SBC

User Manual

SBC-C23

Single Board Computer
with NXP i.MX6SoloX Processor

www.seco.com

REVISION HISTORY

Revision	Date	Note	Ref
1.0	21 March 2019	First Official Release.	SB
1.1	12 March 2020	Update to Rev. C of the PCB microSIM and eSIM paragraph updated (par. 3.3.6) Modem section updated (par. 3.3.15)	SB

Every effort has been made to ensure the accuracy of this manual. However, SECO S.p.A. accepts no responsibility for any inaccuracies, errors or omissions herein. SECO S.p.A. reserves the right to change precise specifications without prior notice to supply the best product possible.

For further information on this module or other SECO products, but also to get the required assistance for any and possible issues, please contact us using the dedicated web form available at http://www.seco.com (registration required).

Our team is ready to assist.

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Chapter 1.
INTRODUCTION

- Warranty
- Information and assistance
- RMA number request
- Safety
- Electrostatic discharges
- RoHS compliance
- Terminology and definitions
- Reference specifications

1.1 Warranty

This product is subject to the Italian Law Decree 24/2002, acting European Directive 1999/44/CE on matters of sale and warranties to consumers.

The warranty on this product lasts for 1 year.

Under the warranty period, the Supplier guarantees the buyer assistance and service for repairing, replacing or credit of the item, at the Supplier's own discretion.

Shipping costs that apply to non-conforming items or items that need replacement are to be paid by the customer.

Items cannot be returned unless previously authorized by the supplier.

The authorization is released after completing the specific form available on the web-site https://www.seco.com/it/support/online-rma.html (RMA Online). The RMA authorization number must be put both on the packaging and on the documents shipped with the items, which must include all the accessories in their original packaging, with no signs of damage to, or tampering with, any returned item.

The error analysis form identifying the fault type must be completed by the customer and has must accompany the returned item.

If any of the above-mentioned requirements for RMA is not satisfied, the item will be shipped back and the customer will have to pay any and all shipping costs.

Following a technical analysis, the supplier will verify if all the requirements, for which a warranty service applies, are met. If the warranty cannot be applied, the Supplier will calculate the minimum cost of this initial analysis on the item and the repair costs. Costs for replaced components will be calculated separately.

Warning!
All changes or modifications to the equipment not explicitly approved by SECO S.p.A. could impair the equipment's functionalities and could void the warranty

1.2 Information and assistance

What do I have to do if the product is faulty?

SECO S.p.A. offers the following services:

- SECO website: visit http://www.seco.com to receive the latest information on the product. In most of the cases it is possible to find useful information to solve the problem.
- SECO Sales Representative: the Sales Rep can help to determine the exact cause of the problem and search for the best solution.
- SECO Help-Desk: contact SECO Technical Assistance. A technician is at disposal to understand the exact origin of the problem and suggest the correct solution.

  E-mail: technical.service@seco.com

  Fax (+39) 0575 350210
- Repair center: it is possible to send the faulty product to the SECO Repair Centre. In this case, follow this procedure:
  - Returned items must be accompanied by an RMA Number. Items sent without the RMA number will be not accepted.
  - Returned items must be shipped in an appropriate package. SECO is not responsible for damages caused by accidental drop, improper usage, or customer neglect.

Note: Please have the following information before asking for technical assistance:

- Name and serial number of the product;
- Description of Customer's peripheral connections;
- Description of Customer's software (operative system, version, application software, etc.);
- A complete description of the problem;
- The exact words of every kind of error message encountered.

1.3 RMA number request

To request an RMA number, please visit SECO's web-site. On the home page, please select "RMA Online" and follow the procedure described.

An RMA Number will be sent within 1 working day (only for on-line RMA requests).

1.4 Safety

The SBC-C23 board uses only extremely-low voltages.

While handling the board, please use extreme caution to avoid any kind of risk or damages to electronic components.

Always switch the power off, and unplug the power supply unit, before handling the board and/or connecting cables or other boards.

Avoid using metallic components - like paper clips, screws and similar - near the board when connected to a power supply, to avoid short circuits due to unwanted contacts with other board components.

If the board has become wet, never connect it to any external power supply unit or battery.

Check carefully that all cables are correctly connected and that they are not damaged.

1.5 Electrostatic discharges

The SBC-C23 board, like any other electronic product, is an electrostatic sensitive device: high voltages caused by static electricity could damage some or all the devices and/or components on-board.

Whenever handling an SBC-C23 board, ground yourself through an anti-static wrist strap. Placement of the board on an anti-static surface is also highly recommended.

1.6 RoHS compliance

The SBC-C23 board is designed using RoHS compliant components and is manufactured on a lead-free production line. It is therefore fully RoHS compliant.

1.7 Terminology and definitions

API	Application Program Interface, a set of commands and functions that can be used by programmers for writing software for specific Operating Systems
CAN Bus	Controller Area network, a protocol designed for in-vehicle communication
DDR	Double Data Rate, a typology of memory devices which transfer data both on the rising and on the falling edge of the clock
DDR3L	DDR, 3rd generation, Low Voltage
GND	Ground
GPI/O	General purpose Input/Output
I2C Bus	Inter-Integrated Circuit Bus, a simple serial bus consisting only of data and clock line, with multi-master capability
LVDS	Low Voltage Differential Signaling, a standard for transferring data at very high speed using inexpensive twisted pairs copper cables, usually used for video applications
MAC	Medium Access Controller, the hardware implementing the Data Link Layer of ISO/OSI-7 model for communication systems
Mbps	Megabits per second
MMC/eMMC	MultiMedia Card / embedded MMC, a type of memory card, having the same interface of SD. The eMMC are the embedded version of the MMC. They are devices that incorporate both the memory controller and the flash memories on a single BGA chip
N.A.	Not Applicable
N.C.	Not Connected
OpenGL	Open Graphics Library, an Open Source API dedicated to 2D and 3D graphics
OpenVG	Open Vector Graphics, an Open Source API dedicated to hardware accelerated 2D vector graphics
OS	Operating System
OTG	On-the-Go, a specification that allows to USB devices to act indifferently as Host or as a Client, depending on the device connected to the port
PHY	Abbreviation of Physical, it is the device implementing the Physical Layer of ISO/OSI-7 model for communication systems
PSU	Power Supply Unit
PWM	Pulse Width Modulation
PWR	Power
RGMII	Reduced Gigabit Media Independent Interface, a particular interface defining the communication between an Ethernet MAC and a PHY
SD	Secure Digital, a memory card type
SM Bus	System Management Bus, a subset of the I2C bus dedicated to communication with devices for system management, like a smart battery and other power supply-related devices

SPI	Serial Peripheral Interface, a 4-Wire synchronous full-duplex serial interface which contemplates a master and one or more slaves, individually enabled through a Chip Select line
TBM	To be measured
TTL	Transistor-transistor Logic
USB	Universal Serial Bus
uSDHC	Ultra Secure Digital Host Controller
V_REF	Voltage reference Pin

1.8 Reference specifications

Here below it is a list of applicable industry specifications and reference documents.

Reference	Link
ACPI	http://www.acpi.info
CAN Bus	http://www.bosch-semiconductors.de/en/ubk_semiconductors/safe/ip_modules/can_literature/can_literature.html
Gigabit Ethernet	http://standards.ieee.org/about/get/802/802.3.html
I2C	http://www.nxp.com/documents/other/UM10204_v5.pdf
LVDS	http://www.ti.com/ww/en/analog/interface/lvds.shtml http://www.ti.com/lit/ml/snla187/snla187.pdf
M.2 Specifications	https://pcisig.com/specifications/pciexpress/M.2_Specification/
MMC/eMMC	http://www.jedec.org/committees/jc-649
OpenGL	http://www.opengl.org
OpenVG	http://www.khronos.org/openvg
PCI Express	http://www.pcisig.com/specifications/pciexpress
SD Card Association	https://www.sdcard.org/home
SM Bus	http://www.smbus.org/specs
USB 2.0 and USB OTG	http://www.usb.org/developers/docs/usb_20_070113.zip
NXP i.MX6 SoloX processor	https://www.nxp.com/products/processors-and-microcontrollers/applications-processors/i.mx-applications-processors/i.mx-6-processors/i.mx-6solox-processors-heterogeneous-processing-with-arm-cortex-a9-and-cortex-m4-cores:i.MX6SX

Chapter 2.
OVERVIEW

- Introduction
- Technical specifications
- Electrical specifications
- Mechanical specifications
- Block diagram

2.1 Introduction

SBC-C23 is a Single Board Computer, measuring just 89.5 x 87 mm (3.52" x 3.43") based on embedded NXP i.MX6SoloX processors, a Single Core ARM® Cortex®-A9 processor, with frequencies up to 1GHz, which is ideal for applications requiring low power consumptions, security features and connectivity, like i.e. IoT applications.

Graphics features of the board are managed directly by NXP i.MX6SoloX processor, which integrate a Vivante GC400T 2D/3D GPU, supporting OpenGL® ES2.0.

The board is completed with up to 1GB DDR3L directly soldered on board, and one eMMC Flash Drive, directly accessible like any standard Drive, with up to 8GB of capacity. Mass storage capabilities are completed by a microSD Card slot.

The two RGMII i.MX6 native interfaces are internally carried to as many Micrel KSZ8091 Ethernet Transceiver, allowing the implementation of up to 10/100 Gigabit Ethernet interfaces (one of them optional).

The communication / networking capabilities of the board are completed by an M.2 Key B Slot, which allows plugging WWAN USB modules, by an M.2 Key E Slot, for the connection of modules with PCI-e interface, by an optional WiFi + BT LE embedded module (Single Band or Dual Band) and by an optional modem soldered on-board (supporting GSM/GPRS, LTE Cat. 1 or LTE Cat. M1 / NB).

The M.2 Key B Slot and the embedded modem can rely on an on-board microSIM slot or e-SIM soldered on-board.

The i.MX6 SoloX offers up to three USB interface. The first USB OTG port is carried out to a USB micro-AB connector, while the second USB port is carried to an USB 2.0 Hub controller, which allows the management of an USB 2-0 Type A port, of two USB 2.0 ports on M.2 Key B and M.2 Key E slots and for the communication with the optional 2G / LTE Cat.1 / LTE Cat. M1/NB1 modem.

The standard functionalities of this board are then completed by two 10-pin expansion connectors, which carry out two PWM ports, an I2C interface, four A/D inputs, an RS-232 port, am RS-485 port and two CAN Bus interfaces.

Please refer to following chapter for a complete list of all peripherals integrated and characteristics. Not all combinations of these features are offered simultaneously; please visit SECO's website for a description of standard configuration modules offered. Configurations different from the standard offered must be evaluated singularly; please contact a SECO's sales representative / distributor for this.

2.2 Technical specifications

Processors

NXP i.MX6SX SoloX, Single ARM® CORTEX®-A9 core processor @ 1GHz + Cortex®-M4 core @ 227MHz

Memory

32-bit soldered down DDR3L memory, up to 1GB

Graphics

Integrated Graphics Vivante GC400T
Dedicated 2D and 3D Hardware accelerator
Supports OpenGL® ES2.0 / 1.1, OpenVG 11.1, DirectFB

Video Interfaces

Optional Single-Channel 18-/24-bit LVDS connector with Touch Screen dedicated signals

Video Resolution

Up to 1366x768 @ 60Hz, 24bpp

Mass Storage

Optional onboard eMMC Disk, up to 8GB *
microSD card slot

Networking

Up to two FastEthernet RJ-45 connectors
Optional WiFi (802.11 b / g / n) +BT LE combo module + antenna on-board
2G, LTE-CatM1 or LTE Cat1 Modem embedded on-board, with up to 3 external antennas
microSIM slot + electronic SIM soldered on-board for the Modem
M.2 Socket 1 Key E 2230 + M.2 Socket 2 Key B 2242 Slot for connectivity

USB

1 x USB 2.0 Type-A socket
1 x USB 2.0 OTG on micro-AB connector

Audio

On-board buzzer

** Please consider that for HDD and Flash Disk manufacturers, 1GB = 10^9 Byte. Some OS (like, for example, Windows) intends 1GB = 1024^3 byte, so global capacity shown for Disk Properties will be less than expected. Please also consider that a portion of disk capacity will be used by internal Flash Controller for Disk management, so final capacity will be lower*

Serial Ports

Expansion connector with:

- 1 x RS-232 port
- 1x RS-485 port
- 2 x CAN port

Other interfaces

3x Multicolor Signalling LEDs
Reset Button
Programmable (*) expansion PCB terminal block with:

- 1x RS-232 port
- 1x RS-485 port
- 2x CAN port
- 4x analog inputs
- I2C
- 2x PWM

(*) Please note that some of these interfaces are factory options, other configurations are made via SW using the pin multiplexing possibilities of the i.MX6SX processor.

Power supply voltage: +12V_{DC}

DC power jack and 2-poles PCB terminal block for voltage supply
Optional Li-Ion Rechargeable battery

Operating temperature: 0°C ÷ +60°C** (commercial version)
-40°C ÷ +85°C** (industrial version)

Dimensions: 89.5 x 153 mm (3.52” x 6.02”).

Supported Operating Systems:

Wind River Linux

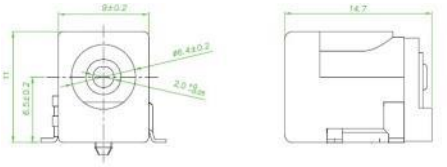
! *** Measured at any point of SECO standard heatspreader for this product, during any and all times (including start-up). Actual temperature will widely depend on application, enclosure and/or environment. Upon customer to consider application-specific cooling solutions for the final system to keep the heatspreader temperature in the range indicated.*

Please also check paragraph 4.1

2.3 Electrical specifications

SBC-C23 needs to be supplied only with an external $12V_{DC}$ ± 10% power supply, with a minimal 20W power rating (SBC-C23 power consumption by itself is around 5W, more power is required for the possible attached devices).

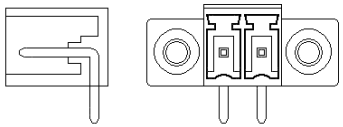
This voltage can be supplied through a standard 6.3mm (internal pin, diameter 2.0 mm) Power Jack. Internal pin is V_{IN} power line. DC mating plug diameter 5.5mmm, internal hole 2.1



Power In Connector – CN76	
Pin	Signal
1	$+12V_{IN}$
2	GND

As an alternative, $+12V_{DC}$ can also be supplied using dedicated PCB Terminal block CN76, which is a Phoenix Connector p/n MC 1,5/ 2-GF-3,81.

Please check Phoenix Connectors' catalogue for the mating plugs suitable for the application needed.



The board can also be supplied by an optional 3.7V 2200mAh rechargeable battery (factory option), which can be an EEMB LIR18650 or a cabled RRC 100587 battery pack (3.6V 2200 mAh) with NTC reading.

2.3.1 RTC Battery

The SBC-C23 board can be equipped with an optional low-power Real Time Clock embedded on the module (which is a NXP PCF2123).

If the board is not equipped with the optional rechargeable battery, then it will be available a soldered horizontal 3V coin cell lithium battery to supply the RTC.

The battery used is a not-rechargeable CR1225 Lithium coin-cell battery, with a nominal capacity of 48mAh.

In case of exhaustion, the battery should only be replaced with devices of the same type. Always check the orientation before inserting and make sure that they are aligned correctly and are not damaged or leaking.

Never allow the batteries to become short-circuited during handling.

! CAUTION: handling batteries incorrectly or replacing with not-approved devices may present a risk of fire or explosion.

Batteries supplied with SBC-C23 are compliant to requirements of European Directive 2006/66/EC regarding batteries and accumulators. When putting out of order SBC-C23, remove the batteries from the board in order to collect and dispose them according to the requirement of the same European Directive above mentioned. Even when replacing the batteries, the disposal has to be made according to these requirements.

2.3.2 Power rails

In all the tables contained in this manual, Power rails are named with the following meaning:

V_{IN}: +12V_{DC} voltage directly coming from the Power Supply connectors CN1 or CN76

3V3_ALW: +3.3V Always voltage, derived from VCC_SW voltage

V_{RTC}: +3V external voltage for supplying the RTC clock

VCC_SW: +5V switched voltage directly derived from V_{IN} voltage

NVCC_3V0: +3.3V switched voltage derived from VCC_SW voltage

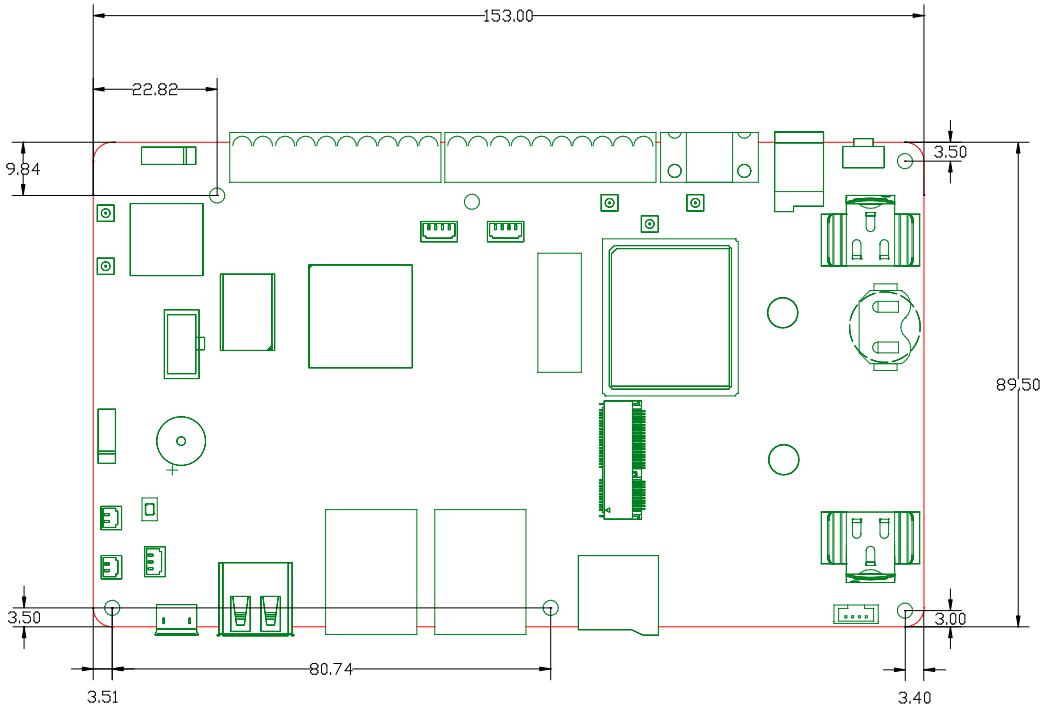
NVCC_1V8: +1.8V Switched voltage generated by the PMIC

SW2_3V0 switched 3.3V voltage, derived by 3V3_ALW Power rail

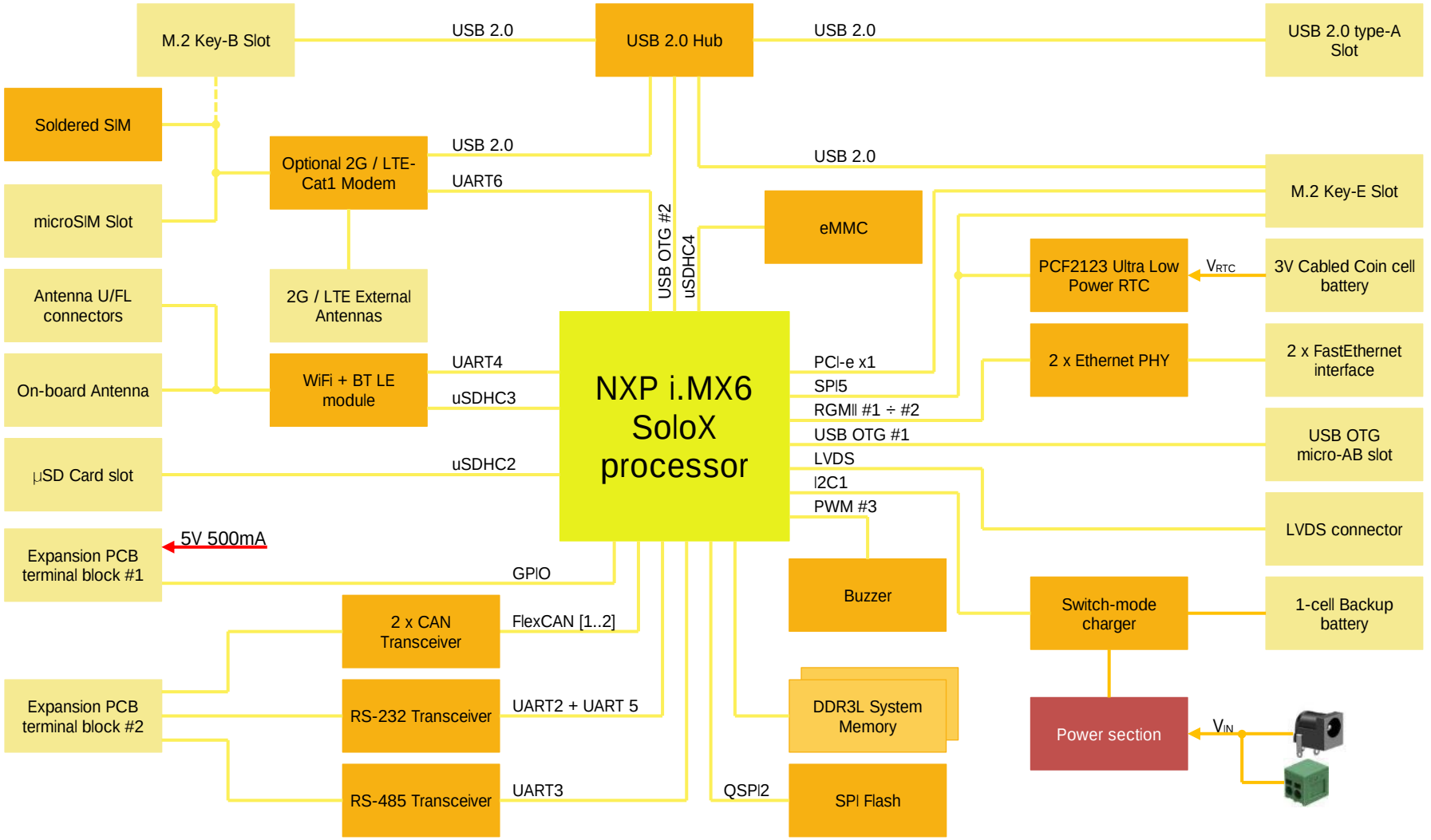
2.4 Mechanical specifications

Board dimensions are 89.5 x 153 mm (3.52” x 6.02”).

The printed circuit of the board is made of ten layers, some of them are ground planes, for disturbance rejection.



2.5 Block diagram



Chapter 3.
CONNECTORS

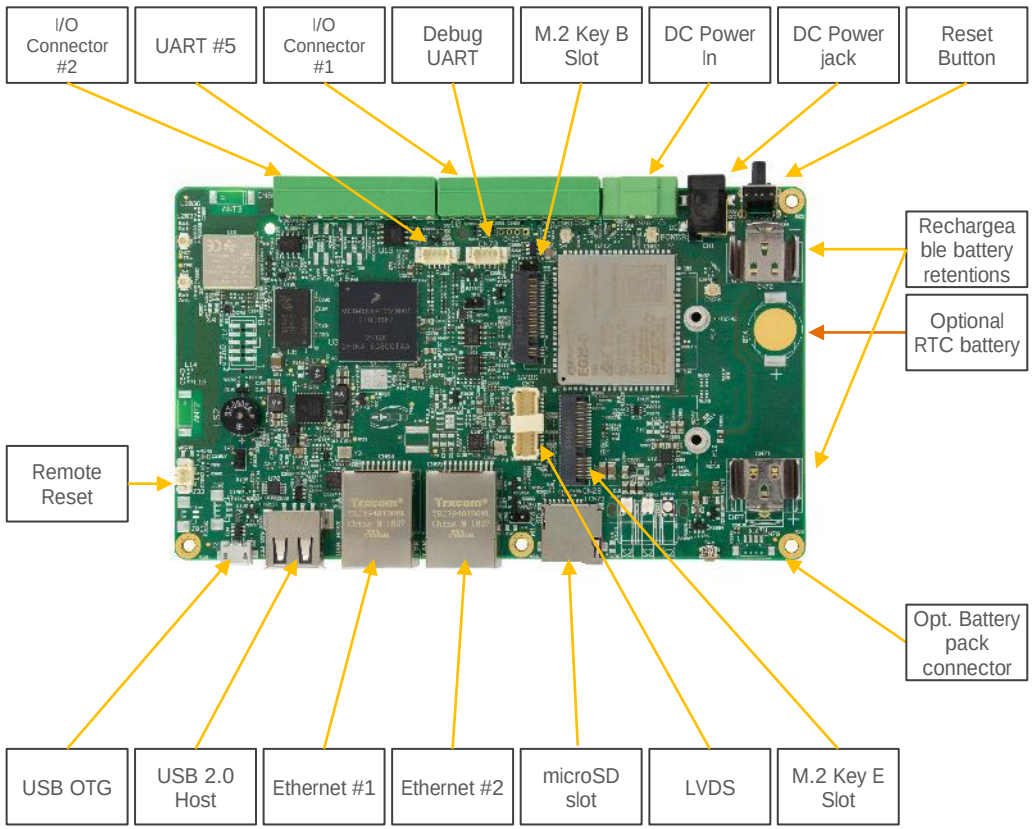
- Introduction
- Connectors overview
- Connectors description

3.1 Introduction

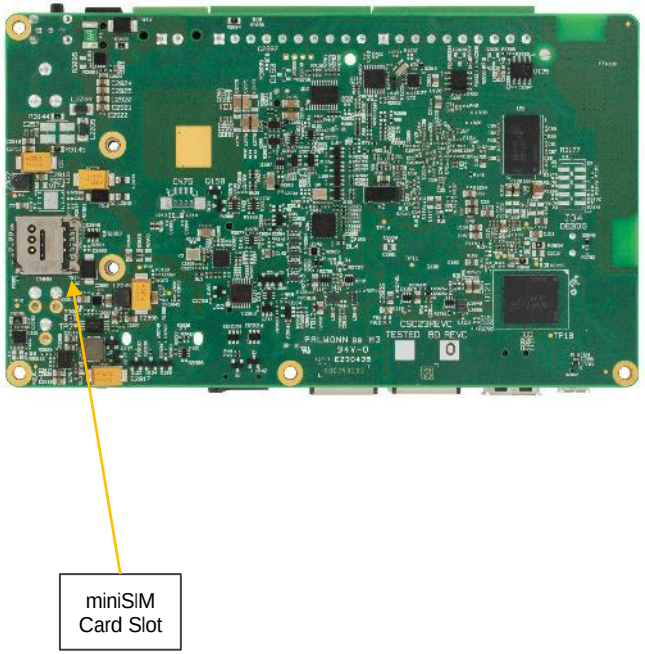
On SBC-C23 board, there are several connectors located on the upper plane. Standard connectors are placed on the same side of PCB, so that it is possible to place them on a panel of an eventual enclosure.

> **!** Please be aware that, depending on the configuration purchased, the appearance of the board can be significantly different from the following pictures.

TOP SIDE



BOTTOM SIDE



3.2 Connectors overview

Name	Description	Name	Description
BT4	Coin Cell battery holder	CN66	microSIM Card Slot
CN1	DC Power Jack	CN69	UART #5
CN3	LVDS	CN70	Debug UART
CN12	M.2 Key B Slot	CN73	microSD Card Slot
CN28	M.2 Key E Slot	CN76	VIN Terminal block
CN59	I/O connector #1	CN79	Battery pack connector
CN60	I/O connector #2	J2	USB OTG micro-AB connector
CN64	Ethernet #1 RJ-45 connector	J3	USB 2.0 Host #1 connector
CN65	Ethernet #2 RJ-45 connector	J33	Remote reset connector

3.2.1 Jumper List

Name	Description	Name	Description
JP6	No Battery	JP8	Boot Selector
JP7	Boot Mode Selector	JP9	SIM Detect

3.3 Connectors description

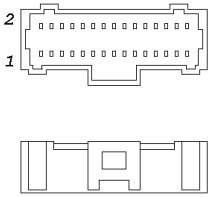
3.3.1 LVDS + backlight connector

SBC-C23 board can be interfaced to LCD displays using its LVDS interface, which allows the connection of displays with a colour depth of 18 or 24 bit, single channel.

LVDS connector - CN3

Pin	Signal	Pin	Signal
1	GND	2	LVDS0_TX0-
3	I2C1_SCL	4	LVDS0_TX0+
5	I2C1_SDA	6	GND
7	GND	8	LVDS0_TX1-
9	$+5V_{LCD}$	10	LVDS0_TX1+
11	$+5V_{LCD}$	12	GND
13	$+3.3V_{LCD}$	14	LVDS0_TX2-
15	$+3.3V_{LCD}$	16	LVDS0_TX2+
17	NVCC_3V0	18	GND
19	LVDS_BLT_EN	20	LVDS0_CLK-
21	TOUCH_INT	22	LVDS0_CLK+
23	TOUCH_RST	24	GND
25	GND	26	LVDS0_TX3-
27	V_{IN}	28	LVDS0_TX3+
29	V_{IN}	30	GND

For the connection, a connector type HR A1014WVB-S-2x15P or equivalent (2 x 15p, male, straight, P1, low profile, polarized) is provided, with the pin-out shown in the table below.



Mating connector: HR A1014H-2X15P with HR A1014-T female crimp terminals.

On the same connectors, are also implemented signals for direct driving of display's backlight: voltages (VIN, $+5V_{LCD}$ and $+3.3V_{LCD}$) and control signals (Backlight enable signal, LVDS_BLT_EN).

V_{IN} voltage, available on pins 27-29, is the Power Voltage that is supplied to the board though DC Jack CN1 or Power in connector CN76 ($+12V_{DC}$ is supported).

$+5V_{LCD}$ is derived from VCC_SW power rail. $+3.3V_{LCD}$ is derived from 3V3_ALW power rail. Both voltages are switched on and off via SW.

When building a cable for connection of LVDS displays, please take care of twist as tight as possible differential pairs' signal wires, in order to reduce EMI interferences. Shielded cables are also recommended. Here following the signals related to LVDS management:

LVDS0_TX0+/LVDS0_TX0-: LVDS Channel #0 differential data pair #0.

LVDS0_TX1+/LVDS0_TX1-: LVDS Channel #0 differential data pair #1.

LVDS0_TX2+/LVDS0_TX2-: LVDS Channel #0 differential data pair #2.

LVDS0_TX3+/LVDS0_TX3-: LVDS Channel #0 differential data pair #3.

LVDS0_CLK+/LVDS0_CLK-: LVDS Channel #0 differential Clock.

LVDS_BLT_EN: NVCC_3V0 electrical level Output with a 10kΩ pull-down resistor, Panel Backlight Enable signal. It can be used to turn On/Off the backlight's lamps of connected LVDS display.

I2C1_SCL: I2C Bus clock line. Bidirectional signal, electrical level NVCC_3V0 with a 10kΩ pull-up resistor. It is managed by i.MX6 processor's I2C1 controller.

I2C1_SDA: I2C Bus data line. Bidirectional signal, electrical level NVCC_3V0 with a 10kΩ pull-up resistor. It is managed by i.MX6 processor's I2C1 controller.

TOUCH_INT: Touch Screen IRQ line, NVCC_3V0 electrical level with a 10kΩ pull-up resistor.

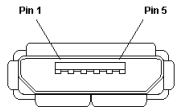
TOUCH_RST: Touch Screen Reset signal, NVCC_3V0 electrical level with a 10kΩ pull-down resistor.

3.3.2 USB ports

The i.MX6 SoloX processor offers two USB 2.0 OTG interfaces

Micro-AB USB connector - J2	
Pin	**Signal**
1	USB_OTG1_VBUS
2	USB_OTG1-
3	USB_OTG1+
4	USB_ID
5	GND

The first USB OTG port is carried out to a standard micro-AB connector, described in the table on the left.



Depending on the needed use of the system, it is necessary to connect micro-A or micro-B USB cables to connector J2.

A micro-A USB cable has to be used when the system has to work in Host mode. In this case, USB_VBUS is a power output of SBC-C23 Board for the connected device.

When a micro-B USB cable is used, its USB_ID pin is floating; this way, the board acknowledges that it must configure itself to work as a Client. In this case, USB_VBUS is an input of the carrier board from the external Host.

Signal description of this port:

USB_OTG1+/USB_OTG1-: USB OTG Port #1 differential pair.

USB_OTG1_VBUS: USB voltage rail. It is an input for USB port working in Client mode, an output for Host mode.

USB_ID: Client/Host identification signal. This signal is high when the USB port works in client mode, is low when works in Host mode. NVCC_3V0 electrical level with a 47KΩ pull-up resistor

The second USB OTG port is used The USB HSIC interface is carried to a Microchip USB2514 USB 2.0 Hub, which makes available four further USB 2.0 Host ports .

USB Host port connector - J3	
Pin	**Signal**
1	USB_OTG2_VBUS
2	USB_DS4-
3	USB_DS4+
4	GND

One of them is carried out to a standard type-A connector, described in the table on the left.

Signal description of this port:

USB_DS4+/USB_DS4-: USB Hub Downstream Port #4 differential pair.

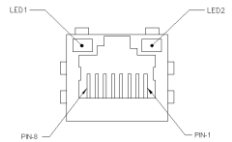
USB_OTG2_VBUS: USB voltage rail, output supply voltage for USB client devices connected to this port.

Common mode chokes are placed on all USB differential pairs for EMI compliance. For ESD protection, on all data and voltage lines are placed clamping diodes for voltage transient suppression.

3.3.3 Ethernet connectors

10/100 Ethernet Port #1 – CN64			
Pin	**Signal**	**Pin**	**Signal**
1	ETH1_Tx+	5	---
2	ETH1_Tx-	6	ETH1_Rx-
3	ETH1_Rx+	7	---
4	---	8	---

10/100 Ethernet Port #2 – CN65			
Pin	**Signal**	**Pin**	**Signal**
1	ETH2_Tx+	5	---
2	ETH2_Tx-	6	ETH2_Rx-
3	ETH2_Rx+	7	---
4	---	8	---



On board, there can be up to two FastEthernet interfaces, made available by as many Micrel KSZ8091RNA 10Base-T/100Base-Tx Ethernet Transceivers interfaced to NXP processor's RGMII interfaces.

Connectors are type TRXCOM p/n TRJ19401BGNL or equivalent, with 2kV decoupling capacitor.

On the connectors there are also two LEDs: LED1 (Left LED, yellow) shows activity on the link (when blinking); LED2 (Right LED, Green) turns on when a 10Mbps or 100Mbps connection has been established.

ETH1_Tx+/ETH1_Tx--: Ethernet Controller #1 Transmit differential pair.

ETH1_Rx+/ETH1_Rx--: Ethernet Controller #1 Receive differential pair.

ETH2_Tx+/ETH2_Tx--: Ethernet Controller #2 Transmit differential pair.

ETH2_Rx+/ETH2_Rx--: Ethernet Controller #2 Receive differential pair.

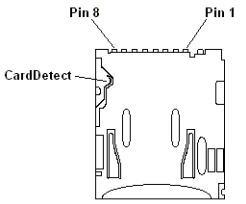
The first Ethernet port is always available, while the second port is a factory option.

3.3.4 µSD card slot

µSD Card Slot – CN73	
Pin	**Signal**
1	SDIO_DAT2
2	SDIO_DAT3
3	SDIO_CMD
4	+3.3V_{SDIO}
5	SDIO_CLK
6	GND
7	SDIO_DAT0
8	SDIO_DAT1
CardDetect	SDIO_CD#

The NXP i.MX6 SoloX processor embeds four Ultra Secured Digital Host controllers (uSDHC), able to support SD / SDIO / MMC Cards.

For this reason, on SBC-C23 board there is also a socket, for the use of standard microSD cards, which can be used as Mass Storage and/or Boot Devices.



The connector is a microSD connector, push-push type, H=2mm, type WELLCO TWF1 or equivalent.

SDIO_CD#: Card Detect Input.

SDIO_CLK: SD Clock Line (output).

SDIO_CMD: Command/Response bidirectional line.

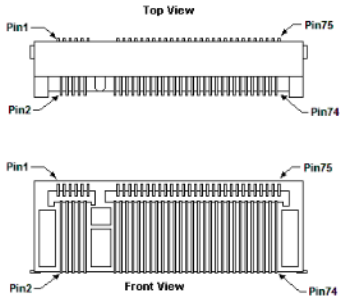
SDIO_DAT[0÷3]: SD Card data bus. SDIO_DAT0 signal is used for all communication modes. SDIO_DAT[1÷3] signals are required for 4-bit communication mode.

+3.3V_{SDIO} voltage is derived from NVCC_3V0 power rail. It can be switched on and off via SW (SDIO_PWR signal, managed using the i.MX6 pad B15).

3.3.5 M.2 WWAN Slot: Socket 2 Key B type 2242

M.2 Key B Slot – CN12			
Pin	**Signal**	**Pin**	**Signal**
1	---	2	+3.3V_ALW
3	GND	4	+3.3V_ALW
5	GND	6	FULL_CARD_PWR_OFF#
7	USB_DS1+	8	---
9	USB_DS1-	10	M2_LED#
11	GND		
		20	---
21	---	22	---
23	---	24	---
25	M2_DPR_1V8	26	W_DISABLE#
27	GND	28	---
29	---	30	USIM_RST
31	---	32	USIM_CLK
33	GND	34	USIM_DATA
35	---	36	USIM_VDD
37	---	38	---
39	GND	40	I2C3_SCL
41	---	42	I2C3_SDA
43	---	44	I2C3_ALERT#
45	GND	46	---
47	---	48	---
49	---	50	---
51	GND	52	---
53	---	54	---
55	---	56	---
57	GND	58	---

The networking capabilities of the SBC-C23 board are completed by an M.2 WWAN Slot, which allow plugging M.2 Socket 2 Key B WWAN Modules with USB 2.0 interface.



The connector used for the M.2 Connectivity slot is CN12, which is a standard 75 pin M.2 Key B connector, type LOTES p/n APCI0087-P001A, H=8.5mm, with the pinout shown in the table on the left.

On the SBC-C23 board there is also a Threaded Spacer which allows the placement of M.2 Socket 2 Key B SSD modules in 2242 size.

Here following the signals available on this slot:

USB_DS1+/USB_DS1-: USB Hub Downstream Port #1 differential pair.

FULL_CARD_POWER_OFF#: Power Off signal for plugged modules, usually used in battery-powered systems, 100kΩ pull-up @ NVCC_3V0. Managed through i.MX6SX pin RGMII1_RD2.

W_DISABLE#: M.2 module disable signal, 100kΩ pull-up @ NVCC_1V8 active low output. Managed through i.MX6SX pin RGMII1_RD3

UIM_RST: Reset signal line, sent from M.2 Connectivity card to the SIM Card Slot or eSIM onboard (depending on the module's configuration).

UIM_DATA: Bidirectional Data line between M.2 Connectivity card and the SIM Card Slot or eSIM onboard (depending on the module's configuration)..

UIM_CLK: Clock line, output from M.2 Connectivity card to the SIM Card Slot or eSIM onboard (depending on the module's configuration)..

UIM_VDD: Power line for the SIM Card Slot or eSIM onboard (depending on the module's configuration).

M2_LED#: Active Low signal, can be used by the module to drive a Green LED available on C23 board, specific for M.2 Key B Slot functionalities.

M2_DPR_1V8: M.2 Dynamic Power Reduction Output, NVCC_1V8 signal directly managed through i.MX6SX pin KEY_COL1

59	---	60	---
61	---	62	---
63	---	64	---
65	---	66	SIM_DETECT
67	M2_RST	68	---
69	---	70	+3.3V_ALW
71	GND	72	+3.3V_ALW
73	GND	74	+3.3V_ALW
75	---		

M2_RST: Reset Signal that is sent from the processor module plugged in CN12 slot NVCC_1V8 signal directly managed through i.MX6SX pin RGMII2_TXC.

SIM_DETECT: Sim Detect output, sent to the WWAN module to signal insertion or removal of the SIM in the slot. NVCC_1V8 signal managed also through i.MX6SX pin RGMII1_TD3.

This pin can also be forced to be low through the jumper JP9

I2C3_SCL: I2C Bus clock line. Bidirectional signal, electrical level NVCC_1V8 with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C3 controller.

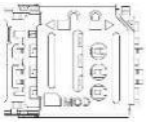
I2C3_SDA: I2C Bus data line. Bidirectional signal, electrical level NVCC_1V8 with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C1 controller.

I2C3_ALERT#: I2C Bus Alert Line. NVCC_1V8 signal directly managed through i.MX6SX pin RGMII1_TXC.

3.3.6 Optional microSIM Card Slot and eSIM

microSIM Slot – CN66			
Pin	**Signal**	**Pin**	**Signal**
1	UIM_VDD	5	GND
2	UIM_RST	6	---
3	UIM_CLK	7	UIM_DATA
4	---	8	---

As a factory option, interfaced to the M.2 WWAN slot CN12 or to the embedded modem described at par. 3.3.14, there can be a microSIM Card Slot.



With this slot it is possible to use the microSIM card provided by any telecommunication operator for the connection to their network, using the modem module plugged in M.2 Slot CN12 or the embedded on-board modem.

The socket is type MOLEX. p/n 78800-0001or equivalent, with the pinout shown in the table on the left.

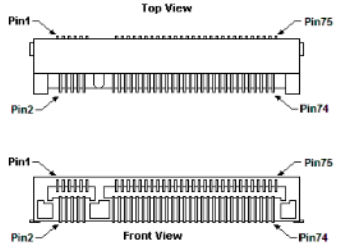
Another factory option includes an electronic SIM soldered on-board. Depending on the factory option purchased, on the board there can be the microSIM Card slot, the e-SIM or both.

Here following the factory possibilities for microSIM slot and eSIM:

- microSIM Slot connected to the onboard module
- eSIM connected to the onboard module
- microSIM Slot connected to the M.2 slot
- eSIM connected to the M.2 slot
- microSIM Slot + eSIM connected to the onboard module

3.3.7 M.2 Connectivity Slot: Key E Socket 1

M.2 Connectivity Slot: Socket 1 Key E type 2230 – CN28			
Pin	**Signal**	**Pin**	**Signal**
1	GND	2	+3.3V_ALW
3	USB_DS3+	4	+3.3V_ALW
5	USB_DS3-	6	LED#
7	GND	8	---
9	---	10	---
11	---	12	---
13	---	14	---
15	---	16	---
17	---	18	GND
19	---	20	---
21	---	22	---
23	---		
		32	---
33	GND	34	---
35	PCIe_Tx+	36	---
37	PCIe_Tx-	38	SPI_CLK
39	GND	40	SPI_MOSI
41	PCIe_Rx+	42	SPI_MISO
43	PCIe_Rx-	44	---
45	GND	46	---
47	PCIe_CLK+	48	---
49	PCIe_CLK-	50	SUS_CLK
51	GND	52	PCIe_RST
53	PCIe_REQ#	54	W_DISABLE2#
55	PCIe_WAKE#	56	W_DISABLE1#
57	GND	58	I2C3_SDA



It is possible to increase the connectivity of the SBC-C23 board by using M.2 Socket 1 Key E connectivity slot.

The connector used for the M.2 Connectivity slot is CN28, which is a standard 75 pin M.2 Key E connector, type LOTES p/n APCI0076-P001A, H=4.2mm, with the pinout shown in the table on the left.

On the SBC-C23 board there is also a threaded Spacer which allows the placement of M.2 Socket 1 Key E connectivity modules in 2230 size.

Here following the signals related to this connectivity interface:

USB_DS3+/USB_DS3-: USB Hub Downstream Port #3 differential pair.

PCIe_TX+/PCIe_TX-: PCI Express port #4, Transmitting Output Differential pair

PCIe_RX+/PCIe_RX-: PCI Express port #4, Receiving Input Differential pair

PCIe_CLK+ / PCIe_CLK-: PCI Express Reference Clock, Differential Pair

PCIe_WAKE#: Board's Wake Input, NVCC_3V0 electrical level with a 10kΩ pull-up resistor. It must be externally driven by the Connectivity module inserted in the slot when it requires waking up the system.

PCIe_RST: Reset Signal that is sent from the processor to the PCI-e devices available on the connectivity module. It is a NVCC_3V0 electrical level active-high signal.

PCIe_REQ#: PCI Express Clock Request Input, active low signal, NVCC_3V0 electrical level with a 10kΩ pull-up resistor. This signal shall be driven low by any module inserted in the connectivity slot, in order to ensure that the SoC makes available the reference clock.

W_DISABLE1#: Wireless module functionality disable signal #1, active low signal, NVCC_3V0 electrical level with a 10kΩ pull-up resistor.

W_DISABLE2#; Wireless module functionality disable signal #1, active low signal, NVCC_3V0 electrical level with a 10kΩ pull-up resistor.

SUS_CLK: 32.768kHz Clock provided by the SBC-C23 board to the module plugged in the slot CN28. NVCC_3V0 electrical level.

59	---	60	I2C3_SCL
61	---	62	I2C3_ALERT_1#
63	GND	64	---
65	---	66	---
67	---	68	---
69	GND	70	---
71	---	72	+3.3V_ALW
73	---	74	+3.3V_ALW
75	GND		

I2C3_SCL: I2C Bus clock line. Bidirectional signal, electrical level NVCC_1V8 with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C3 controller.

I2C3_SDA: I2C Bus data line. Bidirectional signal, electrical level NVCC_1V8 with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C1 controller.

I2C3_ALERT_1#: I2C Bus Alert Line. NVCC_1V8 signal with a 100kΩ pull-up resistor directly managed through i.MX6SX pin RGMII1_TD2.

LED#: Active Low signal, can be used by the module to drive a Red LED available on C23 board, specific for M.2 Key B Slot functionalities.

SPI_CLK: SPI bus Clock Signal, NVCC_3V0 signal, managed by i.MX6Sx ECSPI controller #5 (pin QSPIB_SS1_B)

SPI_MISO: SPI bus Master In Slave Out Data signal, NVCC_3V0 signal, managed by i.MX6Sx ECSPI controller #5 (pin QSPIA_SS1_B)

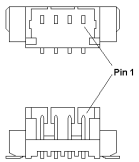
SPI_MOSI: SPI bus Master Out Slave In Data signal, NVCC_3V0 signal, managed by i.MX6Sx ECSPI controller #5 (pin QSPIA_DQS)

3.3.8 Debug UART Connector

Debug UART Connector – CN70	
Pin	**Signal**
1	SW2_3V0
2	UART1_RXD
3	UART1_TXD
4	GND

Onboard, connector CN70 carries out signals related to UART #1 interface at TTL Level. This interface can be used for the debugging of the processor.

For this purpose, a dedicated 4-pin Connector, Type MOLEX p/n 53398-0471 or equivalent is provided. Mating connector: MOLEX 51021-0400 receptacle with MOLEX 50079-8000 female crimp terminals.



UART1_RXD: UART #1 Receive data signal, electrical level NVCC_3V0.

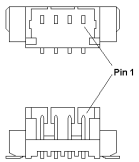
UART1_TXD: UART #1 Transmit data signal, electrical level NVCC_3V0

3.3.9 UART #5 Connector

UART #5 Connector – CN69	
Pin	**Signal**
1	SW2_3V0
2	UART5_RXD
3	UART5_TXD
4	GND

Onboard, connector CN69 carries out signals related to UART #5 interface at TTL Level.

For this purpose, a dedicated 4-pin Connector, Type MOLEX p/n 53398-0471 or equivalent is provided. Mating connector: MOLEX 51021-0400 receptacle with MOLEX 50079-8000 female crimp terminals.



UART5_RXD: UART #5 Receive data signal, electrical level NVCC_3V0.

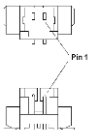
UART5_TXD: UART #5 Transmit data signal, electrical level NVCC_3V0

3.3.10 Factory reset button connector

Factory reset button connector – J33	
Pin	**Signal**
1	Factory_RST#
2	GND

To allow the integration of a SBC-C23 based system inside a box PC-like, there is an optional connector on the carrier board that allows to remote signals for Factory reset.

The dedicated connector is a 2-pin male connector, type MOLEX p/n 53398-0271 or equivalent, with pinout shown in the table on the left.



Mating connector: MOLEX 51021-0200 crimp housing with MOLEX 50079-8000 crimp terminals.

Signals Description:

Factory_RST#: Reset switch input signal. This signal has to be connected to an external momentary pushbutton (contacts normally open). When the pushbutton is pressed (i.e., the signal is connected to GND), the pulse of Reset signal will cause the reset of the board.

Please be aware that the factory reset input signal is also managed directly on the carrier board by the pushbutton SW2, so it is not mandatory to connect them externally using J33.

3.3.11 Boot Mode Selection jumper JP7

The onboard 2-way jumper JP7 can be used to select boot mode for the SBC-C23 module.

When the jumper is inserted, then the processor will search for the USB OTG connection to be established, in order to download a program image to the chip.

When the jumper is not inserted, the processor will continue to execute the boot code from the internal boot ROM.

3.3.12 Boot Selection jumper JP8

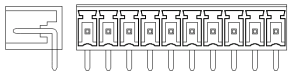
The on-board 2-way jumper JP8 can be used to select boot source for the SBC-C23 module.

When the jumper is inserted, then the boot will be performed from the uSD Card, otherwise, if the jumper is not placed, the boot will be performed from the internal eMMC.

3.3.13 Expansion connectors

Expansion Connector #1 – CN59	
Pin	**Signal**
1	VCC_OUT_5V
2	GND_I/O
3	PWM_6_5V
4	PWM_5_5V
5	I2C2_SDA_5V
6	I2C2_SCL_5V
7	ADC_0
8	ADC_1
9	ADC_2
10	ADC_3

Expansion Connector #2 – CN60	
Pin	**Signal**
1	RS_232_TX
2	RS_232_RX
3	RS_232_RTS
4	RS_232_CTS
5	CAN1_H
6	CAN1_L
7	CAN2_H
8	CAN2_L
9	RS485_D+
10	RS485_D-



The SBC-C23 board offers the possibility of expanding its functionalities by using some additional interfaces, available on two dedicated 10-pin PCB terminal blocks, CN59 and CN60, type EUROCLAMP p/n PV08-3,81-H-P or equivalent.

The pinout of these connectors are shown in the tables on the left .

PWM_6_5V: PWM Output signal, electrical level VCC_SW with 2k2Ω pull-up resistor. It is managed by i.MX6SX pin RGMII2_TD2.

PWM_5_5V: PWM Output signal, electrical level VCC_SW with 2k2Ω pull-up resistor. It is managed by i.MX6SX pin RGMII2_TD3.

I2C2_SDA_5V: I2C Bus data line. Bidirectional signal, electrical level VCC_SW with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C controller #2 (pin GPIO_3)

I2C2_SCL_5V: I2C Bus clock line. Output signal, electrical level VCC_SW with a 2k2Ω pull-up resistor. It is managed by i.MX6 processor's I2C controller #2 (pin GPIO_2)

ADC_[0..3]: i.MX6SX processor's A/D converter Channel 1, inputs #0 .. #3 (signals accepted in the range [0..+3.3V]).

RS_232_TX: i.MX6SX UART #2 transmit data signal, RS-232 electrical level. It is managed by i.MX6SX pin GPIO_IO06

RS_232_RX: i.MX6SX UART #2 Receive data signal, RS-232 electrical level. It is managed by i.MX6SX pin GPIO_IO07

RS_232_RTS: i.MX6SX UART #2 Request to Send signal, RS-232 electrical level. It is managed by i.MX6SX pin SD1_DATA3

RS_232_CTS: i.MX6SX UART #2 Clear to Send signal, RS-232 electrical level. It is managed by i.MX6SX pin SD1_DATA2

CAN ports: they are managed using as many NXP TJA1051T High Speed CAN Transceivers. The i.MX6SX CAN port #1 is available on pins SD3_DATA7 and SD3_DATA5, while CAN port #2 is available on pins SD3_DATA6 and SD3_DATA4

CAN1_H: High-Level CAN bus line, port #1.

CAN1_L: Low-Level CAN bus line, port #1.

CAN2_H: High-Level CAN bus line, port #2.

CAN2_L: Low-Level CAN bus line, port #2.

RS485_D+/RS485_D-: : RS-485 port, differential pair. It is managed using i.MX6SX UART Port #3, available on pins QSPIB_SCLK, QSPIB_SS0_B and QSPIB_DATA0 (CTS signal, necessary to manage the direction of RS-485 port)

VCC_OUT_5V: 5V switched voltage for I/Os, max 500mA, derived from VCC_SW voltage.

3.3.14 On-board optional modems

The SC23 board can be equipped with one embedded modem module (optional). The module is a QUECTEL EG25-G LTE Cat.4 modem, supporting LTE FDD B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B28, LTE-TDD B38/B39/B40/B41, WCDMA B1/B2/B4/B5/B6/B8/B19 and GSM B2/B3/B5/B8, for Global Use.

When the modem module onboard is mounted, then there will be also three U/FL connectors (type HIROSE U.FL-R-SMT1(10))for external antennas, more specifically CN61, CN62 and CN74.

CN61 is the main antenna connector for LTE

CN74 is the antenna connector for Diversity receive feature.

CN62 is the antenna connector that must be used for GNSS feature. By default, the SBC-C23 board is configured to use passive antennas. It can be optionally configured (factory configuration), however, for providing power supply for active antennas.

The modem can then be paired to the microSIM slot CN66 or to the eSIM onboard.

3.3.15 On-board WiFi + BT Modules

The SC23 board is equipped with one WiFi + BT LE embedded module. It is possible to choose between two different modules, listed below:

- Ti WL1831MOD Single-Band module, WLAN 2.4GHz SISO + BT LE
- Ti WL1837MOD Dual Band module, WLAN 2.4GHz SISO/MIMO/MRC + WLAN 5.0GHz + BT LE

Depending on the module mounted, on-board there will be also up to two PCB antennas or U/FL connectors (type HIROSE U.FL-R-SMT1(10))for external antennas, more specifically:

- WL1831MOD module will mount only one PCB antenna or U.FL connector (CN4)
- WL1837MOD module will mount two PCB antennas or U.FL connectors (CN4 primary antenna, CN27 secondary antenna)

Chapter 4.
APPENDICES

- Thermal Design

4.1 Thermal Design

Highly integrated systems, like the SBC-C23 board, offer the user excellent performance in a much reduced space, therefore allowing the system's minimization. On the other hand, the miniaturizing of IC's and the increase of clock frequencies of the processors lead to the generation of a big amount of heat that must be dissipated to prevent critical operating conditions, system hang-off or failures.

It is extremely important to note that, for this reason, a critical design parameter always to be kept in very high consideration is the thermal design and analysis of the final assembled system. It is necessary to carefully consider the heat generated by the module in the final assembled system and the application.

The customer must always ensure that the heatspreader/heatsink surface temperature remain within the declared operating temperature range at any point of the cooling element.

Please always keep in mind that heavy computational tasks will generate much heat, on all versions of the processor.

Therefore, it is always necessary that the customer studies and develops a specifically tailored cooling solution for the final system by evaluating processor's workload, application environment, system enclosure, air flow and so on.

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