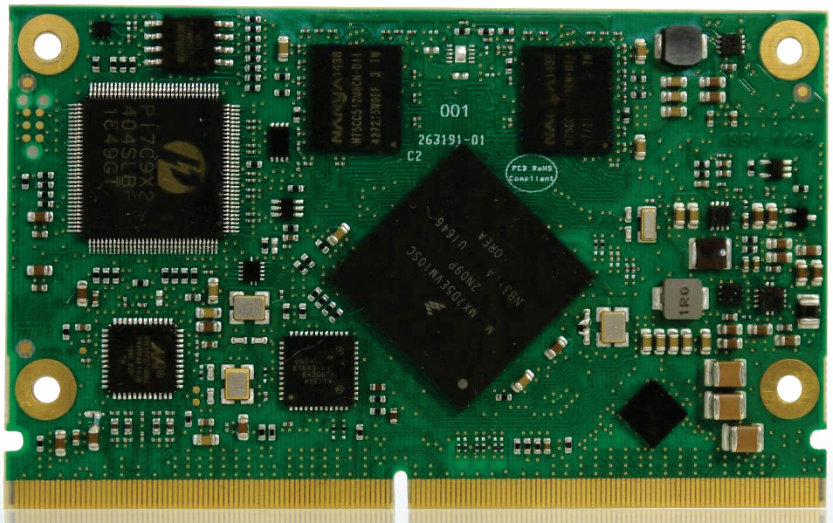
USER GUIDE



SMARC-sAMX7

User Guide Rev. 1.91

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SMARC-SAMX7 - USER GUIDE

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Intended Use

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You understand and agree that your use of Kontron devices as a component in High Risk Applications is entirely at your risk. To minimize the risks associated with your products and applications, you should provide adequate design and operating safeguards. You are solely responsible for compliance with all legal, regulatory, safety, and security related requirements concerning your products. You are responsible to ensure that your systems (and any Kontron hardware or software components incorporated in your systems) meet all applicable requirements. Unless otherwise stated in the product documentation, the Kontron device is not provided with error-tolerance capabilities and cannot therefore be deemed as being engineered, manufactured or setup to be compliant for implementation or for resale as device in High Risk Applications. All application and safety related information in this document (including application descriptions, suggested safety measures, suggested Kontron products, and other materials) is provided for reference only.

⚠CAUTION

Handling and operation of the product is permitted only for trained personnel within a work place that is access controlled. Please follow the "General Safety Instructions" supplied with the system.

NOTICE

You find the most recent version of the "General Safety Instructions" online in the download area of this product.

Revision History

Revision	Brief Description of Changes	Date of Issue	Author
1.0	basic draft	2017-October-26	hjs
1.1	updated certification information	2017-November-23	hjs
1.2	block diagram changed	2018-January-10	hjs
1.3	table 11 changed, block diagram changed	2018-Januray-18	hjs
1.4	table 2, 9, 10, 11 changed,	2018-February-05	hjs
1.5	added chapter RTC power consumption, changed U-Boot licence note	2018-February-12	hjs
1.6	SPI boot flash, memory, Supply voltage corrected, chapter "Bootloader Environment Update" added	2018-March-14	hjs
1.7	Corrected pin 119 in table 5.5.1	2018-November-29	hjs
1.8	Pin P156 added, design issues modified	2019-April-24	hjs
1.9	pSLC Info added	2019-June-13	hjs
1.91	Word2016 issues	2021-March-31	hjs

Terms and Conditions

Kontron warrants products in accordance with defined regional warranty periods. For more information about warranty compliance and conformity, and the warranty period in your region, visit http://www.kontron.com/terms-and-conditions.

Kontron sells products worldwide and declares regional General Terms & Conditions of Sale, and Purchase Order Terms & Conditions. Visit http://www.kontron.com/terms-and-conditions.

For contact information, refer to the corporate offices contact information on the last page of this user guide or visit our website CONTACT US.

Customer Support

Find Kontron contacts by visiting: https://www.kontron.de/support-and-services.

Customer Service

As a trusted technology innovator and global solutions provider, Kontron extends its embedded market strengths into a services portfolio allowing companies to break the barriers of traditional product lifecycles. Proven product expertise coupled with collaborative and highly-experienced support enables Kontron to provide exceptional peace of mind to build and maintain successful products.

For more details on Kontron's service offerings such as: enhanced repair services, extended warranty, Kontron training academy, and more visit http://www.kontron.com/support-and-services/services.

Customer Comments

If you have any difficulties using this user guide, discover an error, or just want to provide some feedback, contact Kontron support. Detail any errors you find. We will correct the errors or problems as soon as possible and post the revised user guide on our website.

Symbols

The following symbols may be used in this manual

⚠DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
NOTICE	NOTICE indicates a property damage message.
⚠CAUTION	CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
	Electric Shock! This symbol and title warn of hazards due to electrical shocks (> 60 V) when touching products or parts of products. Failure to observe the precautions indicated and/or prescribed by the law may endanger your life/health and/or result in damage to your material.
	ESD Sensitive Device! This symbol and title inform that the electronic boards and their components are sensitive to static electricity. Care must therefore be taken during all handling operations and inspections of this product in order to ensure product integrity at all times.
	HOT Surface! Do NOT touch! Allow to cool before servicing.
	Laser! This symbol inform of the risk of exposure to laser beam and light emitting devices (LEDs) from an electrical device. Eye protection per manufacturer notice shall review before servicing.
	This symbol indicates general information about the product and the user guide. This symbol also indicates detail information about the specific product configuration.
	This symbol precedes helpful hints and tips for daily use.

For Your Safety

Your new Kontron product was developed and tested carefully to provide all features necessary to ensure its compliance with electrical safety requirements. It was also designed for a long fault-free life. However, the life expectancy of your product can be drastically reduced by improper treatment during unpacking and installation. Therefore, in the interest of your own safety and of the correct operation of your new Kontron product, you are requested to conform with the following guidelines.

High Voltage Safety Instructions

As a precaution and in case of danger, the power connector must be easily accessible. The power connector is the product's main disconnect device.

⚠CAUTION

Warning

All operations on this product must be carried out by sufficiently skilled personnel only.

⚠CAUTION

Electric Shock!

Before installing a non hot-swappable Kontron product into a system always ensure that your mains power is switched off. This also applies to the installation of piggybacks. Serious electrical shock hazards can exist during all installation, repair, and maintenance operations on this product. Therefore, always unplug the power cable and any other cables which provide external voltages before performing any work on this product.

Earth ground connection to vehicle's chassis or a central grounding point shall remain connected. The earth ground cable shall be the last cable to be disconnected or the first cable to be connected when performing installation or removal procedures on this product.

Special Handling and Unpacking Instruction

NOTICE

ESD Sensitive Device!

Electronic boards and their components are sensitive to static electricity. Therefore, care must be taken during all handling operations and inspections of this product, in order to ensure product integrity at all times.

Do not handle this product out of its protective enclosure while it is not used for operational purposes unless it is otherwise protected.

Whenever possible, unpack or pack this product only at EOS/ESD safe work stations. Where a safe work station is not guaranteed, it is important for the user to be electrically discharged before touching the product with his/her hands or tools. This is most easily done by touching a metal part of your system housing.

It is particularly important to observe standard anti-static precautions when changing piggybacks, ROM devices, jumper settings etc. If the product contains batteries for RTC or memory backup, ensure that the product is not placed on conductive surfaces, including anti-static plastics or sponges. They can cause short circuits and damage the batteries or conductive circuits on the product.

General Instructions on Usage

In order to maintain Kontron's product warranty, this product must not be altered or modified in any way. Changes or modifications to the product, that are not explicitly approved by Kontron and described in this User Guide or received from Kontron's Technical Support as a special handling instruction, will void your warranty.

This product should only be installed in or connected to systems that fulfill all necessary technical and specific environmental requirements. This also applies to the operational temperature range of the specific board version, that must not be exceeded. If batteries are present, their temperature restrictions must be taken into account.

In performing all necessary installation and application operations, only follow the instructions supplied by the present User Guide.

Keep all the original packaging material for future storage or warranty shipments. If it is necessary to store or ship the product then re-pack it in the same manner as it was delivered.

Special care is necessary when handling or unpacking the product. See Special Handling and Unpacking Instruction.

Environmental Protection Statement

This product has been manufactured to satisfy environmental protection requirements where possible. Many of the components used (structural parts, printed circuit boards, connectors, batteries, etc.) are capable of being recycled.

Final disposition of this product after its service life must be accomplished in accordance with applicable country, state, or local laws or regulations.

Environmental protection is a high priority with Kontron.
Kontron follows the WEEE directive
You are encouraged to return our products for proper disposal.

The Waste Electrical and Electronic Equipment (WEEE) Directive aims to:

Reduce waste arising from electrical and electronic equipment (EEE)

Make producers of EEE responsible for the environmental impact of their products, especially when the product become waste

Encourage separate collection and subsequent treatment, reuse, recovery, recycling and sound environmental disposal of EEE

Improve the environmental performance of all those involved during the lifecycle of EEE

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1/ Introduction

This manual describes the Smart Mobility ARChitecture (SMARC) sAMX7 (SMX7) board. The Advanced RISC Machines (ARM) based module is equipped with a NXP i.MX7 processor. The single or dual core SoC take advantage of the optimized power consumption and performance ratio.

The use of this Users Guide implies a basic knowledge of PC hard- and software. This manual is focussed on describing the special features and is not intended to be a standard PC textbook. New users are recommended to study the short installation procedure stated in the following chapter before switching on the power.

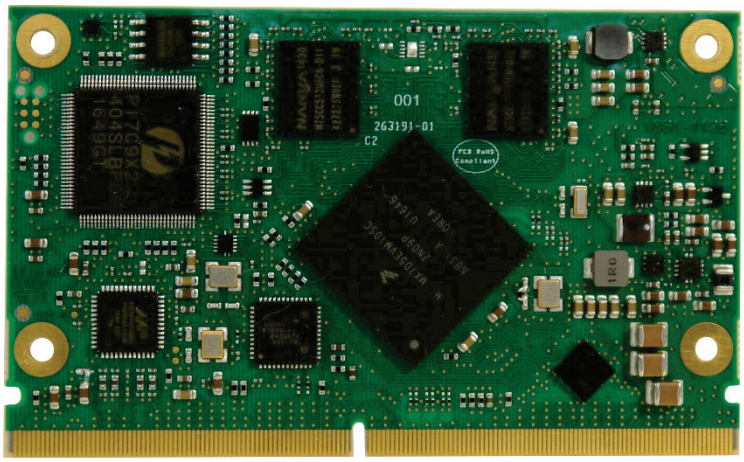
All configuration and setup of the CPU board is either done automatically or manually by the user via the BIOS setup menus.

Latest revision of this manual, datasheet, BIOS, drivers and BSP's (Board Support Packages) can be downloaded from Kontron Web Page.

2/ Description

The SMARC-sAMX7 is a SMARC half-size module using the NXPs i.MX7 processor with either single or dual core ARM. It is designed on the latest SMARC 2.0 specification. The SMARC-sAMX7 is a highly integrated, embedded computer board.

Figure 1: Half-size Card with SMARC interface



2.1. SMARC™ Computer-on-Modules

The SMARC™ standard was developed especially for new modules with ARM- and SoC-processors. Boards with this interfaces are characterized by the extremely flat form factor. The SMARC or MXM 3.0 connector comes with 314 pins and a construction height of just 4.3 millimeters. The connector is also available in a shock- and vibration-resistant version for rough environmental conditions.

Furthermore, the standard integrates dedicated interfaces for the latest ARM, x86 and SoC processors like LVDS, 24-bit RGB and HDMI support. In addition, dedicated camera interfaces are being incorporated into a COM standard. OEMs profit from minimized design effort and low Bill of Material (BoM) costs. SMARC™ defines two different module sizes in order to offer a high level of flexibility regarding different mechanical requirements.

Main characteristics of the SMARC-sAMX7 are:

- Single/Dual Cortex A7-Core based on NXP's processor i.MX7 Solo with 800 MHz and 2 W max power or i.MX7 Dual with 1000 MHz and 4 W max power
- Up to 2 GB DDR3L memory down
- 2 to 64 GB pSLC eMMC (optionally)
- 2 to 32 MB QSPI boot flash
- LVDS dual channel graphics
- MIPI CSI camera interface
- 2x USB 2.0 On the Go (OTG)
- 4x USB 2.0 Host interface
- 2x SPI (1x SPI, 1x QSPI/ESPI) both with 2 chip selects
- 2x Ethernet (Solo processor 1x Ethernet)
- Dual only: 1x PCIe, optional 3x PCIe via bridge
- 12x GPIOs
- 4x UART, with 32 bit FIFO
- 2x CAN Bus interface
- Support for audio and common features (SPI, I2C)
- APPROTECT (security chip) support on request, more information under https://www.kontron.de/products/solutions/security/approtect.html

2.2. Product Variants and Accessories

Following variants are available:

Table 1: Product Variants of SMARC-sAMX7

Board	Description	Product Number
SMARC-sAMX7 Solo	SMARC-sAMX7 Solo with 1 GB DDR3L, 4 GB pSLC eMMC, 2 MB SPI boot flash	51009-0104-08-1
SMARC-sAMX7 Dual	SMARC-sAMX7 Dual with 2 GB DDR3L, 8 GB pSLC eMMC, 2 MB SPI boot flash	51009-0208-10-2

Following accessories are available:

- SMARC 2.0 Evaluation Carrier
- SMARC Starter Kit

2.3. SMARC-sAMX7 Feature Set

Table 2: SMARC-sAMX7 Feature Set

SMARC™ Feature specification	SMARC™ Specification Maximum Number Possible	SMARC-sAMX7 Feature support	Description
LVDS Display support	1	1	LVDS dual Channel
CSI Camera support	2	Yes	Quad lane
USB Interface	6 x USB 2.0 with 2 x USB 3.0 included	6x USB 2.0 with APPROTECT 5x	- single core: 1x USB OTG port, 4 USB host ports (3x with WIBU key option/APPROTECT) - dual core: 2x USB OTG ports, 4x USB host ports (3x with WIBU key option/APPROTECT)
PCIe Interface	4	3	single core: 0 dual core: 1 or 3
GbE Interface	2	Yes	1 (Solo Proc.) 2 (Dual proc.)
SDIO Interface	1	Yes	
SPI Interface	2	Yes	
I2S Interface	2	Yes	
I2C Interface	5	4	
CAN	2	2	

3/ System Specifications

3.1. Component Main Data

The table below summarizes the features of the motherboard.

Table 3: Component Main Data

SMARC-sAMX7	
Form factor	Smart Mobility ARChitecture (SMARC) Hardware with 82 mm x 50 mm, max. thickness 6 mm
Processor	Freescale/NXP/Qualcomm's i.MX7 28nm (Solo and Dual SKUs) with 19mm x 19mm BGA package in 0.75mm pitch (industrial version)
Memory	533 MHz 32-bit DDR3L ▶ Solo CPU: 1 GByte: 4x 2 Gbit density 256 M x8 DDR3L parts ▶ Dual CPU: 2 GByte: 4x 4 Gbit density 512 M x8 DDR3L parts
Boot Flash	2 MB to 32 MB SPI NOR flash, two SPI package sizes are possible with current layout: ▶ WSON8_5x8 (up to 128 Mbit/16 MB) ▶ WSON8_6x8 (256 Mbit/32 MB)
Bootloader/BIOS	U-Boot Bootloader, Flash for Bootloader connected on SPI0.
embedded Multimedia Card (eMMC)	▶ 2 to 32 GB pseudo Single Level Cell (pSLC) ▶ 4 to 64 GB MLC (Multi-level Cell)
EEPROM	▶ Type: 24C32, 4k x 8 (32 kbit) ▶ Connected at I2C_GP bus at address 0x50 (7-bit)
Display	▶ 18/24-bit LVDS RGB (True Color) ▶ Resolution: up to 1920x1080 Pixel ▶ Single/Dual Channel
Onboard Controllers	
Ethernet Controller	1x GBE PHY 88E1510PB2, second optional PHY only on dual SKU
Watchdog Timer	CPU internal watchdog, configurable timeout counter with timeout periods from 0.5 to 128 seconds
USB HUB	USB HSIC 4 port Hub USB4604
PCI Switch	PCIe packet switch PI7C9X2G404SL (optional for Solo SKU)
Display bridge	MIPI DSI to LVDS Flatlink SN65DSI84ZQER
Real Time Clock (RTC)	High accuracy (+/-3%), low power, RV-8803
System Management Controller	No dedicated System Management Controller on module System settings can be arranged in U-Boot environment variables
Storage	2 to 64 GB pSLC eMMC 5.0 Flash (option)
H/W Status Monitor	temperature monitoring sensor
Security	APPROTECT Key optional
Power management	▶ Clock Control Module (CCM) ▶ General Power Controller (GPC) ▶ System Reset Controller (SRC)

Operating System Support	Linux Yocto, other Operating Systems only on customer request
Interfaces via Smarc I/O	
I2C	4x I2C interfaces which are derived from the SoC, the iMX7 I2C IOs PADs are configured according the NXP AN5078, ▶ I2C_PM Power Management Support ▶ I2C_GP General Purpose Use ▶ I2C_CAM0 camera support ▶ I2C_LCD Display support
LAN, USB	1x Gb-Ethernet Solo processor, 2x Gb interface with Dual processor, Solo processor: 1x USB OTG and 4x USB2.0 with High-Speed Inter-Chip (HSIC) hub Dual processor: 2x USB OTG and 4x USB2.0 with HSIC hub
PCIe	solo processor: no PCIe dual processor: 3x PCIe via PCIe switch, option for 1x PCIe without PCIe switch
Audio	2x Synchronous Audio Interface (SAI)
Display	2x LVDS interfaces with DSI to flatlink LVDS bridge over 2 MIPI DSI lanes with 1000 Mbits/sec per DSI lane
Camera	iMX7 display and camera subsystem, MIPI CSI camera interface
SD-Card	1x SDIO
UART	4x UART, one is used for serial console by default
Serial Peripheral Interface (SPI)	4x SPI
GPIO	12x General Purpose Inputs/Outputs (GPIO)
other Connectivity	Keypad, 2x CAN
Power	
Consumption	Maximum Power consumption of the board is measured to 2 W (Single Core) and 4 W (Dual Core)
Input Voltage	Wide range VCC 3.0 V to 5.25 V

3.2. Environmental Conditions

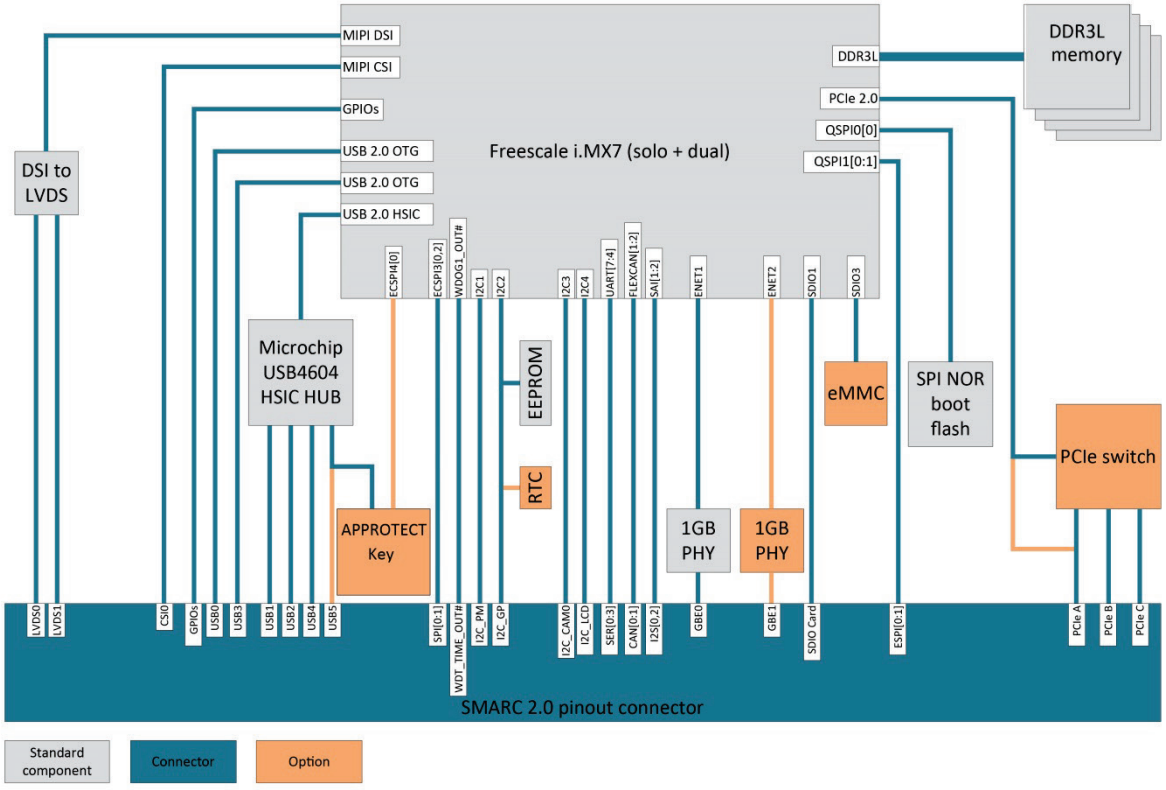
Table 4: Environmental Conditions

Operating	▶ industrial: -20°C to 85°C ▶ relative humidity (non-condensing) 10 % to 93 % at 40°C
Storage	▶ commercial grade: -40°C to +85°C ▶ relative humidity (non-condensing) 10 % to 93 % at 40°C
Electromagnetic Compatibility (EMC)	according to ▶ EN 55032:2015 Electromagnetic compatibility of multimedia equipment - Emission requirements (CISPR 32:2015); German version EN 55032:2015 ▶ EN 55024:2010 + A1:2015 Information technology equipment - Immunity characteristics - Limits and methods of measurement (CISPR 24:2010 + Cor.:2011 + A1:2015); German version EN 55024:2010 + A1:2015
CE	CE according to ▶ EN62368-1:2014 + AC:2017 ▶ EN610000-6-3:2007 + A1:2011 ▶ CISPR 32: Edition 1.0 2012-01, class B, 1-6 GHz ▶ EN55032:2015 ▶ EN55024:2010 + A1:2015
UL	according to IEC 62368-1 (ed.2)
Shock	▶ Pulse: half sinus ▶ Period: 11 ms ▶ Acceleration: 15 g ▶ Cycles: 3 shocks per axis, three axes
Vibration	▶ Sinus from 10 Hz -3000 Hz ▶ Amplitude: 10 Hz-57,6 Hz: +/- 0,15 mm ▶ Acceleration: 57,6 Hz – 3000Hz: 2 g ▶ Cycles: 10 per axis, three axes
Theoretical MTBF	estimated 10 years at 40°C
RoHS II Compliance	The product is RoHS II compliant

3.3. Functional Block Diagram

The block diagram shows all available interfaces on the sAMX7 module.

Figure 2: Block Diagram



4/ Board and Connectors

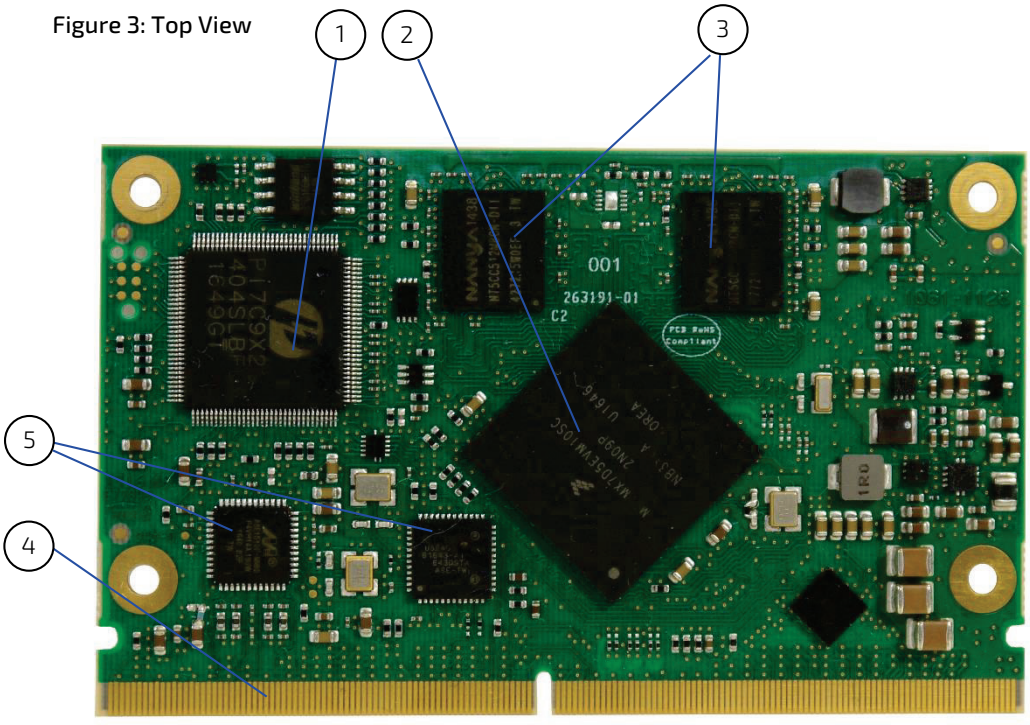
4.1.1. Connectors

Table 5: Connectors of SMARC-sAMX7

Connector	Function	Remark
SMARC	Central Interface	Mating connector: SMARC 2.0 (MXM3)

4.2. Mainboard view and I/O locations

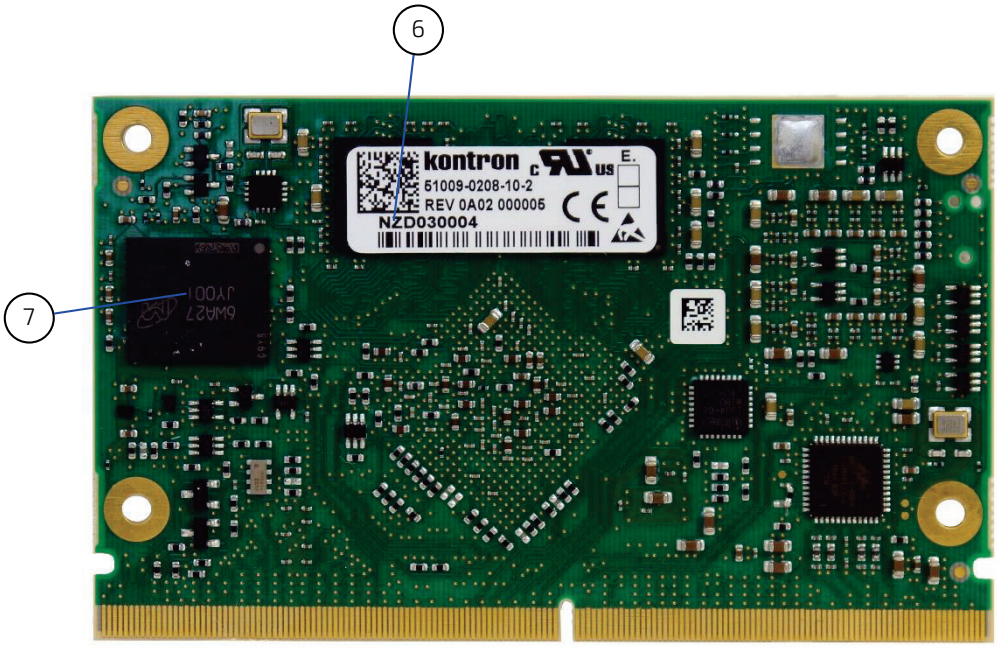
Figure 3: Top View



1. PCIe Switch
2. Freescale Processor
3. DDR3L memory 2x
4. SMARC Interface
5. GbE PHYs 2x

4.3. Bottom Side

Figure 4: Bottom Side from SMARC-sAMX7



6. Type Label on DDR3L memory
7. embedded MultiMedia Card (pSLC eMMC)

4.4. Mechanical Drawings

Figure 5: Dimensions of SMARC-sAMX7

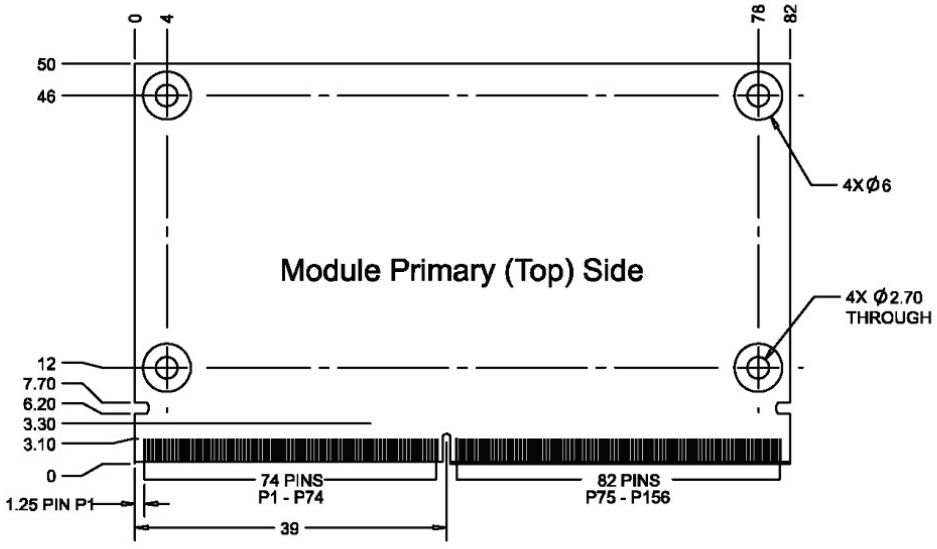
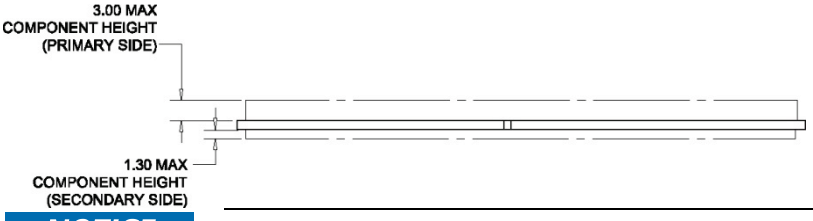


Figure 6: Thickness from side view



NOTICE

Heat spreader mech. data is available on customer section

5/ Pin Definitions

5.1. Processor Support

Kontron used a Freescale/NXP/Qualcomm's i.MX7 chip with 28 nm die. There are Solo and Dual SKUs with 19 mm x 19 mm BGA package in 0.75 mm pitch available.

Table 6: Processor Support

Name	Speed	RAM.	Cache	TDP/Tj
Solo CPU: MCIMX7S5EVM08SC	0.8 GHz	1 GB	512 KB	2 W/-20°C to 105°C
Dual CPU: MCIMX7D5EVM10SC	1.0 GHz	2 GB	512 KB	4 W/-20°C to 105°C

5.2. System Memory Support

The memory system has one DDR3L channel. The system supports the following memory features:

- 32-bit data bus width (4 devices x8 bit)
- 533 MHz (1066 MT/s) clock (data rate)

Table 7: DDR3L memory options

512MB
4x 1 Gbit density 128Mx8 DDR 3L parts
1 GByte
4x 2 GBit density 256Mx8 DDR3L parts
2 GByte
4x 4 GBit density 512Mx8 DDR3L parts

5.3. eMMC Flash Memory

An optional embedded Multimedia Flash Card (eMMC) complying with the eMMC 5.0 specification can be permanently attached to the module, allowing for a capacity of up to 64 GByte NAND Flash. During the COMe-cAL6's manufacturing process, Multi Level Cell (MLC) eMMC is reconfigured to act as a pseudo Single Level Cell (pSLC) eMMC to provide improved reliability, endurance and performance.

Specific eMMC Flash memory features are:

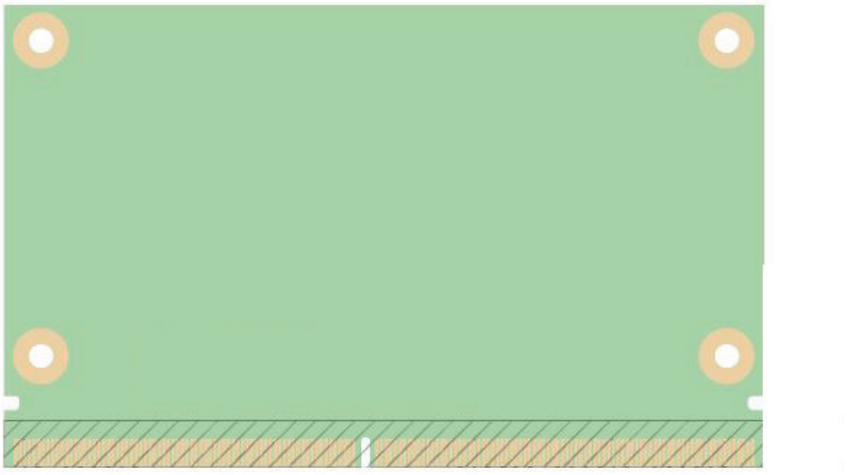
- Up to 64 GByte pSLC (or128 GB MLC)
- eMMC 5.0 specification
- Class 0 (basic); class 2 (block read); class 4 (block write); class 5 (erase); class 6 (write protection); class 7 (lock card)
- HS200/HS400 modes
- DDR modes up to 52 MHz clock speed
- ECC and block management
- Boot operation (High-speed boot)
- Sleep mode
- Permanent and power-on write protection
- Replay-protected memory block (RPMB)
- Secure erase and secure trim

5.4. SMARC Connector

The SMARC connector has different pins on both sides:

- Top side: 74 pins are on the left side, 82 pins on the right side
- Bottom side: 75 pins are on the left side, 83 pins on the right side

Figure 7: 314-pin SMARC Connector,



5.5. Pinout of SMARC sAMX7 Connector

5.5.1. Pinout of SMARC sAMX7 Topside Connector

Table 8: Pinout of SMARC sAMX7 Topside Connector

Pin	Signal	Module Direction	Module Termination	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
P1	SMB_ALERT_1V8#	In	-	CMOS 1.8V	iMX7	EPDC_PWRSTAT	GPIO2_IO31	GPIO2_IO31	
P2	GND	-	-	-	-	-	-	-	GND
P3	CSI1_CK+	In	-	LVDS D-PHY	-	-	-	-	-
P4	CSI1_CK-	In	-	LVDS D-PHY	-	-	-	-	-
P5	GBE1_SDP	Bi-Dir	-	GBE MDI	iMX7	UART2_RXD+ UART2_TXD	ENET2_1588_IN1+ ENET2_1588_OUT1	-	NVCC_UART (1.8V)
P6	GBE0_SDP	Bi-Dir	-	GBE MDI	iMX7	UART3_RTX# +UART3_CTS#	ENET1_1588_IN1+ ENET1_1588_OUT1	ENET1_1588_IN1+ENET1_1588_OUT1	NVCC_UART (1.8V)
P7	CSI1_D0+	In	-	LVDS D-PHY	-	-	-	-	-
P8	CSI1_D0-	In	-	LVDS D-PHY	-	-	-	-	-
P9	GND	-	-	-	-	-	-	-	GND
P10	CSI1_D1+	In	-	LVDS D-PHY	-	-	-	-	-
P11	CSI1_D1-	In	-	LVDS D-PHY	-	-	-	-	-
P12	GND	-	-	-	-	-	-	-	GND
P13	CSI1_D2+	In	-	LVDS D-PHY	-	-	-	-	-
P14	CSI1_D2-	In	-	LVDS D-PHY	-	-	-	-	-
P15	GND	-	-	-	-	-	-	-	GND
P16	CSI1_D3+	IN	-	LVDS D-PHY	-	-	-	-	-
P17	CSI1_D3-	IN	-	LVDS D-PHY	-	-	-	-	-
P18	GND	-	-	-	-	-	-	-	GND
P19	GBE0_MDI3-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI3-	RGMII	RGMII	-
P20	GBE0_MDI3+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI3+	RGMII	RGMII	-
P21	GBE0_LINK100#	Out/OD	-	CMOS 3.3V	88E1510PB2	LED_1	RGMII	RGMII	-
P22	GBE0_LINK1000#	Out/OD	-	CMOS 3.3V	88E1510PB2	LED_0	RGMII	RGMII	-
P23	GBE0_MDI2-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI2-	RGMII	RGMII	-
P24	GBE0_MDI2+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI2+	RGMII	RGMII	-
P25	GBE0_LINK_ACT#	Out/OD	-	CMOS 3.3V	88E1510PB2	LED_2/INT#	RGMII	RGMII	-
P26	GBE0_MDI1-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI1-	RGMII	RGMII	-
P27	GBE0_MDI1+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI1+	RGMII	RGMII	-
P28	GBE0_CTREF	Out	-	-	-	-	-	-	-
P29	GBE0_MDI0-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI0-	RGMII	RGMII	-
P30	GBE0_MDI0+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI0+	RGMII	RGMII	-
P31	SPI0_CS1#	Out	-	CMOS 1.8V	iMX7	SD2_CS#	ECSPI3_SS2	ECSPI3_SS2	NVCC_SD2 (1.8V)
P32	GND	-	-	-	-	-	-	-	GND
P33	SDIO_WP	In	PU-10k	CMOS 3.3V	iMX7	SD1_WP	SD1_WP	SD1_WP	NVCC_SD1 (3.3V)

Pin	Signal	Module Direction	Module Termination	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
P34	SDIO_CMD	Bi-Dir		CMOS 3.3V	iMX7	SD1_CMD	SD1_CMD	SD1_CMD	NVCC_SD1 (3.3V)
P35	SDIO_CD#	In	PU-10k	CMOS 3.3V	iMX7	SD1_CD#	SD1_CD#	SD1_CD#	NVCC_SD1 (3.3V)
P36	SDIO_CK	Out	-	CMOS 3.3V	iMX7	SD1_CLK	SD1_CLK	SD1_CLK	NVCC_SD1 (3.3V)
P37	SDIO_PWR_EN	Out	-	CMOS 3.3V	iMX7	SD1_RESET#	GPIO5_IO02	GPIO5_IO02	NVCC_SD1 (3.3V)
P38	GND	-	-	-	-	-	-	-	GND
P39	SDIO_D0	Bi-Dir	-	CMOS 3.3V	iMX7	SD1_DATA0	SD1_DATA0	SD1_DATA0	NVCC_SD1 (3.3V)
P40	SDIO_D1	Bi-Dir	-	CMOS 3.3V	iMX7	SD1_DATA1	SD1_DATA1	SD1_DATA1	NVCC_SD1 (3.3V)
P41	SDIO_D2	Bi-Dir	-	CMOS 3.3V	iMX7	SD1_DATA2	SD1_DATA2	SD1_DATA2	NVCC_SD1 (3.3V)
P42	SDIO_D3	Bi-Dir	-	CMOS 3.3V	iMX7	SD1_DATA3	SD1_DATA3	SD1_DATA3	NVCC_SD1 (3.3V)
P43	SPI0_CS0#	Out	-	CMOS 1.8V	iMX7	SAI2_TXD	ECSPI3_SS00	ECSPI3_SS00	NVCC_SAI (1.8V)
P44	SPI0_CK	Out	-	CMOS 1.8V	iMX7	SAI2_RXD	ECSPI3_SCLK	ECSPI3_SCLK	NVCC_SAI (1.8V)
P45	SPI0_DIN	In		CMOS 1.8V	iMX7	I2C1_SCL	ECSPI3_MISO	ECSPI3_MISO	NVCC_SPI (1.8V)
P46	SPI0_DO	Out		CMOS 1.8V	iMX7	I2C1_SDA	ECSPI3_MOSI	ECSPI3_MOSI	NVCC_SPI (1.8V)
P47	GND	-	-	-	-	-	-	-	GND
P48	SATA_TX+	Out	-	SATA	-	-	-	-	-
P49	SATA_TX-	Out	-	SATA	-	-	-	-	-
P50	GND	-	-	-	-	-	-	-	GND
P51	SATA_RX+	In	-	SATA	-	-	-	-	-
P52	SATA_RX-	In	-	SATA	-	-	-	-	-
P53	GND	-	-	-	-	-	-	-	GND
P54	ESPI_CS0#	Out	-	CMOS 1.8V	iMX7	EPDC_D14	QSPIB_SS[0]#	QSPIB_SS[0]#	NVCC_EPDC1 (1.8V)
P55	ESPI_CS1#	Out	-	CMOS 1.8V	iMX7	EPDC_D15	QSPIB_SS[1]#	QSPIB_SS[1]#	NVCC_EPDC1 (1.8V)
P56	ESPI_CK	Out	-	CMOS 1.8V	iMX7	EPDC_D13	QSPIB_SCLK	QSPIB_SCLK	NVCC_EPDC1 (1.8V)
P57	ESPI_IO_0	In	-	CMOS 1.8V	iMX7	EPDC_D8	QSPIB_DA0	QSPIB_DA0	NVCC_EPDC1 (1.8V)
P58	ESPI_IO_1	Out	-	CMOS 1.8V	iMX7	EPDC_D9	QSPIB_DA1	QSPIB_DA1	NVCC_EPDC1 (1.8V)
P59	GND	-	-	-	-	-	-	-	GND
P60	USB0+	Bi-Dir	-	USB	iMX7	USB_OTG1_DP	USB_OTG1_DP	USB_OTG1_DP	USB_OTG1_VDDA (3.3V)
P61	USB0-	Bi-Dir	-	USB	iMX7	USB_OTG1_DN	USB_OTG1_DN	USB_OTG1_DN	USB_OTG1_VDDA (3.3V)
P62	USB0_EN_OC#	Bi-Dir OD	PU-4k75	CMOS 3.3V	iMX7	GPIO1_IO04+ GPIO1_IO05	USB_OTG1_OC+USB_OTG2_PWR	USB_OTG1_OC+ USB_OTG2_PWR	USB_OTG1_VDDA (3.3V)
P63	USB0_VBUS_DET	In	-	CMOS 3.3V	iMX7	USB_OTG1_VBUS	USB_OTG1_VBUS	USB_OTG1_VBUS	USB_OTG1_VDDA (3.3V)
P64	USB0_OTG_ID	In	-	CMOS 3.3V	iMX7	USB_OTG1_ID	USB_OTG1_ID	USB_OTG1_ID	USB_OTG1_VDDA (3.3V)
P65	USB1+	Bi-Dir	-	USB	USB4604	USBDN1_DP/ PRT_DIS_P1	HSIC	HSIC	-
P66	USB1-	Bi-Dir	-	USB	USB4604	USBDN1_DM/ PRT_DIS_M1	HSIC	HSIC	-
P67	USB1_EN_OC#	Bi-Dir OD	PU-4k75	CMOS 3.3V	USB4604	PRTPWR1/PRTCTL1	HSIC	HSIC	-
P68	GND	-	-	-	-	-	-	-	GND
P69	USB2+	Bi-Dir	-	USB	USB4604	USBDN2_DP/ PRT_DIS_P2	HSIC	HSIC	-
P70	USB2-	Bi-Dir	-	USB	USB4604	USBDN2_DM /PRT_DIS_M2	HSIC	HSIC	-

Pin	Signal	Module Direction	Module Termination	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
P71	USB2_EN_OC#	Bi-Dir OD	PU-4k75	CMOS 3.3V	USB4604	PRTPWR2/PRTCTL2	HSIC	HSIC	-
P72	RSVD	-	-	-	-	-	-	-	-
P73	RSVD	-	-	-	-	-	-	-	-
P74	USB3_EN_OC#	Bi-Dir OD	PU-4k75	CMOS 3.3V	iMX7	USB_OTG3_ID	USB_OTG3_ID	-	USB_OTG2_VDDA (3.3V)
P75	PCIE_A_RST#	Out	PU-4k75	CMOS 3.3V	iMX7/PI7C9X2G404SL	LCD_DATA_11/DWNRST_1#	GPIO3_IO16	-	NVCC_LCD (1.8V)
P76	USB4_EN_OC#	Bi-Dir OD	PU-4k75	CMOS 3.3V	iMX7	PRTPWR3/PRTCTL3	HSIC	HSIC	-
P77	RSVD	-	-	-	-	-	-	-	-
P78	RSVD	-	-	-	-	-	-	-	-
P79	GND	-	-	-	-	-	-	-	GND
P80	PCIE_C_REFCK+	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	REFCLKO_3+	PCIe	-	-
P81	PCIE_C_REFCK-	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	REFCLKO_3-	PCIe	-	-
P82	GND	-	-	-	-	-	-	-	GND
P83	PCIE_A_REFCK+	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	REFCLKO_1+	PCIe	-	-
P84	PCIE_A_REFCK-	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	REFCLKO_1-	PCIe	-	-
P85	GND	-	-	-	-	-	-	-	GND
P86	PCIE_A_RX+	In	Serial-0R	LVDS PCIe	PI7C9X2G404SL	PER_1+	PCIe	-	-
P87	PCIE_A_RX-	In	Serial-0R	LVDS PCIe	PI7C9X2G404SL	PER_1-	PCIe	-	-
P88	GND	-	-	-	-	-	-	-	GND
P89	PCIE_A_TX+	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_1+	PCIe	-	-
P90	PCIE_A_TX-	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_1-	PCIe	-	-
P91	GND	-	-	-	-	-	-	-	GND
P92	HDMI_D2+/DP1_LANE0+	Out	-	TMDS	-	-	-	-	-
P93	HDMI_D2-/DP1_LANE0-	Out	-	TMDS	-	-	-	-	-
P94	GND	-	-	-	-	-	-	-	GND
P95	HDMI_D1+/DP1_LANE1+	Out	-	TMDS	-	-	-	-	-
P96	HDMI_D1-/DP1_LANE1-	Out	-	TMDS	-	-	-	-	-
P97	GND	-	-	-	-	-	-	-	GND
P98	HDMI_D0+/DP1_LANE2+	Out	-	TMDS	-	-	-	-	-
P99	HDMI_D0-/DP1_LANE2-	Out	-	TMDS	-	-	-	-	-
P100	GND	-	-	-	-	-	-	-	GND
P101	HDMI_CK+/DP1_LANE3+	Out	-	TMDS	-	-	-	-	-
P102	HDMI_CK-/DP1_LANE3-	Out	-	TMDS	-	-	-	-	-
P103	GND	-	-	-	-	-	-	-	GND
P104	HDMI_HPD/DP1_HPD	In	-	CMOS 1.8V	-	-	-	-	-

Pin	Signal	Module Direction	Module Termination	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
P105	HDMI_CTRL_CK/DP1_AUX+	Out	-	CMOS 1.8V	-	-	-	-	-
P106	HDMI_CTRL_DAT/DP1_AUX-	Bi-Dir	-	CMOS 1.8V	-	-	-	-	-
P107	DP1_AUX_SEL	In	-	CMOS 1.8V	-	-	-	-	-
P108	GPIO0/CAM0_PWR#	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA0	GPIO3_IO05	GPIO3_IO05	NVCC_LCD (1.8V)
P109	GPIO1/CAM1_PWR#	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA1	GPIO3_IO06	GPIO3_IO06	NVCC_LCD (1.8V)
P110	GPIO2/CAM0_RST#	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA2	GPIO3_IO07	GPIO3_IO07	NVCC_LCD (1.8V)
P111	GPIO3/CAM1_RST#	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA3	GPIO3_IO08	GPIO3_IO08	NVCC_LCD (1.8V)
P112	GPIO4/HDA_RST#	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA4	GPIO3_IO09	GPIO3_IO09	NVCC_LCD (1.8V)
P113	GPIO5/PWM_OUT	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	GPIO1_IO08	GPIO1_IO08	GPIO1_IO08	NVCC_GPIO1 (3.3V)
P114	GPIO6/TACHIN	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA5	GPIO3_IO10	GPIO3_IO10	NVCC_LCD (1.8V)
P115	GPIO7	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA6	GPIO3_IO11	GPIO3_IO11	NVCC_LCD (1.8V)
P116	GPIO8	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA7	GPIO3_IO12	GPIO3_IO12	NVCC_LCD (1.8V)
P117	GPIO9	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	UART3_RXD	GPIO4_IO04	GPIO4_IO04	NVCC_UART (1.8V)
P118	GPIO10	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	UART3_TXD	GPIO4_IO05	GPIO4_IO05	NVCC_UART (1.8V)
P119	GPIO11	Bi-Dir	PU-470k	CMOS 1.8V	iMX7	LCD_DATA10	GPIO3_IO15	GPIO3_IO15	NVCC_LCD (1.8V)
P120	GND	-	-	-	-	-	-	-	GND
P121	I2C_PM_CK	Bi-Dir	PU-2k2	CMOS 1.8V	iMX7	I2C3_SCL	I2C3_SCL	I2C3_SCL	NVCC_I2C (1.8V)
P122	I2C_PM_DAT	Bi-Dir	PU-2k2	CMOS 1.8V	iMX7	I2C3_SDA	I2C3_SDA	I2C3_SDA	NVCC_I2C (1.8V)
P123	BOOT_SEL0#	In	PU-4k75	CMOS 1.8V	iMX7	LCD_DATA19	GPIO3_IO24	GPIO3_IO24	NVCC_LCD (1.8V)
P124	BOOT_SEL1#	In	PU-4k75	CMOS 1.8V	iMX7	LCD_DATA20	GPIO3_IO25	GPIO3_IO25	NVCC_LCD (1.8V)
P125	BOOT_SEL2#	In	PU-4k75	CMOS 1.8V	iMX7	LCD_DATA21	GPIO3_IO26	GPIO3_IO26	NVCC_LCD (1.8V)
P126	RESET_OUT#	Out -OD	PU-4k75	CMOS 1.8V	i.MX7	EPDC_PWRCOM	GPIO2_IO30	GPIO2_IO30	NVCC_EPDC1 (1.8V)
P127	RESET_IN#	In	PU-4k75 + Buffer	CMOS 1.8V	i.MX7	POR#	POR#	POR#	NVCC_GPIO1 (3.3V)
P128	POWER_BTN#	In	PU-825R + FET	CMOS 1.8V	i.MX7	ONOFF/RESET#	ONOFF/RESET#	ONOFF/RESET#	VDD_SNVS_IN (3V)
P129	SER0_TX	Out	-	CMOS 1.8V	iMX7	ECSPI1_SCLK	UART6_RXD	UART6_RXD	NVCC_SPI (1.8V)
P130	SER0_RX	In	-	CMOS 1.8V	iMX7	ECSPI1_MOSI	UART6_TXD	UART6_TXD	NVCC_SPI (1.8V)
P131	SER0_RTS#	Out	-	CMOS 1.8V	iMX7	ECSPI1_MISO	UART6-RTS#	UART6-RTS#	NVCC_SPI (1.8V)
P132	SER0_CTS#	In	-	CMOS 1.8V	iMX7	ECSPI1_SS0	UART6_CTS#	UART6_CTS#	NVCC_SPI (1.8V)
P133	GND	-	-	-	-	-	-	-	GND
P134	SER1_TX	Out	-	CMOS 1.8V	iMX7	SAI2_TXFS	UART4_RXD	UART4_RXD	NVCC_SAI (1.8V)
P135	SER1_RX	In	-	CMOS 1.8V	iMX7	SAI2_TXC	UART4_TXD	UART4_TXD	NVCC_SAI (1.8V)
P136	SER2_TX	Out	-	CMOS 1.8V	iMX7	ECSPI2_SCLK	UART7_RXD	UART7_RXD	NVCC_SPI (1.8V)
P137	SER2_RX	In	-	CMOS 1.8V	iMX7	ECSPI2_MOSI	UART7_TXD	UART7_TXD	NVCC_SPI (1.8V)
P138	SER2_RTS#	Out	-	CMOS 1.8V	iMX7	ECSPI2_MISO	UART7_RTS#	UART7_RTS#	NVCC_SPI (1.8V)
P139	SER2_CTS#	In	-	CMOS 1.8V	iMX7	ECSPI2_MOSI	UART7_CTS#	UART7_CTS#	NVCC_SPI (1.8V)
P140	SER3_TX	Out	-	CMOS 1.8V	iMX7	I2C4_SCL	UART5_RXD	UART5_RXD	NVCC_I2C (1.8V)
P141	SER3_RX	In	-	CMOS 1.8V	iMX7	I2C4_SDA	UART5_TXD	UART5_TXD	NVCC_I2C (1.8V)
P142	GND	-	-	-	-				GND
P143	CAN0_TX	Out	-	CMOS 1.8V	iMX7	GPIO1_IO13	CAN1_TX	CAN1_TX	NVCC_GPIO2 (1.8V)
P144	CAN0_RX	In	-	CMOS 1.8V	iMX7	GPIO1_IO12	CAN1_RX	CAN1_RX	NVCC_GPIO2 (1.8V)
P145	CAN1_TX	Out	-	CMOS 1.8V	iMX7	GPIO1_IO15	CAN2_TX	CAN2_TX	NVCC_GPIO2 (1.8V)

Pin	Signal	Module Direction	Module Termination	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
P146	CAN1_RX	In	-	CMOS 1.8V	iMX7	GPIO1_IO14	CAN2_RX	CAN2_RX	NVCC_GPIO2 (1.8V)
P147	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P148	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P149	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P150	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P151	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P152	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P153	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P154	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P155	VDD_IN	PWR	-	-	-	-	-	-	3.0V - 5.25V
P156	VDD_IN	PWR							3.0V - 5.25V

5.5.2. Pinout of SMARC sAMX7 Bottom Side Connector

Table 9: Pinout of SMARC sAMX7 Bottom Side Connector

Pin	Signal	Module Direction	Module Termi-nation	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
S1	CSI1_TX+/I2C_CAM1_CK	In	-	TMDS/CMOS 1.8V	-	-	-	-	-
S2	CSI1_TX-/I2C_CAM1_DAT	In	-	TMDS/CMOS 1.8V	-	-	-	-	-
S3	GND	-	-	-	-	-	-	-	GND
S4	RSVD	-	-	-	-	-	-	-	-
S5	CSI0_TX-/I2C_CAM0_CK	Out	PU-2k21	TMDS/CMOS 1.8V	iMX7	LCD_DATA22	I2C4_SCL	I2C4_SCL	NVCC_EPDC1 (1.8V)
S6	CAM_MCK	Out	Ser-10R	CMOS 1.8V	iMX7	CCM_CLK1_P	CCM_CLK1_P	CCM_CLK1_P	VDDA_1P8 (1.8V)
S7	CSI0_TX+/I2C_CAM0_DAT	Bi-Dir	PU-2k21	TMDS/CMOS 1.8V	iMX7	LCD_DATA23	I2C4_SCL	I2C4_SCL	NVCC_EPDC1 (1.8V)
S8	CSI0_CK+	In	-	LVDS D-PHY	iMX7	MIPI_CSI_CLK_P	MIPI_CSI_CLK_P	MIPI_CSI_CLK_P	MIPI_VDDA_1P8 (1.8V)
S9	CSI0_CK-	In	-	LVDS D-PHY	iMX7	MIPI_CSI_CLK_N	MIPI_CSI_CLK_N	MIPI_CSI_CLK_N	MIPI_VDDA_1P8 (1.8V)
S10	GND	-	-	-	-	-		-	GND
S11	CSI0_RX0+	In	-	LVDS D-PHY	iMX7	MIPI_CSI_D0_P	MIPI_CSI_D0_P	MIPI_CSI_D0_P	MIPI_VDDA_1P8 (1.8V)
S12	CSI0_RX0-	In	-	LVDS D-PHY	iMX7	MIPI_CSI_D0_N	MIPI_CSI_D0_N	MIPI_CSI_D0_N	MIPI_VDDA_1P8 (1.8V)
S13	GND	-	-	-	-	-	-	-	GND
S14	CSI0_RX1+	In	-	LVDS D-PHY	iMX7	MIPI_CSI_D1_P	MIPI_CSI_D1_P	MIPI_CSI_D1_P	MIPI_VDDA_1P8 (1.8V)
S15	CSI0_RX1-	In	-	LVDS D-PHY	iMX7	MIPI_CSI_D1_N	MIPI_CSI_D1_N	MIPI_CSI_D1_N	
S16	GND	-	-	-	-	-		-	GND
S17	GBE1_MDI0+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI0+	RGMII	-	-
S18	GBE1_MDI0-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI0-	RGMII	-	-
S19	GBE1_LINK100#	Out/OD	-	CMOS 3.3V	88E1510PB2	LED_1	RGMII	-	-
S20	GBE1_MDI1+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI1+	RGMII	-	-
S21	GBE1_MDI1-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI1-	RGMII	-	-
S22	GBE1_LINK1000#	Out/OD	-	CMOS 3.3V	88E1510PB2	LED_0	RGMII	-	-

Pin	Signal	Module Direction	Module Termi-nation	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
S23	GBE1_MDI2+	Bi-Dir	-	GBE MDI	88E1510PB2	MDI2+	RGMII	-	-
S24	GBE1_MDI2-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI1-	RGMII	-	-
S25	GND	Bi-Dir	-	-	-	-	-	-	GND
S26	GBE1_MDI3+	Out	-	GBE MDI	88E1510PB2	MDI3+	RGMII	-	-
S27	GBE1_MDI3-	Bi-Dir	-	GBE MDI	88E1510PB2	MDI3-	RGMII	-	-
S28	GBE1_CTREF	Bi-Dir	-	GBE MDI	-	-	-	-	-
S29	PCIE_D_TX+	Bi-Dir	-	LVDS PCIe	-	-	-	-	-
S30	PCIE_D_TX-	Bi-Dir	-	LVDS PCIe	-	-	-	-	-
S31	GBE1_LINK_ACT#	Out/OD	-	CMOS 3.3V	iMX7	LED_2/INT#	RGMII	RGMII	-
S32	PCIE_D_RX+	Bi-Dir	-	LVDS PCIe	-	-	-	-	-
S33	PCIE_D_RX-	Bi-Dir	-	LVDS PCIe	-	-	-	-	-
S34	GND	-	-	-	-	-	-	-	GND
S35	USB4+	Bi-Dir	-	USB	USB4604	USBDN4_DP/PRT_DIS_P4	HSIC	HSIC	-
S36	USB4-	Bi-Dir	-	USB	USB4604	USBDN4_DM/PRT_DIS_M4	HSIC	HSIC	-
S37	USB3_VBUS_DET	In	-	CMOS 3.3V	iMX7	USB_OTG2_VBUS	USB_OTG2_VBUS	USB_OTG2_VBUS	USB_OTG2_VDDA (3.3V)
S38	AUDIO_MCK	Out	-	CMOS 1.8V	iMX7	SAI1_MCLK	SAI1_MCLK	SAI1_MCLK	NVCC_SAI (1.8V)
S39	I2S0_LRCK	Bi-Dir	-	CMOS 1.8V	iMX7	ENET1_CRS	SAI1_TXFS	SAI1_TXFS	NVCC_SAI (1.8V)
S40	I2S0_SDOUT	Out	-	CMOS 1.8V	iMX7	ENET1_COL	SAI1_TXD	SAI1_TXD	NVCC_SAI (1.8V)
S41	I2S0_SDIN	In	-	CMOS 1.8V	iMX7	SAI1_RXD	SAI1_RXD	SAI1_RXD	NVCC_SAI (1.8V)
S42	I2S0_CK	Bi-Dir	-	CMOS 1.8V	iMX7	SAI1_RXC	SAI1_RXC	SAI1_RXC	NVCC_SAI (1.8V)
S43	ESPI_ALERT0#	In	-	CMOS 1.8V	iMX7	EPDC_D4	GPIO2_IO4	GPIO2_IO4	NVCC_EPDC1 (1.8V)
S44	ESPI_ALERT1#	In	-	CMOS 1.8V	iMX7	EPDC_D6	GPIO2_IO7	GPIO2_IO7	NVCC_EPDC1 (1.8V)
S45	RSVD	-	-	-	-	-	-	-	-
S46	RSVD	-	-	-	-	-	-	-	-
S47	GND	-	-	-	-	-	-	-	GND
S48	I2C_GP_CK	Out	PU-2k21	CMOS 1.8V	iMX7	I2C2_SCL	I2C2_SCL	I2C2_SCL	NVCC_I2C (1.8V)
S49	I2C_GP_DAT	Bi-Dir	PU-2k21	CMOS 1.8V	iMX7	I2C2_SDA	I2C2_SDA	I2C2_SDA	NVCC_I2C (1.8V)
S50	HDSA_SYNC/I2S2_LRCK	Bi-Dir	-	CMOS 1.5V/1.8V	iMX7	SD2_DATA2	SAI2_TXFS	SAI2_TXFS	NVCC_SD2 (1.8V)
S51	HDA_SDO/I2S2_SDOUT	Out	-	CMOS 1.5V/1.8V	iMX7	SD2_DATA3	SAI2_TXD	SAI2_TXD	NVCC_SD2 (1.8V)
S52	HDA_SDI/I2S2_SDIN	In	-	CMOS 1.5V/1.8V	iMX7	SD2_DATA0	SAI2_RXD	SAI2_RXD	NVCC_SD2 (1.8V)
S53	HDA_CK/I2S2_CK	Bi-Dir	-	CMOS 1.5V/1.8V	iMX7	SD2_DATA1	SAI2_TXC	SAI2_TXC	NVCC_SD2 (1.8V)
S54	SATA_ACT#	-	-	CMOS 3.3V	-	-	-	-	-
S55	USB5_EN_OC#	Bi-Dir OD	-	CMOS 3.3V	iMX7	PRTPWR4/PRTCTL4	HSIC	HSIC	-
S56	ESPI_IO_2	Bi-Dir	-	CMOS 1.8V	iMX7	EPDC_D10	QSPIB_DA2	QSPIB_DA2	NVCC_EPDC1 (1.8V)
S57	ESPI_IO_3	Bi-Dir	-	CMOS 1.8V	iMX7	EPDC_D11	QSPIB_DA3	QSPIB_DA3	NVCC_EPDC1 (1.8V)
S58	ESPI_RESET#	Out	-	CMOS 1.8V	iMX7	EPDC_D12	QSPIB_DQS	QSPIB_DQS	NVCC_EPDC1 (1.8V)
S59	USB5+	Bi-Dir	-	USB	USB4604	USBDN4_DP/PRT_DIS_P4	HSIC	HSIC	-
S60	USB5-	Bi-Dir	-	USB	USB4604	USBDN4_DM/PRT_DIS_M4	HSIC	HSIC	-

Pin	Signal	Module Direction	Module Termi-nation	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
S61	GND	-	-	-	-	-	-	-	GND
S62	USB3_SSTX+	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S63	USB3_SSTX-	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S64	GND	-	-	-	-	-	-	-	GND
S65	USB3_SSRX+	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S66	USB3_SSRX-	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S67	GND	-	-	-	-	-	-	-	GND
S68	USB3+	Bi-Dir	-	LVDS_AFB	iMX7	USB_OTG2_DP	USB_OTG2_DP	-	USB_OTG2_VDDA (3.3V)
S69	USB3-	Bi-Dir	-	LVDS_AFB	iMX7	USB_OTG2_DN	USB_OTG2_DN	-	USB_OTG2_VDDA (3.3V)
S70	GND	-	-	-	-	-	-	-	GND
S71	USB2_SSTX+	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S72	USB2_SSTX-	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S73	GND	-	-	-	-	-	-	-	GND
S74	USB2_SSRX+	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S75	USB2_SSRX-	Bi-Dir	-	LVDS_AFB	-	-	-	-	-
S76	PCIE_B_RST#	Out	-	CMOS 3.3V	PI7C9X2G404SL	DWNRST_2#	PCIe	-	-
S77	PCIE_C_RST#	Out	-	CMOS 3.3V	PI7C9X2G404SL	DWNRST_3#	PCIe	-	-
S78	PCIE_C_RX+	In	-	LVDS PCIe	PI7C9X2G404SL	PER_3+	PCIe	-	-
S79	PCIE_C_RX-	In	-	LVDS PCIe	PI7C9X2G404SL	PER_3-	PCIe	-	-
S80	GND	-	-	-	-	-	-	-	GND
S81	PCIE_C_TX+	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_3+	PCIe	-	-
S82	PCIE_C_TX-	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_3-	PCIe	-	-
S83	GND	-	-	-	-	-	-	-	GND
S84	PCIE_B_REFCK+	Out	-	LVDS PCIe	PI7C9X2G404SL	REFCLKO_2+	PCIe	-	-
S85	PCIE_B_REFCK-	Out	-	LVDS PCIe	PI7C9X2G404SL	REFCLKO_2-	PCIe	-	-
S86	GND	-	-	-	-	-	-	-	GND
S87	PCIE_B_RX+	In	-	LVDS PCIe	PI7C9X2G404SL	PER_2+	PCIe	-	-
S88	PCIE_B_RX-	In	-	LVDS PCIe	PI7C9X2G404SL	PER_2-	PCIe	-	-
S89	GND	-	-	-	-	-	-	-	GND
S90	PCIE_B_TX+	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_2+	PCIe	-	-
S91	PCIE_B_TX-	Out	Seriell-100n	LVDS PCIe	PI7C9X2G404SL	PET_2-	PCIe	-	-
S92	GND	-	-	-	-	-	-	-	GND
S93	DP0_LANE0+	Out	-	LVDS LCD	-	-	-	-	-
S94	DP0_LANE0-	Out	-	LVDS LCD	-	-	-	-	-
S95	DP0_AUX_SEL	In	-	CMOS 1.8V	-	-	-	-	-
S96	DP0_LANE1+	Out	-	LVDS LCD	-	-	-	-	-
S97	DP0_LANE1-	Out	-	LVDS LCD	-	-	-	-	-
S98	DP0_HPD	In	-	CMOS 1.8V	-	-	-	-	-

Pin	Signal	Module Direction	Module Termi-nation	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
S99	DP0_LANE2+	Out	-	LVDS LCD	-	-	-	-	-
S100	DP0_LANE2-	Out	-	LVDS LCD	-	-	-	-	-
S101	GND	-	-	-	-	-	-	-	GND
S102	DP0_LANE3+	Out	-	LVDS LCD	-	-	-	-	-
S103	DP0_LANE3-	Out	-	LVDS LCD	-	-	-	-	-
S104	USB3_OTG_ID	Out	-	CMOS 3.3V	iMX7	USB_OTG2_ID	USB_OTG2_ID	-	USB_OTG2_VDD A (3.3V)
S105	DP0_AUX+	Out	-	LVDS LCD	-	-	-	-	-
S106	DP0_AUX-	Out	-	LVDS LCD	-	-	-	-	-
S107	LCD1_BKLT_EN	Out	-	CMOS 1.8V	iMX7	LCD_DATA15	GPIO3_IO20	GPIO3_IO20	NVCC_LCD (1.8V)
S108	LVDS1_CK+/eDP1 _AUX+/DSI1_CLK+	Out	-	LVDS LCD	SN65DSI84	A_CLKP	MIPI DSI	MIPI DSI	-
S109	LVDS1_CK- /eDP1_AUS- /DSI1_CLK-	Out	-	LVDS LCD	SN65DSI84	A_CLKN	MIPI DSI	MIPI DSI	-
S110	GND	-	-	-	-	-	-	-	GND
S111	LVDS1_0+/EDP1_ TX0+/DSI1_D0+	Out	-	LVDS LCD	SN65DSI84	A_Y0P	MIPI DSI	MIPI DSI	-
S112	LVDS1_0- /EDP1_TX0- /DSI1_D0-	Out	-	LVDS LCD	SN65DSI84	A_Y0N	MIPI DSI	MIPI DSI	-
S113	eDP1_HPD	Out	-	CMOS 1.8V	-	-	-	-	-
S114	LVDS1_1+/EDP1_T X1+/DSI1_D1+	Out	-	LVDS LCD	SN65DSI84	A_Y1P	MIPI DSI	MIPI DSI	
S115	LVDS1_1- /EDP1_TX1- /DSI1_D1-	Out	-	LVDS LCD	SN65DSI84	A_Y1N	MIPI DSI	MIPI DSI	-
S116	LCD1_VDD_EN	Out	-	CMOS 1.8V	iMX7	LCD_DATA12	GPIO3_IO17	GPIO3_IO17	NVCC_LCD (1.8V)
S117	LVDS1_2+/eDP1_ TX2+/DSI1_D2+	Out	-	LVDS LCD	SN65DSI84	A_Y2P	MIPI DSI	MIPI DSI	-
S118	LVDS1_2- /eDP1_TX2- /DSI1_D2-	Out	-	LVDS LCD	SN65DSI84	A_Y2N	MIPI DSI	MIPI DSI	-
S119	GND	-	-	-	-	-	-	-	GND
S120	LVDS1_3+/eDP1_ TX3+/DSI1_D3+	Out	-	LVDS LCD	SN65DSI84	A_Y2P	MIPI DSI	MIPI DSI	-
S121	LVDS1_3- /eDP1_TX3- /DSI1_D3-	Out	-	LVDS LCD	SN65DSI84	A_Y2N	MIPI DSI	MIPI DSI	-
S122	LCD1_BKLT_PWM	Out	Ser-825R + PD-1k	CMOS 1.8V	iMX7	GPIO1_IO03	GPIO1_IO03	GPIO1_IO03	NVCC_GPIO1 (3.3V)
S123	RSVD	Out	-	-	-	-	-	-	-
S124	GND	-	-	-	-	-	-	-	GND
S125	LVDS0_0+/eDP0_TX0+ /DSI0_D0+	Out	-	LVDS LCD	SN65DSI84	B_Y0P	MIPI DSI	MIPI DSI	
S126	LVDS0_0- /eDP0_TX0- /DSI0_D0-	Out	-	LVDS LCD	SN65DSI84	B_Y0N	MIPI DSI	MIPI DSI	-
S127	LCD0_BKLT_EN	Out	-	CMOS 1.8V	iMX7	LCD_DATA13	GPIO3_IO18	GPIO3_IO18	NVCC_LCD (1.8V)
S128	LVDS0_1+/eDP0_ TX1+/DSI0_D1+	Out	-	LVDS LCD	SN65DSI84	B_Y1P	MIPI DSI	MIPI DSI	-
S129	LVDS0_1- /eDP0_TX1- /DSI0_D1-	Out	-	LVDS LCD	SN65DSI84	B_Y1N	MIPI DSI	MIPI DSI	-
S130	GND	-	-	-	-	-	-	-	GND

Pin	Signal	Module Direction	Module Termi-nation	Type/ Tolerance	Controller	Controller Pin Name	Port(i.MX7 dual)	Port (i.MX7 Solo)	Power Rail
S131	LVDS0_2+/eDP0_TX2+/DSI0_D2+	Out	-	LVDS LCD	SN65DSI84	B_Y2P	MIPI DSI	MIPI DSI	-
S132	LVDS0_2-/eDP0_TX2-/DSI0_D2-	Out	-	LVDS LCD	SN65DSI84	B_Y2N	MIPI DSI	MIPI DSI	-
S133	LCD0_VDD_EN	Out	-	CMOS 1.8V	iMX7	LCD_DATA14	GPIO3_IO20	GPIO3_IO20	NVCC_LCD (1.8V)
S134	LVDS0_CK+/eDP0_AUX+/DSI0_CLK+	Out	-	LVDS LCD	SN65DSI84	B_CLKP	MIPI DSI	MIPI DSI	-
S135	LVDS0_CK-/eDP0_AUX-DSI0_CLK-	Out	-	LVDS LCD	SN65DSI84	B_CLKN	MIPI DSI	MIPI DSI	-
S136	GND	-	-	-	-	-	-	-	GND
S137	LVDS0_3+/eDP0_TX3+/DSI0_D3+	Out	-	LVDS LCD	SN65DSI84	B_Y3P	MIPI DSI	MIPI DSI	
S138	LVDS0_3-/eDP0_TX3-/DSI0_D3-	Out	-	LVDS LCD	SN65DSI84	B_Y3N	MIPI DSI	MIPI DSI	-
S139	I2C_LCD_CK	Out	PU-2k21	CMOS 1.8V	iMX7	UART1_RXD	I2C1_SCL	I2C1_SCL	NVCC_I2C (1.8V)
S140	I2C_LCD_DAT	Bi-Dir	PU-2k21	CMOS 1.8V	iMX7	UART1_TXD	I2C1_SDA	I2C1_SDA	NVCC_I2C (1.8V)
S141	LCD0_BKLT_PWM	Out	-	CMOS 1.8V	iMX7	GPIO1_IO09	PWM2_OUT	PWM2_OUT	NVCC_GPIO2 (1.8V)
S142	RSVD	-	-	-	-	-	-	-	-
S143	GND	-	-	-	-	-	-	-	GND
S144	EDP0_HPD	-	-	CMOS 1.8V	-	-	-	-	-
S145	WDT_TIME_OUT#	Out	-	CMOS 1.8V	iMX7	ENET1_RX_CLK	WDOG2#/GPIO7_IO13	WDOG2#/GPIO7_IO13	NVCC_ENET1 (1.8V)
S146	PCIE_WAKE #	In	PU-4k75	CMOS 3.3V	iMX7	SAI1_TXFS	GPIO6_IO14	GPIO6_IO14	NVCC_SAI (1.8V)
S147	VDD_RTC	-	Ser-1k + Diode	PWR	iMX7	VDD_SNVS_IN	VDD_SNVS_IN	VDD_SNVS_IN	VDD_SNVS_IN (3V)
S148	LID#	In	PU-4k75	CMOS 1.8V	iMX7	LCD_DATA8	GPIO3_IO13	GPIO3_IO13	NVCC_LCD (1.8V)
S149	SLEEP#	In	PU-4k75	CMOS VDDIN	iMX7	LCD_DATA9	GPIO3_IO14	GPIO3_IO14	NVCC_LCD (1.8V)
S150	VIN_PWR_BAD#	In	W-PU	CMOS 1.8V	POWER	-	-	-	-
S151	CHARGING#	In	PU-4k75	CMOS 1.8V	iMX7	SD2_CLK	GPIO5_IO12	GPIO5_IO12	NVCC_SD2 (1.8V)
S152	CHARGER_PRSNT#	In	PU-4k75	CMOS 1.8V	iMX7	SD2_WP	GPIO5_IO10	GPIO5_IO10	NVCC_SD2 (1.8V)
S153	CARRIER_STBY#	Out	-	CMOS 1.8V	iMX7	PMIC_STBY_REQ	PMIC_STBY_REQ	PMIC_STBY_REQ	NVCC_SNVS_IN (3V)
S154	CARRIER_PWR_ON	Out	PD-2k21	CMOS 1.8V	POWER	-	-	-	-
S155	FORCE_RECOV#	In	PU-4k75	CMOS 1.8V	iMX7	BOOT_MODE0	BOOT_MODE0	BOOT_MODE0	NVCC_GPIO1 (3.3V)
S156	BATLOW#	In	PU_2k21	CMOS 1.8V	iMX7	LCD_RESET	GPIO3_IO04	GPIO3_IO04	NVCC_LCD (1.8V)
S157	TEST#	In	PU-10k + FET	CMOS 1.8V	PI7C9X2G404SL	JTAG_MOD	-	-	-
S158	GND	-	-	-	-	-	-	-	GND

6/ Installation

6.1. Boot Mode

The following table shows the possible boot sources on the carrier board defined in SMARC 2.0 spec:

Table 10: Boot Options on the carrier board

	Carrier Connection			Boot Source	Supported on sAMX7
	BOOT_SEL2#	BOOT_SEL1#	BOOT_SEL0#		
0	GND	GND	GND	Carrier SATA	No
1	GND	GND	Float	Carrier SD Card	From U-Boot
2	GND	Float	GND	Carrier eSPI (CS0#)	From U-Boot
3	GND	Float	Float	Carrier SPI (CS0#)	From U-Boot
4	Float	GND	GND	Module device (NAND, NOR)	No
5	Float	GND	Float	Remote boot (GBE, serial)	From U-Boot

U-Boot only supports booting from QSPI NOR flash because "boot from fuses" is defined per default.

6.2. Configurable Watchdog

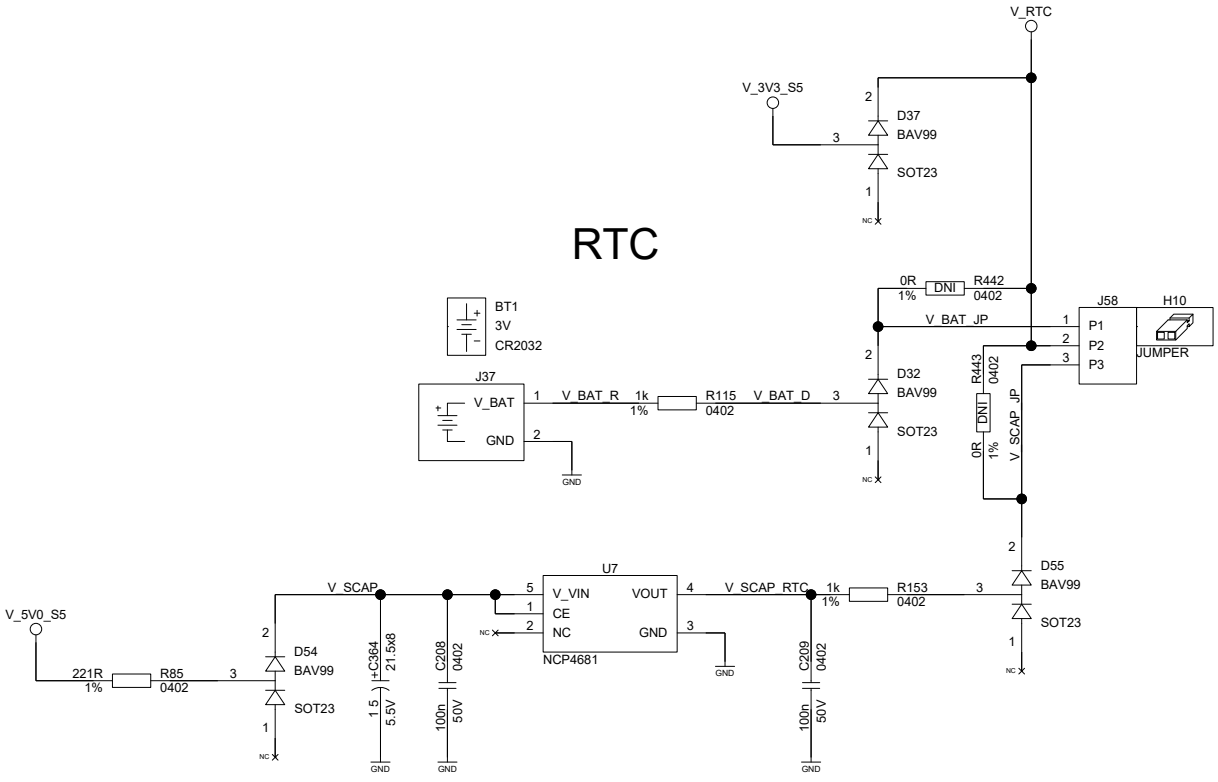
As no CPLD is available, the Watchdog must be used from the SoC. The WDOG features are listed below:

- Configurable timeout counter with timeout periods from 0.5 to 128 seconds which, after timeout expiration, result in the assertion of WDOG_RESET_B_DEB reset signal .
- Time resolution of 0.5 seconds
- Configurable timeout counter that can be programmed to run or stop during low-power modes
- Programmable interrupt generation prior to timeout
- The duration between interrupt and timeout events can be programmed from 0 to 127.5 seconds in steps of 0.5 seconds.

6.3. RTC current consumption

The current consumption of the sAMX7 was tested with following circuit. Jumper was populated to J58 position 1-2. With an external power supply J37 was feed with voltages from 2.0 V to 3.4 V.

Figure 8: RTC current consumption with an external power supply and voltages from 2.0 V to 3.4 V



The module RTC (RV-8803) can operate down to 1.5 V, the i.MX7 RTC minimum supply voltage is 2.4 V. Due to the higher current consumption of the i-MX7 RTC this part is not powered with the V_RTC voltage rail per default (resistor option on the module).

Table 11: Minimum Supply Voltage of the RTC Module

Ambient temperature	Maximum Current in V_BAT_R	Minimum voltage for module RTC (RV-8803) V_BAT_R/V_RTC
-20°C	0.4 µA	2.20V/1.76 V
25°C	0.5 µA	2.02V/1.69 V
85°C	1.8 µA	2.08V/1.71 V

The BAV99 has higher voltage drops as Schottky diodes. Therefore the performance can be increased by changing D32 with a Schottky diode, e.g. BAS70.

Because the sAMX7 module has a reverse serial protection in the VDD_RTC signal with a diode, no super cap charging from module side is possible without shorting the diode on the module.

6.4. UART Interfaces

Use following UART interfaces with control signals of i.MX7.

Table 12: Mapping of SMARC SER interfaces to i.MX7 UARTs

SER	UART
SER0	UART6
SER1	UART4
SER2	UART7
SER3	UART5

Table 13: UART interfaces for SER0 and SER2 (RX, TX, CTS#, RTS#)

UART6	UART7
UART6_CTS#//ECSPI1_SS0/H5	UART7_CTS#/J6
UART6_RTS#/ECSPI1_MISO/H4	UART7_RTS#/H6
UART6_RXD/ECSPI1_SCLK/H3	UART7_RXD/J5
UART6_TXD/ECSPI1_MOSI/G5	UART7_TXD/G6

depends on IO Pin muxing, table corresponds to Kontron default settings

NXP has defined the UART handshake lines in the opposite way from many other vendors. In the SMARC 2.0 specification RTS is defined as an output and CTS as an input. This is the same definition used by the standard PC serial port.

However, in the iMX7 implementation RTS is an input and CTS is an output – i.e. the pin functions corresponding to these names are swapped.

Per table 17 below, configuring the UART for DTE mode will result in the signals being routed to the SMARC pins in conformance with the SMARC definition of the pin functions.

Table 14: UART interfaces for SER1 and SER3 (RX, TX)

UART4	UART5
UART4_RXD/SAI2_TXFS/D9	UART5_RXD/I2C4_SCL/L1
UART4_TXD/SAI2_TXC/D8	UART5_TXD/I2C4_SDA/L2

depends on IO Pin muxing, table corresponds to Kontron default settings

The DTE mode is designated for the SMARC-sAMX7 module. Following additional UART interfaces can be optionally used:

- UART1 shares I2C1 at i.MX7 and I2C_LCD pins at SMARC 2.0 connector. They are only useable if display converter (SN65DSI84ZQER) is not placed.
- UART2 shares SPI[4]_Master Input, Slave Output/Master Output, Slave Input (MISO/MOSI) at i.MX7 and GPIO7/GPIO8 pins at SMARC 2.0 connector. They are only useable if APPROTECT key does not use SPI option with additional resistors and omit SPI level shifter TXB0104RUT.
- UART3 shares 2x GPIOs at i.MX7 and GPIO9/GPIO10 pins at SMARC 2.0 connector.

UART port mapping in DCE/DTE mode defines RTS_B and CTS_B in different manner as used in SMARC 2.0 spec. In the following table the pin and signal direction are like in SMARC 2.0 spec.

Table 15: UART port mapping in DCE/DTE mode

IO Pads Name	DCE mode		DTE mode	
	UART function	IO direction	UART function	IO direction
UARTx_CTS#	RTS#	Output	SERx_CTS#	Input
UARTx_RTX#	CTS#	Input	SERx_RTS#	Output
UARTx_TXD	TX	Output	SERx_RX	Input
UARTx_RXD	RX	Input	SERx_TX	Output

Table 16: UART connections between CPU and SMARC 2.0 connector

CPU Interface	CPU pins	Function	SMARC 2.0 connector
UART1[1]	UART1_RXD/I2C1_SCL/L3	DTE_TX	I2C_LCD_SCL/S139
	UART1_TXD/I2C1_SDA/L4	DTE_RX	I2C_LCD_SDA/S140
UART2[2]	LCD_CLK/ECSPI4_MISO/UART2_RXD/E20	DTE_TX	GPIO[7]/P115
	LCD_ENABLE/ECSPI4_MOSI/UART2_TXD/F25	DTE_RX	GPIO[8]/P116
UART3	UART3_RXD/GPIO4_IO04/M1	DTE_TX	GPIO[9]/P117
	UART3_TXD/GPIO4_IO05/M2	DTE_RX	GPIO[10]/P118
UART4	SAI2_TXFS/UART4_RXD/D9	DTE_TX	SER[1]_TX/P134
	SAI2_TXC/UART4_TXD/D8	DTE_RX	SER[1]_RX/P135
UART5	I2C4_SCL/UART5_RXD/L1	DTE_TX	SER[3]_TX/P140
	I2C4_SDA/UART5_TXD/L2	DTE_RX	SER[3]_RX/P141
UART6	ECSPI1_SCLK/UART6_RXD/H3	DTE_TX	SER[0]_TX/P129
	ECSPI1_MOSI/UART6_TXD/G5	DTE_RX	SER[0]_RX/P130
	ECSPI1_MISO/UART6_RTS#/H4	DTE_RTS#	SER[0]_RTS#/P131
	ECSPI_SS0/UART6_CTS#/H5	DTE_CTS#	SER[0]_CTS#/P132
UART7	ECSPI2_SCLK/UART7_RXD/J5	DTE_TX	SER[2]_TX/P136
	ECSPI2_MOSI/UART7_TXD/G6	DTE_RX	SER[2]_RX/P137
	ECSPI2_SS0/UART7_CTS#/J6	DTE_CTS#	SER[2]_CTS#/P139
	ECSPI2_MISO/UART7_RTS#/H6	DTE_RTS#	SER[2]_RTS#/P138

[1] Only usable if no I2C device is connected at I2C_LCD bus, therefore display converter has to be omit

[2] Only usable if APPROTECT key does not use SPI (omit SPI level shifter TXB0104RUT) and stuffed additional resistors

6.5. Power Control

6.5.1. Power Supply

The SMARC-sAMX7 supports a power input from 3.0 to 5.25V. The supply voltage is applied through the VCC pins (VCC) of the module connector. Considered current rating of protective device is part of End-Equipment.

The following parameters should be delivered from the carrier board:

- Voltage Ripple maximum 100 mV peak to peak 0-20 MHz to 20 ms rise time from input voltage <10% to nominal VCC
- Max allowed inrush current: connector limit (15 W @ 3,0 V)

6.5.2. Power Button (POWER_BTN#)

The power button (Pin P128) is available through the module connector described in the pinout list. To start the module via Power Button the PWRBTN# signal must be at least 50 ms (50 ms ≤ t < 4 s, typical 400 ms) at low level (Power Button Event).

Pressing the power button for at least 4 seconds will turn off power to the module (Power Button Override).

6.5.3. Power Bad Signal (VIN_POWER_BAD#)

The SMARC-sAMX7 provides an external input for a Carrier Board Power Bad signal (Pin S150). The implementation of this subsystem complies with the SMARC Specification. VIN_POWER_BAD# is internally pulled up to 3.3V and must be high level to power on the module.

6.5.4. Reset Button (RESET_IN#)

The reset button (Pin P127) is available through the module connector described in the pinout list. The module will stay in reset as long as RESET_IN# is grounded.

NOTICE

If any of the supply voltages drops below the allowed operating level longer than the specified hold-up time, all the supply voltages should be shut down and left OFF for a time long enough to allow the internal board voltages to discharge sufficiently.
If the OFF time is not observed, parts of the board or attached peripherals may work incorrectly or even suffer a reduction of MTBF.
The minimum OFF time depends on the implemented PSU model and other electrical factors and needs to be measured individually for each case.

NOTICE

To protect external power lines of peripheral devices, make sure that the wires have the right diameter to withstand the maximum available current. The enclosure of the peripheral device has to fulfill the fire-protection requirements of IEC/EN62368.

7/ Bootloader Operation

7.1. Copyrights and Licensing of U-Boot

U-Boot is free Software. It is copyrighted by Wolfgang Denk and many others who contributed code. U-Boot can be redistributed and modified under the terms of version 2 of the GNU General Public (GPL V2) License as published by the Free Software Foundation.

Actual source code of mainline U-Boot and authors of the source can be obtained from the git repository at

- git://git.denx.de/u-boot.git

SMARC-sAMX7 bootloader sources are derived work from a dedicated version of mainline U-Boot, e.g v2017.03. As bootloader evolves, the root of the derived work might change to a later version.

NOTICE	**The source code of U-Boot will be delivered with the standard software package. Additionally the software can be downloaded from Kontron GitHub repository for SMARC-sAMX7: https://github.com/kontron/u-boot-smarc-samx7**

7.2. Bootloader Quickstart

The SMARC-sAMX7 board comes with U-Boot preinstalled on the QSPI flash device. Follow the steps below to gain access to the bootloader command line (CLI) on your host PC.

- Connect your host machine to the carrier port connected with the edge connector SER0 port of the module. On Kontron SMARC 2.0 carrier this port is named SER_0.
- Start a suitable terminal program on your host and attach it to the port connected with the board's serial interface. Configure the serial line using **115200 baud, 8 data bits, 1 stop bit, no parity**.
- Connect power supply to the carrier and power up.
- When boot messages appear, press any key to stop automatic boot sequence.

After power on, bootloader boot messages will appear as shown below. There is a 3 second boot delay counter that will try to boot linux OS automatically after expiration. Pressing any key will stop the boot delay counter and enter the bootloader CLI

.

```
U-Boot <Version> (<Date-code>)

CPU:   Freescale i.MX7D rev1.2 at 996MHz
CPU:   Extended Commercial temperature grade (-20C to 105C) at 54C
Reset cause: POR
Board: Kontron SMX7 SMARC 2.0 Module
I2C:   ready
DRAM:  2 GiB
MMC:   FSL_SDHC: 0, FSL_SDHC: 1
SF: Detected w25q16dw with page size 256 Bytes, erase size 4 KiB, total 2 MiB
In:    serial
Out:   serial
Err:   serial
Net:   FEC0, FEC1

Hit any key to stop autoboot:  0
=>
```

7.3. Bootloader Commands

The bootloader CLI provides a bunch of powerful commands to control the board, which basically can be grouped into

- Information Commands
- Memory Commands
- Flash Memory Commands
- Execution Control Commands
- Download Commands
- Environment Control Commands
- Flattened Device Tree Support Commands
- Storage Device Control Commands
- File System Support Commands
- Kontron Command Extensions

Typing "help" at the bootloader command line prompt will show up a list of the commands available. Typing "help <command>" will show specific command help. Further help can be found under https://www.denx.de/wiki/view/DULG/UBoot

On the SMARC_sAMX7 bootloader, the powerful hush shell is enabled, which is similar to Bourne shell and provides features similar to a linux shell:

- Control structures (if … then … else … fi etc.)
- Command line completion
- Command line editing
- Command line history up to 20 entries
- Local environment variables

7.4. Kontron Bootloader Command Extensions

Kontron's implementation of U-Boot includes certain enhancements to provide board specific functions. They are not part of standard U-Boot as maintained by DENX. The following table provides a complete listing of all Kontron command extensions on the SMARC-sAMX7.

Table 17: Bootloader Command Extensions

Command	Description
kboardinfo	Kontron Board Information - Displays a summary of board and configuration information
md5sum	Creates or checks the md5 message digest over a memory area
watchdog	Start and control i.MX7 CPU watchdog

7.4.1. kboardinfo - Kontron Board Information

The "kboardinfo" command shows a summary of board serialization data gathered from the system EEPROM.

```
=> kboardinfo
Manufacturer:        Kontron Europe GmbH
Product name:        SMARC-sAMX7
Material number:     51009-0208-10-2
Serial number:       NZD070001
MAC0 (ethaddr):      00:a0:a5:79:25:30
MAC1 (eth1addr):     00:a0:a5:79:25:31
Manufacturer Date:   11/15/2017
Revision:            B00
Boot Counter:        10
CPU:                 Freescale i.MX7D rev1.2 at 996 MHz
==>
```

7.4.2. md5sum – MD5 Message Digest

The "md5sum" command is already part of standard U-Boot implementation. However Kontron provides the "-a" extension (ASCII) that allows to check MD5 checksum of a given memory area (e.g. a binary image copied into memory) against the checksum that has been copied into an ASCII file on an external linux host. To achieve this, the ASCII string in the file representing the checksum is converted into hexadecimal values and compared against the calculated one.

Syntax:

```
=> help md5sum
md5sum - compute MD5 message digest

Usage:
md5sum address count [[*]sum]
    - compute MD5 message digest [save to sum]
md5sum -v address count [*]sum
    - verify md5sum of memory area
md5sum -a address count [*]sum
    - verify md5sum given in ASCII format
```

Example:

Calculate MD5 checksum of a given binary using the md5sum command on linux host and redirect output messages into a file:

```
# md5sum image.bin >image.md5
```

Copy both image file and checksum file to USB thumb device with EXT2/3/4 or FAT partition. Connect the USB device to the module carrier.

The following sequence shows how to load both image file and image checksum file into SMARC_sAMX7 memory and compare them. In case of success, the "md5sum -a" command will have no output messages as this extensions is meant to be used in automatic update scripts to check the binary images against their MD5 checksum.

```
usb start
load usb 0:1 88000000 <image.bin>
load usb 0:1 8a000000 <image.md5>
if md5sum -a 88000000 $ubootsz *88a00000; then
    echo  'CRC check passed'
else
    echo  'CRC check failed'
fi
```

7.4.3. Watchdog – CPU Watchdog Control

The "watchdog" command is used to control the i.MX7 CPU internal watchdog. After watchdog has been started using "watchdog start", the watchdog is kicked periodically by U-Boot to prevent expiration.

Watchdog timeout can be changed at any time. However, it is not possible to stop watchdog once it has been started.

Syntax:

```
=> help watchdog
watchdog - start/stop/kick IMX watchdog

Usage:
watchdog <timeout>       - kick watchdog and set timeout (0 = disable kicking)
watchdog start <timeout> - start watchdog and set timeout
```

Example:

Start watchdog with 5 seconds timeout and stop kicking watchdog some time later. Board will reset after watchdog has been expired.

```
=> watchdog 5
=> watchdog 0
```

7.5. Bootloader Environment

The bootloader environment is used to control bootloader and OS startup behavior. Environment variables can be used to control boot timing (e.g. bootdelay), interface properties (e.g. baudrate, ethact) or they define memory locations where OS images are stored before boot (e.g. loadaddr, fdt_addr). In addition, bootloader shell commands can be combined to environment scripts.

The redundant bootloader environment is permanently stored in the QSPI flash device at offset 0x0C0000 and 0x0C8000. During bootloader operation, the environment is held in RAM memory and can be modified and written back to persistent storage.

Bootloader commands to modify the environment are summed up under the "env" command group:

- env default [-f] –a — [forcibly] reset default environment
- env default [-f] var [...] — [forcibly] reset variable(s) to their default values
- env delete [-f] var [...] — [forcibly] delete variable(s)
- env edit name — edit environment variable
- env exists name — tests for existence of variable
- env print [-a | name ...] — print environment
- env run var [...] — run commands in an environment variable
- env save — save environment
- env set [-f] name [arg ...]

However, the legacy commands for environment handling are still available:

- "setenv",
- "editenv",
- "printenv"
- "saveenv".

U-Boot standard environment variables are set up for the SMARC_sAMX7 module as shown below.

Table 18: Standard Environment Variables

Variable	Value	Description
baudrate	115200	Serial line baudrate
bootcmd	Run mmcboot || run sdboot || run usbboot || run netboot || run bootfailed	Try booting (in this order) from eMMC, SD card, USB, network
bootdelay	3	Wait 3 seconds before executing bootcmd
ethprime	FEC0	Use Ethernet port FEC0 as default
loadaddr	0x80800000	Default memory location for OS boot

A typical user modification would be to set the variable "bootcmd" to change OS boot commands.

7.6. Bootloader Environment Update

On the SMARC-sAMX7 it is possible to update the U-Boot environment separately.

This enables the user to either update from a previous version of the official Kontron sAMX7 U-Boot environment (default U-Boot settings), or restore the default in case of problems.

Update procedure:

- Download the official sAMX7 U-Boot environment from the Kontron EMD Customer Section.
- For Release R10 of the sAMX7 U-Boot, the file is called 'smx7-env-r10.bin'.
- Put the file into the root directory of a FAT or EXT formatted USB drive.
- Start the sAMX7 system and stop the boot process at the U-Boot prompt.
- Run the following commands to load the file and flash it into the correct flash memory address (example for R10):

```
usb start && load usb 0:1 $loadaddr smx7-env-r10.bin
sf probe && sf update $loadaddr 0x0c0000 $filesize
```

- After reset the updated environment will be active.

7.7. Kontron Bootloader Environment Extensions

To support SMARC_sAMX7 board properly, Kontron adds some environment variables to the standard set of variables provided by mainline U-Boot. These variables are shown below.

Table 19: Bootloader Environment Extensions

Variable	Value	Description
boot_sel	Depends on BOOT_SEL lines	BOOT_SEL lines from carrier are evaluated during startup and boot_sel is set appropriately. See chapter 0 Bootloader Boot Source for more detail
core_variant	d s	Set to "s" for i.MX7S module, "d" for i.MX7D module.
eth1addr	From EEPROM	Ethernet port FEC1 MAC address
ethaddr	From EEPROM	Ethernet port FEC0 MAC address
fdt_addr	0x83000000	Memory location for device tree blob

Variable	Value	Description
panel	Default: ld101	Describes the panel type attached to the module. It is used to select the appropriate device tree file
pcie_a_prsnt	yes	Enable/disable PCIE_A PRSNT line to reduce power consumption
pcie_b_prsnt	yes	Enable/disable PCIE_B PRSNT line to reduce power consumption
pcie_c_prsnt	yes	Enable/disable PCIE_C PRSNT line to reduce power consumption
pwm_out_disable	yes	Enable/disable PWM_OUT signal. When disabled, GPIO5 pin on SMARC edge connector is used as GPIO.
serial#	From EEPROM	Module serial number

Variables from the table above marked in bold are set automatically each time U-Boot starts. They will override different settings possibly stored in persistent environment.

7.8. Bootloader Mass Storage Support

U-Boot provides support to read and write from mass storage devices like

- QSPI flash
- eMMC device
- SD card
- USB thumb device

7.8.1. QSPI flash

QSPI flash is accessed using the "sf" command

Example: Load one sector (64K) from SPI flash

```
=> sf probe 0
=> sf read ${loadaddr} 0 10000
```

7.8.2. SD Card and eMMC Devices

eMMC and SD card are accessed using the "mmc" command

Example: Load 256 blocks from eMMC

```
=> mmc dev 1
=> mmc read ${loadaddr} 0 100
```

7.8.3. USB Storage Device

USB storage devices are accessed using "usb" command

Example: Load bootloader update file from USB thumb device

```
=> usb start
=> usb dev 0
=> fatload usb 0:1 update_smx7_spl/u-boot-smx7_spl.bin
```

7.9. Bootloader File System Support

U-Boot for the SMARC_sAMX7 provides support for FAT and EXT4 file systems. EXT4 support also includes EXT2 and EXT3 formatted file systems. There are file system specific commands available to list file system contents (ext2ls, fatls) and load a given file into board memory (ext2load, fatload). However, U-Boot also provides generic commands ("ls" and "load"), that will detect the file system on the device and use appropriate file system functions automatically.

Example: Show/boot folder contents from SD card file system

```
=> ls mmc 0:1 /boot
<DIR>       4096 .
<DIR>       4096 ..
<SYM>         48 imx7d-samx7-ld101-m4.dtb
          44034 devicetree-zImage-imx7d-samx7-ld101-m4.dtb
          43986 devicetree-zImage-imx7d-samx7-ld101.dtb
<SYM>         33 zImage
<SYM>         45 imx7d-samx7-ld101.dtb
<SYM>         45 imx7s-samx7-ld101.dtb
        6376512 zImage-4.1.29-fslc+g59b38c3
          43998 devicetree-zImage-imx7s-samx7-ld101.dtb

=> load mmc 0:1 ${loadaddr} /boot/zImage
6376512 bytes read in 536 ms (11.3 MiB/s)
```

7.9.1. EXT4 File System Write Support

There is even support available to write a given memory area into ext4 formatted file systems. However, the implementation is not bullet proof und should be used with care, as this could lead to file system corruption.

Writing to symbolic links in an ext4 filesystem does not work from u-boot!
Do not create new files in ext4 filesystem as this could cause problems.

7.10. Bootloader Network Support

U-Boot provides support for both onboard Ethernet interfaces. The current interface can be selected by setting "ethact" environment variable to either “FEC0” or “FEC1”.

Board specific MAC addresses are read from EEPROM during startup and environment variables are set automatically. In case EEPROM contents is missing or corrupted, a "random" MAC address will be set to "ethaddr"

In case that the current network interface is attached to a network providing a DHCP server, an IP address can be gathered using "bootp" ord "dhcp" commands.

After that, a file from a tftp server can be copied to memory using the "tftpboot" command.

Example:

```
=> bootp
=> tftpboot ${loadaddr} <filename>
```

7.11. Bootloader Boot Source Support

The SMARC v2.0 Specification defines three boot select signals BOOT_SEL[0:2]# that allows the user to select from eight possible boot devices. On the SMARC_sAMX7, U-Boot detects the BOOT_SEL signals from the carrier and sets the environment variable "boot_sel" as shown below.

Table 20: Environment Variables for "boot_sel"

BOOT_SEL2#	BOOT_SEL1#	BOOT_SEL0#	boot_sel	Boot Source
GND	GND	GND	carrier_sata	Carrier SATA
GND	GND	Float	carrier_sd	Carrier SD Card
GND	Float	GND	carrier_mmc	Carrier eSPI (CS0#)
GND	Float	Float	carrier_spi	Carrier SPI (CS0#)
Float	GND	GND	module_device	Module Device (NAND, NOR) – vendor specific
Float	GND	Float	remote	Remote boot (GBE, serial) – vendor specific
Float	Float	GND	module_mmc	Module eMMC Flash
Float	Float	Float	module_spi	Module SPI

Bootloader environment scripts can use the boot_sel environment variable to select the source where the dedicated OS image can be loaded. As an example, the bootloader environment of the SMARC_sAMX7 implements some small scripts that will load a linux system from the boot source as defined by the BOOT_SEL pins.

```
bootsel_boot=echo BOOT_SEL ${boot_sel} selected && run ${boot_sel}_boot
module_mmc_boot=run mmcboot
module_spi_boot=run mmcboot
```

Running the "run bootsel_boot" script will load a linux system from MMC if BOOT_SEL pins define the module MMC Flash or the Module SPI as boot source. Depending on application, the script variables in environment can be adapted.

The bootloader is always booted from the boot source defined by fuse settings, which is normally the QSPI flash device. The BOOT_SEL pins only define boot source for the OS.

7.12. Bootloader Boot Counter

The module EEPROM device contents implements a SMBIOS Running-time data block (type 161) as defined in the KEU EEPROM Specification Rev. 1.4. The running-time data block structure implements a 64bit boot counter. U-Boot on the SMARC_sAMX7 module will read the current boot counter value and increment it on every boot cycle. Current boot counter is shown as part of the information shown by the "kboardinfo" command (see description of kboardinfo).

7.13. Bootloader Update

Bootloader update on SMARC_sAMX7 is using an update script containing all necessary checks and installation commands. It is provided by Kontron on an USB thumb device containing the scriptfile and update images in the dedicated "update_smx7_spl" folder.

As an alternative it is possible to perform bootloader update from network. To achieve this, the "update_smx7_spl" folder mentioned above must have been copied to the server path of the TFTP server machine.

Given these prerequisites are met, update can be done from bootloader CLI using the predefined "update" script:

```
=> run update
```

Or, in case of network update

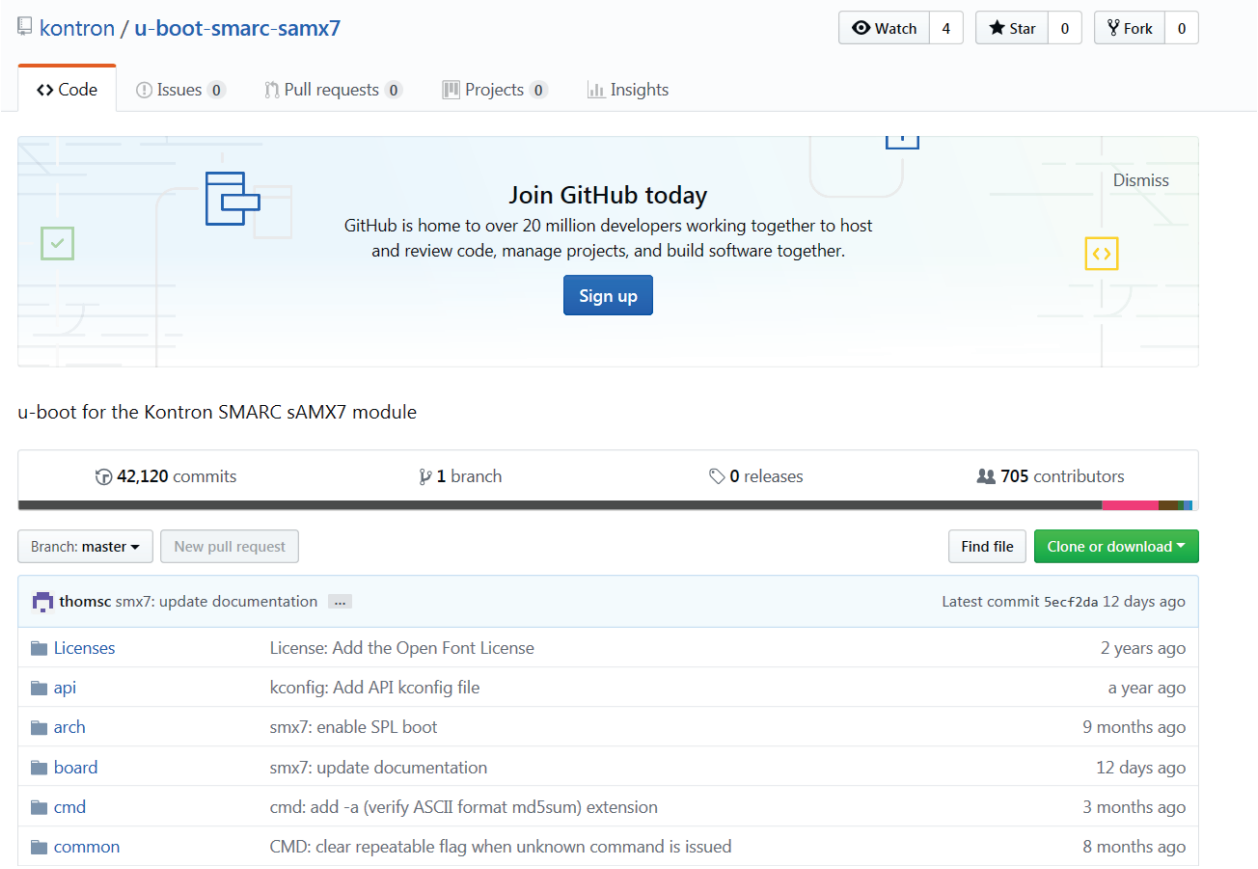
```
=> run updNet
```

It is recommended to use only the update script for bootloader update. This ensures that all necessary installation images are checksum controlled and copied to the appropriate location in QSPI flash.

7.14. U-boot Files for the Kontron SMARC sAMX7 Module on Github.com

You can find the last program code under https://github.com/kontron/u-boot-smarc-samx7.

Figure 9: 7.13. U-boot Files on Github.com



8/ Technical Support

For technical support contact our Support department:

E-mail: support@kontron.com
Phone: +49-821-4086-888

Make sure you have the following information available when you call:

Product ID Number (PN),
Serial Number (SN)

The serial number can be found on the Type Label, located on the product's rear side.

Be ready to explain the nature of your problem to the service technician.

8.1. Warranty

Due to their limited service life, parts that by their nature are subject to a particularly high degree of wear (wearing parts) are excluded from the warranty beyond that provided by law. This applies to the CMOS battery, for example.

If there is a protection label on your product, then the warranty is lost if the product is opened.

8.2. Returning Defective Merchandise

All equipment returned to Kontron must have a Return of Material Authorization (RMA) number assigned exclusively by Kontron. Kontron cannot be held responsible for any loss or damage caused to the equipment received without an RMA number. The buyer accepts responsibility for all freight charges for the return of goods to Kontron's designated facility. Kontron will pay the return freight charges back to the buyer's location in the event that the equipment is repaired or replaced within the stipulated warranty period. Follow these steps before returning any product to Kontron.

1. Visit the RMA Information website:
http://www.kontron.com/support-and-services/support/rma-information

   Download the RMA Request sheet for **Kontron Europe GmbH** and fill out the form. Take care to include a short detailed description of the observed problem or failure and to include the product identification Information (Name of product, Product number and Serial number). If a delivery includes more than one product, fill out the above information in the RMA Request form for each product.

2. Send the completed RMA-Request form to the fax or email address given below at Kontron Europe GmbH. Kontron will provide an RMA-Number.

   Kontron Europe GmbH
   RMA Support
   Phone: +49 (0) 821 4086-0
   Fax: +49 (0) 821 4086 111
   Email: service@kontron.com

3. The goods for repair must be packed properly for shipping, considering shock and ESD protection.

Goods returned to Kontron Europe GmbH in non-proper packaging will be considered as customer caused faults and cannot be accepted as warranty repairs.

4. Include the RMA-Number with the shipping paperwork and send the product to the delivery address provided in the RMA form or received from Kontron RMA Support.

List of Acronyms

CPLD	Complex Programmable Logic Devices
CSI	Camera Serial Interface
DTE	Data Terminal Equipment
DSI	Display Serial Interface
DCE	Data Communications Equipment
eCSPI	enhanced Configurable Synchronous Programmable serial Interface
eCSPI	enhanced Configurable Synchronous Programmable serial Interface
eDP	embedded Display Port
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
eMMC	embedded Multimedia Card
EPDC	Electronic Paper Display Controller
ESD	Electrostatic Discharge
GPIO	General-purpose input/output
HDA	High Definition Audio
HDMI	Integrated High Definition Multimedia Interface
I2S	Inter-IC Sound
KPP	Key Pad Port
LPDDR	Low Power DDR
LVDS	Low Voltage Differential Signalling
MIPI	Mobile Industry Processor Interface
MLC	Multi-level Cell
pSLC	pseudo Single Level Cell
SDIO	Secure Digital Input Output
SMARC	Smart Mobility ARChitecture
SMBus	System Management Bus
SoC	System on Chip
TPM	Trusted Platform Module
UART	Universal Asynchronous Receiver Transmitter

About Kontron – Member of the S&T Group

Kontron is a global leader in Embedded Computing Technology (ECT). As a part of technology group S&T, Kontron offers a combined portfolio of secure hardware, middleware and services for Internet of Things (IoT) and Industry 4.0 applications. With its standard products and tailor-made solutions based on highly reliable state-of-the-art embedded technologies, Kontron provides secure and innovative applications for a variety of industries. As a result, customers benefit from accelerated time-to-market, reduced total cost of ownership, product longevity and the best fully integrated applications overall.

For more information, please visit: **http://www.kontron.com/**

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