash, 192KB RAM)
erased sectors 0 through 63 on flash bank 0 in 2.424058s
```

```
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0xfffffffe msp: 0xfffffffc
target halted due to debug-request, current mode: Thread
xPSR: 0x01000000 pc: 0xfffffffe msp: 0xfffffffc
** Programming Started **
auto erase enabled
wrote 16384 bytes from file ./bootloader.bin in 0.527336s (30.341 KiB/s)
** Programming Finished **
Bootloader protected in the first 16384 bytes
shutdown command invoked
```

4.4 Installation of `osmo-ccid-firmware` via DFU

You can use `dfu-util -l` to test if the device is in DFU mode. If it is, you should see a similar line of output as the one below:

```
$ sudo dfu-util -l

...

Found DFU: [1d50:6141] ver=0000, devnum=27, cfg=1, intf=0, path="1-4.1.1", alt=0, name="SAM ↩
     D5x/E5x DFU bootloader (DFU mode)", serial="UNKNOWN"
```

At this point, you can flash the firmware using `dfu-util` as follows:

```
$ sudo dfu-util -d 1d50:6141 -D sysmoOCTSIM-0.1.188-f4ad.bin -R

...

dfu-util: Invalid DFU suffix signature
dfu-util: A valid DFU suffix will be required in a future dfu-util release!!!
Opening DFU capable USB device...
ID 1d50:6141
Run-time device DFU version 0110
Claiming USB DFU Interface...
Setting Alternate Setting #0 ...
Determining device status: state = dfuERROR, status = 0
dfuERROR, clearing status
Determining device status: state = dfuIDLE, status = 0
dfuIDLE, continuing
DFU mode device DFU version 0110
Device returned transfer size 512
Copying data from PC to DFU device
Download        [=========================] 100%       126488 bytes
Download done.
dfu-util: unable to read DFU status after completion
dfu-util: can't detach
Resetting USB to switch back to runtime mode
```

In older firmware versions button `SW1` needs to be pressed when powering up the sysmoOCTSIM. At this point, the device enumerates as follows:

```
Bus 001 Device 006: ID 1d50:6141 OpenMoko, Inc. sysmoOCTSIM (osmo-ASF4-DFU)
```

You can now use the above commands to update the firmware.

4.5 Installation of combined updates

In some cases it is necessary to update both, boot loader and firmware.

4.5.1 bootloader 0.2, ccid firmware sysmoOCTSIM-0.3

The following commands update the latest bootloader and firmware in sequence:

```
wget -O bootloader-sysmooctsim-dfu.bin https://ftp.osmocom.org/binaries/osmo-asf4-dfu/ ↩
    latest/bootloader-sysmooctsim-dfu.bin -nv
wget -O sysmoOCTSIM.bin http://ftp.osmocom.org/binaries/osmo-ccid-firmware/latest/ ↩
    sysmoOCTSIM.bin -nv
sudo dfu-util --device 1d50:6141 --alt 0 --reset --download bootloader-sysmooctsim-dfu.bin
sleep 2
sudo dfu-util --device 1d50:6141 --alt 0 --reset --download sysmoOCTSIM.bin
```

5 Software Interface / USB Protocol

The sysmoOCTSIM runs open source firmware which implements a USB protocol compliant with the USB CCID Device Class specification.[2]. There is one USB device per sysmoOCTSIM, with one USB interface according to the CCID class specification.

The following details related to the CCID Class Descriptor apply:

- **bMaxCCIDBusySlots** is set to 8, i.e. one outstanding command per slot
- **bMaxSlotIndex** is set to 7, i.e. exposing 8 slots
- **bVoltageSupport** includes support for 1.8, 3.0 and 5.0V
- **dWProtocols** implements Protocol T=0 (let us know if your use case requires T=1)

The SIM card front-ends can deliver clock speeds of 2.5, 5, 10 or 20 MHz to the cards. The use of a CCID compatible USB protocol ensures maximum driver/software compatibility across all operating systems and platforms.

Please note that a small patch to add the USB Vendor+Product ID to the list of known devices may be needed depending on the software stack. All testing at sysmocom is performed using *pcsc-lite* with its CCID library on Debian GNU/Linux.

6 Host Software

The sysmoOCTSIM includes a pre-installed firmware which implements the USB CCID profile as outlined above. Adherence to this profile ensures a maximum compatibility and interoperability with any kind of software accessing smart card readers. On Linux, this includes *libccid* and *pcsc-lite*, which is the common driver stack for all smart card readers. It has been verified that *libccid* and *pcsc-lite* actually supports multi-slot readers such as the sysmoOCTSIM. As such, the only part of software that is required on the host PC, is a small patch to *pcsc-lite* to recognize the USB Vendor and Product ID of the sysmoQMOD. sysmocom will submit this patch to the upstream *libccid/pcsc-lite* project, to ensure that future releases of this driver suite will work out of the box without having to apply any patches.

6.1 pcsc-lite + libccid

The pcsc-lite project (https://pcsclite.apdu.fr/) and the related CCID driver (https://ccid.apdu.fr/) are the de-facto standard software stack of interfacing smart card readers and smart cards on Linux and other Unix-like operating systems, including Apple OS X.

In the case of GNU/Linux, pcsc-lite is a standard package of many if not all Linux distributions. It should be available from the distribution package manager, and you should hence be able to install it using commands like `apt-get install pcsc-lite` or `yum install pcsc-lite`.

It is generally assumed that the reader of this manual is familiar with PC/SC as well as the configuration and use of smart card readers. More information can be found on the pcsc-lite homepage linked above.

[2] https://www.usb.org/sites/default/files/DWG_Smart-Card_CCID_Rev110.pdf

6.1.1 teaching pcsc-lite + libccid about sysmoOCTSIM

pcsc-lite/libccid contain a list of USB vendor/product IDs of all supported readers. Contrary to other operating systems / drivers, this means it doesn't automatically bind to any CCID class device, but the particular vendor/product ID must be configured.

As sysmoOCTSIM is too new to be listed in already-released/stable versions of libccid, you will have to manually add a record to /etc/libccid_Info.plist.

In order to verify if your /etc/libccid_Info.plist contains the required entries for the sysmoOCTSIM (Vendor ID 0x1d50 / Product ID 0x6141), sysmocom provides a small python script called `check_libccid_config.py` in the `sysmoOCTSIM` sub-directory of the `omso-ccid-firmware` git repository.

If you execute the script on a system that already has the required changes, the output will look like this:

```
./check_libccid_config.py
Reading libccid config file at '/etc/libccid_Info.plist'
Matching reader already in libccid_Info.plist; no action required
```

If you execute it on a system without the required configuration, the output will look like this:

```
./check_libccid_config.py
Reading libccid config file at '/etc/libccid_Info.plist'
Reader not found in config file, it needs to be updated...
Generated new config file stored as '/tmp/libccid_Info.plist'
        WARNING: The generated file doesn't preserve comments!
```

You can then use the generated /tmp/libccid_Info.plist and copy it to /etc (`sudo cp /tmp/libccid_Info.plist /etc/libcc` but beware, any comments will be removed from the configuration file during this process. Alternatively, you can manually add the respective entries.

6.1.2 testing your configuration

To test whether a sysmoOCTSIM is installed and recognized properly, the program `pcsc_scan` can be used (in most distributions contained in the `pcsc-tools` package). Invoking `pcsc_scan` with the parameter `-n` should show a result like this (example with eight SIM cards):

```
$ pcsc_scan -n
PC/SC device scanner
V 1.5.2 (c) 2001-2017, Ludovic Rousseau <ludovic.rousseau@free.fr>
Using reader plug'n play mechanism
Scanning present readers...
0: octsim [CCID] (a4c939313335355320202034432d15ff) 00 00
1: octsim [CCID] (a4c939313335355320202034432d15ff) 00 01
2: octsim [CCID] (a4c939313335355320202034432d15ff) 00 02
3: octsim [CCID] (a4c939313335355320202034432d15ff) 00 03
4: octsim [CCID] (a4c939313335355320202034432d15ff) 00 04
5: octsim [CCID] (a4c939313335355320202034432d15ff) 00 05
6: octsim [CCID] (a4c939313335355320202034432d15ff) 00 06
7: octsim [CCID] (a4c939313335355320202034432d15ff) 00 07

Tue Feb 11 16:48:32 2020
 Reader 0: octsim [CCID] (a4c939313335355320202034432d15ff) 00 00
  Card state: Card inserted,
  ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
 Reader 1: octsim [CCID] (a4c939313335355320202034432d15ff) 00 01
  Card state: Card inserted,
  ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
 Reader 2: octsim [CCID] (a4c939313335355320202034432d15ff) 00 02
  Card state: Card inserted,
  ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
 Reader 3: octsim [CCID] (a4c939313335355320202034432d15ff) 00 03
```

```
 Card state: Card inserted,
 ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
Reader 4: octsim [CCID] (a4c939313335355320202034432d15ff) 00 04
 Card state: Card inserted,
 ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
Reader 5: octsim [CCID] (a4c939313335355320202034432d15ff) 00 05
 Card state: Card inserted,
 ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
Reader 6: octsim [CCID] (a4c939313335355320202034432d15ff) 00 06
 Card state: Card inserted,
 ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
Reader 7: octsim [CCID] (a4c939313335355320202034432d15ff) 00 07
 Card state: Card inserted,
 ATR: 3B 9F 96 80 1F C7 80 31 A0 73 BE 21 13 67 43 20 07 18 00 00 01 A5
- ^C
```

Program can then be terminated with `^C`, as it already displayed the presence of all SIM cards inserted.

If the number of cards shown by `pcsc_scan` does not match the number of cards inserted, please check the correct seat of the SIM cards in their drawer as well as the drawer's correct seat in their respective card slot.

6.1.3 constraints of pcsc-lite/libccid

sysmOCTSIM is a reader device with eight fully independent smart card readers, each with their own UART. This means that all slots can be active in parallel, without any serialization of commands between those readres.

While the CCID specification explicitly allows for readers to specify how many of their slots can be active concurrently, unfortunately pcsc-lite/libccid don't support this feature, and instead always serialize access, meaning only one slot can actively transceive a TPDU/APDU, rather than multiple slots in parallel.

If you require fully parallel access to multiple slots, please consider contributing related code to pcsc-lite, and/or contact its maintainer on how to fund this. sysmocom is also able to provide the related implementation as a paid service.

6.2 osmo-remsim

With osmo-remsim (https://git.osmocom.org/osmo-remsim/about/) we are developing a software stack allowing to control multiple SIM sources like sysmoOCTSIM with multiple SIM clients like sysmoQMOD or SIMtrace2.

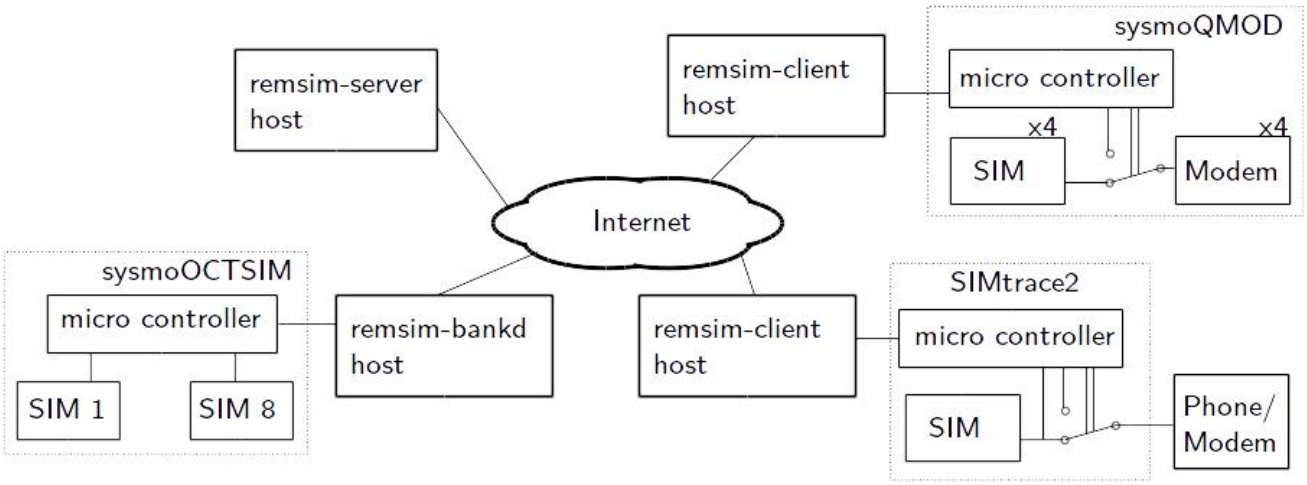

Figure 20: sysmoOCTSIM serving remote SIMs for sysmoQMOD

7 Glossary

2FF
2nd Generation Form Factor; the so-called plug-in SIM form factor

3FF
3rd Generation Form Factor; the so-called microSIM form factor

3GPP
3rd Generation Partnership Project

4FF
4th Generation Form Factor; the so-called nanoSIM form factor

A Interface
Interface between BTS and BSC, traditionally over E1 (*3GPP TS 48.008* [3gpp-ts-48-008])

A3/A8
Algorithm 3 and 8; Authentication and key generation algorithm in GSM and GPRS, typically COMP128v1/v2/v3 or MILENAGE are typically used

A5
Algorithm 5; Air-interface encryption of GSM; currently only A5/0 (no encryption), A5/1 and A5/3 are in use

Abis Interface
Interface between BTS and BSC, traditionally over E1 (*3GPP TS 48.058* [3gpp-ts-48-058] and *3GPP TS 52.021* [3gpp-ts-52-021])

ACC
Access Control Class; every BTS broadcasts a bit-mask of permitted ACC, and only subscribers with a SIM of matching ACC are permitted to use that BTS

AGCH
Access Grant Channel on Um interface; used to assign a dedicated channel in response to RACH request

AGPL
GNU Affero General Public License, a copyleft-style Free Software License

AQPSK
Adaptive QPSK, a modulation scheme used by VAMOS channels on Downlink

ARFCN
Absolute Radio Frequency Channel Number; specifies a tuple of uplink and downlink frequencies

AUC
Authentication Center; central database of authentication key material for each subscriber

BCCH
Broadcast Control Channel on Um interface; used to broadcast information about Cell and its neighbors

BCC
Base Station Color Code; short identifier of BTS, lower part of BSIC

BTS
Base Transceiver Station

BSC
Base Station Controller

BSIC
Base Station Identity Code; 16bit identifier of BTS within location area

BSSGP
Base Station Subsystem Gateway Protocol (*3GPP TS 48.018* [3gpp-ts-48-018])

BVCI
BSSGP Virtual Circuit Identifier

CBC
Cell Broadcast Centre; central entity of Cell Broadcast service

CBCH
Cell Broadcast Channel; used to transmit Cell Broadcast SMS (SMS-CB)

CBS
Cell Broadcast Service

CBSP
Cell Broadcast Service Protocol (*3GPP TS 48.049* [3gpp-ts-48-049])

CC
Call Control; Part of the GSM Layer 3 Protocol

CCCH
Common Control Channel on Um interface; consists of RACH (uplink), BCCH, PCH, AGCH (all downlink)

Cell
A cell in a cellular network, served by a BTS

CEPT
Conférence européenne des administrations des postes et des télécommunications; European Conference of Postal and Telecommunications Administrations.

CGI
Cell Global Identifier comprised of MCC, MNC, LAC and BSIC

CSFB
Circiut-Switched Fall Back; Mechanism for switching from LTE/EUTRAN to UTRAN/GERAN when circuit-switched services such as voice telephony are required.

dB
deci-Bel; relative logarithmic unit

dBm
deci-Bel (milliwatt); unit of measurement for signal strength of radio signals

DHCP
Dynamic Host Configuration Protocol (*IETF RFC 2131* [ietf-rfc2131])

downlink
Direction of messages / signals from the network core towards the mobile phone

DSCP
Differentiated Services Code Point (*IETF RFC 2474* [ietf-rfc2474])

DSP
Digital Signal Processor

dvnixload
Tool to program UBL and the Bootloader on a sysmoBTS

EDGE
Enhanced Data rates for GPRS Evolution; Higher-speed improvement of GPRS; introduces 8PSK

EGPRS
Enhanced GPRS; the part of EDGE relating to GPRS services

EIR
Equipment Identity Register; core network element that stores and manages IMEI numbers

ESME
External SMS Entity; an external application interfacing with a SMSC over SMPP

ETSI
European Telecommunications Standardization Institute

FPGA
Field Programmable Gate Array; programmable digital logic hardware

Gb
Interface between PCU and SGSN in GPRS/EDGE network; uses NS, BSSGP, LLC

GERAN
GPRS/EDGE Radio Access Network

GGSN
GPRS Gateway Support Node; gateway between GPRS and external (IP) network

GMSK
Gaussian Minimum Shift Keying; modulation used for GSM and GPRS

GPL
GNU General Public License, a copyleft-style Free Software License

Gp
Gp interface between SGSN and GGSN; uses GTP protocol

GPRS
General Packet Radio Service; the packet switched 2G technology

GPS
Global Positioning System; provides a highly accurate clock reference besides the global position

GSM
Global System for Mobile Communications. ETSI/3GPP Standard of a 2G digital cellular network

GSMTAP
GSM tap; pseudo standard for encapsulating GSM protocol layers over UDP/IP for analysis

GSUP
Generic Subscriber Update Protocol. Osmocom-specific alternative to TCAP/MAP

GT
Global Title; an address in SCCP

GTP
GPRS Tunnel Protocol; used between SGSN and GGSN

HLR
Home Location Register; central subscriber database of a GSM network

HNB-GW
Home NodeB Gateway. Entity between femtocells (Home NodeB) and CN in 3G/UMTS.

HPLMN
Home PLMN; the network that has issued the subscriber SIM and has his record in HLR

IE
Information Element

IMEI
International Mobile Equipment Identity; unique 14-digit decimal number to globally identify a mobile device, optionally with a 15th checksum digit

IMEISV
IMEI software version; unique 14-digit decimal number to globally identify a mobile device (same as IMEI) plus two software version digits (total digits: 16)

IMSI
International Mobile Subscriber Identity; 15-digit unique identifier for the subscriber/SIM; starts with MCC/MNC of issuing operator

IP
Internet Protocol (*IETF RFC 791* [ietf-rfc791])

IPA
ip.access GSM over IP protocol; used to multiplex a single TCP connection

Iu
Interface in 3G/UMTS between RAN and CN

IuCS
Iu interface for circuit-switched domain. Used in 3G/UMTS between RAN and MSC

IuPS
Iu interface for packet-switched domain. Used in 3G/UMTS between RAN and SGSN

LAC
Location Area Code; 16bit identifier of Location Area within network

LAPD
Link Access Protocol, D-Channel (*ITU-T Q.921* [itu-t-q921])

LAPDm
Link Access Protocol Mobile (*3GPP TS 44.006* [3gpp-ts-44-006])

LLC
Logical Link Control; GPRS protocol between MS and SGSN (*3GPP TS 44.064* [3gpp-ts-44-064])

Location Area
Location Area; a geographic area containing multiple BTS

LU
Location Updating; can be of type IMSI-Attach or Periodic. Procedure that indicates a subscriber's physical presence in a given radio cell.

M2PA
MTP2 Peer-to-Peer Adaptation; a SIGTRAN Variant (*RFC 4165* [ietf-rfc4165])

M2UA
MTP2 User Adaptation; a SIGTRAN Variant (*RFC 3331* [ietf-rfc3331])

M3UA
MTP3 User Adaptation; a SIGTRAN Variant (*RFC 4666* [ietf-rfc4666])

MCC
Mobile Country Code; unique identifier of a country, e.g. 262 for Germany

MFF
Machine-to-Machine Form Factor; a SIM chip package that is soldered permanently onto M2M device circuit boards.

MGW
Media Gateway

MM
Mobility Management; part of the GSM Layer 3 Protocol

MNC
Mobile Network Code; identifies network within a country; assigned by national regulator

MNCC
Mobile Network Call Control; Unix domain socket based Interface between MSC and external call control entity like osmo-sip-connector

MNO
Mobile Network Operator; operator with physical radio network under his MCC/MNC

MO
Mobile Originated. Direction from Mobile (MS/UE) to Network

MS
Mobile Station; a mobile phone / GSM Modem

MSC
Mobile Switching Center; network element in the circuit-switched core network

MSC pool
A number of redundant MSCs serving the same core network, which a BSC / RNC distributes load across; see also the "MSC Pooling" chapter in OsmoBSC's user manual [userman-osmobsc] and *3GPP TS 23.236* [3gpp-ts-23-236]

MSISDN
Mobile Subscriber ISDN Number; telephone number of the subscriber

MT
Mobile Terminated. Direction from Network to Mobile (MS/UE)

MTP
Message Transfer Part; SS7 signaling protocol (*ITU-T Q.701* [itu-t-q701])

MVNO
Mobile Virtual Network Operator; Operator without physical radio network

NCC
Network Color Code; assigned by national regulator

NITB
Network In The Box; combines functionality traditionally provided by BSC, MSC, VLR, HLR, SMSC functions; see OsmoNITB

NRI
Network Resource Indicator, typically 10 bits of a TMSI indicating which MSC of an MSC pool attached the subscriber; see also the "MSC Pooling" chapter in OsmoBSC's user manual [userman-osmobsc] and *3GPP TS 23.236* [3gpp-ts-23-236]

NSEI
NS Entity Identifier

NVCI
NS Virtual Circuit Identifier

NWL
Network Listen; ability of some BTS to receive downlink from other BTSs

NS
Network Service; protocol on Gb interface (*3GPP TS 48.016* [3gpp-ts-48-016])

OCXO
Oven Controlled Crystal Oscillator; very high precision oscillator, superior to a VCTCXO

OML
Operation & Maintenance Link (ETSI/*3GPP TS 52.021* [3gpp-ts-52-021])

OpenBSC
Open Source implementation of GSM network elements, specifically OsmoBSC, OsmoNITB, OsmoSGSN

OpenGGSN
Open Source implementation of a GPRS Packet Control Unit

OpenVPN
Open-Source Virtual Private Network; software employed to establish encrypted private networks over untrusted public networks

Osmocom
Open Source MObile COMmunications; collaborative community for implementing communications protocols and systems, including GSM, GPRS, TETRA, DECT, GMR and others

OsmoBSC
Open Source implementation of a GSM Base Station Controller

OsmoNITB
Open Source implementation of a GSM Network In The Box, combines functionality traditionally provided by BSC, MSC, VLR, HLR, AUC, SMSC

OsmoSGSN
Open Source implementation of a Serving GPRS Support Node

OsmoPCU
Open Source implementation of a GPRS Packet Control Unit

OTA
Over-The-Air; Capability of operators to remotely reconfigure/reprogram ISM/USIM cards

PC
Point Code; an address in MTP

PCH
Paging Channel on downlink Um interface; used by network to page an MS

PCP
Priority Code Point (*IEEE 802.1Q* [?])

PCU
Packet Control Unit; used to manage Layer 2 of the GPRS radio interface

PDCH
Packet Data Channel on Um interface; used for GPRS/EDGE signalling + user data

PIN
Personal Identification Number; a number by which the user authenticates to a SIM/USIM or other smart card

PLMN
Public Land Mobile Network; specification language for a single GSM network

PUK
PIN Unblocking Code; used to unblock a blocked PIN (after too many wrong PIN attempts)

RAC
Routing Area Code; 16bit identifier for a Routing Area within a Location Area

RACH
Random Access Channel on uplink Um interface; used by MS to request establishment of a dedicated channel

RAM
Remote Application Management; Ability to remotely manage (install, remove) Java Applications on SIM/USIM Card

RF
Radio Frequency

RFM
Remote File Management; Ability to remotely manage (write, read) files on a SIM/USIM card

Roaming
Procedure in which a subscriber of one network is using the radio network of another network, often in different countries; in some countries national roaming exists

Routing Area
Routing Area; GPRS specific sub-division of Location Area

RR
Radio Resources; Part of the GSM Layer 3 Protocol

RSL
Radio Signalling Link (*3GPP TS 48.058* [3gpp-ts-48-058])

RTP
Real-Time Transport Protocol (*IETF RFC 3550* [ietf-rfc3550]); Used to transport audio/video streams over UDP/IP

SACCH
Slow Associate Control Channel on Um interface; bundled to a TCH or SDCCH, used for signalling in parallel to active dedicated channel

SCCP
Signaling Connection Control Part; SS7 signaling protocol (*ITU-T Q.711* [itu-t-q711])

SDCCH
Slow Dedicated Control Channel on Um interface; used for signalling and SMS transport in GSM

SDK
Software Development Kit

SGs
Interface between MSC (GSM/UMTS) and MME (LTE/EPC) to facilitate CSFB and SMS.

SGSN
Serving GPRS Support Node; Core network element for packet-switched services in GSM and UMTS.

SIGTRAN
Signaling Transport over IP (*IETF RFC 2719* [ietf-rfc2719])

SIM
Subscriber Identity Module; small chip card storing subscriber identity

Site
A site is a location where one or more BTSs are installed, typically three BTSs for three sectors

SMPP
Short Message Peer-to-Peer; TCP based protocol to interface external entities with an SMSC

SMSC
Short Message Service Center; store-and-forward relay for short messages

SS7
Signaling System No. 7; Classic digital telephony signaling system

SS
Supplementary Services; query and set various service parameters between subscriber and core network (e.g. USSD, 3rd-party calls, hold/retrieve, advice-of-charge, call deflection)

SSH
Secure Shell; *IETF RFC 4250* [ietf-rfc4251] to 4254

SSN
Sub-System Number; identifies a given SCCP Service such as MSC, HLR

STP
Signaling Transfer Point; A Router in SS7 Networks

SUA
SCCP User Adaptation; a SIGTRAN Variant (*RFC 3868* [ietf-rfc3868])

syslog
System logging service of UNIX-like operating systems

System Information
A set of downlink messages on the BCCH and SACCH of the Um interface describing properties of the cell and network

TCH
Traffic Channel; used for circuit-switched user traffic (mostly voice) in GSM

TCP
Transmission Control Protocol; (*IETF RFC 793* [ietf-rfc793])

TFTP
Trivial File Transfer Protocol; (*IETF RFC 1350* [ietf-rfc1350])

TOS
Type Of Service; bit-field in IPv4 header, now re-used as DSCP (*IETF RFC 791* [ietf-rfc791])

TRX
Transceiver; element of a BTS serving a single carrier

TS
Technical Specification

u-Boot
Boot loader used in various embedded systems

UBI
An MTD wear leveling system to deal with NAND flash in Linux

UBL
Initial bootloader loaded by the TI Davinci SoC

UDP
User Datagram Protocol (*IETF RFC 768* [ietf-rfc768])

UICC
Universal Integrated Chip Card; A smart card according to *ETSI TR 102 216* [etsi-tr102216]

Um interface
U mobile; Radio interface between MS and BTS

uplink
Direction of messages: Signals from the mobile phone towards the network

USIM
Universal Subscriber Identity Module; application running on a UICC to provide subscriber identity for UMTS and GSM networks

USSD
Unstructured Supplementary Service Data; textual dialog between subscriber and core network, e.g. **100 → Your extension is 1234*

VAMOS
Voice services over Adaptive Multi-user channels on One Slot; an optional extension for GSM specified in Release 9 of 3GPP GERAN specifications (*3GPP TS 48.018* [3gpp-ts-48-018]) allowing two independent UEs to transmit and receive simultaneously on traffic channels

VCTCXO
Voltage Controlled, Temperature Compensated Crystal Oscillator; a precision oscillator, superior to a classic crystal oscillator, but inferior to an OCXO

VLAN
Virtual LAN in the context of Ethernet (*IEEE 802.1Q* [ieee-802.1q])

VLR
Visitor Location Register; volatile storage of attached subscribers in the MSC

VPLMN
Visited PLMN; the network in which the subscriber is currently registered; may differ from HPLMN when on roaming

VTY
Virtual TeletYpe; a textual command-line interface for configuration and introspection, e.g. the OsmoBSC configuration file as well as its telnet link on port 4242

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